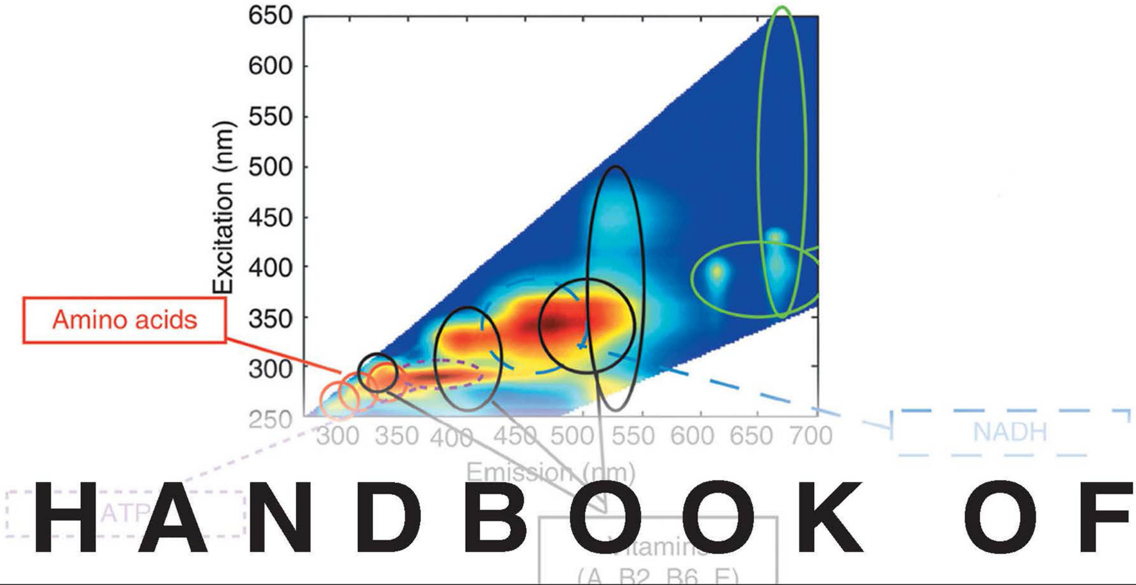

HANDBOOK OF Seafood and Seafood Products Analysis

SECOND EDITION

Edited by
FIDEL TOLDRÁ and
LEO M.L. NOLLET

CRC Press
Taylor & Francis Group

Handbook of Seafood and Seafood Products Analysis

Seafood and seafood products represent some of the most important foods in almost all types of societies around the world. More intensive production of fish and shellfish to meet high demand has raised some concerns related to the nutritional and sensory qualities of these cultured fish in comparison to their wild-catch counterparts. In addition, the variety in processing, preservation, and storage methods from traditional to modern is contributing to an increase in variability in consumer products.

This second edition of the *Handbook of Seafood and Seafood Products Analysis* brings together the work of 109 experts who focus on the most recent research and development trends in analytical techniques and methodologies for the analysis of captured fresh and preserved seafood, either cultivated or wild, as well as for derived products. After providing a general introduction, this handbook provides 48 chapters distributed in six sections:

- *Chemistry and biochemistry* focuses on the analysis of main chemical and biochemical compounds of seafood.
- *Processing control* describes the analysis of technological quality and the use of some non-destructive techniques as well as methods to check freshness, detection of species, and geographic origin and to evaluate smoke flavoring.
- *Nutritional quality* deals with the analysis of nutrients in seafood such as essential amino acids, bioactive peptides, antioxidants, vitamins, minerals and trace elements, and fatty acids.
- *Sensory quality* covers the sensory quality and main analytical tools to determine color, texture, flavor and off-flavor, quality index methods as well as sensory descriptors, sensory aspects of heat-treated seafood, and sensory perception.
- *Biological Safety* looks at tools for the detection of spoilage, pathogens, parasites, viruses, marine toxins, antibiotics, and GM ingredients.
- *Chemical Safety* focuses on the identification of fish species, detection of adulterations, veterinary drug residues, irradiation, food contact materials, and chemical toxic compounds from the environment, generated during processing or intentionally added.

Key Features:

- This comprehensive handbook provides a full overview of the tools now available for the analysis of captured fresh and preserved seafood, either cultivated or wild, as well as for derived products.
- This is a comprehensive and informative book that presents both the merits and limitations of analytical techniques and also gives future developments for guaranteeing the quality of seafood and seafood products.
- This cutting-edge work covers processes used from all of the seven seas to ensure that consumers find safe, nutritionally beneficial, and appealing seafood products at their markets and restaurants.
- This handbook covers the main types of worldwide available analytical techniques and methodologies for the analysis of seafood and seafood products.

Handbook of Seafood and Seafood Products Analysis

Second Edition

Edited by
Fidel Toldrá and Leo M.L. Nollet

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

Cover credit: ©Shutterstock

Second edition published 2024
by CRC Press
2385 NW Executive Center Drive, Suite 320, Boca Raton FL 33431

and by CRC Press
4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

CRC Press is an imprint of Taylor & Francis Group, LLC

First edition published by CRC Press 2009

ISBN: 9781032266787 (hbk)
ISBN: 9781003289401 (ebk)

DOI: 10.1201/9781003289401

Typeset in Times
by codeMantra

Contents

PART 4 Sensory Quality

PART 5 Biological Safety

PART 6 Chemical Safety

Preface

There is a large number of seafood and seafood products. These foods represent some of the most important foods in almost all type of societies, including those in developed countries and developing countries.

Intensive production of fish and shellfish has raised some concerns, some of them are related with the nutritional and sensory quality of the cultured fish in comparison to their wild catch counterpart. In addition, there is a large number of processing and preservation technologies, from traditional drying or curing to high-pressure processing and different methods of storage. This increasing variability in products attending the consumers´ demands makes necessary the use of adequate analytical methodologies focusing on the chemistry and biochemistry of post-mortem seafood, the technological, nutritional, and sensory quality, as well as safety aspects related to processing and preservation, all of them presented in this book.

The first edition of the *Handbook of Seafood and Seafood Products Analysis* was published in 2010 and contained the main analytical techniques and methodologies and their applications. It presented a comprehensive review both in its detailing of analytical methods and its application to the compounds involved in sensory, nutritional, and technological quality as well as safety of seafood and seafood products, and its aims were to compile the top analysis techniques and methodologies from around the world into one, well-organized volume and to serve as an essential reference source to undergraduate and postgraduate students, researchers, and analysts in universities, research institutions, government agencies, and private companies. This will continue to be the purpose of this second edition.

This second edition of the *Handbook of Seafood and Seafood Products Analysis* is bringing the most recent research and development trends in analytical techniques and methodologies. All chapters have been thoroughly revised and updated, some of them entirely renovated by different authors, and there are four new additional chapters covering the analytical techniques and methodologies for determining activity of endogenous enzymes, bioactive peptides, sensory perception of seafood, and detection of microplastics.

The new edition of this book contains 48 chapters distributed in six parts: Part 1.- Chemistry and biochemistry (Chapters 1–8) focused on the analysis of main chemical and biochemical compounds of seafood; Part 2.- Processing Control (Chapters 9–13) describes the analysis of technological quality and the use of some non-destructive techniques as well as methods to check freshness, detection of species and geographic origin, and evaluation of smoke flavorings; Part 3.- Nutritional quality (Chapters 14–20) deals with the analysis of nutrients in seafood such as essential amino acids, bioactive peptides, antioxidants, vitamins, minerals and trace elements, and fatty acids; Part 4.- Sensory quality (Chapters 21–27) is related to the sensory quality and main analytical tools to determine color, texture, flavor and off-flavor, quality index methods, as well as sensory descriptors, sensory aspects of heat-treated seafood, and sensory perception; Part 5.- Biological Safety (Chapters 28–36) is devoted to analytical tools for the detection of spoilage, pathogens, parasites, viruses, marine toxins, antibiotics, and GM ingredients; and, finally, Part 6.- Chemical Safety (Chapters 37–48) is focused on the identification of fish species, detection of adulterations, veterinary drug residues, irradiation, food contact materials, and chemical toxic compounds from the environment, generated during processing, or intentionally added, which can be found in seafood either cultured or wild catched.

This second edition provides a complete overview of the analytical tools available for all kinds of analyses of seafood and seafood products; the roles of these techniques and the methodologies for the analysis of technological, nutritional, and sensory quality as well as of safety aspects. In summary, readers find in this handbook the main types of worldwide available analytical techniques and methodologies for the analysis of seafood and seafood products.

The editors wish to thank all contributors for their excellent jobs and outstanding quality of the delivered manuscripts. Their work and achievements are really appreciated. The editors also wish to thank the production staff at CRC Press for their dedication and making this book possible.

Fidel Toldrá & Leo Nollet
Editors

About the Editors

Fidel Toldrá, Ph.D. in Chemistry (University of Valencia, 1984) and Research Professor at the Department of Food Science, Instituto de Agroquímica y Tecnología de Alimentos (CSIC). He serves as Editor-in-Chief of *Trends in Food Science & Technology* (Elsevier), Associate Editor of *Meat Science* (Elsevier) and Editor of the book series *Advances in Food & Nutrition Research* (Academic Press/Elsevier). He has acted as Editor or Associate Editor of >50 books, being Editor with Leo Nollet of numerous books for CRC Press including the *Handbook of Analysis of Active Compounds in Functional Foods (2012),* the third editions of *Food Analysis by HPLC* (2013) and *Handbook of Food Analysis* (2015), and second edition of *Handbook of Dairy Foods Analysis* (2022). Prof. Toldrá was the Editor of the ninth edition of *Lawrie's Meat Science* (2022, Elsevier) and one of the Editors-in-Chief of the *Encyclopedia of Food & Health* (Academic Press/Elsevier).

Prof. Toldrá serves at the Editorial Board of 15 journals including *Food Chemistry*, *Current Opinion in Food Science* and *Journal of Food Engineering.* He has published >360 research articles (*h* index = 74) and >163 chapters of books, and edited/coedited >62 books. He is a Fellow of the Institute of Food Technologists (IFT), Fellow of the International Academy of Food Science & Technology (IAFOST), Fellow of the Agricultural and Food Chemistry Division of the American Chemical Society (AGFD-ACS) , and Fellow of the International Association of Advanced Materials (IAAM). He received, among others, the 2002 IMS International Prize for Meat Science and Technology, 2010 Distinguished Research Award, 2014 Meat Processing Award, and 2023 International Lectureship award, all three from the American Meat Science Association (AMSA), 2015 Dupont Science Award, the 2019 Innovation Award from the Association of Spanish Meat Industry, and the 2019 Award for Advancement of Application of Agricultural and Food Chemistry from the American Chemical Society (ACS).

Leo M. L. Nollet earned an MS (1973) and PhD (1978) in biology from the Katholieke Universiteit Leuven, Belgium. He is an editor and associate editor of numerous books. He edited for M. Dekker, New York—now CRC Press of Taylor & Francis Publishing Group—the first, second, and third editions of *Food Analysis by HPLC* and *Handbook of Food Analysis*. The last edition is a two-volume book. Dr. Nollet also edited the *Handbook of Water Analysis* (first, second, and third editions) and *Chromatographic Analysis of the Environment*, third and fourth editions (CRC Press). With Fidel Toldrá, he coedited two books published in 2006, 2007, and 2017: *Advanced Technologies for Meat Processing* (CRC Press) and *Advances in Food Diagnostics* (Blackwell Publishing—now Wiley). With M. Poschl, he coedited the book *Radionuclide Concentrations in Foods and the Environment*, also published in 2006 (CRC Press). Dr. Nollet has also coedited with Y. H. Hui and other colleagues on several books: *Handbook of Food Product Manufacturing* (Wiley, 2007), *Handbook of Food Science, Technology, and Engineering* (CRC Press, 2005), *Food Biochemistry and Food Processing* (first and second editions; Blackwell Publishing—now Wiley—2006 and 2012), and the *Handbook of Fruits and Vegetable Flavors* (Wiley, 2010). In addition, he edited the *Handbook of Meat, Poultry, and Seafood Quality*, first and second editions (Blackwell Publishing—now Wiley—2007 and 2012). From 2008 to 2011, he published five volumes on animal product-related books with Fidel Toldrá: *Handbook of Muscle Foods Analysis*, *Handbook of Processed Meats and Poultry Analysis*, *Handbook of Seafood and Seafood Products Analysis*, *Handbook of Dairy Foods Analysis* (second edition in 2021), and *Handbook of Analysis of Edible Animal By-Products*. Also, in 2011, with Fidel Toldrá, he coedited two volumes for CRC Press: *Safety Analysis of Foods of Animal Origin* and *Sensory Analysis of Foods of Animal Origin*. In 2012, they published the *Handbook of Analysis of Active Compounds in Functional Foods*. In a coedition with Hamir Rathore, *Handbook of Pesticides: Methods of Pesticides Residues Analysis* was marketed in 2009; *Pesticides: Evaluation of Environmental Pollution* in 2012; *Biopesticides Handbook* in 2015; and *Green Pesticides Handbook: Essential Oils for Pest Control* in 2017. Other finished book projects include *Food Allergens: Analysis, Instrumentation, and Methods* (with A. van Hengel; CRC Press, 2011) and *Analysis of Endocrine Compounds in Food* (Wiley-Blackwell, 2011). Dr. Nollet's recent projects include *Proteomics in Foods* with Fidel Toldrá (Springer, 2013) and *Transformation Products of Emerging Contaminants in the Environment: Analysis, Processes, Occurrence, Effects, and Risks* with D. Lambropoulou (Wiley, 2014). In the series, Food Analysis & Properties, he edited (with C. Ruiz-Capillas) *Flow Injection Analysis of Food Additives* (CRC Press, 2015) and *Marine Microorganisms: Extraction and Analysis of Bioactive Compounds* (CRC Press, 2016). With A.S. Franca, he coedited *Spectroscopic Methods in Food Analysis* (CRC Press, 2017), and with Horacio Heinzen and Amadeo R. Fernandez-Alba he coedited *Multiresidue Methods for the Analysis of Pesticide Residues in Food* (CRC Press, 2017). Further volumes in the series Food Analysis & Properties are *Phenolic Compounds in Food: Characterization and Analysis* (with Janet Alejandra Gutierrez-Uribe, 2018), *Testing and Analysis of GMO-containing Foods and Feed* (with Salah E. O. Mahgoub, 2018), *Fingerprinting Techniques in Food Authentication and Traceability* (with K. S. Siddiqi, 2018), *Hyperspectral Imaging Analysis and Applications for Food Quality* (with N.C. Basantia, Leo M.L. Nollet, Mohammed Kamruzzaman, 2018), *Ambient Mass Spectroscopy Techniques in Food and the Environment* (with Basil K. Munjanja, 2019), *Food Aroma Evolution: During Food Processing, Cooking, and Aging* (with M. Bordiga, 2019), *Mass Spectrometry Imaging in Food Analysis* (2020), *Proteomics in Food Authentication* (with S. Ötleş, 2020), *Analysis of Nanoplastics and Microplastics in Food* (with K.S. Siddiqi, 2020), *Chiral Organic Pollutants, Monitoring and Characterization in Food and the Environment* (with Edmond Sanganyado and Basil K. Munjanja, 2020), *Sequencing Technologies in Microbial Food Safety and Quality* (with Devarajan Thangardurai, Saher Islam, Jeyabalan Sangeetha, 2021), *Nanoemulsions in Food Technology: Development, Characterization, and Applications* (with Javed Ahmad, 2021), *Mass Spectrometry in Food Analysis* (with Robert Winkler, 2022), *Bioactive Peptides from Food: Sources, Analysis, and Functions* (with Semih Ötles, 2022), and *Nutriomics: Well-being through Nutrition* (with Devarajan Thangadurai, Saher Islam Juliana Bunmi Adetunji, 2022). In 2023, he published with Javed Ahmad *Analysis of Naturally Occurring Food Toxins of Plant Origin*.

List of Contributors

Ola Abdelhedi
University of Sfax
Sfax, Tunisia

Negi Aditi
Formerly Indian Institute of Food Processing Technology
Thanjavur, India

Akansha Agrwal
Department of Applied Sciences
KIET Group of institutions
Ghaziabad, India

Faraat Ali
Charles University
Hradec, Czech Republic

Vazahat Ali
Department of Chemistry
Jamia Hamdard University
New Delhi, India

Samar Zuhair Alshawwa
College of Pharmacy
Princess Nourah bint Abdulrahman University
Riyadh, Saudi Arabia

Muhamad Amin
University of Tasmania
Launceston, Australia

M-Concepción Aristoy
Instituto de Agroquímica y Tecnología de Alimentos
Consejo Superior de Investigaciones Científicas
Paterna, Spain

Mohammad Asif
Faculty of Pharmacy
Lachoo Memorial College of Science and Technology
Jodhpur, India

Santiago P. Aubourg
Instituto de Investigaciones Marinas
Consejo Superior de Investigaciones Científicas
Vigo, Spain

Dimitris P. Balagiannis
University of Reading
Reading, United Kingdom

Federica Bellagamba
Department of Veterinary Medicine and Animal Science
Università degli Studi di Milano
Via dell'Università
Lodi (LO), Italy

Ioannis S. Boziaris
University of Thessaly
Volos, Greece

Emma L. Bradley
Fera Science Ltd., York Biotech Campus, Sand Hutton
York, United Kingdom

Mercedes Careche
Department of Meat and Fishery Products
Instituto de Ciencia y Tecnología de Alimentos y Nutrición (ICTAN-CSIC)

Raquel Carrilho
Universidade do Algarve
Faro, Portugal

Laurence Castle
Fera Science Ltd., York Biotech Campus, Sand Hutton
York, United Kingdom

Marco Cerqueira
CCMAR, Centro de Ciências do Mar
Faro, Portugal

Elizabeth S. Collier
Division of Bioeconomy and Health, Perception and Design Unit
RISE Research Institutes of Sweden
Gothenburg, Sweden
and
Division of Society and Health, Department of Health, Medicine and Caring Sciences
Linköping University
Gothenburg, Sweden

Elena Costa
Division of Bioeconomy and Health, Perception and Design Unit
RISE Research Institutes of Sweden
Gothenburg, Sweden
and
Department of Biological and Environmental Sciences
Gothenburg University
Gothenburg, Sweden

Daniel Cozzolino
The University of Queensland, Brisbane
Queensland, Australia

D. Sylvain Dabadé
Laboratory of Food Science and Technology
University of Abomey-Calavi
Jericho-Cotonou, Benin

Fera R. Dewi
University of Tasmania
Launceston, Australia

Eleftherios H. Drosinos
Agricultural University of Athens
Athens, Greece

John Stephen Elmore
University of Reading
Reading, United Kingdom

Mariana Alves Elois
Federal University of Santa Catarina
Florianópolis, Brazil

Eva Falch
Department of Biotechnology and Food Science
NTNU Norwegian University of Science and Technology
Trondheim, Norway

Ana Paula Farinha
Escola Superior Agrária de Santarém
Portugal

Kaneez Fatima
Department of Pharmacology
Faculty of Pharmacy
Maulana Azad University
Jodhpur, India

Gislaine Fongaro
Federal University of Santa Catarina
Florianópolis, Brazil

Arjen Gerssen
Wageningen Food Safety Research
Wageningen University and Research
Wageningen, the Netherlands

Ishita Ghosh
The Pennsylvania State University
University Park, Pennsylvania

Sadaf Jamal Gilani
Department of Basic Health Sciences
Princess Nourah bint Abdulrahman University
Riyadh, Saudi Arabia

Nalan Gokoglu
Fisheries Faculty
Department of Fish processing
Akdeniz University
Antalya, Türkiye

Rosalee S. Hellberg
Chapman University
Schmid College of Science and Technology, Food Science Program, One University Drive
Orange, California

Isabel Hernando
Universitat Politècnica de València
Valencia, Spain

Ana M. Herrero
Department of Meat and Fish Products
INDMEAT group, Institute of Food Science, Technology and Nutrition (ICTAN-CSIC)
Madrid, Spain

Azamal Husen
Wolaita University
Ethiopia

Grethe Hyldig
National Food Institute
Technical University of Denmark
Kgs. Lyngby, Denmark

Annamaria Iannetta
University of Teramo
Teramo, Italy

Jun Iguchi
Food Labeling Monitoring Department
Food and Agricultural Material Inspection Center
Saitama, Japan

Ida-Johanne Jensen
Department of Biotechnology and Food Science
NTNU Norwegian University of Science and Technology
Trondheim, Norway

Rósa Jónsdóttir
Matís
Reykjavik, Iceland

Mourad Jridi
Higher Institute of Biotechnology of Beja
University of Jendouba
Jendouba, Tunisia

A. Kaarunya
Formerly Indian Institute of Food Processing Technology
Thanjavur, India

Najam Ali Khan
Faculty of Pharmacy
GMS College of Pharmacy
Amroha, India

Vikas Kumar
Aquaculture Research Institute
Department of Animal , Veterinary and Food Sciences
University of Idaho
Moscow, Idaho

Han Liu
E2S UPPA, IPREM, CNRS
Université de Pau et des Pays de l'Adour
Pau, France

Empar Llorca
Universitat Politècnica de València
Valencia, Spain

Annalaura Lopez
Department of Veterinary Medicine and Animal Science
Università degli Studi di Milano
Via dell'Università
Lodi (LO), Italy

Cláudia Raposo de Magalhães
Universidade do Algarve
Faro, Portugal

R. Meenatchi
National Institute of Food Technology Entrepreneurship and Management
Formerly Indian Institute of Food Processing Technology
Thanjavur, India

Rogério Mendes
Portuguese Institute for the Sea and Atmosphere
Lisbon, Portugal

Victor G. Mihucz
Institute of Chemistry
ELTE – Eötvös Loránd University
Budapest, Hungary

Marília Miotto
Federal University of Santa Catarina
Florianópolis, Brazil

Sajad Ahmad Mir
Department of Microbiology and Food Science and Technology
Gitam School of Science
Gitam (Deemed to be University)
Visakhapatnam, India

Sheetal Mital
Department of Applied Sciences
KIET Group of institutions
Ghaziabad, India

Anisa Mitra
Department of Zoology
Sundarban Hazi Desarat College
Pathankhali, India

Francisco Esteban Montero
Universitat de València
Valencia, Spain

Leticia Mora
Instituto de Agroquímica y Tecnología de Alimentos
Consejo Superior de Investigaciones Científicas
Valencia, Spain

Vittorio Maria Moretti
Department of Veterinary Medicine and Animal Science
Università degli Studi di Milano
Via dell'Università
Lodi (LO), Italy

Atsushi Namikoshi
Food Labeling Monitoring Department
Food and Agricultural Material Inspection Center
Saitama, Japan

Shahida Naseem
University of Kashmir
Srinagar, India

Zahida Naseem
SKUAST-K
Srinagar, India

Moncef Nasri
University of Sfax
Sfax, Tunisia

Rim Nasri
Higher Institute of Biotechnology of Monastir
University of Monastir
Monastir, Tunisia

Jun Niimi
Division of Bioeconomy and Health, Perception and Design Unit
RISE Research Institutes of Sweden
Gothenburg, Sweden

Leo M.L. Nollet
University College Ghent
Ghent, Belgium

Olumide A. Odeyemi
University of Tasmania
Launceston, Australia

Guðrún Ólafsdóttir
University of Iceland
Reykjavik, Iceland

Helen Onyeaka
School of Chemical Engineering
University of Birmingham
UK

Semih Otles
Ege University
Izmir, Turkey

Yesim Ozogul
Cukurova University
Balcalı/Adana, Turkey

Vasfiye Hazal Özyurt
Department of Gastronomy and Culinary
Mugla Sıtkı Kocman University
Mugla, Turkey

Foteini F. Parlapani
University of Thessaly
Volos, Greece

Ana Pérez-del-Olmo
Universitat de València
Valencia, Spain

Monia Perugini
University of Teramo
Teramo, Italy

Marcel Afonso Provenzi
Federal University of Santa Catarina
Florianópolis, Brazil

Amparo Quiles
Universitat Politècnica de València
Valencia, Spain

Juan Antonio Raga
Cavanilles Institute of Biodiversity and Evolutionary Biology
Universitat de València
Valencia, Spain

Danish Rizwan
University of Kashmir
Srinagar, India

Pedro Rodrigues
Universidade do Algarve
Faro, Portugal

David Rodríguez-Lázaro
University of Burgos
Burgos, Spain

Claudia Ruiz-Capillas
Department of Meat and Fish Products
INDMEAT group, Institute of Food Science, Technology and Nutrition (ICTAN-CSIC)
Madrid, Spain

Turid Rustad
Department of Biotechnology and Food Science
NTNU Norwegian University of Science and Technology
Trondheim, Norway

Ali Salem
Higher Institute of Biotechnology of Beja
University of Jendouba
Jendouba, Tunisia

Isabel Sánchez-Alonso
Department of Meat and Fishery Products
Instituto de Ciencia y Tecnología de Alimentos y Nutrición (ICTAN-CSIC)
and
Department of Food Technology
Universidad complutense de Madrid (UCM)
Madrid, Spain

Abhilash Sasidharan
Norwegian University of Science and Technology
Trondheim, Norway

Beatriz Pereira Savi
Federal University of Santa Catarina
Florianópolis, Brazil

Denise Schrama
Universidade do Algarve
Faro, Portugal

Reinhard Schubring
Federal Research Institute for Nutrition and Food
Max Rubner-Institut
Hamburg, Germany

K. S. Siddiqi
Aligarh Muslim University
Aligarh, India

Helena Silva
Portuguese Institute for the Sea and Atmosphere
Lisbon, Portugal

Benjamin K. Simpson
McGill University
Quebec, Canada

Hana Sklenářová
Charles University
Hradec, Czech Republic

Rasa Slizyte
Department of Fisheries and New Marine Bioresources
SINTEF Ocean
Trondheim, Norway

Joseph Sneddon
McNeese State University
Lake Charles, Louisiana

Doris Sobral Marques Souza
Federal University of Santa Catarina
Florianópolis, Brazil

Deyan Stratev
Department of Food Quality and Safety and Veterinary Legislation
Faculty of Veterinary Medicine
Trakia University
Bulgaria

Yasuharu Takashima
Food Labeling Monitoring Department
Food and Agricultural Material Inspection Center
Saitama, Japan

Chad A. Thibodeaux
Northeastern University
Natchitoches, Louisiana

Fidel Toldrá
Instituto de Agroquímica y Tecnología de Alimentos
Consejo Superior de Investigaciones Científicas
Valencia, Spain

Véronique Verrez-Bagnis
Ifremer, MASAE Microbiologie Aliment Santé Environnement
Nantes, France

Michiaki Yamashita
Graduate School of Fisheries Science
National Fisheries University
Yamaguchi, Japan

Yumiko Yamashita
Environment and Fisheries Applied Techniques Research development
Fisheries Technology Institute
Kanagawa, Japan

Nadine Yeramian
University of Burgos
Burgos, Spain

Lucas Zanchetta
Federal University of Santa Catarina
Florianópolis, Brazil

Yi Zhang
The Pennsylvania State University
University Park, Pennsylvania

Part 1

Chemistry and Biochemistry

1 Introduction

Importance of Analysis in Seafood and Seafood Products, Variability, and Basic Concepts

Vikas Kumar
University of Idaho

Anisa Mitra
Sundarban Hazi Desarat College

1.1 INTRODUCTION

Seafood, which is broadly categorized as fish (especially white and oily varieties), shellfish such as mussels, and crustaceans such as prawns, crabs, lobsters, and squid, is any form of sea life that humans consider to be food. Molluscs and crustaceans, such as mussels, oysters, and scallops, as well as prawns, prawns, crabs, and lobsters, make up the other broadclass of shellfish (Thakur, 2019). Seafood and seafood products are an important part of the human diet because they provide high-quality protein, omega-3 fatty acids, vitamins, and minerals. It is an essential component of the global food system, making significant contributions to livelihoods and nutritional well-being, particularly in countries with low or middle incomes (Hicks et al., 2019; FAO, 2022). The safety and quality of seafood products, however, can vary due to a variety of factors such as species, geography, harvesting location, processing, handling, and storage facilities. With a rapid increase in aquaculture, geographical switches in trade, and expanding commoditization and vertical integration, the seafood sector has been transforming in recent years. Global concern about fisheries and aquaculture's ability to satisfy future seafood demand sustainably is driving advancements in management and technology (Marwaha et al., 2022).

Global fish and seafood production has increased by four times in the last 50 years. The average individual currently consumes over twice as much seafood as they did 50 years ago, in addition to the fact that the world's population has more than doubled during this time. The greatest seafood producer in the world is China that produced more than 60 million tonnes of seafood in 2019 (see Figure 1.1). Indonesia, India, Vietnam, and finally the United States come after this (Ritchie and Roser, 2020). Nearly 178 million tonnes of aquatic animals were produced globally in 2020, a tiny decrease from the record-breaking 179 million tonnes produced in 2018. Salmon, herring, cod, flatfish (halibut, sole, and turbot), redfish (ocean perch), jack mackerel, tuna, mackerel, and sardine species are the most important ocean fish for commerce. Whitebait and baby eels, which are both approximately 5 cm (2 inches) long, and bluefin tuna, which can reach lengths of 4.3 m (14 feet), are among the catch's smaller species. In 2020, aquaculture contributed 88 million tonnes (49%) compared with the capture fishery's 90 million tonnes (51%). In 2020, inland waterways were used to collect 37% (66 million tonnes) of the total production, with aquaculture accounting for 83% (66 million tonnes) and catch fisheries for 17% (112 million tonnes) of the overall production was gathered in maritime waters. Thirty-six million tonnes (wet weight) of algae were produced in 2020 in place of aquatic animals, with aquaculture accounting for 97% of this production (mainly marine

DOI: 10.1201/9781003289401-2

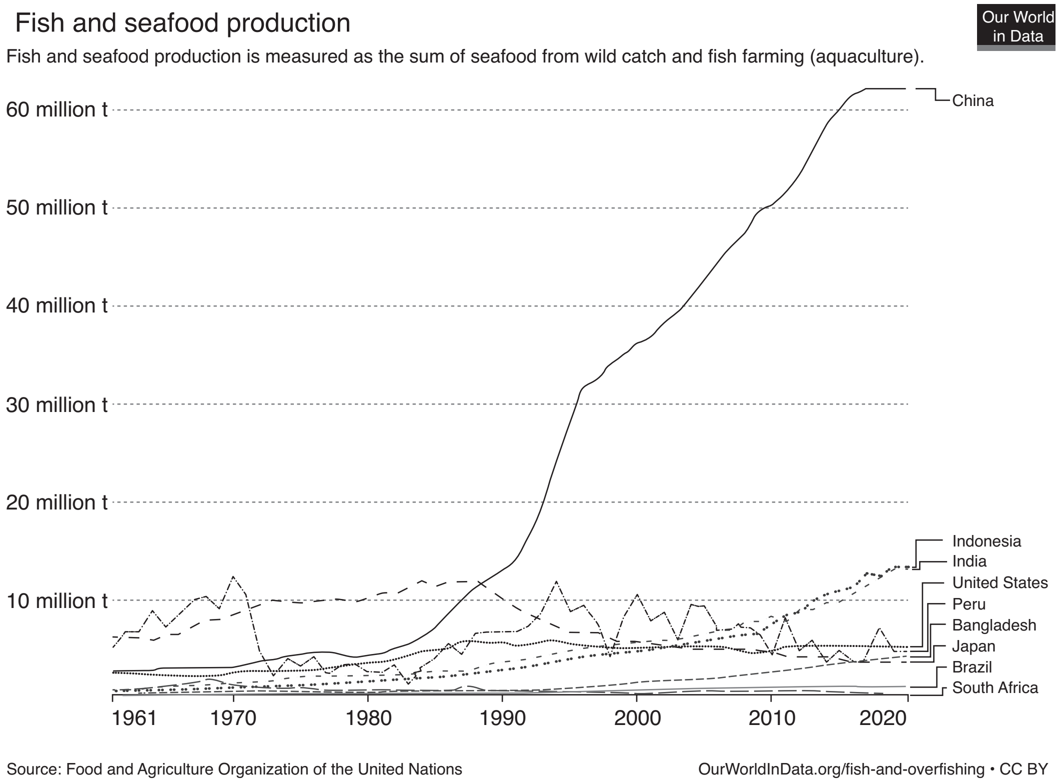

FIGURE 1.1 Global seafood production (FAO, 2022).

aquaculture) (OCED FAO, 2022). A variety of factors, including environmental, economic, social, and political ones, have a role in the global capture and harvest of seafood. It has been predicted that the amount of edible food from the sea might increase by 21–44 million tonnes by 2050, a 36%–74% increase over present yields (Ainsworth et al., 2023), based on demand shifts and supply scenarios. Global fish harvesting has a significant impact on environmental sustainability, human health, and food security. Fish supplies and marine biodiversity have decreased as a result of overfishing, illegal fishing, and unsustainable fishing methods, affecting the long-term viability of the seafood business. Additionally, the seafood sector has detrimental ecological effects, such as habitat degradation, and notably contributes to the release of greenhouse gases. There have been numerous initiatives to promote ethical fishing methods, lessen overfishing, and enhance the management of marine resources in an effort to solve these issues. To increase the sustainability and profitability of the seafood business and policy decisions, research on the global catch and harvest of seafood is crucial.

1.2 VARIABILITY OF AQUATIC ANIMALS

Due to differences in species, geography, harvesting locations, handling, processing, and storage, aquatic animals, such as fish and shellfish, and other marine organisms, such as seaweeds, exhibit significant variability as food. Species diversity is one of the main contributors to variation in aquatic animals used as food. Fish and shellfish come in a variety of species, each with distinctive qualities in terms of size, flavour, texture, and nutritional value. For instance, while some species of fish are prized for their firm flesh and mild flavour, others are more delicate and have a more distinctive flavour. Geographical variation in aquatic animals used as food is also highly influenced. Depending on the region and environmental factors, there can be a wide range in the kind and quality of seafood that is offered. For instance, oysters from different regions may have different flavours and textures due to variations in water temperature, salinity, and nutrient availability. Harvest location, handling, and processing can also affect the variability of aquatic animals such as seafood. The handling and processing techniques used can affect the texture, flavour, and quality of the seafood. For example, the method of catching and handling fish can affect the texture of the flesh, while the processing method used for shellfish can affect their flavour and texture. Finally, storage conditions can also contribute to variability in aquatic animals such as seafood. Factors such as temperature, humidity, and exposure to light can all affect the quality and safety of seafood products. For example, improper storage of fish can result in spoilage and the formation of harmful bacteria, while exposure to light can cause the degradation of certain nutrients in shellfish. To minimize the variability of aquatic animals such as seafood, it is essential to use standardized methods for handling, processing, and storage. Additionally, maintaining a robust quality control system and following best practices in sample collection, handling, and analysis can help to minimize variability and ensure that seafood products are safe and of high quality.

1.3 BENEFITS AND RISKS

Seafood and seafood products have both benefits and risks associated with their consumption. Here are some of the main benefits and risks of seafood and seafood products:

1.3.1 Benefits

Seafood is high in relevant nutrients such as n-3 PUFAs (Polyunsaturated Fatty Acid), protein, fibre, taurine, sterol, pigments, vitamins, and minerals such as iron, zinc, and selenium. These nutrients are essential for good health and lower the risk of chronic diseases such as cardiovascular disease. Seafood proteins have high levels of essential amino acids and are easily digestible. Proteins comprise 10%–25% of all seafoods and are classified into three types: sarcoplasmic, myofibrillar, and stroma. According to prior research, eating fish protein lowers serum cholesterol by blocking cholesterol and bile acid absorption and promoting cholesterol catabolism in the liver (Hosomi et al., 2012). Furthermore, dietary fish protein contains antihypertensive (Boukortt et al., 2004), fibrinolysis-stimulating (Murata et al., 2004), and antiobesity (Oishi and Dohmoto, 2009) properties. Docosahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA), omega-3 fatty acids found in seafood, are essential for newborn and young child brain development. Seafood is often low in calories and high in protein, making it useful for weight management and loss. Free sterols, stanols, and sterol esters are lipid-lowering phytosterols found in seafood that have a lipid-lowering mechanism by competing with cholesterol absorption by binding to micelles in the intestine (Jones et al., 2000; Kanazawa, 2001). Phytosterols are also said to have anti-inflammatory, antioxidant, and anticancer activities (Houweling et al., 2009; Mannarino et al., 2009; Bouic, 2001). The most abundant source of carotenoids is seafood and its by-products; these compounds can be transformed into vitamin A (García-González et al., 2005) and significantly reduce oxidative stress, inflammation, and hyperlipidaemia biomarkers (Iwamoto et al., 2000; Cicero et al., 2008). In general, shellfish with muscle is quite low in fibre and carbohydrates. However, according to Jiménez-Escrig and Sánchez-Muniz (2000), water-soluble fibre makes up between 50% and 85% of the dietary fibre found in edible seaweed, which has been shown to lower plasma levels of total cholesterol, low-density lipoprotein (LDL) cholesterol, and Triglycerides (TG), and additionally acts as an antihypertensive activity (Matsushima et al., 2003; Schaffer et al., 2010).

1.3.2 Risks

There are risks involved with eating seafood, even though it can have significant health benefits. When choosing seafood, it is crucial to consider the source, sustainability, and potential risks. Environmental pollutants such as pesticides, dioxins, and polychlorinated biphenyls (PCBs) can accumulate in fish flesh and be harmful to human health (Arisawa et al., 2003). These contaminants can be present in seafood. High levels of mercury contamination in some fish species can be dangerous to human health, especially for expectant mothers and young children. Exposure to methylmercury affects the delicate

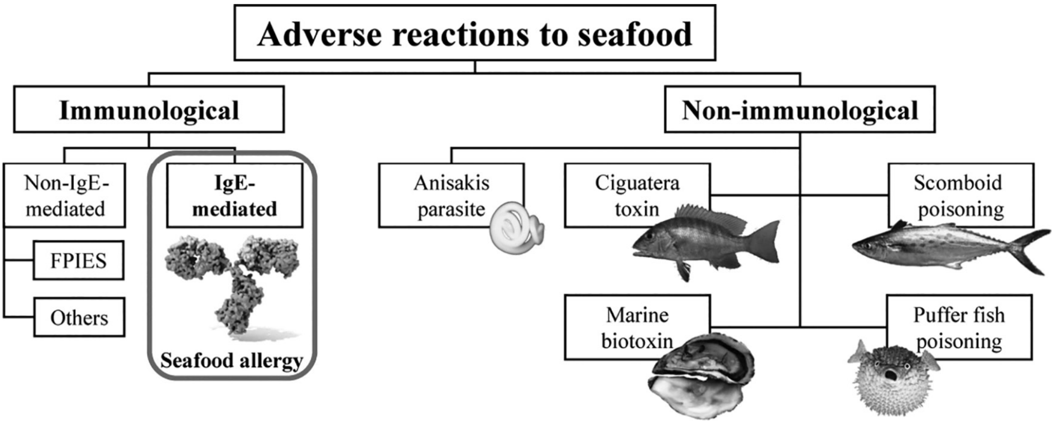

FIGURE 1.2 Adverse reactions to seafood upon ingestion. Reproduced from Ruethers et al. (2018) with permission of Elsevier.

nervous system. Methylmercury also has a strong effect on the developing nervous systems of foetuses and young children. Methylmercury causes damage to the central nervous system that is dependent on the amount ingested (Clarkson et al., 2003; Yoshizawa et al., 2002). Seafood may contain infective bacteria such as *Vibrio* and *Salmonella* and infective viruses such as Norovirus, which can cause foodborne illness. Shellfish taken from sewage-contaminated waters are frequently linked to dangerous viruses such as the Norwalk virus and hepatitis A. Oysters and clams are the main sources of bacteria, but some ready-to-eat fish products can also contain them. Eating raw or partially cooked oysters or clams poses the greatest risk because they can pick up bacteria from runoff, sewage discharges, land use, and other sources such as *Vibrio vulnificus* and *Vibrio parahaemolyticus*. These microbes, which naturally exist in warm coastal waters, have the potential to seriously ill or even kill high-risk people. In addition to bacteria and viruses, some fish, particularly those from tropical or subtropical waters, may contain toxins that make people sick. Histamine poisoning comes in two main forms: ciguatoxin and scombrotoxin. Most reef fish, including barracuda, grouper, and snapper, contain ciguatoxin. Mahi-mahi, fresh tuna, mackerel, and bluefish are the main sources of scombrotoxin (histamine) (Reames, 2012). Seafood allergies, which can have serious and even fatal consequences, may exist in some people. Seafood contains a prominent common allergenic protein termed tropomyosin (TPM), which is relatively resistant to peptic acidic digestion. As a result, the protein has a long-lasting effect on the immune system. For more than 80% of allergic reactions that might result in severe hypersensitivity, such as urticaria and asthma, as well as a large portion of anaphylaxis, shrimp is the most prevalent crustacean among shellfish allergens. A negative reaction to seafood can fall into one of three categories depending on the underlying mechanisms: (i) toxic reactions, which include reactions to marine biotoxins; (ii) immunological reactions, which include allergic reactions and food protein-induced enterocolitis syndrome (FPIES); and (iii) food intolerance. As a result, to protect customers from potentially harmful components, food makers are obligated to analyse, label, and emphasize shellfish allergenic substances on food packages (Woo and Bahna, 2011; Adams et al., 2019; Buyuktiryaki et al., 2021) (Figure 1.2).

1.4 SEAFOOD AND SEAFOOD PRODUCT ANALYSIS

Seafood and seafood products are complex matrices that require sophisticated analytical methods to assess their quality and safety. The analysis of seafood can provide information about the nutritional value, freshness, microbial load, and chemical contaminants (heavy metals, pesticides, and antibiotics) of the product. These contaminants can accumulate in seafood and pose a risk to human health.

Here are some of the key reasons why the analysis of seafood and seafood products is important:

Safety: Analysis of seafood and seafood products helps identify and mitigate potential safety risks, including the presence of harmful contaminants such as bacteria, viruses, parasites, heavy metals, and toxins.

Quality: Analysis of seafood and seafood products is critical to ensure their quality, including freshness, flavour, texture, and nutritional value. The analysis can help to identify the presence of spoilage organisms, monitor quality changes during storage and transportation, and assess the sensory attributes of the products.

Regulatory compliance: Analysis of seafood and seafood products is necessary to ensure compliance with regulatory requirements, including food safety regulations, labelling requirements, and import or export regulations.

Traceability: Analysis of seafood and seafood products is important to maintain traceability and accountability throughout the supply chain. Analytical techniques such as Deoxyribonucleic acid (DNA) barcoding can help verify the species and origin of the products, preventing mislabelling and fraud.

Variability: It is a significant challenge in the analysis of seafood and seafood products. The variability can be due to the intrinsic characteristics of the products, such as differences in species, size, and age, and the extrinsic factors, such as harvest location, processing method, and storage conditions.

Some of the basic concepts involved in the analysis of seafood and seafood products include chemical analysis, microbiological analysis, sensory analysis, and DNA analysis. The choice of analytical method depends on the specific attributes of the product being analysed, the regulatory requirements, and the intended use of the product to ensure its safety, quality, compliance, and traceability. Therefore, regulatory authorities have established maximum residue limits (MRLs) for these contaminants in seafood. Analytical methods such as atomic absorption spectrometry (AAS), gas chromatography (GC), polymerase chain reaction (PCR), liquid chromatography (LC), enzyme-linked immunosorbent assay (ELISA), and sensory evaluation techniques are commonly used for the detection and quantification of chemical contaminants in seafood.

1.5 CHEMICAL CONTAMINANTS

It is challenging to identify the precise species and allergens that are the cause of allergic reactions given the variety of seafood available. Because commercially accessible diagnostic techniques do not take into account this diversity, it is frequently advised to avoid all seafood (Lopata and Kamath, 2012). Currently, the clinical history, sensitization tests, such as allergen-specific IgE quantification and Skin prick test (SPT), and oral challenge tests, if necessary, are used to make the diagnosis of seafood allergy. In commercial preparations for the SPT, complete protein extracts with an unknown protein composition are typically sold by multiple, frequently local manufacturers. *In vitro* IgE tests are preferred over SPT or oral food challenges to reduce the danger of potentially fatal allergic reactions.

The simplicity of testing for sensitization and the accessibility of commercial tests against a range of seafood species on various platforms are advantages of this strategy. Standardizing allergen concentrations may be challenging when using natural extracts, and detecting specific IgE to rare allergens may not be precise, producing findings that are untruthfully negative. To alleviate these issues, recent research is increasingly emphasizing the use of extracted allergens for component-resolved diagnosis (Lopata et al., 2016). Understanding the allergens' natural abundance, location within the organism, and biological function may be important to produce a seafood allergy component-resolved diagnosis (Ruethers et al., 2018).

Microplastics (MPs) have contaminated the marine environment in all compartments, including seafood (Lusher et al., 2017). An estimated 11,000 MP particles are eaten annually by seafood eaters in Europe who live in shellfish-eating nations. Fish and shellfish that are significant for commerce, both wild and farmed, have been discovered to contain MP particles (Duis and Coors, 2016). The consumption of complete organism in seafood is a big source of concern. The majority of research has been done on bivalves in terms of MP concentrations (Lusher et al., 2017). Only a small number of studies have discovered MPs in crabs or prawns (Andrady, 2011; EFAS Panel on Contaminants in the Food Chain, 2016). Surprisingly, there is little information available on seafood species other than bivalves or fish digestive tissue, leaving out the edible section, such as the muscle (Teuten et al., 2009; Murray and Cowie, 2011). The most significant dietary exposure sources for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in seafood are per- and poly(fluoroalkyl) substances (PFASs), a class of synthetic chemicals that have been used in a variety of industrial and consumer products. To spot packaging that might have been PFAS-coated, the majority of the seafood packaging was also looked at utilizing Fourier transform infrared-attenuated total reflectance (FTIR-ATR) (Young et al., 2022) (Figure 1.3).

The most common method for detecting MPs in seafood is to first identify visible plastic particles. To solidify the scientific evidence on MP contamination and human exposures, high-quality research is required using standardized methods such as particle-extraction procedures and composition identification method specifications, highlighting the varying effectiveness of research protocols (Danopoulos et al., 2020). Secondary confirmation via spectroscopic analysis, including Fourier Transform Infrared Spectroscopy (FTIR), is the most commonly used technique for confirming the polymer type present in seafood (Renner et al., 2018). Pyrolysis–gas chromatography–mass spectrometry (Py-GC/MS) is an intriguing method for studying MPs

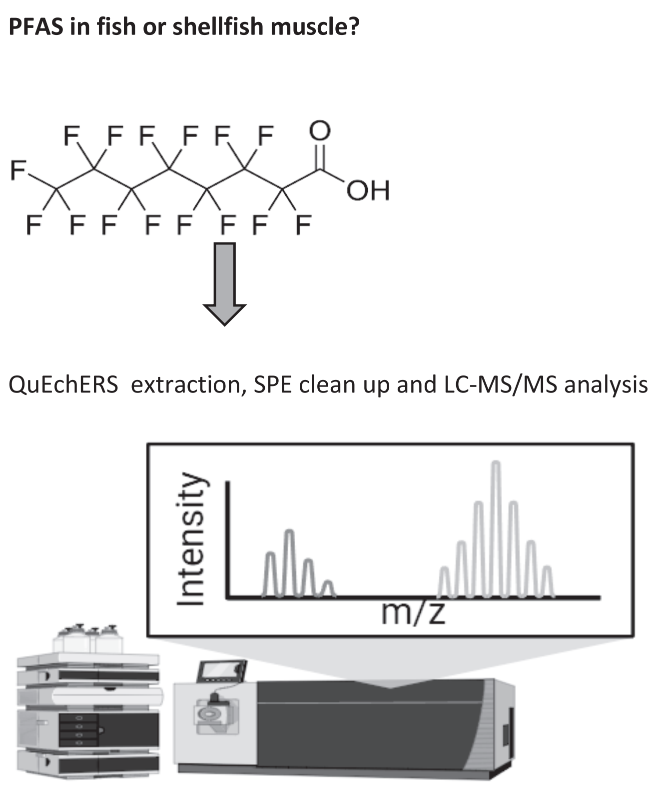

FIGURE 1.3 Analysis of per- and poly(fluoroalkyl) substances (PFASs) in highly consumed seafood.

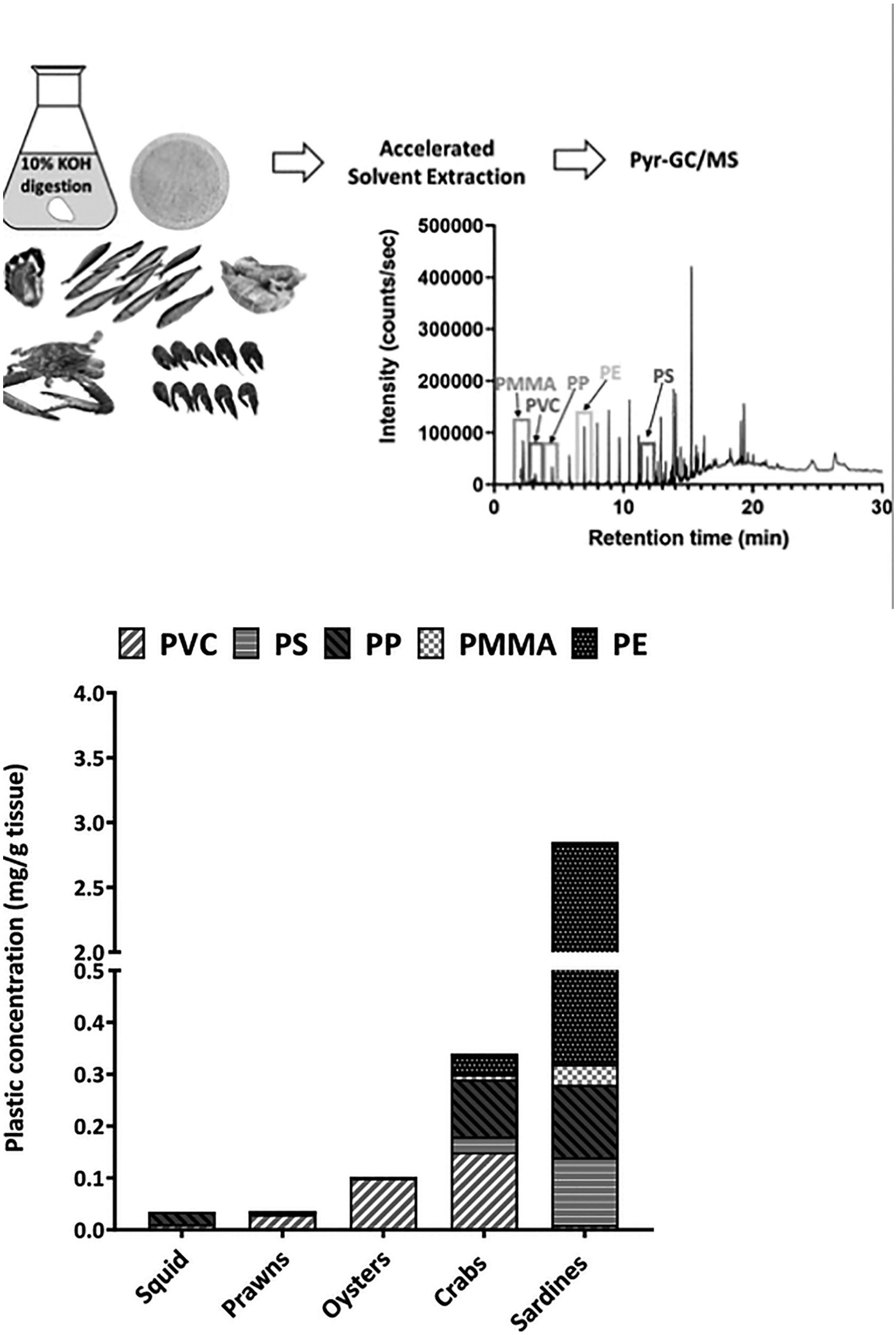

FIGURE 1.4 Five kinds of plastic (PVC, PS, PP, PMMA, and PE) were quantified in five different organisms (squid, prawns, oysters, crabs, and sardines) at a total plastic concentration ($n=10$) (in mg per g of tissue). Polyvinyl chloride (PVC), polypropylene (PP), poly(methyl methacrylate), polystyrene (PS), polyethylene (PE) and polymethyl methacrylate (PMMA). Reproduced from Ribeiro et al. (2020).

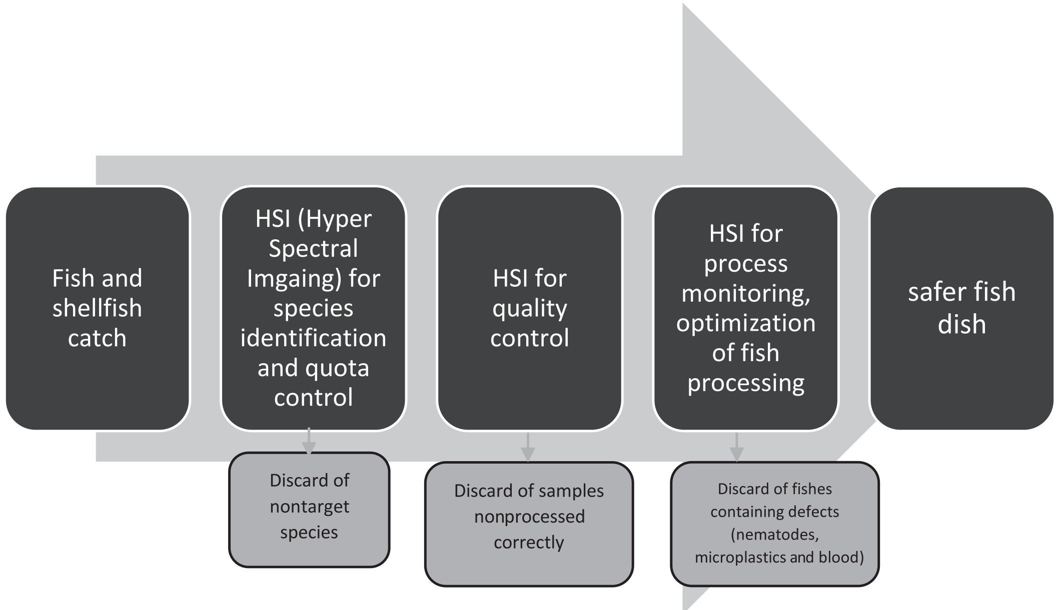

FIGURE 1.5 Applications of hyperspectral imaging in the seafood sector. Reproduced from Hassoun et al. (2022).

(Mintenig et al., 2018; La Nasa et al., 2020; De Sales-Ribeiro et al., 2020) (Figures 1.4 and 1.5). It is challenging to establish methodologies to identify and quantify the most prevalent types of plastics discovered in seafood due to the inconsistent reporting of estimates of MP concentration levels in fish and shellfish. To maximize the identification and quantification of MPs by Py-GC/MS using a mass-related quantification approach, an alkaline digestion procedure was followed by an accelerated solvent extraction (ASE) method, which used a solvent at high temperature and pressure to dissolve and extract plastics from seafood. This is an evaluation of the amount of plastic that a consumer might consume when eating seafood.

The artificial preservative formaldehyde, a known carcinogen, has been found in fish products (Jinadasa et al., 2022). Fish might be purposely sprayed or dipped in formaldehyde solution to increase shelf life, stiffen, maintain freshness, and prevent rotting. However, formaldehyde has the capacity to excite the body's dominant cells and can result in agitation, nausea, neuralgia, and skin allergies (EFSA, 2014). Numerous methods for measuring the amount of formaldehyde have been developed recently, including spectrophotometry, electrochemistry, and chromatography. These methods are accurate and reliable but call for a labour-intensive, expensive process. The substrate

FIGURE 1.6 Use of biodegradable hybrid polymer film for the detection of formaldehyde in seafood products. Reproduced from Rovina et al. (2020) with permission of Elsevier.

TABLE 1.1
Summary of Pros and Cons of the Main Approaches Using DNA Barcode Markers for Seafood Authentication (Fernandes et al., 2021)

	Pros	Cons
DNA barcoding	Well established Medium to high cost of equipment Low cost per analysis Reliable species identification	Limited application to processed samples Not applied to mixed species identification
NGS	High-throughput species identification Multiple species identification Reliable species identification Application to a complex and processed sample Application to a complex and processed sample	High cost of equipment High cost of analysis High complexity of data
PCR RFLP	Simple setup Low cost of equipment	Low reproducibility Limited application to processed samples Time-consuming Limited species identification No sequencing information
Real-time PCR	Reliable species identification Highly sensitive Quantitative Simple setup	
HRM	High throughput Cost-effective Medium to low cost of equipment Application to processed food	Not applied to mixed species identification Not applied to mixed species identification

for a novel biodegradable hybrid polymer film was made of starch and chitosan, which was utilized to entrap Nash colorimetric reagents for the quantitative detection of formaldehyde (Rovina et al., 2020) (Figure 1.6).

As a result of an increase in seafood mislabelling over the past few years (Khaksar et al., 2015; Vandamme et al., 2016; Christiansen et al., 2018), consumers may now be exposed to hidden or undeclared species that may contain toxins, pathogens, parasites, chemicals, or allergens. DNA barcoding based on Sanger's sequencing has been the most used method for seafood authenticity. However, recent developments in DNA barcoding techniques (Table 1.1) using next-generation sequencing (NGS) have proved noteworthy. Techniques using real-time PCR with species-specific primers and probes, or those that are followed by high-resolution melting (HRM) analysis combined with DNA barcodes, are potential alternatives for simple, inexpensive, and high-throughput species discrimination in processed seafood (Fernandes et al., 2021). DNA metabarcoding is anticipated to be employed more and more, eventually taking over, particularly for multiple species identification in intricate seafood matrices. In view of declining equipment prices and advances in bioinformatics, this trend is anticipated to continue. As dependable and economical technologies, real-time PCR-based techniques that use species-specific primers and probes to target DNA barcodes and those that are followed by High-Resolution Melting (HRM) analysis are also projected to advance in the near future. Additionally, being tested are NGS, isotopic analysis, and trace. Droplet digital PCR (ddPCR), a new technique, was used to create a very accurate quantitative method that was used for the quantitative examination of raw elements in mixed meats and highly processed blended foods (Floren et al., 2015; Noh et al., 2020).

1.6 MICROBIAL DIVERSITY OF SEAFOOD

Microbial deterioration and safety hazards in post-harvest handling, icing, packaging, processing, storage, and distribution can cost fish producers, processors, and distributors billions of dollars each year. Microbial analysis is also critical in seafood analysis, and different techniques such as enumeration, identification, and detection of specific pathogenic microorganisms are used. For example, quantitative PCR (qPCR) is a rapid and sensitive method to detect and quantify specific bacterial pathogens in seafood products.

Seafood microbiologists create and use novel molecular techniques to describe the microbial diversity of seafood and guarantee microbial safety and quality along the seafood value chain in order to solve problems for stakeholders and contribute to sustainable development, poverty reduction, and One Health. The development of NGS technology over the past few years has allowed for paradigm-shifting discoveries regarding the microbial diversity of seafood (Villicaña et al., 2019). The ability of 16S NGS to distinguish between cultivable and non-cultivable bacterial genera from a sample has altered our knowledge of the microorganisms that predominate in or are present in seafood. However, PCR-based techniques are used to separate potential spoilers from hygiene indicators down to the strain level, such as HRM, or detect food safety-related genes specifically, such as virulence or antibiotic resistance genes, such as multiplex PCR, real-time PCR, and HRM (Parlapani et al., 2020). Bacteriological analysis can identify food spoilage brought on by bacteria, but it cannot detect the loss of freshness brought on by autolytic deterioration.

Electrochemical impedance spectroscopy (EIS) is a non-destructive, very sensitive method for analysing the electrical properties of materials and systems. It works by creating alternating electrical impulses at different frequencies and measuring the related signals. To estimate the electrical impedance of an electrochemical system, Zhang et al. (2022) claim that the impedance technique fixes a tiny sinusoidal voltage at a certain frequency and detects the ensuing alternating current. Electrochemical sensor devices are new and promising analytical instruments that have the potential to be extremely beneficial as outstanding control and monitoring tools for the seafood sector since they are rapid, effective, environmentally friendly, and economically viable. However, it still seems challenging to deploy electrochemical sensors on a broad scale in the food business. Future work in this area may concentrate on creating small, portable arrays that include sensors for gas, liquid, and colour analysis, as well as enzymatic biosensors that can quickly, accurately, and selectively monitor the quality and safety of food products at the industrial level (Marx, 2023). Numerous benefits come with electrochemical biosensors, including simple miniaturization and potential integration with multiplexed analysis using straightforward formats. The time restrictions associated with traditional laboratory approaches have been successfully reduced by recent developments in the development of such electrochemical sensors (Figure 1.7) for real-time, on-site monitoring by offering high-throughput, multi-analyte, and portable biosensors (Mishra et al., 2018).

One of the most novel and inventive technologies that can be employed in the food business for food production, processing, preservation, and packaging is nanotechnology (Qiu et al., 2020; Hassoun et al., 2022). Using nanoencapsulation or nanoemulsions, nanostructures may be useful in enhancing low-soluble compound accessibility, bioactivity, stability, or control of their release into the product. They can also successfully inhibit microbial growth and enhance the sensory qualities of hairtail during storage (Liu et al., 2021). Silver, zinc oxide, titanium oxide, or chitosan nanoparticles are examples of nanocomposites that can be used to inhibit microbiological development, preserve product freshness, and lengthen shelf life (Ranadheera et al., 2017).

Metagenomics, proteomics, and metabolomics combined with traditional quality indices such as colour, texture, and flavour provide novel analytical tools (Table 1.2) for optimization and ensuring the quality of seafood. According to den Besten et al. (2018), omics technologies pave the way for cutting-edge monitoring tools that are essential for developing the next wave of risk assessment techniques. Current technological advancements that make use of electronic data systems, such as web platforms and applications for smartphones, will be crucial for the adoption and wide

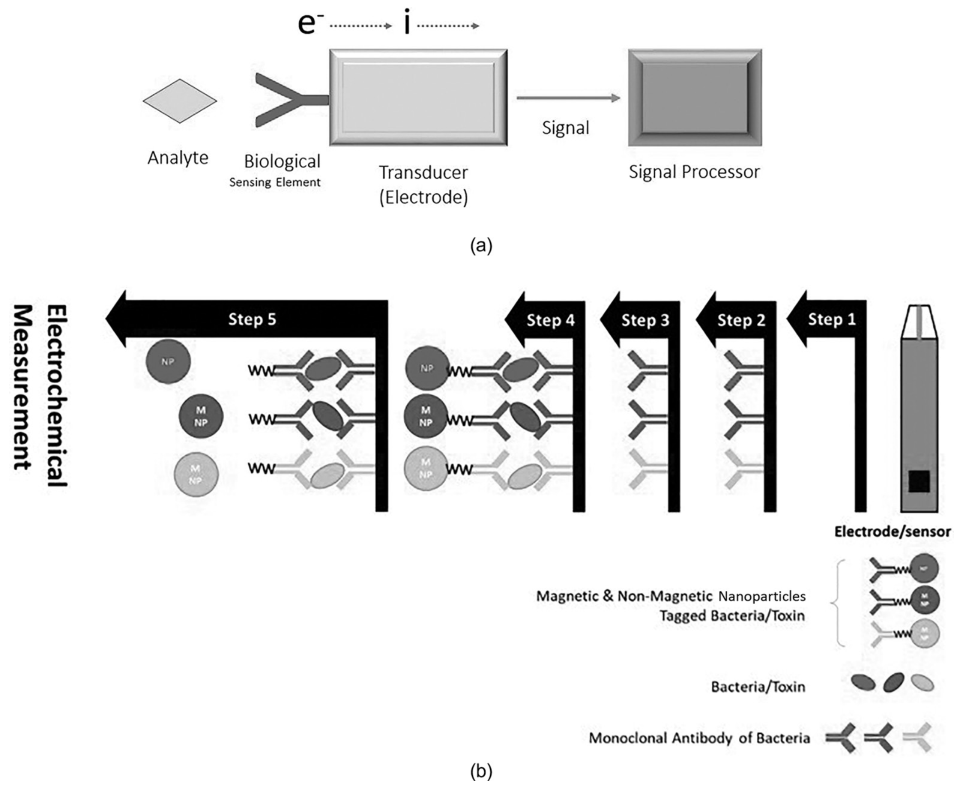

FIGURE 1.7 (a) Schematic illustration of mechanism or principle of an electrochemical biosensor. (b) Schematics for bacteria and toxin detection using an antibody-based electrochemical biosensor. Reproduced from Mishra et al. (2018).

TABLE 1.2
Examples of Omics Tools for Quality Evaluation of Aquatic Products

Product Category	Aim of the Analysis	Analytical Tool
Fresh and high pressure treated fish	Flesh quality assessment after high pressure processing	16S rRNA gene amplicon sequencing, LC-SWATH-MS acquisition on a triple TOF™ system
Fresh fish, shrimp, and roe product	Characterization of fish flesh microbial ecology, connection with histamine production	Numerical taxonomy, SDS-PAGE electrophoresis, plasmid profiling, next generation sequencing (NGS), intergenic spacer region (ISR) analysis, and examination of amplified-fragment length polymorphism (AFLP)
Iced-stored fish	Determination of total cultivable microbiota and freshness assessment	16S rRNA gene amplicon sequencing
Chilled fish	Freshness assessment	CG-MS analysis, ^{1}H NMR spectroscopy SPME-GC/MS analysis, SDS-PAGE electrophoresis, and 16S rRNA gene amplicon sequencing
Macroalga	Lipidomics	MS analysis

Modified after Power et al. (2023).

implementation of this molecular labelling (Ferri et al., 2015). Future improvements to universal primer sets and molecular microbiological tools should be directed at better differentiating between positive outcomes and actual pathogen contamination (Cook and Nightingle, 2018).

1.7 CONCLUSIONS

The analysis of seafood and seafood products is important for ensuring their quality, safety, and authenticity. The variability of seafood requires the development of robust and adaptable analytical methods. The choice of analytical method depends on the type of parameter being measured and the properties of the seafood matrix. Analytical methods can be non-destructive or destructive, depending on the specific application. Therefore, it is important to have a comprehensive understanding of the basic concepts of seafood analysis and to validate analytical methods for different types of seafood and seafood products. It should be noted that the majority of the aforementioned applications have not yet crossed the threshold into the industrial sphere. To fully realize the potential of Industry 4.0 and further harness its technologies to address present difficulties, further collaboration between laboratory research institutes and industrial actors is essential in the future (Hassoun et al., 2022).

REFERENCES

Adams S., Lopata A.L., Smuts C.M., Baatjies R., Jeebhay M.F. (2019) Relationship between serum omega-3 fatty acid and asthma endpoints. *Int. J. Environ. Res. Public Health.* 16:43. doi:10.3390/ijerph16010043.

Ainsworth G.B., Pita P., Rodrigues J.G., Pita C., Roumbedakis K., Fonseca T., Castelo D. Longo C., Power A.M., Pierce G.J., Villasante S. (2023) Disentangling global market drivers for cephalopods to foster transformations towards sustainable seafood systems. *People Nat.* 5(2):508–528.

Andrady A.L. (2011) Microplastics in the marine environment. *Mar. Pollut. Bull.* 62(8):1596–1605. doi:10.1016/j.marpolbul.2011.05.030.

Arisawa K., Matsumura T., Tohyama C., Saito H., Satoh H., Nagai M., Morita M., Suzuki T. (2003) Fish intake, plasma omega-3 polyunsaturated fatty acids, and polychlorinated dibenzo-p-dioxins/polychlorinated dibenzo-furans and co-planar polychlorinated biphenyls in the blood of the Japanese population. *Int. Arch. Occup. Environ. Health.* 76(3):205–215.

Bouic P.J. (2001) The role of phytosterols and phytosterolins in immune modulation: A review of the past 10 years. *Curr. Opin. Clin. Nutr. Metab. Care*. 4(6):471–475. doi:10.1097/00075197-200111000-00001.

Boukortt F.O., Girard A., Prost J., Bouchenak M., Belleville J. (2004) Effect of fish protein on blood pressure, glycemia and plasma and urinary parameters in spontaneously hypertensive rats (SHR) and diabetic SHR. *J. Hypertens.* 22(8):A1–A2.

Buyuktiryaki B., Masini M., Mori F., Barni S., Liccioli G., Sarti L., Lodi L., Giovannini M., du Toit G., Lopata A.L., Marques-Mejias M.A. (2021) IgE-Mediated fish allergy in children. *Medicina (Kaunas)*. 57(1):76. doi:10.3390/medicina57010076.

Christiansen H., Fournier N., Hellemans B., Volckaert F.A. (2018) Seafood substitution and mislabeling in Brussels' restaurants and canteens. *Food Control*. 85:66–75.

Cicero A.F.G., Nascetti S., López-Sabater M.C., Elosua R., Salonen J.T., Nyyssonen K., Poulsen H.E., Zunft H.-J.F., Kiesewetter H., de la Torre K., Covas M.-I., Kaikkonen J., Mursu J., Koenbick C., Bäumler H., Gaddi A.V. (2008) Changes in LDL fatty acid composition as a response to olive oil treatment are inversely related to lipid oxidative damage: The EUROLIVE study. *J. Am. Coll. Nutr.* 27(2):314–320.

Clarkson T.W., Magos L., Myers G.J. (2003) The toxicology of mercury-current exposures and clinical manifestations. *N. Engl. J. Med.* 349(18):1731–1737.

Cook P.W., Nightingale K.K. (2018) Use of omics methods for the advancement of food quality and food safety. *Anim. Front.* 8(4):33–41.

Danopoulos E., Twiddy M., Rotchell J.M. (2020) Microplastic contamination of drinking water: A systematic review. *PloS One*. 15(7):e0236838.

De Sales-Ribeiro C., Brito-Casillas Y., Fernandez A., Caballero M.J. (2020) An end to the controversy over the microscopic detection and effects of pristine microplastics in fish organs. *Sci. Rep*. 10(1):12434.

den Besten H.M., Amézquita A., Bover-Cid S., Dagnas S., Ellouze M., Guillou S., Nychas G., O'Mahony C., Pérez-Rodriguez F., Membré J.M. (2018) Next generation of microbiological risk assessment: Potential of omics data for exposure assessment. *Int. J. Food Microbiol.* 287:18–27.

Duis K, Coors A. (2016) Microplastics in the aquatic and terrestrial environment: Sources (with a specific focus on personal care products), fate and effects. *Environ. Sci. Eur*. 28(1):2.

EFSA (2014) Endogenous formaldehyde turnover in humans compared with exogenous contribution from food sources. *EFSA J.* 12:3550.

EFSA (2016) Presence of microplastics and nanoplastics in food, with particular focus on seafood. *EFSA J.* 14(6):4501.

FAO (2022) Total seafood production by country 1961–2020. Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/FBS (accessed on 15 May 2023).

Fernandes T.J., Amaral J.S., Mafra I. (2021) DNA barcode markers applied to seafood authentication: An updated review. *Crit. Rev. Food Sci. Nutr.* 61(22):3904–3935.

Ferri E., Galimberti A., Casiraghi M., Airoldi C., Ciaramelli C., Palmioli A., Mezzasalma V., Bruni I., Labra M. (2015) Towards a universal approach based on omics technologies for the quality control of food. *BioMed Res. Int.* 2015:365794.

Floren C., Wiedemann I., Brenig B., Schütz E., Beck J. (2015) Species identification and quantification in meat and meat products using droplet digital PCR (ddPCR). *Food Chem*. 173:1054–1058.

García-González M., Moreno J., Manzano J.C., Florencio F.J., Guerrero M.G. (2005) Production of Dunaliella salina biomass rich in 9-cis-beta-carotene and lutein in a closed tubular photobioreactor. *J. Biotechnol.* 115(1):81–90.

Hassoun A., Siddiqui S.A., Smaoui S., Ucak I., Arshad R.N., Garcia-Oliveira P., Prieto M.A., Aït-Kaddour A., Perestrelo R., Câmara J.S., Bono G. (2022) Seafood processing, preservation, and analytical techniques in the age of Industry 4.0. *Appl. Sci*. 12:1703. doi:10.3390/app12031703.

Hicks C.C., Cohen P.J., Graham N.A.J., Nash K.L., Allison E.H., D'Lima C., Mills D.J., Roscher M., Thilsted S.H., Thorne-Lyman A.L., MacNeil M.A. (2019) Harnessing global fisheries to tackle micronutrient deficiencies. *Nature*. 574(7776):95–98. doi:10.1038/s41586-019-1592-6.

Hosomi R., Yoshida M., Fukunaga K. (2012) Seafood consumption and components for health. *Glob. J. Health Sci.* 4(3):72–86. doi:10.5539/gjhs.v4n3p72.

Houweling A.H., Vanstone C.A., Trautwein E.A., Duchateau G.S.M.J.E., Jones P.J.H. (2009) Baseline plasma plant sterol concentrations do not predict changes in serum lipids, C-reactive protein (CRP) and plasma plant sterols following intake of a plant sterol-enriched food. *Eur. J. Clin. Nutr.* 63(4):543–551. doi:10.1016/j.chemosphere.2021.133499.

Iwamoto T., Hosoda K., Hirano R., Kurata H., Matsumoto A., Miki W., Kamiyama M., Itakura H., Yamamoto S., Kondo K. (2000) Inhibition of low-density lipoprotein oxidation by astaxanthin. *J. Atheroscler. Thromb.* 7(4):216–222.

Jiménez-Escrig A., Sánchez-Muniz F.J. (2000) Dietary fibre from edible seaweeds: Chemical structure, physicochemical properties and effects on cholesterol metabolism. *Nutr. Res*. 20(4):585–598.

Jinadasa B.K.K.K., Elliott C., Jayasinghe G.D.T.M. (2022) A review of the presence of formaldehyde in fish and seafood. *Food Control*. 136:108882. doi:10.1016/j.foodcont.2022.108882.

Jones P.J., Raeini-Sarjaz M., Ntanios F.Y., Vanstone C.A., Feng J.Y., Parsons W.E. (2000) Modulation of plasma lipid levels and cholesterol kinetics by phytosterol versus phytostanol esters. *J. Lipid Res.* 41(5):697–705.

Kanazawa, A. (2001) Sterols in marine invertebrates. *Fisheries Science* 67(6): 997–1007.

Khaksar R., Carlson T., Schaffner D.W., Ghorashi M., Best D., Jandhyala S., Traverso J. Amini S. (2015) Unmasking seafood mislabeling in US markets: DNA barcoding as a unique technology for food authentication and quality control. *Food Control*. 56:71–76.

La Nasa J., Biale G., Fabbri D., Modugno F. (2020) A review on challenges and developments of analytical pyrolysis and other thermo-analytical techniques for the quali-quantitative determination of microplastics. *J. Anal. Appl. Pyrolysis*. 149:104841. doi:10.1016/j.jaap.2020.104841.

Liu J., Shao Y., Yuan C., Takaki K., Li Y., Ying Y., Hu Y. (2021) Eugenol-chitosan nanoemulsion as an edible coating: Its impact on physicochemical, microbiological and sensorial properties of hairtail (*Trichiurus haumela*) during storage at 4°C. *Int. J. Biol. Macromol.* 183:2199–2204.

Lopata A.L., Kamath S. (2012) Shellfish allergy diagnosis-gaps and needs. *Curr. Opin. Allergy Clin. Immunol.* 25(2):60–66.

Lopata A.L., Kleine-Tebbe J., Kamath S.D. (2016) Allergens and molecular diagnostics of shellfish allergy: Part 22 of the Series Molecular Allergology. *Allergo. J.* 25:24–32.

Lusher A., Hollman P., Mendoza-Hill J. (2017) Microplastics in fisheries and aquaculture: Status of knowledge on their occurrence and implications for aquatic organisms and food safety. FAO Fisheries and Aquaculture Technical Paper, 615.

Mannarino E., Pirro M., Cortese C., Lupattelli G., Siepi D., Mezzetti A., Bertolini S., Parillo M., Fellin R., Pujia A., Averna M., Nicolle C., Notarbartolo A. (2009) Effects of a phytosterol-enriched dairy product on lipids, sterols and 8-isoprostane in hypercholesterolemic patients: A multicenter Italian study. *Nutr. Metab. Cardiovasc. Dis*. 19(2):84–90.

Marwaha N., Beveridge Malcolm C.M., Phillips Michael J. (2022) Fad, food, or feed: Alternative seafood and its contribution to food systems. *Front. Sustain. Food Syst.* 6:2022. doi:10.3389/fsufs.2022.750253.

Marx Í.M. (2023) Emerging trends of electrochemical sensors in food analysis. *Electrochem*. 4(1):42–46.

Matsushima K., Schimmel H., Wyrowski F. (2003) Fast calculation method for optical diffraction on tilted planes by use of the angular spectrum of plane waves. *JOSA A*. 20(9):1755–1762.

Mintenig S.M., Bäuerlein P.S., Koelmans A.A., Dekker S.C., van Wezel A.P. (2018) Closing the gap between small and smaller: Towards a framework to analyse nano-and microplastics in aqueous environmental samples. *Environ. Sci. Nano*. 5:1640–1649. doi:10.1039/C8EN00186C.

Mishra G.K., Barfidokht A., Tehrani F., Mishra R.K. (2018) Food safety analysis using electrochemical biosensors. *Foods*. 7(9):141.

Murata, M., Sano Y., Bannai S., Ishihara K., Matsushima R., Uchida M. (2004) Fish protein stimulated the fibrinolysis in rats. *Annals of Nutrition and Metabolism*. 48(5): 348–356.

Murray F., Cowie P.R. (2011) Plastic contamination in the decapod crustacean *Nephrops norvegicus* (Linnaeus, 1758). *Mar. Pollut. Bull.* 62(6):1207–1217. doi:10.1016/j.marpolbul.2011.03.032.

Noh M.F.M., Gunasegavan R.D.N., Mustafa Khalid N., Balasubramaniam V., Mustar S., Abd Rashed A. (2020) Recent techniques in nutrient analysis for food composition database. *Molecules*. 25(19):4567.

OECD FAO. (2022) OECD-FAO *Agricultural Outlook*, *FAO, 2022–2031*.

Oishi Y., Dohmoto N. (2009) Alaska pollack protein prevents the accumulation of visceral fat in rats fed a high fat diet. *J. Nutr. Sci. Vitaminol. (Tokyo).* 55(2):156–161. doi:10.3177/jnsv.55.156.

Parlapani F.F., Ferrocino I., Michailidou S., Argiriou A., Haroutounian S.A., Kokokiris L., Rantsiou K., Boziaris I.S. (2020) Microbiota and volatilome profile of fresh and chill-stored deepwater rose shrimp (Parapenaeus longirostris). *Food Res. Int.* 132:109057.

Qiu L., Zhang M., Bhandari B., Yang C. (2020) Shelf life extension of aquatic products by applying nanotechnology: A review. *Crit. Rev. Food Sci. Nutr*. 0:1–15.

Ranadheera C.S., Prasanna P.H.P., Vidanarachchi J.K., McConchie R., Naumovski N., Mellor D. (2017) Nanotechnology in Microbial Food Safety. In: *Nanotechnology Applications in Food: Flavor, Stability, Nutrition and Safety*; Elsevier Inc.: Amsterdam, The Netherlands. pp. 245–265. ISBN 9780128119433.

Reames E. (2012) *Nutritional Benefits of Seafood*. Southern Regional Aquaculture Center.

Renner G., Schmidt T.C., Schram J. (2018) Analytical methodologies for monitoring micro(nano)plastics: Which are fit for purpose? *Curr. Opin. Environ. Sci. Health*. 1:55–61. doi:10.1016/j.coesh.2017.11.001.

Ribeiro F., Okoffo E.D., O'Brien J.W., Fraissinet-Tachet S., O'Brien S., Gallen M., Samanipour S., Kaserzon S., Mueller J.F., Galloway T., Thomas K.V. (2020) Quantitative analysis of selected plastics in high-commercial-value Australian Seafood by pyrolysis gas chromatography mass spectrometry. *Environ. Sci. Technol.* 54:9408–9417. doi:10.1021/acs.est.0c02337.

Ritchie, H., Roser, M. (2020). Energy—Our World in Data. https://scirp.org/reference/referencespapers?referenceid=2943205

Rovina K., Vonnie J.M., Shaeera S.N., Yi S.X., Abd Halid N.F. (2020) Development of biodegradable hybrid polymer film for detection of formaldehyde in seafood products. *Sens. Bio-Sens. Res.* 27:100310. doi:10.1016/j.sbsr.2019.100310.

Ruethers T., Taki A.C., Johnston E.B., Nugraha R., Le T.T.K., Kalic T., McLean T.R., Kamath S.D., Lopata A.L. (2018) Seafood allergy: A comprehensive review of fish and shellfish allergens. *Mol. Immunol*. 100:28–57. doi:10.1016/j.molimm.2018.04.008. Epub 2018 May 30. PMID: 29858102.

Schaffer S.W, Jong C.J., Ramila K.C., Azuma J. (2010) Physiological roles of taurine in heart and muscle. *J. Biomed. Sci.* 17(Suppl 1):S2.

Teuten E.L., Saquing J.M., Knappe D.R.U., Barlaz M.A., Jonsson S., Björn A., Rowland S.J., Thompson R.C., Galloway T.S., Yamashita R., Ochi D., Watanuki Y., Moore C., Viet P.H., Tana T.S., Prudente M., Boonyatumanond R., Zakaria M.P., Akkhavong K., Ogata Y., Hirai H., Iwasa S., Mizukawa K., Hagino Y., Imamura A., Saha M., Takada H. (2009) Transport and release of chemicals from plastics to the environment and to wildlife. *Philos. Trans. R. Soc. Lond. Ser. B. Biol. Sci.* 364(1526):2027–2045. doi:10.1098/rstb.2008.0284.

Thakur M. (2019) Marine Bioactive Components: Sources, Health Benefits, and Future Prospects. In: *Technological Processes for Marine Foods, from Water to Fork*; Apple Academic Press. pp. 61–72.

Vandamme S.G., Griffiths A.M., Taylor S.A., Di Muri C., Hankard E.A., Towne J.A., Watson M., Mariani S. (2016) Sushi barcoding in the UK: Another kettle of fish. *Peer J.* 4:e1891.

Villicaña C., Amarillas L., Soto-Castro L., Gómez-Gil B., Lizárraga-Partida M.L., León-Félix J. (2019) Occurrence and abundance of pathogenic vibrio species in raw oysters at retail seafood markets in Northwestern Mexico. *J. Food Prot.* 82:2094–2099. doi:10.4315/0362-028X.JFP-19-237.

Woo C.K., Bahna S.L. (2011) Not all shellfish "allergy" is allergy! *Clin. Transl. Allergy*. 1(1):3. doi:10.1186/2045-7022-1-3.

Yoshizawa K., Rimm E.B., Morris J.S., Spate V.L., Hsieh C.-C., Spiegelman D., Stampfer M.J., Willett W.C. (2002) Mercury and the risk of coronary heart disease in men. *New Engl. J. Med.* 347:1755–1760.

Young W., Wiggins S., Limm W., Fisher C.M., DeJager L., Genualdi S. (2022) Analysis of per-and poly (fluoroalkyl) substances (PFASs) in highly consumed seafood products from US Markets. *J. Agric. Food Chem.* 70: 13545–13553.

Zhang W., Tang Y., Han Y., Zhou W., Shi W., Teng S., Ren P., Xiao G., Li S., Liu G. (2022) Microplastics boost the accumulation of tetrabromobisphenol A in a commercial clam and elevate corresponding food safety risks. *Chemosphere*. 292:133499. doi: 10.1016/j.chemosphere.2021.133499. Epub 2021 Dec 31. PMID: 34979205.

Introduction

Adams S. , Lopata A.L. , Smuts C.M. , Baatjies R. , Jeebhay M.F. (2019) Relationship between serum omega-3 fatty acid and asthma endpoints. Int. J. Environ. Res. Public Health. 16:43. doi:10.3390/ijerph16010043.

Ainsworth G.B. , Pita P. , Rodrigues J.G. , Pita C. , Roumbedakis K. , Fonseca T. , Castelo D. Longo C. , Power A.M. , Pierce G.J. , Villasante S. (2023) Disentangling global market drivers for cephalopods to foster transformations towards sustainable seafood systems. People Nat. 5(2):508–528.

Andrady A.L. (2011) Microplastics in the marine environment. Mar. Pollut. Bull. 62(8):1596–1605. doi:10.1016/j.marpolbul.2011.05.030.

Arisawa K. , Matsumura T. , Tohyama C. , Saito H. , Satoh H. , Nagai M. , Morita M. , Suzuki T. (2003) Fish intake, plasma omega-3 polyunsaturated fatty acids, and polychlorinated dibenzo-p-dioxins/polychlorinated dibenzo-furans and co-planar polychlorinated biphenyls in the blood of the Japanese population. Int. Arch. Occup. Environ. Health. 76(3):205–215.

Bouic P.J. (2001) The role of phytosterols and phytosterolins in immune modulation: A review of the past 10 years. Curr. Opin. Clin. Nutr. Metab. Care. 4(6):471–475. doi:10.1097/00075197-200111000-00001.

Boukortt F.O. , Girard A. , Prost J. , Bouchenak M. , Belleville J. (2004) Effect of fish protein on blood pressure, glycemia and plasma and urinary parameters in spontaneously hypertensive rats (SHR) and diabetic SHR. J. Hypertens. 22(8):A1–A2.

Buyuktiryaki B. , Masini M. , Mori F. , Barni S. , Liccioli G. , Sarti L. , Lodi L. , Giovannini M. , du Toit G. , Lopata A.L. , Marques-Mejias M.A. (2021) IgE-Mediated fish allergy in children. Medicina (Kaunas). 57(1):76. doi:10.3390/medicina57010076.

Christiansen H. , Fournier N. , Hellemans B. , Volckaert F.A. (2018) Seafood substitution and mislabeling in Brussels' restaurants and canteens. Food Control. 85:66–75.

Cicero A.F.G. , Nascetti S. , López-Sabater M.C. , Elosua R. , Salonen J.T. , Nyyssonen K. , Poulsen H.E. , Zunft H.-J.F. , Kiesewetter H. , de la Torre K. , Covas M.-I. , Kaikkonen J. , Mursu J. , Koenbick C. , Bäumler H. , Gaddi A.V. (2008) Changes in LDL fatty acid composition as a response to olive oil treatment are inversely related to lipid oxidative damage: The EUROLIVE study. J. Am. Coll. Nutr. 27(2):314–320.

Clarkson T.W. , Magos L. , Myers G.J. (2003) The toxicology of mercury-current exposures and clinical manifestations. N. Engl. J. Med. 349(18):1731–1737.

Cook P.W. , Nightingale K.K. (2018) Use of omics methods for the advancement of food quality and food safety. Anim. Front. 8(4):33–41.

Danopoulos E. , Twiddy M. , Rotchell J.M. (2020) Microplastic contamination of drinking water: A systematic review. PloS One. 15(7):e0236838.

De Sales-Ribeiro C. , Brito-Casillas Y. , Fernandez A. , Caballero M.J. (2020) An end to the controversy over the microscopic detection and effects of pristine microplastics in fish organs. Sci. Rep. 10(1):12434.

den Besten H.M. , Amézquita A. , Bover-Cid S. , Dagnas S. , Ellouze M. , Guillou S. , Nychas G. , O'Mahony C. , Pérez-Rodriguez F. , Membré J.M. (2018) Next generation of microbiological risk assessment: Potential of omics data for exposure assessment. Int. J. Food Microbiol. 287:18–27.

Duis K , Coors A. (2016) Microplastics in the aquatic and terrestrial environment: Sources (with a specific focus on personal care products), fate and effects. Environ. Sci. Eur. 28(1):2.

EFSA (2014) Endogenous formaldehyde turnover in humans compared with exogenous contribution from food sources. EFSA J. 12:3550.

EFSA (2016) Presence of microplastics and nanoplastics in food, with particular focus on seafood. EFSA J. 14(6):4501.

FAO (2022) Total seafood production by country 1961–2020. Food and Agriculture Organization of the United Nations, https://www.fao.org/faostat/en/#data/FBS (accessed on 15 May 2023).

Fernandes T.J. , Amaral J.S. , Mafra I. (2021) DNA barcode markers applied to seafood authentication: An updated review. Crit. Rev. Food Sci. Nutr. 61(22):3904–3935.

Ferri E. , Galimberti A. , Casiraghi M. , Airoldi C. , Ciaramelli C. , Palmioli A. , Mezzasalma V. , Bruni I. , Labra M. (2015) Towards a universal approach based on omics technologies for the quality control of food. BioMed Res. Int. 2015:365794.

Floren C. , Wiedemann I. , Brenig B. , Schütz E. , Beck J. (2015) Species identification and quantification in meat and meat products using droplet digital PCR (ddPCR). Food Chem. 173:1054–1058.

García-González M. , Moreno J. , Manzano J.C. , Florencio F.J. , Guerrero M.G. (2005) Production of Dunaliella salina biomass rich in 9-cis-beta-carotene and lutein in a closed tubular photobioreactor. J. Biotechnol. 115(1):81–90.

Hassoun A. , Siddiqui S.A. , Smaoui S. , Ucak I. , Arshad R.N. , Garcia-Oliveira P. , Prieto M.A. , Aït-Kaddour A. , Perestrelo R. , Câmara J.S. , Bono G. (2022) Seafood processing, preservation, and analytical techniques in the age of Industry 4.0. Appl. Sci. 12:1703. doi:10.3390/app12031703.

Hicks C.C. , Cohen P.J. , Graham N.A.J. , Nash K.L. , Allison E.H. , D'Lima C. , Mills D.J. , Roscher M. , Thilsted S.H. , Thorne-Lyman A.L. , MacNeil M.A. (2019) Harnessing global fisheries to tackle micronutrient deficiencies. Nature. 574(7776):95–98. doi:10.1038/s41586-019-1592-6.

Hosomi R. , Yoshida M. , Fukunaga K. (2012) Seafood consumption and components for health. Glob. J. Health Sci. 4(3):72–86. doi:10.5539/gjhs.v4n3p72.

Houweling A.H. , Vanstone C.A. , Trautwein E.A. , Duchateau G.S.M.J.E. , Jones P.J.H. (2009) Baseline plasma plant sterol concentrations do not predict changes in serum lipids, C-reactive protein (CRP) and plasma plant sterols following intake of a plant sterol-enriched food. Eur. J. Clin. Nutr. 63(4):543–551. doi:10.1016/j.chemosphere.2021.133499.

Iwamoto T. , Hosoda K. , Hirano R. , Kurata H. , Matsumoto A. , Miki W. , Kamiyama M. , Itakura H. , Yamamoto S. , Kondo K. (2000) Inhibition of low-density lipoprotein oxidation by astaxanthin. J. Atheroscler. Thromb. 7(4):216–222.

Jiménez-Escrig A. , Sánchez-Muniz F.J. (2000) Dietary fibre from edible seaweeds: Chemical structure, physicochemical properties and effects on cholesterol metabolism. Nutr. Res. 20(4):585–598.

Jinadasa B.K.K.K. , Elliott C. , Jayasinghe G.D.T.M. (2022) A review of the presence of formaldehyde in fish and seafood. Food Control. 136:108882. doi:10.1016/j.foodcont.2022.108882.

Jones P.J. , Raeini-Sarjaz M. , Ntanios F.Y. , Vanstone C.A. , Feng J.Y. , Parsons W.E. (2000) Modulation of plasma lipid levels and cholesterol kinetics by phytosterol versus phytostanol esters. J. Lipid Res. 41(5):697–705.

Kanazawa, A. (2001) Sterols in marine invertebrates. Fisheries Science 67(6): 997–1007.

Khaksar R. , Carlson T. , Schaffner D.W. , Ghorashi M. , Best D. , Jandhyala S. , Traverso J. Amini S. (2015) Unmasking seafood mislabeling in US markets: DNA barcoding as a unique technology for food authentication and quality control. Food Control. 56:71–76.

La Nasa J. , Biale G. , Fabbri D. , Modugno F. (2020) A review on challenges and developments of analytical pyrolysis and other thermo-analytical techniques for the quali-quantitative determination of microplastics. J. Anal. Appl. Pyrolysis. 149:104841. doi:10.1016/j.jaap.2020.104841.

Liu J. , Shao Y. , Yuan C. , Takaki K. , Li Y. , Ying Y. , Hu Y. (2021) Eugenol-chitosan nanoemulsion as an edible coating: Its impact on physicochemical, microbiological and sensorial properties of hairtail (*Trichiurus haumela*) during storage at 4°C. Int. J. Biol. Macromol. 183:2199–2204.

Lopata A.L. , Kamath S. (2012) Shellfish allergy diagnosis-gaps and needs. Curr. Opin. Allergy Clin. Immunol. 25(2):60–66.

Lopata A.L. , Kleine-Tebbe J. , Kamath S.D. (2016) Allergens and molecular diagnostics of shellfish allergy: Part 22 of the Series Molecular Allergology. Allergo. J. 25:24–32.

Lusher A. , Hollman P. , Mendoza-Hill J. (2017) Microplastics in fisheries and aquaculture: Status of knowledge on their occurrence and implications for aquatic organisms and food safety. FAO Fisheries and Aquaculture Technical Paper, 615.

Mannarino E. , Pirro M. , Cortese C. , Lupattelli G. , Siepi D. , Mezzetti A. , Bertolini S. , Parillo M. , Fellin R. , Pujia A. , Averna M. , Nicolle C. , Notarbartolo A. (2009) Effects of a phytosterol-enriched dairy product on lipids, sterols and 8-isoprostane in hypercholesterolemic patients: A multicenter Italian study. Nutr. Metab. Cardiovasc. Dis. 19(2):84–90.

Marwaha N. , Beveridge Malcolm C.M. , Phillips Michael J. (2022) Fad, food, or feed: Alternative seafood and its contribution to food systems. Front. Sustain. Food Syst. 6:2022. doi:10.3389/fsufs.2022.750253.

Marx Í.M. (2023) Emerging trends of electrochemical sensors in food analysis. Electrochem. 4(1):42–46.

Matsushima K. , Schimmel H. , Wyrowski F. (2003) Fast calculation method for optical diffraction on tilted planes by use of the angular spectrum of plane waves. JOSA A. 20(9):1755–1762.

Mintenig S.M. , Bäuerlein P.S. , Koelmans A.A. , Dekker S.C. , van Wezel A.P. (2018) Closing the gap between small and smaller: Towards a framework to analyse nano-and microplastics in aqueous environmental samples. Environ. Sci. Nano. 5:1640–1649. doi:10.1039/C8EN00186C.

Mishra G.K. , Barfidokht A. , Tehrani F. , Mishra R.K. (2018) Food safety analysis using electrochemical biosensors. Foods. 7(9):141.

Murata, M. , Sano Y. , Bannai S. , Ishihara K. , Matsushima R. , Uchida M. (2004) Fish protein stimulated the fibrinolysis in rats. Annals of Nutrition and Metabolism. 48(5): 348–356.

Murray F. , Cowie P.R. (2011) Plastic contamination in the decapod crustacean *Nephrops norvegicus* (Linnaeus, 1758). Mar. Pollut. Bull. 62(6):1207–1217. doi:10.1016/j.marpolbul.2011.03.032.

Noh M.F.M. , Gunasegavan R.D.N. , Mustafa Khalid N. , Balasubramaniam V. , Mustar S. , Abd Rashed A. (2020) Recent techniques in nutrient analysis for food composition database. Molecules. 25(19):4567.

OECD FAO . (2022) OECD-FAO Agricultural Outlook, FAO, 2022–2031.

Oishi Y. , Dohmoto N. (2009) Alaska pollack protein prevents the accumulation of visceral fat in rats fed a high fat diet. J. Nutr. Sci. Vitaminol. (Tokyo). 55(2):156–161. doi:10.3177/jnsv.55.156.

Parlapani F.F. , Ferrocino I. , Michailidou S. , Argiriou A. , Haroutounian S.A. , Kokokiris L. , Rantsiou K. , Boziaris I.S. (2020) Microbiota and volatilome profile of fresh and chill-stored deepwater rose shrimp (Parapenaeus longirostris). Food Res. Int. 132:109057.

Qiu L. , Zhang M. , Bhandari B. , Yang C. (2020) Shelf life extension of aquatic products by applying nanotechnology: A review. Crit. Rev. Food Sci. Nutr. 0:1–15.

Ranadheera C.S. , Prasanna P.H.P. , Vidanarachchi J.K. , McConchie R. , Naumovski N. , Mellor D. (2017) Nanotechnology in Microbial Food Safety. In: Nanotechnology Applications in Food: Flavor, Stability, Nutrition and Safety; Elsevier Inc.: Amsterdam, The Netherlands. pp. 245–265. ISBN 9780128119433.

Reames E. (2012) Nutritional Benefits of Seafood. Southern Regional Aquaculture Center.

Renner G. , Schmidt T.C. , Schram J. (2018) Analytical methodologies for monitoring micro(nano)plastics: Which are fit for purpose? Curr. Opin. Environ. Sci. Health. 1:55–61. doi:10.1016/j.coesh.2017.11.001.
Ribeiro F. , Okoffo E.D. , O'Brien J.W. , Fraissinet-Tachet S. , O'Brien S. , Gallen M. , Samanipour S. , Kaserzon S. , Mueller J.F. , Galloway T. , Thomas K.V. (2020) Quantitative analysis of selected plastics in high-commercial-value Australian Seafood by pyrolysis gas chromatography mass spectrometry. Environ. Sci. Technol. 54:9408–9417. doi:10.1021/acs.est.0c02337.
Ritchie, H. , Roser, M. (2020). Energy—Our World in Data. https://scirp.org/reference/referencespapers?referenceid=2943205
Rovina K. , Vonnie J.M. , Shaeera S.N. , Yi S.X. , Abd Halid N.F. (2020) Development of biodegradable hybrid polymer film for detection of formaldehyde in seafood products. Sens. Bio-Sens. Res. 27:100310. doi:10.1016/j.sbsr.2019.100310.
Ruethers T. , Taki A.C. , Johnston E.B. , Nugraha R. , Le T.T.K. , Kalic T. , McLean T.R. , Kamath S.D. , Lopata A.L. (2018) Seafood allergy: A comprehensive review of fish and shellfish allergens. Mol. Immunol. 100:28–57. doi:10.1016/j.molimm.2018.04.008. Epub 2018 May 30. PMID: 29858102.
Schaffer S.W. , Jong C.J. , Ramila K.C. , Azuma J. (2010) Physiological roles of taurine in heart and muscle. J. Biomed. Sci. 17(Suppl 1):S2.
Teuten E.L. , Saquing J.M. , Knappe D.R.U. , Barlaz M.A. , Jonsson S. , Björn A. , Rowland S.J. , Thompson R.C. , Galloway T.S. , Yamashita R. , Ochi D. , Watanuki Y. , Moore C. , Viet P.H. , Tana T.S. , Prudente M. , Boonyatumanond R. , Zakaria M.P. , Akkhavong K. , Ogata Y. , Hirai H. , Iwasa S. , Mizukawa K. , Hagino Y. , Imamura A. , Saha M. , Takada H. (2009) Transport and release of chemicals from plastics to the environment and to wildlife. Philos. Trans. R. Soc. Lond. Ser. B. Biol. Sci. 364(1526):2027–2045. doi:10.1098/rstb.2008.0284.
Thakur M. (2019) Marine Bioactive Components: Sources, Health Benefits, and Future Prospects. In: Technological Processes for Marine Foods, from Water to Fork; Apple Academic Press. pp. 61–72.
Vandamme S.G. , Griffiths A.M. , Taylor S.A. , Di Muri C. , Hankard E.A. , Towne J.A. , Watson M. , Mariani S. (2016) Sushi barcoding in the UK: Another kettle of fish. Peer J. 4:e1891.
Villicaña C. , Amarillas L. , Soto-Castro L. , Gómez-Gil B. , Lizárraga-Partida M.L. , León-Félix J. (2019) Occurrence and abundance of pathogenic vibrio species in raw oysters at retail seafood markets in Northwestern Mexico. J. Food Prot. 82:2094–2099. doi:10.4315/0362-028X.JFP-19-237.
Woo C.K. , Bahna S.L. (2011) Not all shellfish "allergy" is allergy! Clin. Transl. Allergy. 1(1):3. doi:10.1186/2045-7022-1-3.
Yoshizawa K. , Rimm E.B. , Morris J.S. , Spate V.L. , Hsieh C.-C. , Spiegelman D. , Stampfer M.J. , Willett W.C. (2002) Mercury and the risk of coronary heart disease in men. New Engl. J. Med. 347:1755–1760.
Young W. , Wiggins S. , Limm W. , Fisher C.M. , DeJager L. , Genualdi S. (2022) Analysis of per-and poly (fluoroalkyl) substances (PFASs) in highly consumed seafood products from US Markets. J. Agric. Food Chem. 70: 13545–13553.
Zhang W. , Tang Y. , Han Y. , Zhou W. , Shi W. , Teng S. , Ren P. , Xiao G. , Li S. , Liu G. (2022) Microplastics boost the accumulation of tetrabromobisphenol A in a commercial clam and elevate corresponding food safety risks. Chemosphere. 292:133499. doi: 10.1016/j.chemosphere.2021.133499. Epub 2021 Dec 31. PMID: 34979205.

Peptides and Proteins

Aitken, A. and Learmonth, M. P. 2002. Protein Determination by UV Absorption, In The Protein Protocols Handbook, 2nd Edition, Edited by: J. M. Walker , Humana Press Inc., Totowa, NJ pp. 3–6.
Baron, C. P. ; Kjærsgård, I. V. H. ; Jessen, F. and Jacobsen, C. 2007. Protein and lipid oxidation during frozen storage of rainbow trout (Oncorhynchus mykiss). J. Agric. Food Chem. 55, 8118–8125.
Bauchart, C. , Chambon, C. , Mirand, P. P. , Savary-Auzeloux, I. , Rémond, D. , and Morzel, M. 2007. Peptides in rainbow trout (Oncorhynchus mykiss) muscle subjected to ice storage and cooking. Food Chem., 100(4), 1566–1572. doi: 10.1016/j.foodchem.2005.12.023.
Benjakul, S. and Bauer, F. 2000. Physicochemical and enzymatic changes of cod muscle proteins subjected to different freeze-thaw cycles. J. Sci. Food Agric. 80, 1143–1150.
Bergvik, M. ; Overrein, I. ; Bantle, M. ; Evjemo, J.O. and Turid Rustad, T. 2012. Properties of Calanus finmarchicus biomass during frozen storage after heat inactivation of autolytic enzymes, Food Chem. 132(1), 209–215. doi:10.1016/j.foodchem.2011.10.058.
Bowker, B. 2017. Developments in Our understanding of water-holding capacity. In Poultry Quality Evaluation. Edited by: Petracci, M. & Berri, Woodhead Publishing. pp. 77–113. doi: 10.1016/B978-0-08-100763-1.00004-0.
Bradford, M. A. 1976. A rapid and sensitive method for the quantification of microgram quantities of protein using the principle of protein-dye binding. Anal. Biochem. 72, 248–254.
Chalamaiah, M. ; Dinesh Kumar, B. ; Hemalatha, R. and Jyothirmayiet, T. 2012. Fish protein hydrolysates: Proximate composition, amino acid composition, antioxidant activities and applications: A review. Food Chem.

135, 3020–3038. doi:10.1016/j.foodchem.2012.06.100.
Chan, S. T. ; Roth, B. ; Jessen, F. ; Jakobsen, A. N. and Lerfall, J. 2021. Water holding properties of Atlantic salmon. Comp. Rev Food Sci Food Saf. 1–22. doi:10.1111/1541-4337.12871.
Chan, S. T. ; Roth, B. ; Skare, M. ; Hernar, M. ; Jessen, F. ; Løvdal, T. ; Jakobsen, A. J. and Lerfall, J. 2020. Effect of chilling technologies on water holding properties and other quality parameters throughout the whole value chain: From whole fish to cold-smoked fillets of Atlantic salmon (Salmo salar). Aquaculture. 526, 735381. doi:10.1016/j.aquaculture.
Elavarasan, K. ; Naveen Kumar, V. and Shamasundar, B. A. 2014. Antioxidant and functional properties of (FPH) from freshwater carp (*Catla catla*) as influenced by the nature of enzyme. J. Food Process. Preser. 38, 1207–1214.
Faisal, M. ; Vasiljevic, T. and Donkor, O. N. 2019. A review on methodologies for extraction, identification and quantification of allergenic proteins in prawns. Food Res. Int. (Ottawa, ON). 121, 307–318. doi:10.1016/j.foodres.2019.03.040.
Fu, L. ; Cherayil, B. J. ; Shi, H. ; Wang, Y. and Zhu, Y. 2019. Detection and Quantification Methods for Food Allergens, In Food Allergy-From molecular mechanisms to control strategies (Edited by: Fu, L. , Cherayil, B. J. , Shi, H. , Wang, Y. and Zhu, Y.) Springer, Singapore. pp 69–71. doi:10.1007/978-981-13-6928-5_4
Hematyar, N. ; Rustad, T. ; Sampels, S. and Kastrup Dalsgaard, T. 2019. Relationship between lipid and protein oxidation in fish. Aquac Res. 50, 1393–1403. doi:10.1111/are.14012
Hjellnes, V. H. ; Slizyte, R. ; Rustad, T. ; Carvajal, A. K. and Greiff, K. 2020. Utilization of egg-laying hens (Gallus Gallus domesticus) for production of ingredients for human consumption and animal feed. BMC Biotechnol. 20, art. 22.
Hultmann, L. and Rustad, T. 2002. Textural changes during iced storage of salmon (*Salmo salar) and cod (Gadus morhua)* . J. Aquatic Food Product Technol. 11(3/4), 105–123.
Hultmann, L. and Rustad, T. 2004. Iced storage of Atlantic salmon (Salmo salar) – Effects on endogenous enzymes and their impact on muscle proteins and texture. Food Chem. 87(1), 31–41.
Hultmann, L. ; Bencze Rørå, A. M. ; Steinsland, I. ; Skåra, T. and Rustad, T. 2004. Proteolytic activity and properties of proteins in smoked salmon (Salmo salar) – Effects of smoking temperature. Food Chem. 85(3), 377–387.
Johns, P. W. ; Jacobs, W. A. ; Phillips, R. R. ; McKenna, R. J. ; O'Kane, K. A. and McEwen, J. W. 2011. Characterisation of peptide molecular mass distribution in commercial hydrolysates and hydrolysate-based nutritional products. Food Chem. 125(3), 1041–1050.
Kinsella, J. E. , & Melachouris, N. 1976. Functional properties of proteins in foods: A survey. CRC Critical Reviews in Food Science and Nutrition, 7(3), 219–280. doi: 10.1080/10408397609527208.
Kinsella, J. E. 1982. Protein structure and functional properties: emulsification and flavor binding effects. In ACS Symposium Series, Food Protein deterioration, 206, Chapter 12, 301–326. doi:10.1021/bk-1982-0206.
Kruger, N. J. 2002. The Bradford Method for Protein Quantitation, In The Protein Protocols Handbook, 2nd Edition, Edited by: J. M. Walker , Humana Press Inc., Totowa, NJ, 17–24.
Lam, R. S. H. and Nickerson, M. T. 2013. Food proteins: A review on their emulsifying properties using a structure-function approach. Food Chem. 141, 975–984. doi:10.1016/j.foodchem.2013.04.038.
Lam, A. ; Can Karaca, A. , Tyler, R. and Nickerson, M. 2018. Pea protein isolates: Structure, extraction, and functionality. Food Rev. Int. 34(2), 126–147.
Le, H. , Ting, L. , Jun, C. , and Weng, W. 2018. Gelling properties of myofibrillar protein from abalone (Haliotis Discus Hannai Ino) muscle. Int. J. Food Prop., 21(1), 277–288. doi: 10.1080/10942912.2018.1454463.
Li, J. ; Wang, H. and Cheng, J.-H. 2023. DNA, protein and aptamer-based methods for seafood allergens detection: Principles, comparisons and updated applications. Crit. Rev. Food Sci. Nutr. 63(2), 178–191. doi:10.1080/10408398.2021.1944977.
Liu, R. ; Zhao, S.-M. ; Xiong, S.-B. ; Qui, C.-G. and Xie, B.-J. 2008. Rheological properties of fish actomyosin and pork actomyosin solutions. J. Food Eng. 85, 173–179.
Lowry, G. H. ; Rosebrough, R. J. ; Farr, A. L. and Randall, R. J. 1951. Protein measurements with the Folin phenol reagent. J. Biol. Chem. 193, 263–275.
Lund, M. N. ; Heinonen, M. ; Baron, C. P. and Estévez, M. 2011. Protein oxidation in muscle foods: A review. Mol. Nutr. Food Res. 55(1), 83–95. doi:10.1002/mnfr.201000453.
Mæhre, H. K. , Dalheim, L. , Edvinsen, G. K. , Elvevoll, E. O. and Jensen, I. J. 2018. Protein determination-method matters. Foods. 7(1), 5. doi:10.3390/foods7010005.
Mallikarjunan, P. K. 2016. Physical measurements. In Handbook of frozen food processing and packaging, Edited by: Sun D.W. , 2nd edition, CRC Press, Boca Raton, FL, pp. 549–562.
McClements, D. J. 2015. Food Emulsions, 3rd Edition, CRC Press, Boca Raton, FL.
Noll, J. S. ; Simmonds, D. H. and Bushuk, W. C. 1974. A modified biuret reagent for the determination of protein. Cereal Chem. 52, 610–616.
Ofstad, R. ; Kidman, S. ; Myklebust, R. and Hermansson, A. M. 1993. Liquid holding capacity and structural-changes during heating of fish muscle – Cod (gadus-morhua l) and salmon (salmo-salar). Food Struct. 12(2), 163–174.

Owusu-Apenten, R. K. 2002. Food Protein Analysis, Marcel Dekker, Inc., New York.
Özyurt, G. , Şimşek, A. , Karakaya, B. T. , Aksun, E. T. and Yeşilsu, A. F. 2015. Functional, Physicochemical and Nutritional Properties of Protein from Klunzinger's Ponyfish Extracted by the pH Shifting Method. J. Food Proc. and Pres., 39(6), 1934–1943. doi: 10.1111/jfpp.12432
Purschke, B. ; Tanzmeister, H. ; Meinlschmidt, P. ; Baumgartner, S. ; Lauter, K. and Jäger, H. 2018. Recovery of soluble proteins from migratory locust (Locusta migratoria) and characterisation of their compositional and techno-functional properties. Food Res. Int. 106, 271–279.
Rawdkuen, S. , Sai-Ut, S. , Khamsorn, S. , Chaijan, M. and Benjakul, S. 2009. Biochemical and gelling properties of tilapia surimi and protein recovered using an acid-alkaline process. Food Chem., 112(1), 112–119. https://doi.org/https:/doi.org/10.1016/j.foodchem.2008.05.047
Rohm, H. ; Jaros, D. ; Rockenbauer, C. ; Riedler-Hellrigl, M. ; Uniacke-Lowe, T. and Fox, P. F. 1996. Comparison of ethanol and trichloroacetic acid fractionation for measurement of proteolysis in Emmental cheese. Int. Dairy J. 6, 1069–1077.
Sasidharan, A. and Venugopal, V. 2020. Proteins and co-products from seafood processing discards: Their recovery, functional properties and applications. Waste Biomass Valorization. 11, 5647–5663. doi:10.1007/s12649-019-00812-9.
Sathe, S.K. and Salunkhe, D.K. 1981. Functional Properties of Great Northen Bean (Paeolus vulgaris L.) Protein: Emulsification Foaming, Viscocity and Gelation Properties. Journal of Food Science, 46, 71–81.doi: 10.1111/j.1365-2621.1981.tb14533.x.
Sigurgisladottir, S. , Torrissen, O. Ø. ; Lie, Ø. ; Thomassen, M. and Hafsteinsson, H. 1997. Salmon quality: Methods to determine the quality parameters. Rev. Fish. Sci. 5(3), 223–252. doi:10.1080/10641269709388599.
Skipnes, D. ; Østby, M. L. and Hendrickx, M. E. 2007. A method for characterising cook loss and water holding capacity in heat treated cod (Gadus morhua) muscle. J. Food Eng. 80(4), 1078–1085. doi:10.1016/j.jfoodeng.2006.08.015.
Søvik, S. L. and Rustad, T. 2005. Effect of season and fishing ground on the activity of lipases in byproducts from cod (Gadus morhua). Lwt-Food Sci. Technol. 38, 867–876.
Sun, Y. , Ma, L. , Ma, M. , Zheng, H. , Zhang, X. , Cai, L. , Li, J. , and Zhang, Y. 2018. Texture characteristics of chilled prepared Mandarin fish (Siniperca chuatsi) during storage. Int. J. Food Prop. 21(1), 242–254. doi: 10.1080/10942912.2018.1451343
Taheri, A. ; Anvar, S. A. A. ; Ahari, H. and Fogliano, V. 2013. Comparison the functional properties of protein hydrolysates from poultry by-products and rainbow trout (*Onchorhynchus mykiss*) viscera. Iran. J. Fish. Sci. 12(1), 154–169.
Tian, Y. ; Wang, W. ; Yuan, C. ; Zhang, L. and Liu, J. 2017. Nutritional and digestive properties of protein isolates extracted from the muscle of the common carp using pH-shift processing. J. Food Process. Preserv. 41, e12847.
Van Camp, J. and Dierckx, S. 2004. Proteins, In Handbook of Food Analysis, Physical Characterisation and Nutrient Analysis, Volume I, 2nd Edition, Revised and Expanded, Edited by: L. M. L. Nollet , Marcel Dekker, Inc., New York., pp. 167–202.
Varmbo, G. , Skåra, T. , Olsen, S. O. , and Sivertsvik, M. 2000. Modelling of water holding capacity (WHC) in ground Atlantic salmon (Salmo Salar), as affected by heat, pH and salt content. 30th WEFTA Plenary Meeting, Torshavn, Faroe Islands.
Villamil, O. ; Váquiro, H. and Solanilla, J. F. 2017. Fish viscera protein hydrolysates: Production, potential applications and functional and bioactive properties. Food Chem. 224, 160–171. doi:10.1016/j.foodchem.2016.12.057.
Walker, J. M. 2002. The Bicinchoninic Acid (BCA) Assay for Protein Quantitation, In The Protein Protocols Handbook, 2nd Edition, Edited by: J. M. Walker , Humana Press Inc., Totowa, NJ, 11–15.
Walker, R. , Decker, E. A. and McClements, D. J. 2015. Development of food-grade nanoemulsions and emulsions for delivery of omega-3 fatty acids: Opportunities and obstacles in the food industry. Food Funct. 6, 41–54. doi:10.1039/C4FO00723A.
Warner, R. D. 2014. Measurement of Water Holding Capacity and Colour: Objective and Subjective, In Encyclopedia of Meat Sciences, Volume 2, 2nd Edition, Edited by: Carrick Devine & Michael Dikeman , Elsevier, Academic Press, London, pp. 164–171.
Waterborg, J. H. 2002. The Lowry Method for Protein Quantitation, In The Protein Protocols Handbook, 2nd Edition, Edited by: J. M. Walker , Humana Press Inc., Totowa, NJ, pp. 7–10.
Yang, S. C. and Baldwin, R. E. 2017. Functional Properties of Eggs in Foods, In Egg Science and Technology, Edited by: W. J. Stadelman, D. Newkirk and L. Newby, CRC Press, Boca Raton, FL, pp. 405–463.

Proteomics for Comprehensive Analysis of Seafood Products

Abril, A.G. , Calo-Mata, P. , Böhme, K. , Villa, T.G. , Barros-Velázquez, J. , Pazos, M. , Carrera, M. , 2023. Shotgun proteomics analysis, functional networks, and peptide biomarkers for seafood-originating biogenic-amine-producing bacteria. International Journal of Molecular Sciences 24, 7704.

Abril, A.G. , Villa, T.G. , Calo-Mata, P. , Barros-Velázquez, J. , Carrera, M. , 2022. Application of proteomics to the identification of foodborne pathogens, in: Pedrouso, M.L. , Ruiz, D.F. , Lorenzo, J.M. (Eds.), Food Proteomics, Academic Press, Cambridge, Massachusetts. pp. 337–362.

Addis, M.F. , Cappuccinelli, R. , Tedde, V. , Pagnozzi, D. , Porcu, M.C. , Bonaglini, E. , Roggio, T. , Uzzau, S. , 2010. Proteomic analysis of muscle tissue from gilthead sea bream (Sparus aurata, L.) farmed in offshore floating cages. Aquaculture 309, 245–252.

Aebersold, R. , Mann, M. , 2016. Mass-spectrometric exploration of proteome structure and function. Nature 537, 347–355.

Afzaal, M. , Saeed, F. , Hussain, M. , Shahid, F. , Siddeeg, A. , Al-Farga, A. , 2022. Proteomics as a promising biomarker in food authentication, quality and safety: A review. Food Science & Nutrition 10, 2333–2346.

Agregán, R. , Echegaray, N. , López-Pedrouso, M. , Kharabsheh, R. , Franco, D. , Lorenzo, J.M. , 2021. Proteomic advances in milk and dairy products. Molecules (Basel, Switzerland) 26, 3832.

Ahmed, F. , Kumar, G. , Soliman, F.M. , Adly, M.A. , Soliman, H.A.M. , El-Matbouli, M. , Saleh, M. , 2019. Proteomics for understanding pathogenesis, immune modulation and host pathogen interactions in aquaculture. Comparative Biochemistry and Physiology Part D: Genomics and Proteomics 32, 100625.

Alban, A. , David, S.O. , Bjorkesten, L. , Andersson, C. , Sloge, E. , Lewis, S. , Currie, I. , 2003. A novel experimental design for comparative two-dimensional gel analysis: Two-dimensional difference gel electrophoresis incorporating a pooled internal standard. Proteomics 3, 36–44.

Almeida, A.M. , Bassols, A. , Bendixen, E. , Bhide, M. , Ceciliani, F. , Cristobal, S. , Eckersall, P.D. , Hollung, K. , Lisacek, F. , Mazzucchelli, G. , McLaughlin, M. , Miller, I. , Nally, J.E. , Plowman, J. , Renaut, J. , Rodrigues, P. , Roncada, P. , Staric, J. , Turk, R. , 2015. Animal board invited review: Advances in proteomics for animal and food sciences. Animal: An International Journal of Animal Bioscience 9, 1–17.

Anand, S. , Samuel, M. , Ang, C.-S. , Keerthikumar, S. , Mathivanan, S. , 2017. Label-based and label-free strategies for protein quantitation, in: Keerthikumar, S. , Mathivanan, S. (Eds.), Proteome Bioinformatics, Springer, New York, pp. 31–43.

Aragão, C. , Gonçalves, A.T. , Costas, B. , Azeredo, R. , Xavier, M.J. , Engrola, S. , 2022. Alternative proteins for fish diets: Implications beyond growth. Animals 12, 1211.

Araújo, M.J. , Sousa, M.L. , Felpeto, A.B. , Turkina, M.V. , Fonseca, E. , Martins, J.C. , Vasconcelos, V. , Campos, A. , 2021. Comparison of sample preparation methods for shotgun proteomic studies in aquaculture species. Proteomes 9, 46.

Arshad, N. , Samat, N. , Lee, L.K. , 2022. Insight into the relation between nutritional benefits of aquaculture products and its consumption hazards: A global viewpoint. Frontiers in Marine Science 9, 925463.

Aslam, B. , Basit, M. , Nisar, M.A. , Khurshid, M. , Rasool, M.H. , 2017. Proteomics: Technologies and their applications. Journal of Chromatographic Science 55, 182–196.

Ayer, N. , Côté, R.P. , Tyedmers, P.H. , Martin Willison, J.H. , 2009. Sustainability of seafood production and consumption: An introduction to the special issue. Journal of Cleaner Production 17, 321–324.

Bai, M. , Tang, R. , Li, G. , She, W. , Chen, G. , Shen, H. , Zhu, S. , Zhang, H. , Wu, H. , 2022. High-throughput screening of 756 chemical contaminants in aquaculture products using liquid chromatography/quadrupole time-of-flight mass spectrometry. Food Chemistry: X 15, 100380.

Banerjee, R. , Maheswarappa, N.B. , Mohan, K. , Biswas, S. , 2022. Proteomic approaches for authentication of foods of animal origin, in: Pedrouso, M.L. , Ruiz, D.F. , Lorenzo, J.M. (Eds.), Food Proteomics, Academic Press, Cambridge, Massachusetts, pp. 301–336.

Berrini, A. , Tepedino, V. , Borromeo, V. , Secchi, C. , 2006. Identification of freshwater fish commercially labelled “perch” by isoelectric focusing and two-dimensional electrophoresis. Food Chemistry 96, 163–168.

Bi, H. , Zhong, C. , Shao, M. , Wang, C. , Yi, J. , Qiao, L. , Zhang, J. , 2019. Differentiation and authentication of fishes at the species level through analysis of fish skin by matrix-assisted laser desorption/ionization time-of-flight mass spectrometry. Rapid Communications in Mass Spectrometry 33, 1336–1343.

Bianchi, M. , Hallström, E. , Parker, R.W.R. , Mifflin, K. , Tyedmers, P. , Ziegler, F. , 2022. Assessing seafood nutritional diversity together with climate impacts informs more comprehensive dietary advice. Communications Earth & Environment 3, 188.

Bilić, P. , Kuleš, J. , Galan, A. , Gomes de Pontes, L. , Guillemin, N. , Horvatić, A. , Festa Sabes, A. , Mrljak, V. , Eckersall, P.D. , 2018. Proteomics in veterinary medicine and animal science: Neglected scientific opportunities with immediate impact. Proteomics 18, 1800047.

Bintsis, T. , 2017. Foodborne pathogens. AIMS Microbiology 3, 529–563.

Böhme, K. , Antelo, S.C. , Fernández-No, I.C. , Quintela-Baluja, M. , Barros-Velázquez, J. , Cañas, B. , Calo-Mata, P. , 2016. Detection of foodborne pathogens using MALDI-TOF mass spectrometry, in: Barros-Velázquez, J. (Ed.), Antimicrobial Food Packaging, Academic Press, San Diego, pp. 203–214.

Böhme, K. , Fernández-No, I.C. , Pazos, M. , Gallardo, J.M. , Barros-Velázquez, J. , Cañas, B. , Calo-Mata, P. , 2013. Identification and classification of seafood-borne pathogenic and spoilage bacteria: 16S rRNA

sequencing versus MALDI-TOF MS fingerprinting. Electrophoresis 34, 877–887.
Böhme, K. , Morandi, S. , Cremonesi, P. , Fernández No, I.C. , Barros-Velázquez, J. , Castiglioni, B. , Brasca, M. , Cañas, B. , Calo-Mata, P. , 2012. Characterization of Staphylococcus aureus strains isolated from Italian dairy products by MALDI-TOF mass fingerprinting. Electrophoresis 33, 2355–2364.
Borràs, E. , Sabidó, E. , 2017. What is targeted proteomics? A concise revision of targeted acquisition and targeted data analysis in mass spectrometry. Proteomics 17, 1700180.
Brausch, J.M. , Rand, G.M. , 2011. A review of personal care products in the aquatic environment: Environmental concentrations and toxicity. Chemosphere 82, 1518–1532.
Brown, K.A. , Melby, J.A. , Roberts, D.S. , Ge, Y. , 2020. Top-down proteomics: Challenges, innovations, and applications in basic and clinical research. Expert Review of Proteomics 17, 719–733.
Browning, H. , 2023. Improving welfare assessment in aquaculture. Frontiers in Veterinary Science 10, 1060720.
Burkhart, J.M. , Schumbrutzki, C. , Wortelkamp, S. , Sickmann, A. , Zahedi, R.P. , 2012. Systematic and quantitative comparison of digest efficiency and specificity reveals the impact of trypsin quality on MS-based proteomics. Journal of Proteomics 75, 1454–1462.
But, G.W.-C. , Wu, H.-Y. , Shaw, P.-C. , 2019. Identification of fish species of sushi products in Hong Kong. Food Control 98, 164–173.
Campos, A.M. , de Almeida, A.M. , 2016. Top-down proteomics and farm animal and aquatic sciences. Proteomes 4, 38.
Canellas, A.L.B. , Costa, W.F. , Freitas-Silva, J. , Lopes, I.R. , de Oliveira, B.F.R. , Laport, M.S. , 2022. In sickness and in health: Insights into the application of omics in aquaculture settings under a microbiological perspective. Aquaculture 554, 738132.
Carpenter, D.O. , 2011. Health effects of persistent organic pollutants: The challenge for the Pacific Basin and for the world. Reviews on Environmental Health 26, 61–69.
Carrera, M. , Böhme, K. , Gallardo, J.M. , Barros-Velázquez, J. , Cañas, B. , Calo-Mata, P. , 2017. Characterization of foodborne strains of Staphylococcus aureus by shotgun proteomics: Functional networks, virulence factors and species-specific peptide biomarkers. Frontiers in Microbiology 8, 2458.
Carrera, M. , Cañas, B. , Gallardo, J.M. , 2012. Rapid direct detection of the major fish allergen, parvalbumin, by selected MS/MS ion monitoring mass spectrometry. Journal of Proteomics 75, 3211–3220.
Carrera, M. , Cañas, B. , Gallardo, J.M. , 2013. Proteomics for the assessment of quality and safety of fishery products. Food Research International 54, 972–979.
Carrera, M. , Cañas, B. , López-Ferrer, D. , Piñeiro, C. , Vázquez, J. , Gallardo, J.M. , 2011. Fast monitoring of species-specific peptide biomarkers using high-intensity-focused-ultrasound-assisted tryptic digestion and selected MS/MS ion monitoring. Analytical Chemistry 83, 5688–5695.
Carrera, M. , Cañas, B. , Piñeiro, C. , Vázquez, J. , Gallardo, J.M. , 2006. Identification of commercial hake and grenadier species by proteomic analysis of the parvalbumin fraction. Proteomics 6, 5278–5287.
Carrera, M. , Cañas, B. , Piñeiro, C. , Vázquez, J. , Gallardo, J.M. , 2007. De novo mass spectrometry sequencing and characterization of species-specific peptides from nucleoside diphosphate kinase B for the classification of commercial fish species belonging to the family Merlucciidae. Journal of Proteome Research 6, 3070–3080.
Carrera, M. , Cañas, B. , Vázquez, J. , Gallardo, J.M. , 2010. Extensive de novo sequencing of new parvalbumin isoforms using a novel combination of bottom-up proteomics, accurate molecular mass measurement by FTICR-MS, and selected MS/MS ion monitoring. Journal of Proteome Research 9, 4393–4406.
Carrera, M. , Fidalgo, L.G. , Saraiva, J.A. , Aubourg, S.P. , 2018. Effects of high-pressure treatment on the muscle proteome of hake by bottom-up proteomics. Journal of Agriculture and Food Chemistry 66, 4559–4570.
Carrera, M. , Gallardo, J.M. , Pascual, S. , González Á.F. , Medina, I. , 2016. Protein biomarker discovery and fast monitoring for the identification and detection of Anisakids by parallel reaction monitoring (PRM) mass spectrometry. Journal of Proteomics 142, 130–137.
Carrera, M. , González-Fernández, Á. , Magadán, S. , Mateos, J. , Pedrós, L. , Medina, I. , Gallardo, J.M. , 2019. Molecular characterization of B-cell epitopes for the major fish allergen, parvalbumin, by shotgun proteomics, protein-based bioinformatics and IgE-reactive approaches. Journal of Proteomics 200, 123–133.
Carrera, M. , Pazos, M. , Gasset, M. , 2020a. Proteomics-based methodologies for the detection and quantification of seafood allergens. Foods 9, 1134.
Carrera, M. , Piñeiro, C. , Martinez, I. , 2020b. Proteomic strategies to evaluate the impact of farming conditions on food quality and safety in aquaculture products. Foods 9, 1050.
Cermakova, E. , Lencova, S. , Mukherjee, S. , Horka, P. , Vobruba, S. , Demnerova, K. , Zdenkova, K. , 2023. Identification of fish species and targeted genetic modifications based on DNA analysis: State of the art. Foods 12, 228.
Cerqueira, M. , Farinha, A.P. , Schrama, D. , Moreira, M. , Raposo de Magalhães, C. , Rodrigues, P. , 2020a. Fish, in: Nollet, L.M.L. , Ötleş, S. (Eds.), Proteomics for Food Authentication, CRC Press, Boca Raton, Florida pp. 1977–1996.
Cerqueira, M. , Schrama, D. , Silva, T.S. , Colen, R. , Engrola, S.A.D. , Conceição, L.E.C. , Rodrigues, P.M.L. , Farinha, A.P. , 2020b. How tryptophan levels in plant-based aquafeeds affect fish physiology, metabolism and

proteome. Journal of Proteomics 221, 103782.
Cheng, K. , Chui, H. , Domish, L. , Hernandez, D. , Wang, G. , 2016. Recent development of mass spectrometry and proteomics applications in identification and typing of bacteria. Proteomics. Clinical Applications 10, 346–357.
Chien, H.-J. , Huang, Y.-H. , Zheng, Y.-F. , Wang, W.-C. , Kuo, C.-Y. , Wei, G.-J. , Lai, C.-C. , 2022. Proteomics for species authentication of cod and corresponding fishery products. Food Chemistry 374, 131631.
Chiesa, L. , Panseri, S. , Pasquale, E. , Malandra, R. , Pavlovic, R. , Arioli, F. , 2018. Validated multiclass targeted determination of antibiotics in fish with high performance liquid chromatography-benchtop quadrupole orbitrap hybrid mass spectrometry. Food Chemistry 258, 222–230.
Chiozzi, R.Z. , Capriotti, A.L. , Cavaliere, C. , La Barbera, G. , Montone, C.M. , Piovesana, S. , Laganà, A. , 2018. Label-free shotgun proteomics approach to characterize muscle tissue from farmed and wild European Sea Bass (Dicentrarchus labrax). Food Analytical Methods 11, 292–301.
Colás-Ruiz, N.R. , Courant, F. , Gomez, E. , Lara-Martín, P.A. , Hampel, M. , 2023. Transcriptomic and metabolomic integration to assess the response of gilthead sea bream (Sparus aurata) exposed to the most used insect repellent: DEET. Environmental Pollution 316, 120678.
Colás-Ruiz, N.R. , Ramirez, G. , Courant, F. , Gomez, E. , Hampel, M. , Lara-Martín, P.A. , 2022. Multi-omic approach to evaluate the response of gilt-head sea bream (Sparus aurata) exposed to the UV filter sulisobenzone. Science of the Total Environment 803, 150080.
Cook, P.W. , Nightingale, K.K. , 2018. Use of omics methods for the advancement of food quality and food safety. Animal Frontiers 8, 33–41.
Costa, J. , Villa, C. , Verhoeckx, K. , Cirkovic-Velickovic, T. , Schrama, D. , Roncada, P. , Rodrigues, P.M. , Piras, C. , Martín-Pedraza, L. , Monaci, L. , Molina, E. , Mazzucchelli, G. , Mafra, I. , Lupi, R. , Lozano-Ojalvo, D. , Larré, C. , Klueber, J. , Gelencser, E. , Bueno-Diaz, C. , Diaz-Perales, A. , Benedé, S. , Bavaro, S.L. , Kuehn, A. , Hoffmann-Sommergruber, K. , Holzhauser, T. , 2022. Are physicochemical properties shaping the allergenic potency of animal allergens? Clinical Reviews in Allergy & Immunology 62, 1–36.
Craig, R. , Beavis, R.C. , 2004. TANDEM: Matching proteins with tandem mass spectra. Bioinformatics (Oxford, England) 20, 1466–1467.
Cui, M. , Cheng, C. , Zhang, L. , 2022. High-throughput proteomics: A methodological mini-review. Laboratory Investigation 102, 1170–1181.
Dale, K. , Yadetie, F. , Müller, M.B. , Pampanin, D.M. , Gilabert, A. , Zhang, X. , Tairova, Z. , Haarr, A. , Lille-Langøy, R. , Lyche, J.L. , Porte, C. , Karlsen, O.A. , Goksøyr, A. , 2020. Proteomics and lipidomics analyses reveal modulation of lipid metabolism by perfluoroalkyl substances in liver of Atlantic cod (Gadus morhua). Aquatic Toxicology 227, 105590.
Danezis, G.P. , Tsagkaris, A.S. , Camin, F. , Brusic, V. , Georgiou, C.A. , 2016. Food authentication: Techniques, trends & emerging approaches. TrAC Trends in Analytical Chemistry 85, 123–132.
Darie-Ion, L. , Whitham, D. , Jayathirtha, M. , Rai, Y. , Neagu, A.-N. , Darie, C.C. , Petre, B.A. , 2022. Applications of MALDI-MS/MS-based proteomics in biomedical research. Molecules (Basel, Switzerland) 27, 6196.
Dasanayaka, B.P. , Li, Z. , Pramod, S.N. , Chen, Y. , Khan, M.U. , Lin, H. , 2022. A review on food processing and preparation methods for altering fish allergenicity. Critical Reviews in Food Science and Nutrition 62, 1951–1970.
Daskalova, A. , 2019. Farmed fish welfare: Stress, post-mortem muscle metabolism, and stress-related meat quality changes. International Aquatic Research 11, 113–124.
Dempson, J.B. , Power, M. , 2004. Use of stable isotopes to distinguish farmed from wild Atlantic salmon, Salmo salar. Ecology of Freshwater Fish 13, 176–184.
Deschamps, E. , Calabrese, V. , Schmitz, I. , Hubert-Roux, M. , Castagnos, D. , Afonso, C. , 2023. Advances in ultra-high-resolution mass spectrometry for pharmaceutical analysis. Molecules (Basel, Switzerland) 28, 2061.
Di Girolamo, F. , Muraca, M. , Mazzina, O. , Lante, I. , Dahdah, L. , 2015. Proteomic applications in food allergy: Food allergenomics. Current Opinion in Allergy and Clinical Immunology 15, 259–266.
Dietrich, M.A. , Ciereszko, A. , 2018. Proteomic characterization of fresh spermatozoa and supernatant after cryopreservation in relation to freezability of carp (Cyprinus carpio L) semen. PLoS One 13, e0192972.
Diwan, A.D. , Harke, S.N. , Panche, A.N. , 2022. Application of proteomics in shrimp and shrimp aquaculture. Comparative Biochemistry and Physiology Part D: Genomics and Proteomics 43, 101015.
Doll, S. , Burlingame, A.L. , 2015. Mass spectrometry-based detection and assignment of protein posttranslational modifications. ACS Chemical Biology 10, 63–71.
Duong, V.A. , Lee, H. , 2023. Bottom-up proteomics: Advancements in sample preparation. International Journal of Molecular Sciences 24, 5350.
Dupree, E.J. , Jayathirtha, M. , Yorkey, H. , Mihasan, M. , Petre, B.A. , Darie, C.C. , 2020. A critical review of bottom-up proteomics: The good, the bad, and the future of this field. Proteomes 8, 14.
Edelmann, M.J. , 2011. Strong cation exchange chromatography in analysis of posttranslational modifications: Innovations and perspectives. Journal of Biomedicine and Biotechnology 2011, 936508.
Elbashir, S. , Parveen, S. , Schwarz, J. , Rippen, T. , Jahncke, M. , DePaola, A. , 2018. Seafood pathogens and information on antimicrobial resistance: A review. Food Microbiology 70, 85–93.

Elghoudi, A. , Narchi, H. , 2022. Food allergy in children-the current status and the way forward. World Journal of Clinical Pediatrics 11, 253–269.
Eng, J.K. , McCormack, A.L. , Yates, J.R. , 1994. An approach to correlate tandem mass spectral data of peptides with amino acid sequences in a protein database. Journal of the American Society for Mass Spectrometry 5, 976–989.
Esteki, M. , Regueiro, J. , Simal-Gándara, J. , 2019. Tackling fraudsters with global strategies to expose fraud in the food chain. Comprehensive Reviews in Food Science and Food Safety 18, 425–440.
Eurogroup for Animals , 2018. European Public Perceptions on Fish Welfare, Compassion in World Farming, ComRes.
European Food Safety Authority and European Centre for Disease Prevention and Control , 2022. The European Union One Health 2021 Zoonoses Report. EFSA Journal 20, e07666.
Fæste, C.K. , Tartor, H. , Moen, A. , Kristoffersen, A.B. , Dhanasiri, A.K.S. , Anonsen, J.H., Furmanek, T. , Grove, S. , 2020. Proteomic profiling of salmon skin mucus for the comparison of sampling methods. Journal of Chromatography. B, Analytical Technologies in the Biomedical and Life Sciences 1138, 121965.
Fan, G. , Song, Y. , Yang, L. , Huang, X. , Zhang, S. , Zhang, M. , Yang, X. , Chang, Y. , Zhang, H. , Li, Y. , 2020. Initial data release and announcement of the 10,000 Fish Genomes Project (Fish10K). GigaScience 9, giaa080.
FAO , 2022. The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation, FAO, Rome.
Farinha, A.P. , Schrama, D. , Silva, T. , Conceição, L.E.C. , Colen, R. , Engrola, S. , Rodrigues, P. , Cerqueira, M. , 2021. Evaluating the impact of methionine-enriched diets in the liver of European seabass through label-free shotgun proteomics. Journal of Proteomics 232, 104047.
Fellows, P.J. , 2009. Food processing technology, in: Fellows, P.J. (Ed.), Food processing technology: Principles and practice, Third Edition, Woodhead Publishing, Sawston, Cambridge, pp. 1–8.
Feng, J. , Zhang, L. , Xia, X. , Hu, W. , Zhou, P. , 2020. Effect of geographic variation on the proteome of sea cucumber (Stichopus japonicus). Food Research International 136, 109498.
Fernández Sánchez, J.L. , Le Breton, A. , Brun, E. , Vendramin, N. , Spiliopoulos, G. , Furones, D. , Basurco, B. , 2022. Assessing the economic impact of diseases in Mediterranean grow-out farms culturing European sea bass. Aquaculture 547, 737530.
Ferrer, E.M. , Giron-Nava, A. , Aburto-Oropeza, O. , 2022. Overfishing increases the carbon footprint of seafood production from small-scale fisheries. Frontiers in Marine Science 9, 768784.
Ferri, E. , Galimberti, A. , Casiraghi, M. , Airoldi, C. , Ciaramelli, C. , Palmioli, A. , Mezzasalma, V. , Bruni, I. , Labra, M. , 2015. Towards a universal approach based on omics technologies for the quality control of food. BioMed Research International 2015, 365794.
Filipe, D. , Gonçalves, M. , Fernandes, H. , Oliva-Teles, A. , Peres, H. , Belo, I. , Salgado, J.M. , 2023. Shelf-life performance of fish feed supplemented with bioactive extracts from fermented olive mill and winery by-products. Foods 12, 305.
Forné, I. , Abián, J. , Cerdà, J. , 2010. Fish proteome analysis: Model organisms and non-sequenced species. Proteomics 10, 858–872.
Gajahin Gamage, N.T. , Miyashita, R. , Takahashi, K. , Asakawa, S. , Senevirathna, J.D.M. , 2022. Proteomic applications in aquatic environment studies. Proteomes 10, 32.
Gallardo, J.M. , Carrera, M. , Ortea, I. , 2013a. Proteomics in food science, in: Cifuentes, A. (Ed.), Foodomics: Advances Mass Spectrometry in Modern Food Science and Nutrition, John Wiley & Sons, Inc., Hoboken, New Jersey, pp. 125–165.
Gallardo, J.M. , Ortea, I. , Carrera, M. , 2013b. Proteomics and its applications for food authentication and food-technology research. TrAC Trends in Analytical Chemistry 52, 135–141.
Gebriel, M. , Prabhudesai, S. , Uleberg, K.E. , Larssen, E. , Piston, D. , Bjørnstad, A.H. , Møller, S.G. , 2014. Zebrafish brain proteomics reveals central proteins involved in neurodegeneration. Journal of Neuroscience Research 92, 104–115.
Gerbig, S. , Neese, S. , Penner, A. , Spengler, B. , Schulz, S. , 2017. Real-time food authentication using a miniature mass spectrometer. Analytical Chemistry 89, 10717–10725.
Gevaert, K. , Vandekerckhove, J. , Vandekerckhove, J. , 2011. Gel-Free Proteomics. Springer.
Giusti, A. , Tinacci, L. , Sotelo, C.G. , Acutis, P.L. , Ielasi, N. , Armani, A. , 2019. Authentication of ready-to-eat anchovy products sold on the Italian market by BLAST analysis of a highly informative cytochrome b gene fragment. Food Control 97, 50–57.
Gomes, T. , Albergamo, A. , Costa, R. , Mondello, L. , Dugo, G. , 2017. Potential use of proteomics in shellfish aquaculture: From assessment of environmental toxicity to evaluation of seafood quality and safety. Current Organic Chemistry 21, 402–425.
Gupta, K.R. , Patle, U. , Kabra, U. , Mishra, P. , Umekar, M.J. , 2021. Analytical tools in protein structure determination. International Journal of Pharmaceutical Chemistry and Analysis 8, 103–111.
Haider, A. , Ringer, M. , Kotroczó, Z. , Mohácsi-Farkas, C. , Kocsis, T. , 2023. The current level of MALDI-TOF MS applications in the detection of microorganisms: A short review of benefits and limitations. Microbiology Research 14, 80–90.
Haji, M. , Kerbache, L. , Al-Ansari, T. , 2022. Food quality, drug safety, and increasing public health measures in supply chain management. Processes 10, 1715.

Hassoun, A. , Karoui, R. , 2017. Quality evaluation of fish and other seafood by traditional and nondestructive instrumental methods: Advantages and limitations. Critical Reviews in Food Science and Nutrition 57, 1976–1998.
Hassoun, A. , Siddiqui, S.A. , Smaoui, S. , Ucak, İ. , Arshad, R.N. , Garcia-Oliveira, P. , Prieto, M.A. , Aït-Kaddour, A. , Perestrelo, R. , Câmara, J.S. , Bono, G. , 2022. Seafood processing, preservation, and analytical techniques in the age of Industry 4.0. Applied Sciences 12, 1703.
Hathaway, D. , Pandav, K. , Patel, M. , Riva-Moscoso, A. , Singh, B.M. , Patel, A. , Min, Z.C. , Singh-Makkar, S. , Sana, M.K. , Sanchez-Dopazo, R. , Desir, R. , Fahem, M.M.M. , Manella, S. , Rodriguez, I. , Alvarez, A. , Abreu, R. , 2020. Omega 3 fatty acids and COVID-19: A comprehensive review. Infection & Chemotherapy 52, 478–495.
Henriksson, P.J.G. , Troell, M. , Banks, L.K. , Belton, B. , Beveridge, M.C.M. , Klinger, D.H. , Pelletier, N. , Phillips, M.J. , Tran, N. , 2021. Interventions for improving the productivity and environmental performance of global aquaculture for future food security. One Earth 4, 1220–1232.
Hicks, D.T. , 2016. Seafood safety and quality: The consumer’s role. Foods 5, 71.
Hochberg, N.S. , Hamer, D.H. , Hughes, J.M. , Wilson, M.E. , 2010. Anisakidosis: Perils of the deep. Clinical Infectious Diseases 51, 806–812.
Hoque, M.S. , Jacxsens, L. , De Meulenaer, B. , Alam, A.K.M.N. , 2016. Quantitative risk assessment for formalin treatment in fish preservation: Food safety concern in local market of Bangladesh. Procedia Food Science 6, 151–158.
Hu, L. , Zhang, H. , Zhang, X. , Zhang, T. , Chang, Y. , Zhao, X. , Xu, J. , Xue, Y. , Li, Z. , Wang, Y. , Xue, C. , 2018. Identification of peptide biomarkers for discrimination of shrimp species through SWATH-MS-based proteomics and chemometrics. Journal of Agricultural and Food Chemistry 66, 10567–10574.
Jaiswal, S. , Rasal, K.D. , Chandra, T. , Prabha, R. , Iquebal, M.A. , Rai, A. , Kumar, D. , 2023. Proteomics in fish health and aquaculture productivity management: Status and future perspectives. Aquaculture 566, 739159.
Jeebhay, M.F. , Moscato, G. , Bang, B.E. , Folletti, I. , Lipińska-Ojrzanowska, A. , Lopata, A.L. , Pala, G. , Quirce, S. , Raulf, M. , Sastre, J. , Swoboda, I. , Walusiak-Skorupa, J. , Siracusa, A. , 2019. Food processing and occupational respiratory allergy-An EAACI position paper. Allergy 74, 1852–1871.
Jiang, X. , Rao, Q. , 2021. Effect of processing on fish protein antigenicity and allergenicity. Foods 10, 969.
Karlsen, O.A. , Bjørneklett, S. , Berg, K. , Brattås, M. , Bohne-Kjersem, A. , Grøsvik, B.E. , Goksøyr, A. , 2011. Integrative environmental genomics of Cod (Gadus morhua): The proteomics approach. Journal of Toxicology and Environmental Health. Part A 74, 494–507.
Khalili Tilami, S. , Sampels, S. , 2018. Nutritional value of fish: Lipids, proteins, vitamins, and minerals. Reviews in Fisheries Science & Aquaculture 26, 243–253.
Kim, D.-B. , Cha, S.-S. , 2019. A study on microbial contamination of foods exposed to multiple environments. The Korean Journal of Food & Health Convergence 5, 35–40.
Kim, H. , Rebholz, C.M. , Hegde, S. , LaFiura, C. , Raghavan, M. , Lloyd, J.F. , Cheng, S. , Seidelmann, S.B. , 2021. Plant-based diets, pescatarian diets and COVID-19 severity: A population-based case-control study in six countries. BMJ Nutrition, Prevention & Health 4, 257–266.
Kobayashi, Y. , Yang, T. , Yu, C.T. , Ume, C. , Kubota, H. , Shimakura, K. , Shiomi, K. , Hamada-Sato, N. , 2016. Quantification of major allergen parvalbumin in 22 species of fish by SDS-PAGE. Food Chemistry 194, 345–353.
Kubota, H. , Kobayashi, A. , Kobayashi, Y. , Shiomi, K. , Hamada-Sato, N. , 2016. Reduction in IgE reactivity of Pacific mackerel parvalbumin by heat treatment. Food Chemistry 206, 78–84.
Kuehn, A. , Scheuermann, T. , Hilger, C. , Hentges, F. , 2010. Important variations in parvalbumin content in common fish species: A factor possibly contributing to variable allergenicity. International Archives of Allergy and Immunology 153, 359–366.
Kumar, V. , Sinha, A.K. , Uka, A. , Antonacci, A. , Scognamiglio, V. , Mazzaracchio, V. , Cinti, S. , Arduini, F. , 2020. Multi-potential biomarkers for seafood quality assessment: Global wide implication for human health monitoring. TrAC Trends in Analytical Chemistry 132, 116056.
Kwon, Y.S. , Park, C.-B. , Lee, S.-M. , Zee, S. , Kim, G.-E. , Kim, Y.-J. , Sim, H.-J. , Kim, J.-H. , Seo, J.-S. , 2023. Proteomic analysis of zebrafish (Danio rerio) embryos exposed to benzyl benzoate. Environmental Science and Pollution Research 30, 26375–26386.
Lafleur, J.P. , Jönsson, A. , Senkbeil, S. , Kutter, J.P. , 2016. Recent advances in lab-on-a-chip for biosensing applications. Biosensors and Bioelectronics 76, 213–233.
Laly, S.J. , Sankar, T.V. , Panda, S.K. , 2019. Identification of allergic proteins of Flower tail shrimp (Metapenaeus dobsonii). Journal of Food Science and Technology 56, 5415–5421.
Larbi, N.B. , Jefferies, C. , 2009. 2D-DIGE: Comparative proteomics of cellular signalling pathways. Methods in Molecular Biology (Clifton, N.J.) 517, 105–132.
Lasch, P. , Uhlig, S. , Uhlig, C. , Wilhelm, C. , Bergmann, N. , Wittke, S. , 2019. Development and in-house validation of an LC-MS and LC-MS/MS assay for the determination of food fraud for different fish species. Journal of AOAC International 102, 1330–1338.
Lazado, C.C. , Timmerhaus, G. , Breiland, M.W. , Pittman, K. , Hytterød, S. , 2021. Multiomics provide insights into the key molecules and pathways involved in the physiological adaptation of Atlantic salmon (Salmo salar)

to chemotherapeutic-induced oxidative stress. Antioxidants (Basel, Switzerland) 10, 1931.
Lee, P.Y. , Saraygord-Afshari, N. , Low, T.Y. , 2020. The evolution of two-dimensional gel electrophoresis - From proteomics to emerging alternative applications. Journal of Chromatography A 1615, 460763.
Li, C. , Chu, S. , Tan, S. , Yin, X. , Jiang, Y. , Dai, X. , Gong, X. , Fang, X. , Tian, D. , 2021. Towards Higher sensitivity of mass spectrometry: A perspective from the mass analyzers. Frontiers in Chemistry 9, 813359.
Li, J. , Zhang, G. , Yin, D. , Li, Y. , Zhang, Y. , Cheng, J. , Zhang, K. , Ji, J. , Wang, T. , Jia, Y. , Yin, S. , 2022. Integrated application of multiomics strategies provides insights into the environmental hypoxia response in Pelteobagrus vachelli muscle. Molecular & Cellular Proteomics: MCP 21, 100196.
Li, T. , Li, J. , Hu, W. , Chen, J. , Li, H. , 2014. Protein changes in post mortem large yellow croaker (Pseudosciaena crocea) monitored by SDS-PAGE and proteome analysis. Food Control 41, 49–55.
Li, Y. , Wang, W.-X. , 2021. Integrated transcriptomics and proteomics revealed the distinct toxicological effects of multi-metal contamination on oysters. Environmental Pollution 284, 117533.
Liu, S. , Li, Z. , Yu, B. , Wang, S. , Shen, Y. , Cong, H. , 2020. Recent advances on protein separation and purification methods. Advances in Colloid and Interface Science 284, 102254.
Liu, Y. , Yao, M. , Li, S. , Wei, X. , Ding, L. , Han, S. , Wang, P. , Lv, B. , Chen, Z. , Sun, Y. , 2022. Integrated application of multi-omics approach and biochemical assays provides insights into physiological responses to saline-alkaline stress in the gills of crucian carp (Carassius auratus). Science of the Total Environment 822, 153622.
Longo, S.B. , Clark, B. , York, R. , Jorgenson, A.K. , 2019. Aquaculture and the displacement of fisheries captures. Conservation Biology 33, 832–841.
Lopata, A.L. , Kleine-Tebbe, J. , Kamath, S.D. , 2016. Allergens and molecular diagnostics of shellfish allergy. Allergo Journal International 25, 210–218.
López-Pedrouso, M. , Varela, Z. , Franco, D. , Fernández, J.A. , Aboal, J.R. , 2020. Can proteomics contribute to biomonitoring of aquatic pollution? A critical review. Environmental Pollution (Barking, Essex: 1987) 267, 115473.
López, J. , Marina, A. , Vázquez, J. , Alvarez, G. , 2002. A proteomic approach to the study of the marine mussels Mytilus edulis and M. galloprovincialis. Marine Biology 141, 217–223.
Lu, Z. , Wang, S. , Ji, C. , Li, F. , Cong, M. , Shan, X. , Wu, H. , 2020. iTRAQ-Based proteomic analysis on the mitochondrial responses in gill tissues of juvenile olive flounder Paralichthys olivaceus exposed to cadmium. Environmental Pollution 257, 113591.
Ludwig, C. , Gillet, L. , Rosenberger, G. , Amon, S. , Collins, B.C. , Aebersold, R. , 2018. Data-independent acquisition-based SWATH-MS for quantitative proteomics: A tutorial. Molecular Systems Biology 14, e8126.
Ma, B. , Zhang, K. , Hendrie, C. , Liang, C. , Li, M. , Doherty-Kirby, A. , Lajoie, G. , 2003. PEAKS: Powerful software for peptide de novo sequencing by tandem mass spectrometry. Rapid Communications in Mass Spectrometry: RCM 17, 2337–2342.
Maesano, G. , Di Vita, G. , Chinnici, G. , Pappalardo, G. , #039, Amico, M. , 2020. The role of credence attributes in consumer choices of sustainable fish products: A review. Sustainability 12, 10008.
Manzoni, C. , Kia, D.A. , Vandrovcova, J. , Hardy, J. , Wood, N.W. , Lewis, P.A. , Ferrari, R. , 2016. Genome, transcriptome and proteome: The rise of omics data and their integration in biomedical sciences. Briefings in Bioinformatics 19, 286–302.
Marco-Ramell, A. , de Almeida, A.M. , Cristobal, S. , Rodrigues, P. , Roncada, P. , Bassols, A. , 2016. Proteomics and the search for welfare and stress biomarkers in animal production in the one-health context. Molecular Biosystems 12, 2024–2035.
Marcus, K. , Lelong, C. , Rabilloud, T. , 2020. What room for two-dimensional gel-based proteomics in a shotgun proteomics world? Proteomes 8, 17.
Marinova, D. , Bogueva, D. , 2019. Planetary health and reduction in meat consumption. Sustainable Earth 2, 3.
Martinez, I. , Sánchez-Alonso, I. , Piñeiro, C. , Careche, M. , Carrera, M. , 2020. Protein signatures to trace seafood contamination and processing. Foods 9, 1751.
Martinez, I. , Šližytė, R. , Daukšas, E. , 2007. High resolution two-dimensional electrophoresis as a tool to differentiate wild from farmed cod (Gadus morhua) and to assess the protein composition of klipfish. Food Chemistry 102, 504–510.
Matricardi, P.M. , Kleine-Tebbe, J. , Hoffmann, H.J. , Valenta, R. , Hilger, C. , Hofmaier, S. , Aalberse, R.C. , Agache, I. , Asero, R. , Ballmer-Weber, B. , Barber, D. , Beyer, K. , Biedermann, T. , Bilò, M.B. , Blank, S. , Bohle, B. , Bosshard, P.P. , Breiteneder, H. , Brough, H.A. , Caraballo, L. , Caubet, J.C. , Crameri, R. , Davies, J.M. , Douladiris, N. , Ebisawa, M. , PA, E.I., Fernandez-Rivas, M. , Ferreira, F. , Gadermaier, G. , Glatz, M. , Hamilton, R.G. , Hawranek, T. , Hellings, P. , Hoffmann-Sommergruber, K. , Jakob, T. , Jappe, U. , Jutel, M. , Kamath, S.D. , Knol, E.F. , Korosec, P. , Kuehn, A. , Lack, G. , Lopata, A.L. , Mäkelä, M. , Morisset, M. , Niederberger, V. , Nowak-Węgrzyn, A.H. , Papadopoulos, N.G. , Pastorello, E.A. , Pauli, G. , Platts-Mills, T. , Posa, D. , Poulsen, L.K. , Raulf, M. , Sastre, J. , Scala, E. , Schmid, J.M. , Schmid-Grendelmeier, P. , van Hage, M. , van Ree, R. , Vieths, S. , Weber, R. , Wickman, M. , Muraro, A. , Ollert, M. , 2016. EAACI molecular allergology user's guide. Pediatr Allergy Immunology 23, 1–250.
Mazzeo, M.F. , Sorrentino, A. , Gaita, M. , Cacace, G. , Di Stasio, M. , Facchiano, A. , Comi, G. , Malorni, A. , Siciliano, R.A. , 2006. Matrix-assisted laser desorption ionization-time of flight mass spectrometry for the discrimination of food-borne microorganisms. Applied and Environmental Microbiology 72, 1180–1189.

Medina, S. , Pereira, J.A. , Silva, P. , Perestrelo, R. , Câmara, J.S. , 2019. Food fingerprints – A valuable tool to monitor food authenticity and safety. Food Chemistry 278, 144–162.
Mejrhit, N. , Azdad, O. , El Kabbaoui, M. , Ouahidi, I. , Tazi, A. , Aarab, L. , 2017. Sensitivity of Moroccans to sardine parvalbumin and effect of heating and enzymatic treatments. Food and Agricultural Immunology 28, 1362–1373.
Misra, B.B. , Langefeld, C.D. , Olivier, M. , Cox, L.A. , 2018. Integrated omics: Tools, advances, and future approaches. Journal of Molecular Endocrinology 62, JME-18-0055.
Moreira, M. , Schrama, D. , Farinha, A.P. , Cerqueira, M. , Raposo de Magalhães, C. , Carrilho, R. , Rodrigues, P. , 2021. Fish pathology research and diagnosis in aquaculture of farmed fish; a proteomics perspective. Animals: An Open Access Journal from MDPI 11, 125.
Moreira, M. , Schrama, D. , Soares, F. , Wulff, T. , Pousão-Ferreira, P. , Rodrigues, P. , 2017. Physiological responses of reared sea bream (Sparus aurata Linnaeus, 1758) to an Amyloodinium ocellatum outbreak. Journal of Fish Diseases 40, 1545–1560.
Morro, B. , Doherty, M.K. , Balseiro, P. , Handeland, S.O. , MacKenzie, S. , Sveier, H. , Albalat, A. , 2020. Plasma proteome profiling of freshwater and seawater life stages of rainbow trout (Oncorhynchus mykiss). PloS One 15, e0227003.
Mukherjee, S. , Horka, P. , Zdenkova, K. , Cermakova, E. , 2023. Parvalbumin: A major fish allergen and a forensically relevant marker. Genes 14, 123.
Muth, T. , Renard, B.Y. , 2017. Evaluating de novo sequencing in proteomics: Already an accurate alternative to database-driven peptide identification? Briefings in Bioinformatics 19, 954–970.
Nanou, E. , Kotsiri, M. , Kogiannou, D. , Katsouli, M. , Grigorakis, K. , 2023. Consumer perception of freshness and volatile composition of fresh gilthead seabream and seabass in active packaging with and without CO2-emitting pads. Foods 12, 505.
Naryzhny, S. , 2016. Towards the full realization of 2DE power. Proteomes 4, 33.
Natnan, M.E. , Low, C.-F. , Chong, C.-M. , Bunawan, H. , Baharum, S.N. , 2021. Integration of omics tools for understanding the fish immune response due to microbial challenge. Frontiers in Marine Science 8, 668771.
Neagu, A.-N. , Jayathirtha, M. , Baxter, E. , Donnelly, M. , Petre, B.A. , Darie, C.C. , 2022. Applications of tandem mass spectrometry (MS/MS) in protein analysis for biomedical research. Molecules (Basel, Switzerland) 27, 2411.
Nessen, M.A. , van der Zwaan, D.J. , Grevers, S. , Dalebout, H. , Staats, M. , Kok, E. , Palmblad, M. , 2016. Authentication of closely related fish and derived fish products using tandem mass spectrometry and spectral library matching. Journal of Agriculture and Food Chemistry 64, 3669–3677.
Neverova, I. , Van Eyk, J.E. , 2005. Role of chromatographic techniques in proteomic analysis. Journal of Chromatography B 815, 51–63.
Nissa, M.U. , Pinto, N. , Parkar, H. , Goswami, M. , Srivastava, S. , 2021. Proteomics in fisheries and aquaculture: An approach for food security. Food Control 127, 108125.
Nonthawong, K. , Srisomsap, C. , Chokchaichamnankit, D. , Svasti, J. , Phiriyangkul, P. , 2023. Comparative proteomics and in silico allergenicity of fresh and powdered skipjack tuna and Nile tilapia. Food Control 144, 109345.
Nugraha, R. , Kamath, S.D. , Johnston, E. , Zenger, K.R. , Rolland, J.M. , O'Hehir, R.E. , Lopata, A.L. , 2018. Rapid and comprehensive discovery of unreported shellfish allergens using large-scale transcriptomic and proteomic resources. Journal of Allergy and Clinical Immunology 141, 1501–1504.e1508.
Nynca, J. , Arnold, G. , Fröhlich, T. , Ciereszko, A. , 2017. Proteomic identification of rainbow trout blood plasma proteins and their relationship to seminal plasma proteins. Proteomics 17, 1600460.
Ocaña-González, J.A. , Villar-Navarro, M. , Ramos-Payán, M. , Fernández-Torres, R. , Bello-López, M.A. , 2015. New developments in the extraction and determination of parabens in cosmetics and environmental samples. A review. Analytica Chimica Acta 858, 1–15.
Orisasona, O. , Ajani, E.K. , Jenyo-Oni , Olanrewaju, N.A. , 2016. Effects of fasting period on post-harvest flesh quality of Clarias gariepinus. Tropical Animal Production Investigation 19, 26–32.
Ortea, I. , Cañas, B. , Calo-Mata, P. , Barros-Velázquez, J. , Gallardo, J.M. , 2010a. Identification of commercial prawn and shrimp species of food interest by native isoelectric focusing. Food Chemistry 121, 569–574.
Ortea, I. , Cañas, B. , Gallardo, J.M. , 2009. Mass spectrometry characterization of species-specific peptides from arginine kinase for the identification of commercially relevant shrimp species. Journal of Proteome Research 8, 5356–5362.
Ortea, I. , Cañas, B. , Gallardo, J.M. , 2011. Selected tandem mass spectrometry ion monitoring for the fast identification of seafood species. Journal of Chromatography A 1218, 4445–4451.
Ortea, I. , Rodríguez, A. , Tabilo-Munizaga, G. , Pérez-Won, M. , Aubourg, S.P. , 2010b. Effect of hydrostatic high-pressure treatment on proteins, lipids and nucleotides in chilled farmed salmon (Oncorhynchus kisutch) muscle. European Food Research and Technology 230, 925–934.
Paolacci, S. , Mendes, R. , Klapper, R. , Velasco, A. , Ramilo-Fernandez, G. , Muñoz-Colmenero, M. , Potts, T. , Martins, S. , Avignon, S. , Maguire, J. , De Paz, E. , Johnson, M. , Denis, F. , Pardo, M.A. , McElligott, D. , Sotelo, C.G. , 2021. Labels on seafood products in different European countries and their compliance to EU legislation. Marine Policy 134, 104810.

Pardo, M.Á. , Jiménez, E. , Viðarsson, J.R. , Ólafsson, K. , Ólafsdóttir, G. , Daníelsdóttir, A.K. , Pérez-Villareal, B. , 2018. DNA barcoding revealing mislabeling of seafood in European mass caterings. Food Control 92, 7–16.
Pepe, T. , Ceruso, M. , Carpentieri, A. , Ventrone, I. , Amoresano, A. , Anastasio, A. , 2010. Proteomics analysis for the identification of three species of Thunnus. Veterinary Research Communications 34(Suppl 1), S153–S155.
Pérez-Sánchez, R. , Carnero-Morán, A. , Luz Valero, M. , Oleaga, A. , 2022. A proteomics informed by transcriptomics insight into the proteome of Ornithodoros erraticus adult tick saliva. Parasites & Vectors 15, 1.
Perez-Riverol, Y. , Alpi, E. , Wang, R. , Hermjakob, H. , Vizcaíno, J.A. , 2015. Making proteomics accessible and reusable: Current state of proteomics databases and repositories. Proteomics 15, 930–950.
Perkins, D.N. , Pappin, D.J. , Creasy, D.M. , Cottrell, J.S. , 1999. Probability-based protein identification by searching sequence databases using mass spectrometry data. Electrophoresis 20, 3551–3567.
Piñeiro, C. , Barros-Velázquez, J. , Sotelo, C.G. , Pérez-Martín, R.I. , Gallardo, J.M. , 1998. Two-Dimensional electrophoretic study of the water-soluble protein fraction in white muscle of gadoid fish species. Journal of Agricultural and Food Chemistry 46, 3991–3997.
Piñeiro, C. , Martinez, I. , 2013. Evaluation of fish quality and safety by proteomics techniques, in: Toldrá, F. , Nollet, L.M.L. (Eds.), Proteomics in Foods: Principles and Applications, Springer US, Boston, MA, pp. 161–180.
Piñeiro, C. , Vázquez, J. , Marina, A.I. , Barros-Velázquez, J. , Gallardo, J.M. , 2001. Characterization and partial sequencing of species-specific sarcoplasmic polypeptides from commercial hake species by mass spectrometry following two-dimensional electrophoresis. Electrophoresis 22, 1545–1552.
Pinto, P.I. , Anjos, L. , Estêvão, M.D. , Santos, S. , Santa, C. , Manadas, B. , Monsinjon, T. , Canário, A.V.M. , Power, D.M. , 2022. Proteomics of sea bass skin-scales exposed to the emerging pollutant fluoxetine compared to estradiol. Science of the Total Environment 814, 152671.
Pinu, F.R. , Beale, D.J. , Paten, A.M. , Kouremenos, K. , Swarup, S. , Schirra, H.J. , Wishart, D. , 2019. Systems biology and multi-omics integration: Viewpoints from the metabolomics research community. Metabolites 9, 76.
Piovesana, S. , Capriotti, A.L. , Caruso, G. , Cavaliere, C. , La Barbera, G. , Zenezini Chiozzi, R. , Laganà, A. , 2016. Labeling and label free shotgun proteomics approaches to characterize muscle tissue from farmed and wild gilthead sea bream (Sparus aurata). Journal of Chromatography A 1428, 193–201.
Piras, C. , Roncada, P. , Rodrigues, P.M. , Bonizzi, L. , Soggiu, A. , 2016. Proteomics in food: Quality, safety, microbes, and allergens. Proteomics 16, 799–815.
Pitt, J.J. , 2009. Principles and applications of liquid chromatography-mass spectrometry in clinical biochemistry. The Clinical Biochemist. Reviews 30, 19–34.
Power, D.M. , Taoukis, P. , Houhoula, D. , Tsironi, T. , Flemetakis, E. , 2023. Integrating omics technologies for improved quality and safety of seafood products. Aquaculture and Fisheries 8, 457–462.
Raposo de Magalhães, C. , Farinha, A.P. , Blackburn, G. , Whitfield, P.D. , Carrilho, R. , Schrama, D. , Cerqueira, M. , Rodrigues, P.M. , 2022. Gilthead seabream liver integrative proteomics and metabolomics analysis reveals regulation by different prosurvival pathways in the metabolic adaptation to stress. International Journal of Molecular Sciences 23, 15395.
Raposo de Magalhães, C. , Farinha, A.P. , Carrilho, R. , Schrama, D. , Cerqueira, M. , Rodrigues, P.M. , 2023. A new window into fish welfare: A proteomic discovery study of stress biomarkers in the skin mucus of gilthead seabream (Sparus aurata). Journal of Proteomics 281, 104904.
Raposo de Magalhães, C. , Schrama, D. , Farinha, A.P. , Revets, D. , Kuehn, A. , Planchon, S. , Rodrigues, P.M. , Cerqueira, M. , 2020a. Protein changes as robust signatures of fish chronic stress: A proteomics approach to fish welfare research. BMC Genomics 21, 309.
Raposo de Magalhães, C. , Schrama, D. , Nakharuthai, C. , Boonanuntanasarn, S. , Revets, D. , Planchon, S. , Kuehn, A. , Cerqueira, M. , Carrilho, R. , Farinha, A.P. , Rodrigues, P.M. , 2021. Metabolic plasticity of gilthead seabream under different stressors: Analysis of the stress responsive hepatic proteome and gene expression. Frontiers in Marine Science 8, 676189.
Raposo de Magalhães, C.S.F. , Cerqueira, M.A.C. , Schrama, D. , Moreira, M.J.V. , Boonanuntanasarn, S. , Rodrigues, P.M.L. , 2020b. A proteomics and other omics approach in the context of farmed fish welfare and biomarker discovery. Reviews in Aquaculture 12, 122–144.
Reilly, A. , 2018. Overview of Food Fraud in the Fisheries Sector. FAO Fisheries and Aquaculture Circular I-21. FAO, Rome.
Richards, A.L. , Eckhardt, M. , Krogan, N.J. , 2021. Mass spectrometry-based protein-protein interaction networks for the study of human diseases. Molecular Systems Biology 17, e8792.
Riva, C. , Cristoni, S. , Binelli, A. , 2012. Effects of triclosan in the freshwater mussel Dreissena polymorpha: A proteomic investigation. Aquatic Toxicology (Amsterdam, Netherlands) 118–119, 62–71.
Roberts, R.J. , Agius, C. , Saliba, C. , Bossier, P. , Sung, Y.Y. , 2010. Heat shock proteins (chaperones) in fish and shellfish and their potential role in relation to fish health: A review. Journal of Fish Diseases 33, 789–801.
Rocha, C.P. , Cabral, H.N. , Marques, J.C. , Gonçalves, A.M.M. , 2022. A global overview of aquaculture food production with a focus on the activity's development in transitional systems—The case study of a South European Country (Portugal). Journal of Marine Science and Engineering 10, 417.
Rodrigues, P.M. , Martin, S.A.M. , Silva, T.S. , Boonanuntanasarn, S. , Schrama, D. , Moreira, M. , Raposo, C. , 2018 Proteomics in fish and aquaculture research, in: de Almeida, A.M. , Eckersall, D. , Miller, I. (Eds.),

Proteomics in Domestic Animals: From Farm to Systems Biology, Springer International Publishing AG, Midtown Manhattan, New York City, pp. 311–338.
Rodrigues, P.M. , Schrama, D. , Campos, A. , Osório, H. , Freitas, M. , 2016. Applications of proteomics in aquaculture, in: Salekdeh, G.H. (Ed.), Agricultural Proteomics Volume 1: Crops, Horticulture, Farm Animals, Food, Insect and Microorganisms, Springer International Publishing, Cham, pp. 175–209.
Rodrigues, P.M. , Silva, T.S. , Dias, J. , Jessen, F. , 2012. Proteomics in aquaculture: Applications and trends. Journal of Proteomics 75, 4325–4345.
Rodriguez-Salvador, B. , Calvo Dopico, D. , 2023. Differentiating fish products: Consumers' preferences for origin and traceability. Fisheries Research 262, 106682.
Roh, H. , Kim, A. , Kim, N. , Lee, Y. , Kim, D.H. , 2020. Multi-omics analysis provides novel insight into immuno-physiological pathways and development of thermal resistance in rainbow trout exposed to acute thermal stress. International Journal of Molecular Sciences 21, 9198.
Roobab, U. , Fidalgo, L.G. , Arshad, R.N. , Khan, A.W. , Zeng, X.-A. , Bhat, Z.F. , Bekhit, A.E.-D.A. , Batool, Z. , Aadil, R.M. , 2022. High-pressure processing of fish and shellfish products: Safety, quality, and research prospects. Comprehensive Reviews in Food Science and Food Safety 21, 3297–3325.
Rozanova, S. , Barkovits, K. , Nikolov, M. , Schmidt, C. , Urlaub, H. , Marcus, K. , 2021. Quantitative mass spectrometry-based proteomics: An overview, in: Marcus, K. , Eisenacher, M. , Sitek, B. (Eds.), Quantitative Methods in Proteomics, Springer US, New York, pp. 85–116.
Ruethers, T. , Taki, A.C. , Johnston, E.B. , Nugraha, R. , Le, T.T.K. , Kalic, T. , McLean, T.R. , Kamath, S.D. , Lopata, A.L. , 2018. Seafood allergy: A comprehensive review of fish and shellfish allergens. Molecular Immunology 100, 28–57.
Saelens, G. , Planckaert, S. , Martínez-Sernández, V. , Ubeira, F.M. , Devreese, B. , Gabriël, S. , 2022. Targeted proteomics and specific immunoassays reveal the presence of shared allergens between the zoonotic nematodes Anisakis simplex and Pseudoterranova decipiens. Scientific Reports 12, 4127.
Saleh, E.S.E. , Tawfeek, S.S. , Abdel-Fadeel, A.A.A. , Abdel-Daim, A.S.A. , Abdel-Razik, A.H. , Youssef, I.M.I. , 2022. Effect of dietary protease supplementation on growth performance, water quality, blood parameters and intestinal morphology of Nile tilapia (Oreochromis niloticus). Journal of Animal Physiology and Animal Nutrition 106, 419–428.
Saleh, M. , Kumar, G. , Abdel-Baki, A.-A.S. , Dkhil, M.A. , El-Matbouli, M. , Al-Quraishy, S. , 2019. Quantitative proteomic profiling of immune responses to Ichthyophthirius multifiliis in common carp skin mucus. Fish & Shellfish Immunology 84, 834–842.
Saptarshi, S.R. , Sharp, M.F. , Kamath, S.D. , Lopata, A.L. , 2014. Antibody reactivity to the major fish allergen parvalbumin is determined by isoforms and impact of thermal processing. Food Chemistry 148, 321–328.
Schilling, M.W. , Suman, S.P. , Zhang, X. , Nair, M.N. , Desai, M.A. , Cai, K. , Ciaramella, M.A. , Allen, P.J. , 2017. Proteomic approach to characterize biochemistry of meat quality defects. Meat Science 132, 131–138.
Schrama, D. , Czolk, R. , Raposo de Magalhães, C. , Kuehn, A. , Rodrigues, P.M. , 2022a. Fish allergenicity modulation using tailored enriched diets–Where are we? Frontiers in Physiology 13, 897168.
Schrama, D. , Raposo de Magalhães, C. , Cerqueira, M. , Carrilho, R. , Farinha, A.P. , Rosa da Costa, A.M. , Gonçalves, A. , Kuehn, A. , Revets, D. , Planchon, S. , Engrola, S. , Rodrigues, P.M. , 2022b. Effect of creatine and EDTA supplemented diets on European seabass (Dicentrarchus labrax) allergenicity, fish muscle quality and omics fingerprint. Comparative Biochemistry and Physiology Part D: Genomics and Proteomics 41, 100941.
Schrama, D. , Raposo de Magalhães, C. , Cerqueira, M. , Carrilho, R. , Revets, D. , Kuehn, A. , Engrola, S. , Rodrigues, P.M. , 2022c. Fish processing and digestion affect parvalbumins detectability in gilthead seabream and European seabass. Animals 12, 3022.
Shehata, H.R. , Bourque, D. , Steinke, D. , Chen, S. , Hanner, R. , 2019. Survey of mislabelling across finfish supply chain reveals mislabelling both outside and within Canada. Food Research International (Ottawa, Ont.) 121, 723–729.
Sheng, L. , Wang, L. , 2021. The microbial safety of fish and fish products: Recent advances in understanding its significance, contamination sources, and control strategies. Comprehensive Reviews in Food Science and Food Safety 20, 738–786.
Sicherer, S.H. , Muñoz-Furlong, A. , Sampson, H.A. , 2004. Prevalence of seafood allergy in the United States determined by a random telephone survey. The Journal of Allergy and Clinical Immunology 114, 159–165.
Silva, T.S. , Cordeiro, O.D. , Matos, E.D. , Wulff, T. , Dias, J.P. , Jessen, F. , Rodrigues, P.M. , 2012. Effects of preslaughter stress levels on the post-mortem sarcoplasmic proteomic profile of gilthead seabream muscle. Journal of Agricultural and Food Chemistry 60, 9443–9453.
Singhal, N. , Kumar, M. , Kanaujia, P.K. , Virdi, J.S. , 2015. MALDI-TOF mass spectrometry: An emerging technology for microbial identification and diagnosis. Frontiers in Microbiology 6, 791.
Sivanich, M.K. , Gu, T.-J. , Tabang, D.N. , Li, L. , 2022. Recent advances in isobaric labeling and applications in quantitative proteomics. Proteomics 22, 2100256.
Sletten, G. , Van Do, T. , Lindvik, H. , Egaas, E. , Florvaag, E. , 2010. Effects of industrial processing on the immunogenicity of commonly ingested fish species. International Archives of Allergy and Immunology 151, 223–236.

Somkuti, J. , Bublin, M. , Breiteneder, H. , Smeller, L. , 2012. Pressure-temperature stability, Ca2+ binding, and pressure-temperature phase diagram of cod parvalbumin: Gad m 1. Biochemistry 51, 5903–5911.
Speranza, B. , Racioppo, A. , Bevilacqua, A. , Buzzo, V. , Marigliano, P. , Mocerino, E. , Scognamiglio, R. , Corbo, M.R. , Scognamiglio, G. , Sinigaglia, M. , 2021. Innovative preservation methods improving the quality and safety of fish products: Beneficial effects and limits. Foods 10, 2854.
Stahl, A. , Schröder, U. , 2017. Development of a MALDI-TOF MS-based protein fingerprint database of common food fish allowing fast and reliable identification of fraud and substitution. Journal of Agricultural and Food Chemistry 65, 7519–7527.
Stentiford, G.D. , Peeler, E.J. , Tyler, C.R. , Bickley, L.K. , Holt, C.C. , Bass, D. , Turner, A.D. , Baker-Austin, C. , Ellis, T. , Lowther, J.A. , Posen, P.E. , Bateman, K.S. , Verner-Jeffreys, D.W. , van Aerle, R. , Stone, D.M. , Paley, R. , Trent, A. , Katsiadaki, I. , Higman, W.A. , Maskrey, B.H. , Devlin, M.J. , Lyons, B.P. , Hartnell, D.M. , Younger, A.D. , Bersuder, P. , Warford, L. , Losada, S. , Clarke, K. , Hynes, C. , Dewar, A. , Greenhill, B. , Huk, M. , Franks, J. , Dal-Molin, F. , Hartnell, R.E. , 2022. A seafood risk tool for assessing and mitigating chemical and pathogen hazards in the aquaculture supply chain. Nature Food 3, 169–178.
Stentiford, G.D. , Viant, M.R. , Ward, D.G. , Johnson, P.J. , Martin, A. , Wenbin, W. , Cooper, H.J. , Lyons, B.P. , Feist, S.W. , 2005. Liver tumors in wild flatfish: A histopathological, proteomic, and metabolomic study. Omics: A Journal of Integrative Biology 9, 281–299.
Sun, L. , Lin, H. , Li, Z. , Sun, W. , Wang, J. , Wu, H. , Ge, M. , Ahmed, I. , Pavase, T.R. , 2019. Development of a method for the quantification of fish major allergen parvalbumin in food matrix via liquid chromatography-tandem mass spectrometry with multiple reaction monitoring. Food Chemistry 276, 358–365.
Sussarellu, R. , Suquet, M. , Thomas, Y. , Lambert, C. , Fabioux, C. , Pernet, M.E.J. , Le Goïc, N. , Quillien, V. , Mingant, C. , Epelboin, Y. , 2016. Oyster reproduction is affected by exposure to polystyrene microplastics. Proceedings of the National Academy of Sciences 113, 2430–2435.
Sveinsdóttir, H. , Martin, S.A.M. , Vilhelmsson, O.T. , 2012. Application of proteomics to fish processing and quality, in: Simpson, B.K. (Ed.), Food Biochemistry and Food Processing, John Wiley & Sons, Inc., Hoboken, New Jersey, pp. 406–424.
Terova, G. , Addis, M.F. , Preziosa, E. , Pisanu, S. , Pagnozzi, D. , Biosa, G. , Gornati, R. , Bernardini, G. , Roggio, T. , Saroglia, M. , 2011. Effects of postmortem storage temperature on sea bass (Dicentrarchus labrax) muscle protein degradation: Analysis by 2-D DIGE and MS. Proteomics 11, 2901–2910.
Thomas, S.N. , French, D. , Jannetto, P.J. , Rappold, B.A. , Clarke, W.A. , 2022. Liquid chromatography-tandem mass spectrometry for clinical diagnostics. Nature Reviews. Methods Primers 2, 96.
Tiziana, P. , Marina, C. , Andrea, C. , Iole, V. , Angela, A. , Aniello, A. , Maria Luisa, C. , 2012. Differentiation of four tuna species by two-dimensional electrophoresis and mass spectrometric analysis, in: Joshua, L.H. , Christopher, J.P. , Subject editors: Tsz-Kwong, M. , Ricardo, J.F. (Eds.), Proteomic Applications in Biology, IntechOpen, Rijeka, Ch. 9, pp. 191–208.
Tsironi, T. , Anjos, L. , Pinto, P.I. , Dimopoulos, G. , Santos, S. , Santa, C. , Manadas, B. , Canario, A. , Taoukis, P. , Power, D. , 2019a. High pressure processing of European sea bass (Dicentrarchus labrax) fillets and tools for flesh quality and shelf life monitoring. Journal of Food Engineering 262, 83–91.
Tsironi, T. , Lougovois, V. , Simou, V.N. , Mexi, A. , Koussissis, S. , Tsakali, E. , Papatheodorou, S.A. , Stefanou, V. , Van Impe, J. , Houhoula, D. , 2019b. Next generation sequencing (NGS) for the determination of fish flesh microbiota. Journal of Food Research 8, 101–110.
Tubaon, R.M. , Haddad, P.R. , Quirino, J.P. , 2017. Sample clean-up strategies for ESI mass spectrometry applications in bottom-up proteomics: Trends from 2012 to 2016. Proteomics 17, 1700011.
Uehara, S. , Kobayashi, M. , Kimura, K. , Suzuki, J. , Sadamasu, K. , 2021. Rapid identification of histamine-producing bacteria isolated from fish using MALDI-TOF MS. Journal of Food Science and Technology 58, 4055–4061.
Ulrich, S. , Beindorf, P.M. , Biermaier, B. , Schwaiger, K. , Gareis, M. , Gottschalk, C. , 2017. A novel approach for the determination of freshness and identity of trouts by MALDI-TOF mass spectrometry. Food Control 80, 281–289.
United Nations Department of Economic and Social Affairs, P.D. , 2022. World Population Prospects 2022: Summary of Results, UN DESA/POP/2022/TR/NO. 3.
Valente, L.M.P. , Cornet, J. , Donnay-Moreno, C. , Gouygou, J.P. , Bergé, J.P. , Bacelar, M. , Escórcio, C. , Rocha, E. , Malhão, F. , Cardinal, M. , 2011. Quality differences of gilthead sea bream from distinct production systems in Southern Europe: Intensive, integrated, semi-intensive or extensive systems. Food Control 22, 708–717.
Vandermeersch, G. , Lourenço, H.M. , Alvarez-Muñoz, D. , Cunha, S. , Diogène, J. , Cano-Sancho, G. , Sloth, J.J. , Kwadijk, C. , Barcelo, D. , Allegaert, W. , Bekaert, K. , Fernandes, J.O. , Marques, A. , Robbens, J. , 2015. Environmental contaminants of emerging concern in seafood – European database on contaminant levels. Environmental Research 143, 29–45.
Verbeke, W. , Sioen, I. , Brunsø, K. , De Henauw, S. , Van Camp, J. , 2007. Consumer perception versus scientific evidence of farmed and wild fish: Exploratory insights from Belgium. Aquaculture International 15, 121–136.
Verrez-Bagnis, V. , Ladrat, C. , Morzel, M. , Noël, J. , Fleurence, J. , 2001. Protein changes in post mortem sea bass (Dicentrarchus labrax) muscle monitored by one- and two-dimensional gel electrophoresis.

Electrophoresis 22, 1539–1544.
Vihinen, M. , 2001. Bioinformatics in proteomics. Biomolecular Engineering 18, 241–248.
Vincent, E. , Bilaver, L.A. , Fierstein, J.L. , Thivalapill, N. , Pappalardo, A.A. , Coleman, A. , Robinson, A. , Sharma, H.P. , Brewer, A. , Assa'ad, A.H. , Jiang, J. , Hultquist, H.W. , Kulkarni, A.J. , Choi, J. , Mahdavinia, M. , Pongracic, J. , Tobin, M.C. , Warren, C. , Gupta, R.S. , 2022. Associations of food allergy-related dietary knowledge, attitudes, and behaviors among caregivers of black and white children with food allergy. Journal of the Academy of Nutrition and Dietetics 122, 797–810.
Visciano, P. , Schirone, M. , Paparella, A. , 2020. An overview of histamine and other biogenic amines in fish and fish products. Foods 9, 1795.
Warner, O.K. , Roberts, W. , Mustain, P. , Lowell, B. , Swain, M. , 2019. Casting a wider net: More action needed to stop seafood fraud in the United States. doi:10.31230/osf.io/sbm8h.
Wen, X. , Hu, Y. , Zhang, X. , Wei, X. , Wang, T. , Yin, S. , 2019. Integrated application of multi-omics provides insights into cold stress responses in pufferfish Takifugu fasciatus. BMC Genomics 20, 563.
Westermeier, R. , Naven, T. , 2002. Proteomics in Practice: A Laboratory Manual of Proteome Analysis. Wiley-vch, Weinheim, Germany.
Wijaya, C.H. , Wijaya, W. , Mehta, B.M. , 2014. General properties of major food components, in: Cheung, P.C.K. , Mehta, B.M. (Eds.), Handbook of Food Chemistry, Springer, Berlin, Heidelberg, pp. 1–32.
Wojnarowski, K. , Podobiński, P. , Cholewińska, P. , Smoliński, J. , Dorobisz, K. , 2021. Impact of estrogens present in environment on health and welfare of animals. Animals 11, 2152.
Wulff, T. , Nielsen, M.E. , Deelder, A.M. , Jessen, F. , Palmblad, M. , 2013. Authentication of fish products by large-scale comparison of tandem mass spectra. Journal of Proteome Research 12, 5253–5259.
Xiang, Y. , Sun, C. , Zhao, Y. , Li, L. , Yang, X. , Wu, Y. , Chen, S. , Wei, Y. , Li, C. , Wang, Y. , 2022. Label-free proteomic analysis reveals freshness-related proteins in sea bass (Lateolabrax japonicus) fillets stored on ice. LWT 155, 112885.
Xiong, X. , Yuan, F. , Huang, M. , Lu, L. , Xiong, X. , Wen, J. , 2019. DNA barcoding revealed mislabeling and potential health concerns with roasted fish products sold across China. Journal of Food Protection 82, 1200–1209.
Yadzir, Z.H. , Misnan, R. , Murad, S. , 2012. Identification of tropomyosin as major allergen of white squid (Loligo edulis) by two-dimensional immunoblotting and mass spectrometry. The Southeast Asian Journal of Tropical Medicine and Public Health 43, 185–191.
Yi, Z. , Xie, J. , 2021. Comparative proteomics reveals the spoilage-related factors of Shewanella putrefaciens under refrigerated condition. Frontiers in Microbiology 12, 740482.
Zander, K. , Feucht, Y. , 2018. Consumers’ willingness to pay for sustainable seafood made in Europe. Journal of International Food & Agribusiness Marketing 30, 251–275.
Zhang, F. , Ge, W. , Ruan, G. , Cai, X. , Guo, T. , 2020. Data-independent acquisition mass spectrometry-based proteomics and software tools: A glimpse in 2020. Proteomics 20, e1900276.
Zhang, H. , Zhang, X. , Zhao, X. , Xu, J. , Lin, C. , Jing, P. , Hu, L. , Zhao, S. , Wang, X. , Li, B. , 2019. Discrimination of dried sea cucumber (Apostichopus japonicus) products from different geographical origins by sequential windowed acquisition of all theoretical fragment ion mass spectra (SWATH-MS)-based proteomic analysis and chemometrics. Food Chemistry 274, 592–602.
Zhang, Q.H. , Huang, L. , Zhang, Y. , Ke, C.H. , Huang, H.Q. , 2013. Proteomic approach for identifying gonad differential proteins in the oyster (Crassostrea angulata) following food-chain contamination with $HgCl_2$. Journal of Proteomics 94, 37–53.
Zhang, Y. , Liu, C. , Liu, J. , Liu, X. , Tu, Z. , Zheng, Y. , Xu, J. , Fan, H. , Wang, Y. , Hu, M. , 2022a. Multi-omics reveals response mechanism of liver metabolism of hybrid sturgeon under ship noise stress. The Science of the Total Environment 851, 158348.
Zhang, Y. , Shen, W. , Li, J. , Zheng, B. , Lou, Z. , Hosain, M.A. , Qian, B. , Xue, L. , 2021. Effect of fasting on protein metabolism in muscle tissue of Larimichthys crocea revealed by transcriptome and proteome. Journal of Oceanology and Limnology 39, 1972–1984.
Zhang, Z. , Sun, Y. , Sang, S. , Jia, L. , Ou, C. , 2022b. Emerging approach for fish freshness evaluation: Principle, application and challenges. Foods 11, 1897.

Endogenous Enzymes

Ahmed, Z. , Donkor, O. N. , Street, W. A. , & Vasiljevic, T. (2013). Activity of endogenous muscle proteases from 4 Australian underutilized fish species as affected by ionic strength, pH, and temperature. Journal of Food Science, 78(12), C1858–C1864. https://doi.org/10.1111/1750-3841.12303
Ahmed, Z. , Donkor, O. , Street, W. A. , & Vasiljevic, T. (2015). Calpains- and cathepsins-induced myofibrillar changes in post-mortem fish: Impact on structural softening and release of bioactive peptides. Trends in Food Science & Technology, 45(1), 130–146. https://doi.org/10.1016/j.tifs.2015.04.002

Ajima, M. N. O. , Kumar, K. , Poojary, N. , & Pandey, P. K. (2021). Oxidative stress biomarkers, biochemical responses and Na+-K+-ATPase activities in Nile tilapia, *Oreochromis niloticus* exposed to diclofenac. Comparative Biochemistry and Physiology Part C: Toxicology & Pharmacology, 240, 108934. https://doi.org/10.1016/j.cbpc.2020.108934

Albalat, A. , Sánchez-Gurmaches, J. , Gutiérrez, J. , & Navarro, I. (2006). Regulation of lipoprotein lipase activity in rainbow trout (*Oncorhynchus mykiss*) tissues. General and Comparative Endocrinology, 146(3), 226–235. https://doi.org/10.1016/j.ygcen.2005.11.011

Alfaro, B. , Hernández, I. , le Marc, Y. , & Pin, C. (2013). Modelling the effect of the temperature and carbon dioxide on the growth of spoilage bacteria in packed fish products. Food Control, 29(2), 429–437. https://doi.org/10.1016/j.foodcont.2012.05.046

Almy, L. H. (1926). The role of the proteolytic enzymes in the decomposition of the herring. Journal of the American Chemical Society, 48(8), 2136–2146.

Aoki, T. , Yamashita, T. , & Ueno, R. (2000). Distribution of cathepsins in red and white muscles among fish species. Fisheries Science, 66(4), 776–782. https://doi.org/10.1046/j.1444-2906.2000.00126.x

Arai, K. , Inoue, A. , & Ojima, T. (2020). Isolation and characterization of an adenylate kinase from the lateral muscle of bastard halibut Paralichthys olivaceus. Fisheries Science, 86(2), 385–394. https://doi.org/10.1007/s12562-019-01393-1

Aranishi, F. , Hara, K. , Osatomi, K. , & Ishihara, T. (1997a). Purification and characterization of cathepsin B from hepatopancreas of carp Cyprinus carpio. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 117(4), 579–587. https://doi.org/10.1016/S0305-0491(97)00191-0

Aranishi, F. , Ogata, H. , Hara, K. , Osatomi, K. , & Ishihara, T. (1997b). Purification and characterization of cathepsin L from hepatopancreas of carp Cyprinus carpio. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 118(3), 531–537. https://doi.org/10.1016/S0305-0491(97)00111-9

Arockiaraj, J. , Gnanam, A. J. , Palanisamy, R. , Kumaresan, V. , Bhatt, P. , Thirumalai, M. K. , Roy, A. , Pasupuleti, M. , Kasi, M. , Sathyamoorthi, A. , & Arasu, A. (2013). A prawn transglutaminase: Molecular characterization and biochemical properties. Biochimie, 95(12), 2354–2364. https://doi.org/10.1016/j.biochi.2013.08.029

Bahuaud, D. , Mørkøre, T. , Østbye, T.-K. , Veiseth-Kent, E. , Thomassen, M. S. , & Ofstad, R. (2010). Muscle structure responses and lysosomal cathepsins B and L in farmed Atlantic salmon (*Salmo salar* L.) pre- and post-rigor fillets exposed to short and long-term crowding stress. Food Chemistry, 118(3), 602–615. https://doi.org/10.1016/j.foodchem.2009.05.028

Bakke, A. M. , Glover, C. , & Krogdahl, Å. (2010). Feeding, digestion and absorption of nutrients. Fish Physiology, 30, 57–110. https://doi.org/10.1016/S1546-5098(10)03002-5

Baldissera, M. D. , Souza, C. F. , & Baldisserotto, B. (2018a). *Ichthyophthirius multifiliis* impairs splenic enzymes of the phosphoryl transfer network in naturally infected *Rhamdia quelen*: Effects on energetic homeostasis. Parasitology Research, 117(2), 413–418. https://doi.org/10.1007/s00436-017-5715-4

Baldissera, M. D. , Souza, C. F. , Dias, J. B. , da Silva, T. O. , Tavares, G. C. , Valladão, G. M. R. , da Silva, A. S. , Verdi, C. M. , Santos, R. C. V. , Vencato, M. , da Veiga, M. L. , da Rocha, M. I. U. M. , Cunha, M. A. , & Baldisserotto, B. (2020). Branchial bioenergetics dysfunction as a relevant pathophysiological mechanism in freshwater silver catfish (*Rhamdia quelen*) experimentally infected with *Flavobacterium columnare* . Microbial Pathogenesis, 138, 103817. https://doi.org/10.1016/j.micpath.2019.103817

Baldissera, M. D. , Souza, C. F. , Doleski, P. H. , Santos, R. C. V. , Raffin, R. P. , & Baldisserotto, B. (2018b). Involvement of xanthine oxidase inhibition with the antioxidant property of nanoencapsulated Melaleuca alternifolia essential oil in fish experimentally infected with Pseudomonas aeruginosa. Journal of Fish Diseases, 41(5), 791–796. https://doi.org/10.1111/jfd.12779

Balti, R. , Barkia, A. , Bougatef, A. , Ktari, N. , & Nasri, M. (2009). A heat-stable trypsin from the hepatopancreas of the cuttlefish (Sepia officinalis): Purification and characterisation. Food Chemistry, 113(1), 146–154. https://doi.org/10.1016/j.foodchem.2008.07.059

Balti, R. , Bougherra, F. , Bougatef, A. , Hayet, B. K. , Nedjar-Arroume, N. , Dhulster, P. , Guillochon, D. , & Nasri, M. (2012). Chymotrypsin from the hepatopancreas of cuttlefish (Sepia officinalis) with high activity in the hydrolysis of long chain peptide substrates: Purification and biochemical characterisation. Food Chemistry, 130(3), 475–484. https://doi.org/10.1016/j.foodchem.2011.07.019

Balti, R. , Hmidet, N. , Jellouli, K. , Nedjar-Arroume, N. , Guillochon, D. , & Nasri, M. (2010). Cathepsin D from the hepatopancreas of the cuttlefish (Sepia officinalis): Purification and characterization. Journal of Agricultural and Food Chemistry, 58(19), 10623–10630. https://doi.org/10.1021/jf102233d

Barokah, G. R. , Ariyani, F. , Wibowo, S. , Januar, H. I. , & Annisah, U. (2020). Determination of endogenous formaldehyde in moonfish (Lampris guttatus) during frozen storage. Egyptian Journal of Aquatic Biology and Fisheries, 24(3), 17–28. https://doi.org/10.21608/ejabf.2020.87813

Baron, C. P. , KjÆrsgård, I. V. H. , Jessen, F. , & Jacobsen, C. (2007). Protein and lipid oxidation during frozen storage of Rainbow Trout (Oncorhynchus mykiss). Journal of Agricultural and Food Chemistry, 55(20), 8118–8125. https://doi.org/10.1021/jf070686f

Bartolo, I. , & Birk, E. O. (1998). Some factors affecting Norway lobster (*Nephrops norvegicus*) cuticle polyphenol oxidase activity and blackspot development. International Journal of Food Science & Technology, 33(3), 329–336. https://doi.org/10.1046/j.1365-2621.1998.00168.x

Basiri, S. , Shekarforoush, S. S. , Aminlari, M. , & Akbari, S. (2015). The effect of pomegranate peel extract (PPE) on the polyphenol oxidase (PPO) and quality of Pacific white shrimp (*Litopenaeus vannamei*) during refrigerated storage. LWT – Food Science and Technology, 60(2), 1025–1033. https://doi.org/10.1016/j.lwt.2014.10.043

Beninati, S. , & Piacentini, M. (2004). The transglutaminase family: An overview: Minireview article. Amino Acids, 26(4), 367–372. https://doi.org/10.1007/s00726-004-0091-7

Benjakul, S. , Visessanguan, W. , & Leelapongwattana, K. (2003). Purification and characterization of heat-stable alkaline proteinase from bigeye snapper (*Priacanthus macracanthus*) muscle. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 134(4), 579–591. https://doi.org/10.1016/S1096-4959(02)00290-7

Benjakul, S. , Visessanguan, W. , & Tanaka, M. (2004). Induced formation of dimethylamine and formaldehyde by lizardfish (*Saurida micropectoralis*) kidney trimethylamine-N-oxide demethylase. Food Chemistry, 84(2), 297–305. https://doi.org/10.1016/S0308-8146(03)00214-0

Benjakul, S. , Visessanguan, W. , & Tanaka, M. (2005). Properties of phenoloxidase isolated from the cephalothorax of kuruma prawn (*Penaeus japonicus*). Journal of Food Biochemistry, 29(5), 470–485. https://doi.org/10.1111/j.1745-4514.2005.00042.x

Binsi, P. K. , & Shamasundar, B. A. (2012). Purification and characterisation of transglutaminase from four fish species: Effect of added transglutaminase on the viscoelastic behaviour of fish mince. Food Chemistry, 132(4), 1922–1929. https://doi.org/10.1016/j.foodchem.2011.12.027

Borgstrom, G. (2012). Fish as Food V1: Production, Biochemistry, and Microbiology. Elsevier, New York and London.

Bougatef, A. , Balti, R. , Nasri, R. , Jellouli, K. , Souissi, N. , & Nasri, M. (2010). Biochemical properties of anionic trypsin acting at high concentration of NaCl purified from the intestine of a carnivorous fish: Smooth hound (*Mustelus mustelus*). Journal of Agricultural and Food Chemistry, 58(9), 5763–5769. https://doi.org/10.1021/jf100534a

Bougatef, A. , Balti, R. , Zaied, S. B. , Souissi, N. , & Nasri, M. (2008). Pepsinogen and pepsin from the stomach of smooth hound (*Mustelus mustelus*): Purification, characterization and amino acid terminal sequences. Food Chemistry, 107(2), 777–784. https://doi.org/10.1016/j.foodchem.2007.08.077

Bracho, G. E. , & Haard, N. F. (1995). Identification of two matrix metalloproteinases in the skeletal muscle of Pacific rockfish (*Sebastes* sp.). Journal of Food Biochemistry, 19(4), 299–319. https://doi.org/10.1111/j.1745-4514.1995.tb00536.x

Burmester, T. (2002). Origin and evolution of arthropod hemocyanins and related proteins. Journal of Comparative Physiology B: Biochemical, Systemic, and Environmental Physiology, 172(2), 95–107. https://doi.org/10.1007/s00360-001-0247-7

Caballero, M. J. , Betancor, M. , Escrig, J. C. , Montero, D. , Espinosa de los Monteros, A. , Castro, P. , Ginés, R. , & Izquierdo, M. (2009). Post mortem changes produced in the muscle of sea bream (*Sparus aurata*) during ice storage. Aquaculture, 291(3–4), 210–216. https://doi.org/10.1016/j.aquaculture.2009.03.032

Capasso, C. , Lees, W. E. , Capasso, A. , Scudiero, R. , Carginale, V. , Kille, P. , Kay, J. , & Parisi, E. (1999). Cathepsin D from the liver of the Antarctic icefish Chionodraco hamatus exhibits unusual activity and stability at high temperatures. Biochimica et Biophysica Acta (BBA) – Protein Structure and Molecular Enzymology, 1431(1), 64–73. https://doi.org/10.1016/S0167-4838(99)00039-4

Castillo-Yáñez, F. J. , Pacheco-Aguilar, R. , García-Carreño, F. L. , de los Ángeles Navarrete-Del Toro, M. , & López, M. F. (2006). Purification and biochemical characterization of chymotrypsin from the viscera of Monterey sardine (*Sardinops sagax caeruleus*). Food Chemistry, 99(2), 252–259. https://doi.org/10.1016/j.foodchem.2005.06.052

Chaiyasit, W. (2007). Role of Association Colloids in Bulk Oils on Lipid Oxidation [Doctoral dissertations]. University of Massachusetts Amherst.

Chanarat, S. , & Benjakul, S. (2013). Effect of formaldehyde on protein cross-linking and gel forming ability of surimi from lizardfish induced by microbial transglutaminase. Food Hydrocolloids, 30(2), 704–711. https://doi.org/10.1016/j.foodhyd.2012.09.001

Chandrakumar, S. H. , Rai, A. K. , Manjabhat, S. N. , & Narayan, B. (2010). Seafood enzymes and their potential industrial application. Handbook of seafood quality, safety and health applications, Alasalvar, C. , Shahidi, F. , Miyashita, K. , Wanasundara, U. , (eds.), Wiley-Blackwell, Chichester, UK, pp. 522–535.

Chang, W. C.-W. , Wu, H.-Y. , Yeh, Y. , & Liao, P.-C. (2020). Untargeted foodomics strategy using high-resolution mass spectrometry reveals potential indicators for fish freshness. Analytica Chimica Acta, 1127, 98–105. https://doi.org/10.1016/j.aca.2020.06.016

Chaudhuri, A. , Podder, A. , Biswas, M. , Roy, A. , & Homechaudhuri, S. (2021). Characterization of chloride cells coupled with immunolocalization of Na+ K+ ATPase in fishes of different migratory guilds of Indian Sundarbans. Regional Studies in Marine Science, 47, 101980. https://doi.org/10.1016/j.rsma.2021.101980

Chen, D.-W. , & Zhang, M. (2007). Non-volatile taste active compounds in the meat of Chinese mitten crab (*Eriocheir sinensis*). Food Chemistry, 104(3), 1200–1205. https://doi.org/10.1016/j.foodchem.2007.01.042

Chen, J. , Zhang, L. , Yang, N. , Cao, M. , Tian, M. , Fu, Q. , Su, B. , & Li, C. (2020). Characterization of the immune roles of cathepsin L in turbot (*Scophthalmus maximus* L.) mucosal immunity. Fish & Shellfish Immunology, 97, 322–335. https://doi.org/10.1016/j.fsi.2019.12.005

Chen, M.-Y. , Hu, K.-Y. , Huang, C.-C. , & Song, Y.-L. (2005). More than one type of transglutaminase in invertebrates? A second type of transglutaminase is involved in shrimp coagulation. Developmental & Comparative Immunology, 29(12), 1003–1016. https://doi.org/10.1016/j.dci.2005.03.012
Chen, Q. , Zhang, Y. , Jing, L. , Xiao, N. , Wu, X. , & Shi, W. (2022). Changes in protein degradation and non-volatile flavor substances of swimming crab (*Portunus trituberculatus*) during steaming. Foods, 11(21), 3502. https://doi.org/10.3390/foods11213502
Cheret, R. , Delbarreladrat, C. , Lamballerieanton, M. , & Verrezbagnis, V. (2007). Calpain and cathepsin activities in post mortem fish and meat muscles. Food Chemistry, 101(4), 1474–1479. https://doi.org/10.1016/j.foodchem.2006.04.023
Chung, S. W. C. , & Chan, B. T. P. (2009). Trimethylamine oxide, dimethylamine, trimethylamine and formaldehyde levels in main traded fish species in Hong Kong. Food Additives and Contaminants: Part B, 2(1), 44–51. https://doi.org/10.1080/02652030902858921
Coates, L. , Tuan, H.-F. , Tomanicek, S. , Kovalevsky, A. , Mustyakimov, M. , Erskine, P. , & Cooper, J. (2008). The catalytic mechanism of an aspartic proteinase explored with neutron and X-ray diffraction. Journal of the American Chemical Society, 130(23), 7235–7237. https://doi.org/10.1021/ja801269x
Cui, L. , & Decker, E. A. (2016). Phospholipids in foods: Prooxidants or antioxidants? Journal of the Science of Food and Agriculture, 96(1), 18–31. https://doi.org/10.1002/jsfa.7320
Dai, L.-S. , Chu, S.-H. , Yu, X.-M. , & Li, Y.-Y. (2017). A role of cathepsin L gene in innate immune response of crayfish (*Procambarus clarkii*). Fish & Shellfish Immunology, 71, 246–254. https://doi.org/10.1016/j.fsi.2017.10.021
Dai, L.-S. , Sun, Y. , Sun, Y.-X. , Zhu, B.-J. , & Liu, C.-L. (2016). Characterization and function of a cathepsin B in red crayfish (*Procambarus clarkii*) following lipopolysaccharide challenge. Fish & Shellfish Immunology, 56, 162–168. https://doi.org/10.1016/j.fsi.2016.07.016
Danwattananusorn, T. , Kondo, H. , Aoki, T. , & Hirono, I. (2009). Molecular cloning, characterization and expression analysis of a chymotrypsin-like serine protease from kuruma shrimp Marsupenaeus japonicus. Fisheries Science, 75(5), 1231–1238. https://doi.org/10.1007/s12562-009-0159-0
Delbarre-Ladrat, C. , Verrez-Bagnis, V. , Noël, J. , & Fleurence, J. (2004). Relative contribution of calpain and cathepsins to protein degradation in muscle of sea bass (*Dicentrarchus labrax* L.). Food Chemistry, 88(3), 389–395. https://doi.org/10.1016/j.foodchem.2004.01.053
Dervisevic, M. , Custiuc, E. , Çevik, E. , Durmus, Z. , Şenel, M. , & Durmus, A. (2015a). Electrochemical biosensor based on REGO/Fe3O4 bionanocomposite interface for xanthine detection in fish sample. Food Control, 57, 402–410. https://doi.org/10.1016/j.foodcont.2015.05.001
Dervisevic, M. , Custiuc, E. , Çevik, E. , & Şenel, M. (2015b). Construction of novel xanthine biosensor by using polymeric mediator/MWCNT nanocomposite layer for fish freshness detection. Food Chemistry, 181, 277–283. https://doi.org/10.1016/j.foodchem.2015.02.104
Díaz-López, M. , Moyano-López, F. J. , Alarcón-López, F. J. , García-Carreño, F. L. , & Navarrete del Toro, M. A. (1998). Characterization of fish acid proteases by substrate-gel electrophoresis. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 121(4), 369–377. https://doi.org/10.1016/S0305-0491(98)10123-2
Doke, S. N. , Ninjoor, V. , & Nadkarni, G. B. (1980). Characterization of cathepsin D from the skeletal muscle of fresh water fish, Tilapia mossambica. Agricultural and Biological Chemistry, 44(7), 1521–1528. https://doi.org/10.1080/00021369.1980.10864161
Dong, Z. , Zhang, J. , Ji, X. , Zhou, F. , Fu, Y. , Chen, W. , Zeng, Y. , Li, T. , & Wang, H. (2012). Molecular cloning, characterization and expression of cathepsin D from grass carp (*Ctenopharyngodon idella*). Fish & Shellfish Immunology, 33(5), 1207–1214. https://doi.org/10.1016/j.fsi.2012.09.012
Dutson, T. R. (1983). Relationship of pH and temperature to disruption of specific muscle proteins and activity of lysosomal proteases. Journal of Food Biochemistry, 7(4), 223–245. https://doi.org/10.1111/j.1745-4514.1983.tb00800.x
Eckert, R. L. , Kaartinen, M. T. , Nurminskaya, M. , Belkin, A. M. , Colak, G. , Johnson, G. V. W. , & Mehta, K. (2014). Transglutaminase regulation of cell function. Physiological Reviews, 94(2), 383–417. https://doi.org/10.1152/physrev.00019.2013
Effront, J. , Prescott, S. C. , & Venable, C. S. (2007). Biochemical catalysts in life and industry: Proteolytic enzymes. Nature, 103, 403.
Einarsson, S. , Davies, P. S. , & Talbot, C. (1996). The effect of feeding on the secretion of pepsin, trypsin and chymotrypsin in the Atlantic salmon, *Salmo salar* L. Fish Physiology and Biochemistry, 15(5), 439–446. https://doi.org/10.1007/BF01875587
El Hadj Ali, N. , Hmidet, N. , Zouari-Fakhfakh, N. , Ben Khaled, H. , & Nasri, M. (2010). Alkaline chymotrypsin from Striped Seabream (*Lithognathus mormyrus*) Viscera: Purification and characterization. Journal of Agricultural and Food Chemistry, 58(17), 9787–9792. https://doi.org/10.1021/jf101667s
El-Beltagy, A. E. , El-Adawy, T. A. , Rahma, E. H. , & El-Bedawey, A. A. (2004). Purification and characterization of an acidic protease from the viscera of bolti fish (*Tilapia nilotica*). Food Chemistry, 86(1), 33–39. https://doi.org/10.1016/j.foodchem.2003.08.009
Fagutao, F. F. , Maningas, M. B. B. , Kondo, H. , Aoki, T. , & Hirono, I. (2012). Transglutaminase regulates immune-related genes in shrimp. Fish & Shellfish Immunology, 32(5), 711–715.

https://doi.org/10.1016/j.fsi.2012.01.018
Falkeborg, M. , Cheong, L.-Z. , Gianfico, C. , Sztukiel, K. M. , Kristensen, K. , Glasius, M. , Xu, X. , & Guo, Z. (2014). Alginate oligosaccharides: Enzymatic preparation and antioxidant property evaluation. Food Chemistry, 164, 185–194. https://doi.org/10.1016/j.foodchem.2014.05.053
Fan, T. , Zhang, Y. , Yang, L. , Yang, X. , Jiang, G. , Yu, M. , & Cong, R. (2009). Identification and characterization of a hemocyanin-derived phenoloxidase from the crab Charybdis japonica. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 152(2), 144–149. https://doi.org/10.1016/j.cbpb.2008.10.010
FAO. (2020). The State of World Fisheries and Aquaculture 2020. FAO, Rome. https://doi.org/10.4060/ca9231en
Fatima, R. , Farooqui, B. , & Qadri, R. B. (1981). Inosine monophosphate and hypoxanthine as indices of quality of shrimp (*Penaeus Merguensis*). Journal of Food Science, 46(4), 1125–1127. https://doi.org/10.1111/j.1365-2621.1981.tb03006.x
Felberg, H. S. , Hagen, L. , Slupphaug, G. , Batista, I. , Nunes, M. L. , Olsen, R. L. , & Martinez, I. (2010). Partial characterisation of gelatinolytic activities in herring (*Clupea harengus*) and sardine (*Sardina pilchardus*) possibly involved in post-mortem autolysis of ventral muscle. Food Chemistry, 119(2), 675–683. https://doi.org/10.1016/j.foodchem.2009.07.012
Feng, S. , Li, W. , & Lin, H. (2008). Characterization and expression of the pepsinogen C gene and determination of pepsin-like enzyme activity from orange-spotted grouper (*Epinephelus coioides*). Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 149(2), 275–284. https://doi.org/10.1016/j.cbpb.2007.09.017
Feng, T. , Zhang, H. , Liu, H. , Zhou, Z. , Niu, D. , Wong, L. , Kucuktas, H. , Liu, X. , Peatman, E. , & Liu, Z. (2011). Molecular characterization and expression analysis of the channel catfish cathepsin D genes. Fish & Shellfish Immunology, 31(1), 164–169. https://doi.org/10.1016/j.fsi.2011.04.006
Fernández, I. , Moyano, F. J. , Díaz, M. , & Martínez, T. (2001). Characterization of α-amylase activity in five species of Mediterranean sparid fishes (Sparidae, Teleostei). Journal of Experimental Marine Biology and Ecology, 262(1), 1–12. https://doi.org/10.1016/S0022-0981(01)00228-3
Fines, B. C. , & Holt, G. J. (2010). Chitinase and apparent digestibility of chitin in the digestive tract of juvenile cobia, Rachycentron canadum. Aquaculture, 303(1–4), 34–39. https://doi.org/10.1016/j.aquaculture.2010.03.010
Freitas-Júnior, A. C. V. , Costa, H. M. S. , Icimoto, M. Y. , Hirata, I. Y. , Marcondes, M. , Carvalho, L. B. , Oliveira, V. , & Bezerra, R. S. (2012). Giant Amazonian fish pirarucu (*Arapaima gigas*): Its viscera as a source of thermostable trypsin. Food Chemistry, 133(4), 1596–1602. https://doi.org/10.1016/j.foodchem.2012.02.056
Fu, X. , Xu, S. , & Wang, Z. (2009). Kinetics of lipid oxidation and off-odor formation in silver carp mince: The effect of lipoxygenase and hemoglobin. Food Research International, 42(1), 85–90. https://doi.org/10.1016/j.foodres.2008.09.004
Fu, X.-Y. , Xue, C.-H. , Miao, B.-C. , Li, Z.-J. , Zhang, Y. , & Wang, Q. (2007). Effect of processing steps on the physico-chemical properties of dried-seasoned squid. Food Chemistry, 103(2), 287–294. https://doi.org/10.1016/j.foodchem.2006.07.047
Gaarder, M. , Thomassen, M. S. , & Veiseth-Kent, E. (2011). Identification of calpastatin, μ-calpain and m-calpain in Atlantic salmon (*Salmo salar* L.) muscle. Food Chemistry, 125(3), 1091–1096. https://doi.org/10.1016/j.foodchem.2010.09.095
Ge, L. , Xu, Y. , & Xia, W. (2015). The function of endogenous cathepsin in quality deterioration of grass carp (*Ctenopharyngodon idella*) fillets stored in chilling conditions. International Journal of Food Science & Technology, 50(3), 797–803. https://doi.org/10.1111/ijfs.12713
Geesink, G. H. , Morton, J. D. , Kent, M. P. , & Bickerstaffe, R. (2000). Partial purification and characterization of Chinook Salmon (*Oncorhynchus tshawytscha*) calpains and an evaluation of their role in postmortem proteolysis. Journal of Food Science, 65(8), 1318–1324. https://doi.org/10.1111/j.1365-2621.2000.tb10605.x
German, J. B. , & Creveling, R. K. (1990). Identification and characterization of a 15-lipoxygenase from fish gills. Journal of Agricultural and Food Chemistry, 38(12), 2144–2147. https://doi.org/10.1021/jf00102a009
Ghaly, A. E. , Dave, D. , Budge, S. , & Brooks, M. S. (2010). Fish spoilage mechanisms and preservation techniques. American Journal of Applied Sciences, 7(7), 859.
Gildberg, A. (1988). Aspartic proteinases in fishes and aquatic invertebrates. Comparative Biochemistry and Physiology Part B: Comparative Biochemistry, 91(3), 425–435. https://doi.org/10.1016/0305-0491(88)90002-8
Gildberg, A. (2004a). Enzymes and bioactive peptides from fish waste related to fish silage, fish feed and fish sauce production. Journal of Aquatic Food Product Technology, 13(2), 3–11. https://doi.org/10.1300/J030v13n02_02
Gildberg, A. (2004b). Digestive enzyme activities in starved pre-slaughter farmed and wild-captured, Atlantic cod (*Gadus morhua*). Aquaculture, 238(1–4), 343–353. https://doi.org/10.1016/j.aquaculture.2004.03.021
Gill, T. A. , Keith, R. A. , & Lall, B. S. (1979). Textural deterioration of red hake and haddock muscle in frozen storage as related to chemical parameters and changes in the myofibrillar proteins. Journal of Food Science, 44(3), 661–667. https://doi.org/10.1111/j.1365-2621.1979.tb08470.x
Godiksen, H. , Morzel, M. , Hyldig, G. , & Jessen, F. (2009). Contribution of cathepsins B, L and D to muscle protein profiles correlated with texture in rainbow trout (*Oncorhynchus mykiss*). Food Chemistry, 113(4),

889–896. https://doi.org/10.1016/j.foodchem.2008.08.012
Goldman-Levkovitz, S. , Rimon, A. , & Rimon, S. (1995). Purification properties and specificity of cathepsin D from Cyprinus carpio. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 112(1), 147–151. https://doi.org/10.1016/0305-0491(95)00036-8
Goll, D. E. , Thompson, V. F. , Li, H. , Wei, W. , & Cong, J. (2003). The calpain system. Physiological Reviews, 83(3), 731–801. https://doi.org/10.1152/physrev.00029.2002
Gómez-Guillén, M. C. , Martínez-Alvarez, Ó. , Llamas, A. , & Montero, P. (2005). Melanosis inhibition and SO2 residual levels in shrimps (*Parapenaeus longirostris*) after different sulfite-based treatments. Journal of the Science of Food and Agriculture, 85(7), 1143–1148. https://doi.org/10.1002/jsfa.1990
Gonçalves, A. , Mendes, R. , & Nunes, M. L. (2004). Effect of oxygen absorber on the shelf life of Gilthead Seabream (*Sparus aurata*). Journal of Aquatic Food Product Technology, 13(3), 49–59. https://doi.org/10.1300/J030v13n03_05
Goncalves, R. , Gesto, M. , Rodríguez, C. , Reis, D. B. , Pérez, J. A. , & Lund, I. (2022). Ontogenetic changes in digestive enzyme activity and biochemical indices of larval and postlarval European lobster (*Homarus gammarus*, L). Marine Biology, 169(5), 53. https://doi.org/10.1007/s00227-022-04034-x
Gornik, S. G. , Albalat, A. , Theethakaew, C. , & Neil, D. M. (2013). Shelf life extension of whole Norway lobster Nephrops norvegicus using modified atmosphere packaging. International Journal of Food Microbiology, 167(3), 369–377. https://doi.org/10.1016/j.ijfoodmicro.2013.10.002
Griffin, M. , Casadio, R. , & Bergamini, C. M. (2002). Transglutaminases: Nature's biological glues. Biochemical Journal, 368(2), 377–396. https://doi.org/10.1042/bj20021234
Grzonka, Z. , Kasprzykowski, F. , & Wiczk, W. (2007). Cysteine proteases. In Industrial Enzymes (pp. 181–195). Springer, Netherlands. https://doi.org/10.1007/1-4020-5377-0_11
Gutowska, M. A. , Drazen, J. C. , & Robison, B. H. (2004). Digestive chitinolytic activity in marine fishes of Monterey Bay, California. Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 139(3), 351–358. https://doi.org/10.1016/j.cbpb.2004.09.020
Hagar, A. F. , Hwang, D. H. , & Dietz, T. H. (1989). Lipoxygenase activity in the gills of the freshwater mussel, Ligumia subrostrata. Biochimica et Biophysica Acta (BBA) – Lipids and Lipid Metabolism, 1005(2), 162–169. https://doi.org/10.1016/0005-2760(89)90182-3
Hall, M. , Wang, R. , van Antwerpen, R. , Sottrup-Jensen, L. , & Söderhäll, K. (1999). The crayfish plasma clotting protein: A vitellogenin-related protein responsible for clot formation in crustacean blood. Proceedings of the National Academy of Sciences, 96(5), 1965–1970. https://doi.org/10.1073/pnas.96.5.1965
Han-Ching Wang, K. , Tseng, C.-W. , Lin, H.-Y. , Chen, I.-T. , Chen, Y.-H. , Chen, Y.-M. , Chen, T.-Y. , & Yang, H.-L. (2010). RNAi knock-down of the Litopenaeus vannamei Toll gene (LvToll) significantly increases mortality and reduces bacterial clearance after challenge with Vibrio harveyi. Developmental & Comparative Immunology, 34(1), 49–58. https://doi.org/10.1016/j.dci.2009.08.003
Hata, M. , Kumagai, Y. , Rahman, M. M. , Chiba, S. , Tanaka, H. , Inoue, A. , & Ojima, T. (2009). Comparative study on general properties of alginate lyases from some marine gastropod mollusks. Fisheries Science, 75(3), 755–763. https://doi.org/10.1007/s12562-009-0079-z
Hawkins, D. J. , & Brash, A. R. (1987). Eggs of the sea urchin, *Strongylocentrotus purpuratus*, contain a prominent (11R) and (12R) lipoxygenase activity. Journal of Biological Chemistry, 262(16), 7629–7634. https://doi.org/10.1016/S0021-9258(18)47612-0
Heidari, M. G. , & Rezaei, M. (2022). Extracted pepsin of trout waste and ultrasound-promoted method for green recovery of fish collagen. Sustainable Chemistry and Pharmacy, 30, 100854. https://doi.org/10.1016/j.scp.2022.100854
Hemre, G.-I. , Mommsen, T. P. , & Krogdahl, Å. (2002). Carbohydrates in fish nutrition: Effects on growth, glucose metabolism and hepatic enzymes. Aquaculture Nutrition, 8(3), 175–194. https://doi.org/10.1046/j.1365-2095.2002.00200.x
Hermes, C. J. L. , & Melo, C. (2008). A first-principles simulation model for the start-up and cycling transients of household refrigerators. International Journal of Refrigeration, 31(8), 1341–1357. https://doi.org/10.1016/j.ijrefrig.2008.04.003
Hidalgo, M. C. , Urea, E. , & Sanz, A. (1999). Comparative study of digestive enzymes in fish with different nutritional habits. Proteolytic and amylase activities. Aquaculture, 170(3–4), 267–283. https://doi.org/10.1016/S0044-8486(98)00413-X
Hillegass, J. M. , Villano, C. M. , Cooper, K. R. , & White, L. A. (2007). Matrix metalloproteinase-13 is required for zebra fish (*Danio rerio*) development and is a target for glucocorticoids. Toxicological Sciences, 100(1), 168–179. https://doi.org/10.1093/toxsci/kfm192
Hinsui, J. , Worawattanamateekul, W. , Raksakulthai, N. , & Runglerdkriangkrai, J. (2006). Characterization of partial purified trypsin and chymotrypsin from viscera of Nile tilapia (Oreochromis niloticus Linneaus). Agriculture and Natural Resources, 40(5), 242–248.
Ho, M.-L. , Chen, G.-H. , & Jiang, S.-T. (2000). Effects of mackerel cathepsins L and L-like, and calpain on the degradation of mackerel surimi. Fisheries Science, 66(3), 558–568. https://doi.org/10.1046/j.1444-2906.2000.00087.x
Hong, H. , Regenstein, J. M. , & Luo, Y. (2015). The importance of ATP-related compounds for the freshness and flavor of post-mortem fish and shellfish muscle: A Review. Critical Reviews in Food Science and Nutrition,

57, 1787–1798. https://doi.org/10.1080/10408398.2014.1001489
Hosseini, H. , Ghorbani, M. , Jafari, S. M. , & Mahoonak, A. S. (2018). Investigating the effect of lipase from Candida rugosa on the production of EPA and DHA concentrates from Kilka fish (Clupeonella cultiventris caspia). LWT, 93, 534–541. https://doi.org/10.1016/j.lwt.2018.03.066
Huang, C.-C. , Sritunyalucksana, K. , Söderhäll, K. , & Song, Y.-L. (2004). Molecular cloning and characterization of tiger shrimp (*Penaeus monodon*) transglutaminase. Developmental & Comparative Immunology, 28(4), 279–294. https://doi.org/10.1016/j.dci.2003.08.005
IMP, I. (1959). A new method for estimating the freshness of fish. Bulletin of the Japanese Society of Scientific Fisheries, 24(9), 749.
Intarasirisawat, R. , Benjakul, S. , Visessanguan, W. , Prodpran, T. , Tanaka, M. , & Howell, N. K. (2007). Autolysis study of bigeye snapper (*Priacanthus macracanthus*) skin and its effect on gelatin. Food Hydrocolloids, 21(4), 537–544. https://doi.org/10.1016/j.foodhyd.2006.05.012
Itoh, R. (2013). Enzymatic properties and physiological roles of cytosolic 5′-nucleotidase II. Current Medicinal Chemistry, 20(34), 4260–4284. https://doi.org/10.2174/0929867311320340006
Jacober, L. F. , Rice, C. , & Rand, A. G. (1980). Characterization of the carbohydrate degrading enzymes in the Surf clam crystalline style. Journal of Food Science, 45(2), 381–385. https://doi.org/10.1111/j.1365-2621.1980.tb02620.x
Jensen, R. G. (1983). Detection and determination of lipase (Acylglycerol hydrolase) activity from various sources. Lipids, 18(9), 650–657. https://doi.org/10.1007/BF02534677
Jeuniaux, C. (1961). Chitinase: An addition to the list of hydrolases in the digestive tract of vertebrates. Nature, 192(4798), 135–136. https://doi.org/10.1038/192135a0
Jiang, S. T. , Wang, J. H. , & Chen, C. S. (1991). Purification and some properties of calpain II from tilapia muscle (*Tilapia nilotica*. times. *Tilapia aurea*). Journal of Agricultural and Food Chemistry, 39(2), 237–241.
Jinadasa, B. K. K. K. (2014). Determination of quality of marine fishes based on total volatile base nitrogen test (TVB-N). Nature and Science, 5(12), 106–111.
Kaewudom, P. , Benjakul, S. , & Kijroongrojana, K. (2012). Effect of bovine and fish gelatin in combination with microbial transglutaminase on gel properties of threadfin bream surimi. International Aquatic Research, 4(1), 12. https://doi.org/10.1186/2008-6970-4-12
Kani, Y. , Yoshikawa, N. , Okada, S. , & Abe, H. (2008). Taste-active components in the mantle muscle of the oval squid *Sepioteuthis lessoniana* and their effects on squid taste. Food Research International, 41(4), 371–379. https://doi.org/10.1016/j.foodres.2008.01.001
Khaled, H. B. , Ghorbel-Bellaaj, O. , Hmidet, N. , Jellouli, K. , Ali, N. E.-H. , Ghorbel, S. , & Nasri, M. (2011). A novel aspartic protease from the viscera of Sardinelle (*Sardinella aurita*): Purification and characterisation. Food Chemistry, 128(4), 847–853. https://doi.org/10.1016/j.foodchem.2011.03.104
Khantaphant, S. , & Benjakul, S. (2010). Purification and characterization of trypsin from the pyloric caeca of brownstripe red snapper (*Lutjanus vitta*). Food Chemistry, 120(3), 658–664. https://doi.org/10.1016/j.foodchem.2009.09.098
Kianersi, S. , Solouk, A. , Saber-Samandari, S. , Keshel, S. H. , & Pasbakhsh, P. (2021). Alginate nanoparticles as ocular drug delivery carriers. Journal of Drug Delivery Science and Technology, 66, 102889. https://doi.org/10.1016/j.jddst.2021.102889
Kimura, M. , Seki, N. , & Kimura, I. (2000). Occurrence and some properties of trimethylamine-N-oxide demethylase in myofibrillar fraction from walleye pollack muscle. Fisheries Science, 66(4), 725–729. https://doi.org/10.1046/j.1444-2906.2000.00118.x
Kinsella, J. E. (1982). Protein structure and functional properties: emulsification and flavor binding effects. In Series Food Protein deterioration,ACS Symposium, 206, 301–326 doi:10.1021/bk-1982-0206.
Klomklao, S. (2008). Digestive proteinases from marine organisms and their applications. Songklanakarin Journal of Science & Technology, 30(1), 37–46.
Klomklao, S. , Benjakul, S. , Visessanguan, W. , Kishimura, H. , & Simpson, B. (2006). Proteolytic degradation of sardine (*Sardinella gibbosa*) proteins by trypsin from skipjack tuna (*Katsuwonus pelamis*) spleen. Food Chemistry, 98(1), 14–22. https://doi.org/10.1016/j.foodchem.2005.05.047
Klomklao, S. , Kishimura, H. , & Benjakul, S. (2008). Endogenous proteinases in true sardine (*Sardinops melanostictus*). Food Chemistry, 107(1), 213–220. https://doi.org/10.1016/j.foodchem.2007.08.007
Kostaki, M. , Giatrakou, V. , Savvaidis, I. N. , & Kontominas, M. G. (2009). Combined effect of MAP and thyme essential oil on the microbiological, chemical and sensory attributes of organically aquacultured sea bass (*Dicentrarchus labrax*) fillets. Food Microbiology, 26(5), 475–482. https://doi.org/10.1016/j.fm.2009.02.008
Kristjánsson, M. M. , & Nielsen, H. H. (1992). Purification and characterization of two chymotrypsin-like proteases from the pyloric caeca of rainbow trout (*Oncorhynchus mykiss*). Comparative Biochemistry and Physiology Part B: Comparative Biochemistry, 101(1–2), 247–253. https://doi.org/10.1016/0305-0491(92)90187-V
Krogdahl, Å. , Sundby, A. , & Holm, H. (2015). Characteristics of digestive processes in Atlantic salmon (*Salmo salar*). Enzyme pH optima, chyme pH, and enzyme activities. Aquaculture, 449, 27–36. https://doi.org/10.1016/j.aquaculture.2015.02.032
Ktari, N. , Ben Khaled, H. , Nasri, R. , Jellouli, K. , Ghorbel, S. , & Nasri, M. (2012). Trypsin from zebra blenny (*Salaria basilisca*) viscera: Purification, characterisation and potential application as a detergent additive. Food

Chemistry, 130(3), 467–474. https://doi.org/10.1016/j.foodchem.2011.07.015
Kubota, M. , Kinoshita, M. , Kubota, S. , Yamashita, M. , Toyohara, H. , & Sakaguchi, M. (2001). Possible implication of metalloproteinases in post-mortem tenderization of fish muscle. Fisheries Science, 67(5), 965–968. https://doi.org/10.1046/j.1444-2906.2001.00347.x
Kubota, M. , Kinoshita, M. , Takeuchi, K. , Kubota, S. , Toyohara, H. , & Sakaguchi, M. (2003). Solubilization of type I collagen from fish muscle connective tissue by matrix metalloproteinase-9 at chilled temperature. Fisheries Science, 69(5), 1053–1059. https://doi.org/10.1046/j.1444-2906.2003.00726.x
Kumaresan, V. , Bhatt, P. , Palanisamy, R. , Gnanam, A. J. , Pasupuleti, M. , & Arockiaraj, J. (2014). A murrel cysteine protease, cathepsin L: Bioinformatics characterization, gene expression and proteolytic activity. Biologia, 69(3), 395–406. https://doi.org/10.2478/s11756-013-0326-8
Kurtovic, I. , Marshall, S. N. , Zhao, X. , & Simpson, B. K. (2009). Lipases from mammals and fishes. Reviews in Fisheries Science, 17(1), 18–40. https://doi.org/10.1080/10641260802031322
Ladrat, C. , Verrez-Bagnis, V. , Noël, J. , & Fleurence, J. (2002). Milli-calpain from sea bass (*Dicentrarchus labrax*) white muscle: Purification, characterization of its activity and activation in vitro. Marine Biotechnology, 4(1), 51–62. https://doi.org/10.1007/s1012601-0075-5
Ladrat, C. , Verrez-Bagnis, V. , Noël, J. , & Fleurence, J. (2003). *In vitro* proteolysis of myofibrillar and sarcoplasmic proteins of white muscle of sea bass (*Dicentrarchus labrax L*.): Effects of cathepsins B, D and L. Food Chemistry, 81(4), 517–525. https://doi.org/10.1016/S0308-8146(02)00481-8
Leaver, M. J. , Bautista, J. M. , Björnsson, B. T. , Jönsson, E. , Krey, G. , Tocher, D. R. , & Torstensen, B. E. (2008). Towards fish lipid nutrigenomics: Current state and prospects for Fin-fish aquaculture. Reviews in Fisheries Science, 16(sup1), 73–94. https://doi.org/10.1080/10641260802325278
Lee, J. , & Park, J. W. (2016). Pacific whiting frozen fillets as affected by postharvest processing and storage conditions. Food Chemistry, 201, 177–184. https://doi.org/10.1016/j.foodchem.2016.01.083
Lee, J. , & Park, J. W. (2018). Roles of TMAOase in muscle and drips of Alaska pollock fillets at various freeze/thaw cycles. Journal of Food Processing and Preservation, 42(2), e13427. https://doi.org/10.1111/jfpp.13427
Lewandowicz, A. , & Schramm, V. L. (2004). Transition state analysis for human and Plasmodium falciparum purine nucleoside phosphorylases. Biochemistry, 43(6), 1458–1468. https://doi.org/10.1021/bi0359123
Li, C. , Song, L. , Tan, F. , Su, B. , Zhang, D. , Zhao, H. , & Peatman, E. (2015). Identification and mucosal expression analysis of cathepsin B in channel catfish (*Ictalurus punctatus*) following bacterial challenge. Fish & Shellfish Immunology, 47(2), 751–757. https://doi.org/10.1016/j.fsi.2015.10.028
Li, D. , Zhang, L. , Song, S. , Wang, Z. , Kong, C. , & Luo, Y. (2017). The role of microorganisms in the degradation of adenosine triphosphate (ATP) in chill-stored common carp (*Cyprinus carpio*) fillets. Food Chemistry, 224, 347–352. https://doi.org/10.1016/j.foodchem.2016.12.056
Li, D. , Zhou, D. , Yin, F. , Dong, X. , Xie, H. , Liu, Z. , Li, A. , Li, J. , Rakariyatham, K. , & Shahidi, F. (2020). Impact of different drying processes on the lipid deterioration and color characteristics of Penaeus vannamei. Journal of the Science of Food and Agriculture, 100(6), 2544–2553. https://doi.org/10.1002/jsfa.10280
Li, D. , Zhuang, S. , Peng, Y. , Tan, Y. , Hong, H. , & Luo, Y. (2022). Mechanism of inosine monophosphate degradation by specific spoilage organism from grass carp in fish juice system. Foods, 11(17), 2672. https://doi.org/10.3390/foods11172672
Liang, F.-R. , Wang, Q.-Q. , Jiang, Y.-L. , Yue, B.-Y. , Zhou, Q.-Z. , & Wang, J.-H. (2020). Characterization of matrix metalloprotease-9 gene from Nile tilapia (*Oreochromis niloticus*) and its high-level expression induced by the *Streptococcus agalactiae* challenge. Biomolecules, 10(1), 76. https://doi.org/10.3390/biom10010076
Likhar, V. , & Chudasama, B. J. (2021). Seafood enzymes and their potential industrial applications. Journal of Entomology and Zoology Studies, 9(1), 1410–1417.
Liu, H. , Yin, L. , Zhang, N. , Li, S. , & Ma, C. (2006). Purification and characterization of cathepsin L from the muscle of silver carp (*Hypophthalmichthys molitrix*). Journal of Agricultural and Food Chemistry, 54(25), 9584–9591. https://doi.org/10.1021/jf062038m
Liu, H. , Yin, L. , Zhang, N. , Li, S. , & Ma, C. (2008). Isolation of cathepsin B from the muscle of silver carp (Hypophthalmichthys molitrix) and comparison of cathepsins B and L actions on surimi gel softening. Food Chemistry, 110(2), 310–318. https://doi.org/10.1016/j.foodchem.2008.01.068
Liu, W. , Madry, H. , & Cucchiarini, M. (2022a). Application of alginate hydrogels for next-generation articular cartilage regeneration. International Journal of Molecular Sciences, 23(3), 1147. https://doi.org/10.3390/ijms23031147
Liu, X. , Huang, Z. , Jia, S. , Zhang, J. , Li, K. , & Luo, Y. (2018). The roles of bacteria in the biochemical changes of chill-stored bighead carp (*Aristichthys nobilis*): Proteins degradation, biogenic amines accumulation, volatiles production, and nucleotides catabolism. Food Chemistry, 255, 174–181. https://doi.org/10.1016/j.foodchem.2018.02.069
Liu, Y. , Bao, Z. , Lin, Z. , & Xue, Q. (2022b). Transcriptomic identification of key genes in Pacific oysters Crassostrea gigas responding to major abiotic and biotic stressors. Fish & Shellfish Immunology, 131, 1027–1039. https://doi.org/10.1016/j.fsi.2022.11.009
Lødemel, J. B. , & Olsen, R. L. (2003). Gelatinolytic activities in muscle of Atlantic cod (Gadus morhua), spotted wolffish (Anarhichas minor) and Atlantic salmon (Salmo salar). Journal of the Science of Food and Agriculture, 83(10), 1031–1036. https://doi.org/10.1002/jsfa.1501

López-Caballero, M. E. , Martínez-Álvarez, Ó. , Gómez-Guillén, M. C. , & Montero, P. (2006). Effect of natural compounds alternative to commercial antimelanosics on polyphenol oxidase activity and microbial growth in cultured prawns (*Marsupenaeus tiger*) during chilled storage. European Food Research and Technology, 223(1), 7–15. https://doi.org/10.1007/s00217-005-0049-3
Lu, Y. , Chen, Y. , Wu, Y. , Hao, H. , Liang, W. , Liu, J. , & Huang, R. (2019). Marine unsaturated fatty acids: Structures, bioactivities, biosynthesis and benefits. RSC Advances, 9(61), 35312–35327. https://doi.org/10.1039/C9RA08119D
Lushchak, V. I. , Husak, V. V. , & Storey, K. B. (2008). Regulation of AMP-deaminase activity from white muscle of common carp Cyprinus carpio. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 149(2), 362–369. https://doi.org/10.1016/j.cbpb.2007.10.008
Malinowska-Pańczyk, E. , & Kołodziejska, I. (2016). The effect of high pressure on formation of volatile amines in minced meat of cod (Gadus morhua). European Food Research and Technology, 242(3), 415–420. https://doi.org/10.1007/s00217-015-2552-5
Manheem, K. , Benjakul, S. , Kijroongrojana, K. , & Visessanguan, W. (2012). The effect of heating conditions on polyphenol oxidase, proteases and melanosis in pre-cooked Pacific white shrimp during refrigerated storage. Food Chemistry, 131(4), 1370–1375. https://doi.org/10.1016/j.foodchem.2011.10.001
Mansur, M. A. , Bhadra, A. , Takamura, H. , & Matoba, T. (2003). Volatile flavor compounds of some sea fish and prawn species. Fisheries Science, 69(4), 864–866. https://doi.org/10.1046/j.1444-2906.2003.00700.x
Marcuschi, M. , Espósito, T. S. , Machado, M. F. M. , Hirata, I. Y. , Machado, M. F. M. , Silva, M. v., Carvalho, L. B. , Oliveira, V. , & Bezerra, R. S. (2010). Purification, characterization and substrate specificity of a trypsin from the Amazonian fish tambaqui (*Colossoma macropomum*). Biochemical and Biophysical Research Communications, 396(3), 667–673. https://doi.org/10.1016/j.bbrc.2010.04.155
Mariutti, L. R. B. , & Bragagnolo, N. (2017). Influence of salt on lipid oxidation in meat and seafood products: A review. Food Research International, 94, 90–100. https://doi.org/10.1016/j.foodres.2017.02.003
Marseno, D. W. , Hori, K. , & Miyazawa, K. (1992). Distribution of 5′-nucleotidase in muscle of some marine fishes. Comparative Biochemistry and Physiology Part B: Comparative Biochemistry, 102(2), 247–253. https://doi.org/10.1016/0305-0491(92)90118-B
Marseno, D. W. , Hori, K. , & Miyazawa, K. (1993a). Purification and properties of cytosol 5′-nucleotidase from black rockfish (*Sebastes inermis*) muscle. Journal of Agricultural and Food Chemistry, 41(8), 1208–1212.
Marseno, D. W. , Hori, K. , & Miyazawa, K. (1993b). Purification and properties of membrane-bound 5′-nucleotidase from black rockfish (*Sebastes inermis*) muscle. Journal of Agricultural and Food Chemistry, 41(6), 863–869.
Marseno, D. W. , Hori, K. , & Miyazawa, K. (1994). Comparison of membrane-bound and cytosol 5′-nucleotidases from black rockfish Sebastes inermis muscle and their influence on the freshness of fish. Fisheries Science, 60(1), 115–121. https://doi.org/10.2331/fishsci.60.115
Maruyama, M. , Furukawa, Y. , Kinoshita, M. , Mukaiyama, A. , Akiyama, S. , & Yoshimura, T. (2022). Adenylate kinase 1 overexpression increases locomotor activity in medaka fish. PLoS One, 17(1), e0257967. https://doi.org/10.1371/journal.pone.0257967
Maskos, K. , & Bode, W. (2003). Structural basis of matrix metalloproteinases and tissue inhibitors of metalloproteinases. Molecular Biotechnology, 25(3), 241–266. https://doi.org/10.1385/MB:25:3:241
Mathew, G. M. , Sukumaran, R. K. , Sindhu, R. , Binod, P. , & Pandey, A. (2021). Green remediation of the potential hazardous shellfish wastes generated from the processing industries and their bioprospecting. Environmental Technology & Innovation, 24, 101979. https://doi.org/10.1016/j.eti.2021.101979
Mathew, S. , Raman, M. , Kalarikkathara Parameswaran, M. , & Rajan, D. P. (2019). Assessment of nutritional quality of fish. In Fish and Fishery Products Analysis (pp. 1–62). Springer, Singapore.
Matsumiya, M. , & Mochizuki, A. (1996). Distribution of chitinase and acetylhexosaminidase in the organs of several fishes. Fisheries Science, 62(1), 150–151. https://doi.org/10.2331/fishsci.62.150
McLay, R. (1980). Activities of cathepsins A and D in cod muscle. Journal of the Science of Food and Agriculture, 31(10), 1050–1054. https://doi.org/10.1002/jsfa.2740311012
Mendes, R. , Quinta, R. , & Nunes, M. L. (2001). Changes in baseline levels of nucleotides during ice storage of fish and crustaceans from the Portuguese coast. European Food Research and Technology, 212(2), 141–146. https://doi.org/10.1007/s002170000222
Meyer, S. , Dunkel, A. , & Hofmann, T. (2016). Sensomics-Assisted elucidation of the tastant code of cooked crustaceans and taste reconstruction experiments. Journal of Agricultural and Food Chemistry, 64(5), 1164–1175. https://doi.org/10.1021/acs.jafc.5b06069
Mohri, S. , Cho, S.-Y. , Endo, Y. , & Fujimoto, K. (1990). Lipoxygenase activity in sardine skin. Agricultural and Biological Chemistry, 54(7), 1889–1891. https://doi.org/10.1271/bbb1961.54.1889
Montero, P. , Ávalos, A. , & Pérez-Mateos, M. (2001). Characterization of polyphenoloxidase of prawns (*Penaeus japonicus*). Alternatives to inhibition. Food Chemistry, 75(3), 317–324. https://doi.org/10.1016/S0308-8146(01)00206-0
Moon, S. , Kim, J. , & Bae, E. (2017). Structural analyses of adenylate kinases from Antarctic and tropical fishes for understanding cold adaptation of enzymes. Scientific Reports, 7(1), 16027. https://doi.org/10.1038/s41598-017-16266-9

Moreno, H. M. , Domínguez-Timón, F. , Díaz, M. T. , Pedrosa, M. M. , Borderías, A. J. , & Tovar, C. A. (2020). Evaluation of gels made with different commercial pea protein isolate: Rheological, structural and functional properties. Food Hydrocolloids, 99, 105375. https://doi.org/10.1016/j.foodhyd.2019.105375

Mørkøre, T. , Rødbotten, M. , Vogt, G. , Fjæra, S. O. , Kristiansen, I. Ø., & Manseth, E. (2010). Relevance of season and nucleotide catabolism on changes in fillet quality during chilled storage of raw Atlantic salmon (*Salmo salar* L.). Food Chemistry, 119(4), 1417–1425.

Morselli, M. B. , Baldissera, M. D. , Souza, C. F. , Reis, J. H. , Baldisserotto, B. , Sousa, A. A. , Zimmer, F. , Lopes, D. L. A. , Petrolli, T. G. , & da Silva, A. S. (2020). Effects of thymol supplementation on performance, mortality and branchial energetic metabolism in grass carp experimentally infected by Aeromonas hydrophila. Microbial Pathogenesis, 139, 103915. https://doi.org/10.1016/j.micpath.2019.103915

Munagala, N. , & Wang, C. C. (2002). The purine nucleoside phosphorylase from Trichomonas vaginalis is a homologue of the bacterial enzyme. Biochemistry, 41(33), 10382–10389. https://doi.org/10.1021/bi026025n

Murakami, Y. , Ando, M. , Futamata, R. , Horibe, T. , Ueda, K. , Kinoshita, M. , & Kobayashi, T. (2022). Targeted deletion of ecto-5′-nucleotidase results in retention of inosine monophosphate content in postmortem muscle of medaka (*Oryzias latipes*). Scientific Reports, 12(1), 18588. https://doi.org/10.1038/s41598-022-22029-y

Nalinanon, S. , Benjakul, S. , & Kishimura, H. (2010). Biochemical properties of pepsinogen and pepsin from the stomach of albacore tuna (*Thunnus alalunga*). Food Chemistry, 121(1), 49–55. https://doi.org/10.1016/j.foodchem.2009.11.089

Nalinanon, S. , Benjakul, S. , Visessanguan, W. , & Kishimura, H. (2008). Tuna pepsin: Characteristics and its use for collagen extraction from the skin of threadfin bream (*Nemipterus* spp.). Journal of Food Science, 73(5), C413–C419. https://doi.org/10.1111/j.1750-3841.2008.00777.x

Nalinanon, S. , Benjakul, S. , Visessanguan, W. , & Kishimura, H. (2009). Partitioning of protease from stomach of albacore tuna (*Thunnus alalunga*) by aqueous two-phase systems. Process Biochemistry, 44(4), 471–476. https://doi.org/10.1016/j.procbio.2008.12.018

Nedachi, K. , & Hirota, N. (1992). Purification and properties of 5′-Nucleotidase from snapper muscle. Nippon Suisan Gakkaishi, 58(10), 1905–1911. https://doi.org/10.2331/suisan.58.1905

Nielsen, L. B. , & Nielsen, H. H. (2001). Purification and characterization of cathepsin D from herring muscle (*Clupea harengus*). Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 128(2), 351–363. https://doi.org/10.1016/S1096-4959(00)00332-8

Nielsen, M. K. , & Jørgensen, B. M. (2004). Quantitative relationship between trimethylamine oxide aldolase activity and formaldehyde accumulation in white muscle from gadiform fish during frozen storage. Journal of Agricultural and Food Chemistry, 52(12), 3814–3822. https://doi.org/10.1021/jf035169l

Nimbkar, S. , Auddy, M. , Manoj, I. , & Shanmugasundaram, S. (2021). Novel techniques for quality evaluation of fish: A review. Food Reviews International, 39, 1–24. https://doi.org/10.1080/87559129.2021.1925291

Nirmal, N. P. , & Benjakul, S. (2011). Use of tea extracts for inhibition of polyphenoloxidase and retardation of quality loss of Pacific white shrimp during iced storage. LWT – Food Science and Technology, 44(4), 924–932. https://doi.org/10.1016/j.lwt.2010.12.007

Nirmal, N. P. , Benjakul, S. , Ahmad, M. , Arfat, Y. A. , & Panichayupakaranant, P. (2015). Undesirable enzymatic browning in crustaceans: Causative effects and its inhibition by phenolic compounds. Critical Reviews in Food Science and Nutrition, 55(14), 1992–2003. https://doi.org/10.1080/10408398.2012.755148

Nozawa, H. , & Seki, N. (2001). Purification of transglutaminase from scallop striated adductor muscle and NaCl-induced inactivation. Fisheries Science, 67(3), 493–499. https://doi.org/10.1046/j.1444-2906.2001.00263.x

Nurhayati, T. , Nurilmala, M. , & Nuraini, A. (2019). Characterization of trimethylamin-N-oxide demethylase (TMAOase) of izardfish from Indonesian waters. IOP Conference Series: Earth and Environmental Science, 278(1), 012053. https://doi.org/10.1088/1755-1315/278/1/012053

Nurhayati, T. , Trilaksani, W. , Ramadhan, W. , & Ichsani, S. P. (2022). The role of pepsin in improving the quality of surimi of red tilapia (*Orechromis niloticus*). Current Research in Nutrition and Food Science, 10(2), 584–594.

Oliveira, F. A. D. , Neto, O. C. , Santos, L. M. R. D. , Ferreira, E. H. R. , & Rosenthal, A. (2017). Effect of high pressure on fish meat quality – A review. Trends in Food Science & Technology, 66, 1–19. https://doi.org/10.1016/j.tifs.2017.04.014

Pandey, P. K. , & Parhi, J. (2021). Advances in Fisheries Biotechnology. Springer, Singapore.

Park, S.-K. , Jo, D.-M. , Yu, D. , Khan, F. , Lee, Y. B. , & Kim, Y.-M. (2020). Reduction of Trimethylamine off-odor by lactic acid bacteria isolated from Korean traditional fermented food and their in situ application. Journal of Microbiology and Biotechnology, 30(10), 1510–1515. https://doi.org/10.4014/jmb.2005.05007

Parlapani, F. F. , Verdos, G. I. , Haroutounian, S. A. , & Boziaris, I. S. (2015). The dynamics of pseudomonas and volatilome during the spoilage of gutted sea bream stored at 2°C. Food Control, 55, 257–265. https://doi.org/10.1016/j.foodcont.2015.03.004

Peng, Y. , Chen, S. , Ji, H. , & Liu, S. (2019). Localization of trypsin-like protease in postmortem tissue of white shrimp (*Litopenaeus vannamei*) and its effect in muscle softening. Food Chemistry, 290, 277–285. https://doi.org/10.1016/j.foodchem.2019.03.147

Podok, P. , Xu, L. , Xu, D. , & Lu, L. (2014). Different expression profiles of Interleukin 11 (IL-11), Intelectin (ITLN) and Purine nucleoside phosphorylase 5a (PNP 5a) in crucian carp (*Carassius auratus gibelio*) in response to *Cyprinid herpesvirus* 2 and *Aeromonas hydrophila* . Fish & Shellfish Immunology, 38(1), 65–73. https://doi.org/10.1016/j.fsi.2014.03.001
Pongsomboon, S. , Wongpanya, R. , Tang, S. , Chalorsrikul, A. , & Tassanakajon, A. (2008). Abundantly expressed transcripts in the lymphoid organ of the black tiger shrimp, Penaeus monodon, and their implication in immune function. Fish & Shellfish Immunology, 25(5), 485–493. https://doi.org/10.1016/j.fsi.2008.07.010
Prabhakar, P. K. , Vatsa, S. , Srivastav, P. P. , & Pathak, S. S. (2020). A comprehensive review on freshness of fish and assessment: Analytical methods and recent innovations. Food Research International, 133, 109157. https://doi.org/10.1016/j.foodres.2020.109157
Prost, C. , Hallier, A. , Cardinal, M. , Serot, T. , & Courcoux, P. (2006). Effect of storage time on raw sardine (*Sardina pilchardus*) flavor and aroma quality. Journal of Food Science, 69(5), S198–S204. https://doi.org/10.1111/j.1365-2621.2004.tb10732.x
Qiu, H. , Guo, X. , Deng, X. , Guo, X. , Mao, X. , Xu, C. , & Zhang, J. (2020). The influence of endogenous cathepsin in different subcellular fractions on the quality deterioration of Northern pike (*Esox lucius*) fillets during refrigeration and partial freezing storage. Food Science and Biotechnology, 29(10), 1331–1341. https://doi.org/10.1007/s10068-020-00781-z
Qiu, R. , Liu, X. , Hu, Y. , & Sun, B. (2013). Expression characterization and activity analysis of a cathepsin B from Pacific abalone Haliotis discus hannai. Fish & Shellfish Immunology, 34(5), 1376–1382. https://doi.org/10.1016/j.fsi.2013.02.025
Raae, A. J. , & Walther, B. T. (1989). Purification and characterization of chymotrypsin, trypsin and elastase like proteinases from cod (*Gadus morhua L.*). Comparative Biochemistry and Physiology Part B: Comparative Biochemistry, 93(2), 317–324. https://doi.org/10.1016/0305-0491(89)90087-4
Rangasamy, B. , Malafaia, G. , & Maheswaran, R. (2022). Evaluation of antioxidant response and Na+-K+-ATPase activity in zebrafish exposed to polyethylene microplastics: Shedding light on a physiological adaptation. Journal of Hazardous Materials, 426, 127789. https://doi.org/10.1016/j.jhazmat.2021.127789
Rey-Mansilla, M. , Sotelo, C. G. , & Perez-Martin, R. I. (2002). TMAOase activity of European Hake (*Merluccius merluccius*) organs: Influence of biological condition and season. Journal of Food Science, 67(9), 3242–3251. https://doi.org/10.1111/j.1365-2621.2002.tb09573.x
Richmond, G. S. , & Smith, T. K. (2011). Phospholipases A1. International Journal of Molecular Sciences, 12(1), 588–612. https://doi.org/10.3390/ijms12010588
Rodriguez, L. A. , Ellis, A. E. , & Nieto, T. P. (1992). Purification and characterisation of an extracellular metalloprotease, serine protease and haemolysin of Aeromonas hydrophila strain B32: All are lethal for fish. Microbial Pathogenesis, 13(1), 17–24. https://doi.org/10.1016/0882-4010(92)90028-M
Roobab, U. , Fidalgo, L. G. , Arshad, R. N. , Khan, A. W. , Zeng, X. , Bhat, Z. F. , Bekhit, A. E. A. , Batool, Z. , & Aadil, R. M. (2022). Highpressure processing of fish and shellfish products: Safety, quality, and research prospects. Comprehensive Reviews in Food Science and Food Safety, 21(4), 3297–3325. https://doi.org/10.1111/1541-4337.12977
Sae-Leaw, T. , & Benjakul, S. (2019). Prevention of melanosis in crustaceans by plant polyphenols: A review. Trends in Food Science & Technology, 85, 1–9. https://doi.org/10.1016/j.tifs.2018.12.003
Sainz, J. C. , Sierra-Beltrán, A. , García-Carreño, F. , & Hernández-Cortés, P. (2004). Trypsin synthesis and storage as zymogen in the midgut gland of the shrimp Litopenaeus Vannamei. Journal of Crustacean Biology, 24(2), 266–273. https://doi.org/10.1651/C-2423
Saito, M. , Li, H. , Thompson, V. F. , Kunisaki, N. , & Goll, D. E. (2007). Purification and characterization of calpain and calpastatin from rainbow trout, Oncorhynchus mykiss. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 146(4), 445–455. https://doi.org/10.1016/j.cbpb.2006.10.110
Salem, M. , Kenney, P. B. , Killefer, J. , & Nath, J. (2005). Isolation and characterization of calpains from rainbow trout muscle and their role in texture development. Journal of Muscle Foods, 15(4), 245–255. https://doi.org/10.1111/j.1745-4573.2004.06803.x
Sarower, M. G. , Hasanuzzaman, A. F. M. , Biswas, B. , & Abe, H. (2012). Taste producing components in fish and fisheries products: A review. International Journal of Food and Fermentation Technology, 2(2), 113.
Secades, P. , Alvarez, B. , & Guijarro, J. A. (2003). Purification and properties of a new psychrophilic metalloprotease (Fpp2) in the fish pathogen Flavobacterium psychrophilum. FEMS Microbiology Letters, 226(2), 273–279. https://doi.org/10.1016/S0378-1097(03)00599-8
Secci, G. , & Parisi, G. (2016). From farm to fork: Lipid oxidation in fish products. A review. Italian Journal of Animal Science, 15(1), 124–136. https://doi.org/10.1080/1828051X.2015.1128687
Segato, S. , Corato, A. , Fasolato, L. , & Andrighetto, I. (2005). Effect of the partial replacement of fish meal and oil by vegetable products on performance and quality traits of juvenile shi drum (*Umbrina cirrosa* L.). Italian Journal of Animal Science, 4(2), 159–166. https://doi.org/10.4081/ijas.2005.159
Senphan, T. , Benjakul, S. , & Kishimura, H. (2015). Purification and characterization of trypsin from hepatopancreas of Pacific white shrimp. Journal of Food Biochemistry, 39(4), 388–397. https://doi.org/10.1111/jfbc.12147
Shahidi, F. , & Hossain, A. (2022). Role of lipids in food flavor generation. Molecules, 27(15), 5014. https://doi.org/10.3390/molecules27155014

Shahidi, F. , & Wanasundara, U. N. (1998). Omega-3 fatty acid concentrates: Nutritional aspects and production technologies. Trends in Food Science & Technology, 9(6), 230–240. https://doi.org/10.1016/S0924-2244(98)00044-2
Shahidi, F. , & Zhong, Y. (2010). Novel antioxidants in food quality preservation and health promotion. European Journal of Lipid Science and Technology, 112(9), 930–940. https://doi.org/10.1002/ejlt.201000044
Shan, Y. , Zhang, Y. , Zhuo, X. , Li, X. , Peng, J. , & Fang, W. (2016). Matrix metalloproteinase-9 plays a role in protecting zebrafish from lethal infection with Listeria monocytogenes by enhancing macrophage migration. Fish & Shellfish Immunology, 54, 179–187. https://doi.org/10.1016/j.fsi.2016.04.003
Shen, J.-D. , Cai, Q.-F. , Yan, L.-J. , Du, C.-H. , Liu, G.-M. , Su, W.-J. , Ke, C. , & Cao, M.-J. (2015). Cathepsin L is an immune-related protein in Pacific abalone (*Haliotis discus hannai*) – Purification and characterization. Fish & Shellfish Immunology, 47(2), 986–995. https://doi.org/10.1016/j.fsi.2015.11.004
Shi, S. , Wang, X. , Wu, X. , & Shi, W. (2020). Effects of four cooking methods on sensory and taste quality of Portunus trituberculatus. Food Science & Nutrition, 8(2), 1115–1124. https://doi.org/10.1002/fsn3.1398
Shi, X. , Zhao, X. , & Wang, J. (2008). Molecular cloning and expression analysis of chymotrypsin-like serine protease from the Chinese shrimp, Fenneropenaeus chinensis. Fish & Shellfish Immunology, 25(5), 589–597. https://doi.org/10.1016/j.fsi.2008.07.011
Sholeh, M. M. , Ambarsari, L. , Nurcholis, W. , & Nurhayati, T. (2020). Characterization of ammonium sulphate fraction of pepsin from fish stomach. IOP Conference Series: Earth and Environmental Science, 404(1), 012039. https://doi.org/10.1088/1755-1315/404/1/012039
Sila, A. , Nasri, R. , Jridi, M. , Balti, R. , Nasri, M. , & Bougatef, A. (2012). Characterisation of trypsin purified from the viscera of Tunisian barbel (*Barbus callensis*) and its application for recovery of carotenoproteins from shrimp wastes. Food Chemistry, 132(3), 1287–1295. https://doi.org/10.1016/j.foodchem.2011.11.105
Singh, A. , & Benjakul, S. (2018). Proteolysis and its control using protease inhibitors in fish and fish products: A review. Comprehensive Reviews in Food Science and Food Safety, 17(2), 496–509. https://doi.org/10.1111/1541-4337.12337
Sirikharin, R. , Söderhäll, I. , & Söderhäll, K. (2018). Characterization of a cold-active transglutaminase from a crayfish, Pacifastacus leniusculus. Fish & Shellfish Immunology, 80, 546–549. https://doi.org/10.1016/j.fsi.2018.06.042
Song, Y.-L. , Yu, C.-I. , Lien, T.-W. , Huang, C.-C. , & Lin, M.-N. (2003). Haemolymph parameters of Pacific white shrimp (*Litopenaeus vannamei*) infected with Taura syndrome virus. Fish & Shellfish Immunology, 14(4), 317–331. https://doi.org/10.1006/fsim.2002.0440
Sriket, C. (2014). Proteases in fish and shellfish: Role on muscle softening and prevention. International Food Research Journal, 21(2), 433–445.
Sriket, C. , Benjakul, S. , & Visessanguan, W. (2011). Characterisation of proteolytic enzymes from muscle and hepatopancreas of fresh water prawn (*Macrobrachium rosenbergii*). Journal of the Science of Food and Agriculture, 91(1), 52–59. https://doi.org/10.1002/jsfa.4145
Sriket, C. , Benjakul, S. , Visessanguan, W. , Hara, K. , Yoshida, A. , & Liang, X. (2012). Low molecular weight trypsin from hepatopancreas of freshwater prawn (*Macrobrachium rosenbergii*): Characteristics and biochemical properties. Food Chemistry, 134(1), 351–358. https://doi.org/10.1016/j.foodchem.2012.02.173
Summers, G. , Wibisono, R. D. , Hedderley, D. I. , & Fletcher, G. C. (2017). Trimethylamine oxide content and spoilage potential of New Zealand commercial fish species. New Zealand Journal of Marine and Freshwater Research, 51(3), 393–405. https://doi.org/10.1080/00288330.2016.1250785
Surette, M. , Gill, T. , & MacLean, S. (1990). Purification and characterization of purine nucleoside phosphorylase from Proteus vulgaris. Applied and Environmental Microbiology, 56(5), 1435–1439. https://doi.org/10.1128/aem.56.5.1435-1439.1990
Suzuki, H. , Suzuki, K. , Inoue, A. , & Ojima, T. (2006). A novel oligoalginate lyase from abalone, Haliotis discus hannai, that releases disaccharide from alginate polymer in an exolytic manner. Carbohydrate Research, 341(11), 1809–1819. https://doi.org/10.1016/j.carres.2006.04.032
Świeca, M. , Sęczyk, Ł. , Gawlik-Dziki, U. , & Dziki, D. (2014). Bread enriched with quinoa leaves – The influence of protein-phenolics interactions on the nutritional and antioxidant quality. Food Chemistry, 162, 54–62. https://doi.org/10.1016/j.foodchem.2014.04.044ss
Thiansilakul, Y. , Benjakul, S. , & Richards, M. P. (2010). Changes in heme proteins and lipids associated with off-odour of seabass (*Lates calcarifer*) and red tilapia (*Oreochromis mossambicus×O. niloticus*) during iced storage. Food Chemistry, 121(4), 1109–1119. https://doi.org/10.1016/j.foodchem.2010.01.058
Toyohara, H. , Makinodan, Y. , Tanaka, K. , & Ikeda, S. (1985). Purification and properties of carp (*Cyprinus carpio*) muscle calpain II (high-Ca2+-requiring form of calpain). Comparative Biochemistry and Physiology Part B: Comparative Biochemistry, 81(3), 573–578. https://doi.org/10.1016/0305-0491(85)90368-2
Turk, V. , & Bode, W. (1991). The cystatins: Protein inhibitors of cysteine proteinases. FEBS Letters, 285(2), 213–219. https://doi.org/10.1016/0014-5793(91)80804-C
van Hau, P. , & Benjakul, S. (2006). Purification and characterization of trypsin from pyloric caeca of bigeye snapper (*Pricanthus macracanthus*). Journal of Food Biochemistry, 30(4), 478–495. https://doi.org/10.1111/j.1745-4514.2006.00089.x
Verrez-Bagnis, V. , Ladrat, C. , Noelle, J. , & Fleurence, J. (2002). In vitro proteolysis of European sea bass (*Dicentrarchus labrax*) myofibrillar and sarcoplasmic proteins by an endogenous m-calpain. Journal of the

Science of Food and Agriculture, 82, 1256–1262.
Vervaet, A. (2019). Assessing the Presence of Chitinases in the Digestive Tract and Their Relationship to Diet and Morphology in Freshwater Fish [Doctoral dissertation]. Ghent University.
Vicente, S. J. V. , Sampaio, G. R. , Ferrari, C. K. B. , & Torres, E. A. F. S. (2012). Oxidation of cholesterol in foods and its importance for human health. Food Reviews International, 28(1), 47–70. https://doi.org/10.1080/87559129.2011.594972
Vieira, S. A. , Zhang, G. , & Decker, E. A. (2017). Biological implications of lipid oxidation products. Journal of the American Oil Chemists' Society, 94(3), 339–351. https://doi.org/10.1007/s11746-017-2958-2
Vigneswaran, C. , Ananthasubramanian, M. , & Kandhavadivu, P. (2014). Bioprocessing of Textiles. Woodhead Publishing India Pvt Limited, India.
Villalba-Villalba, A. G. , Ramírez-Suárez, J. C. , Pacheco-Aguilar, R. , Valenzuela-Soto, E. M. , Lugo-Sánchez, M. E. , & Figueroa-Soto, C. G. (2013). Purification and characterization of chymotrypsin from viscera of vermiculated sailfin catfish, *Pterygoplichthys disjunctivus*, Weber, 1991. Fish Physiology and Biochemistry, 39(2), 121–130. https://doi.org/10.1007/s10695-012-9684-3
Wang, D. , Zhang, M. , Deng, S. , Xu, W. , Liu, Y. , Geng, Z. , Sun, C. , Bian, H. , & Liu, F. (2016). Postmortem changes in actomyosin dissociation, myofibril fragmentation and endogenous enzyme activities of grass carp (*Ctenopharyngodon idellus*) muscle. Food Chemistry, 197, 340–344. https://doi.org/10.1016/j.foodchem.2015.10.132
Wang, J. H. , Ma, W. C. , Su, J. C. , Chen, C. S. , & Jiang, S. T. (1993). Comparison of the properties of m-calpain from tilapia and grass shrimp muscles. Journal of Agricultural and Food Chemistry, 41(9), 1379–1384.
Wang, P. A. , Stenvik, J. , Larsen, R. , Mæhre, H. , & Olsen, R. L. (2007). Cathepsin D from Atlantic cod (*Gadus morhua L.*) liver. Isolation and comparative studies. Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 147(3), 504–511. https://doi.org/10.1016/j.cbpb.2007.03.004
Wang, R. , Liang, Z. , Hall, M. , & Söderhäll, K. (2001). A transglutaminase involved in the coagulation system of the freshwater crayfish, Pacifastacus leniusculus. Tissue localisation and cDNA cloning. Fish & Shellfish Immunology, 11(7), 623–637. https://doi.org/10.1006/fsim.2001.0341
Wang, S.-Y. , Moyne, A.-L. , Thottappilly, G. , Wu, S.-J. , Locy, R. D. , & Singh, N. K. (2001). Purification and characterization of a Bacillus cereus exochitinase. Enzyme and Microbial Technology, 28(6), 492–498. https://doi.org/10.1016/S0141-0229(00)00362-8
Wang, Y.-C. , Chang, P.-S. , & Chen, H.-Y. (2006). Tissue distribution of prophenoloxidase transcript in the Pacific white shrimp Litopenaeus vannamei. Fish & Shellfish Immunology, 20(3), 414–418. https://doi.org/10.1016/j.fsi.2005.05.003
Wei, H. , Tian, Y. , Lin, Y. , Maeda, H. , Yamashita, T. , Yu, K. , Takaki, K. , & Yuan, C. (2020). Condition dependent adenosine monophosphate decomposition pathways in striated adductor muscle from Japanese scallop (*Patinopecten yessoensis*). Journal of Food Science, 85(5), 1462–1469. https://doi.org/10.1111/1750-3841.15142
Weil, C. , Lefèvre, F. , & Bugeon, J. (2013). Characteristics and metabolism of different adipose tissues in fish. Reviews in Fish Biology and Fisheries, 23(2), 157–173. https://doi.org/10.1007/s11160-012-9288-0
Whang, I. , de Zoysa, M. , Nikapitiya, C. , Lee, Y. , Kim, Y. , Lee, S. , Oh, C. , Jung, S.-J. , Oh, M.-J. , Choi, C. Y. , Yeo, S.-Y. , Kim, B.-S. , Kim, S.-J. , & Lee, J. (2011). Molecular characterization and expression analysis of cathepsin B and L cysteine proteases from rock bream (*Oplegnathus fasciatus*). Fish & Shellfish Immunology, 30(3), 763–772. https://doi.org/10.1016/j.fsi.2010.12.022
Wolska, J. , Jonkers, J. , Holst, O. , & Adlercreutz, P. (2015). The addition of transglutaminase improves the physical quality of extruded fish feed. Biotechnology Letters, 37(11), 2265–2270. https://doi.org/10.1007/s10529-015-1911-4
Wong, H. , & Schotz, M. C. (2002). The lipase gene family. Journal of Lipid Research, 43(7), 993–999. https://doi.org/10.1194/jlr.R200007-JLR200
Wu, G.-P. , Cao, M.-J. , Chen, S.-H. , Weng, W.-Y. , Cai, Q.-F. , & Su, W.-J. (2010a). Purification and characterization of a gelatinolytic metalloproteinase from the skeletal muscle of red sea bream (*Pagrus major*). Journal of Agricultural and Food Chemistry, 58(9), 5730–5736. https://doi.org/10.1021/jf100320d
Wu, G.-P. , Chen, S.-H. , Liu, G.-M. , Yoshida, A. , Zhang, L.-J. , Su, W.-J. , & Cao, M.-J. (2010b). Purification and characterization of a collagenolytic serine proteinase from the skeletal muscle of red sea bream (*Pagrus major*). Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology, 155(3), 281–287. https://doi.org/10.1016/j.cbpb.2009.11.014
Wu, J. , Wang, S. , Sun, X. , Cao, M. , Chen, M. , Wang, J. , & Zhang, Q. (2016). Purification, characterization, and cDNA cloning of a matrix metalloproteinase from the skeletal muscle of silver carp (*Hypophthalmichthys molitrix*) with collagen degradation activity. Process Biochemistry, 51(7), 854–864. https://doi.org/10.1016/j.procbio.2016.04.004
Wu, J.-L. , Ge, S.-Y. , Cai, Z.-X. , Liu, H. , Liu, Y.-X. , Wang, J.-H. , & Zhang, Q.-Q. (2014). Purification and characterization of a gelatinolytic matrix metalloproteinase from the skeletal muscle of grass carp (*Ctenopharyngodon idellus*). Food Chemistry, 145, 632–638. https://doi.org/10.1016/j.foodchem.2013.08.055
Wu, T. , Sun, L.-C. , Du, C.-H. , Cai, Q.-F. , Zhang, Q.-B. , Su, W.-J. , & Cao, M.-J. (2009). Identification of pepsinogens and pepsins from the stomach of European eel (*Anguilla anguilla*). Food Chemistry, 115(1), 137–142. https://doi.org/10.1016/j.foodchem.2008.11.077

Wu, T. H. , & Bechtel, P. J. (2008). Ammonia, dimethylamine, trimethylamine, and trimethylamine oxide from raw and processed fish by-products. Journal of Aquatic Food Product Technology, 17(1), 27–38. https://doi.org/10.1080/10498850801891140
Xu, C. , Wang, C. , Cai, Q.-F. , Zhang, Q. , Weng, L. , Liu, G.-M. , Su, W.-J. , & Cao, M.-J. (2015). Matrix metalloproteinase 2 (MMP-2) plays a critical role in the softening of common carp muscle during chilled storage by degradation of type I and V collagens. Journal of Agricultural and Food Chemistry, 63(51), 10948–10956. https://doi.org/10.1021/acs.jafc.5b03893
Xu, D. , Yang, X. , Wang, Y. , & Sun, L. (2020). Cascading mechanism triggering the activation of polyphenol oxidase zymogen in shrimp Litopenaeus vannamei after postmortem and the correlation with melanosis development. Food and Bioprocess Technology, 13(7), 1131–1145. https://doi.org/10.1007/s11947-020-02435-8
Xu, F. , Wang, P. , Zhang, Y. Z. , & Chen, X. L. (2017). Alginate lyases: Diversity of three dimensional structures and catalytic mechanisms. Applied and Environmental Microbiology, 84, e02040-17.
Xu, X.-Y. , Shen, Y.-B. , Fu, J.-J. , Liu, F. , Guo, S.-Z. , Yang, X.-M. , & Li, J.-L. (2012). Matrix metalloproteinase 2 of grass carp Ctenopharyngodon idella (CiMMP2) is involved in the immune response against bacterial infection. Fish & Shellfish Immunology, 33(2), 251–257. https://doi.org/10.1016/j.fsi.2012.05.015
Yamada, A. , Takano, K. , & Kamoi, I. (1993). Digestive enzyme of tilapia-IV. Purification and properties of protease from tilapia stomach. Nippon Suisan Gakkaishi, 59(11), 1903–1908. https://doi.org/10.2331/suisan.59.1903
Yamamoto, H. , Tomioka, K. , Kawai, H. , & Endo, K. (1986). Purification and properties of 5′-nucleotidase from cod muscle. Agricultural and Biological Chemistry, 50(5), 1123–1129. https://doi.org/10.1080/00021369.1986.10867539
Yasueda, H. , Kumazawa, Y. , & Motoki, M. (1994). Purification and characterization of a tissue-type transglutaminase from red sea bream (Pagrus major). Bioscience, Biotechnology, and Biochemistry, 58(11), 2041–2045. https://doi.org/10.1271/bbb.58.2041
Yeasmin, T. , Reza, M. S. , Shikha, F. H. , Khan, M. N. A. , & Kamal, M. (2010). Quality changes in formalin treated rohu fish (*Labeo rohita*, Hamilton) during ice storage condition. Asian Journal of Agricultural Sciences, 2(4), 158–163.
Yeh, M.-S. , Kao, L.-R. , Huang, C.-J. , & Tsai, I.-H. (2006). Biochemical characterization and cloning of transglutaminases responsible for hemolymph clotting in *Penaeus monodon* and *Marsupenaeus japonicus* . Biochimica et Biophysica Acta (BBA) – Proteins and Proteomics, 1764(7), 1167–1178. https://doi.org/10.1016/j.bbapap.2006.04.005
Yeh, M.-S. , Liu, C.-H. , Hung, C.-W. , & Cheng, W. (2009). cDNA cloning, identification, tissue localisation, and transcription profile of a transglutaminase from white shrimp, Litopenaeus vannamei, after infection by Vibrio alginolyticus. Fish & Shellfish Immunology, 27(6), 748–756. https://doi.org/10.1016/j.fsi.2009.09.006
Yeh, M.-S. , Tsai, W.-L. , & Cheng, W. (2013). Identification and cloning of the second type transglutaminase from Litopenaeus vannamei, and its transcription following pathogen infection and in relation to the haemolymph coagulation. Fish & Shellfish Immunology, 35(5), 1613–1623. https://doi.org/10.1016/j.fsi.2013.09.002
Yi, Z. , & Xie, J. (2021). Comparative proteomics reveals the spoilage-related factors of Shewanella putrefaciens under refrigerated condition. Frontiers in Microbiology, 12, 740482. https://doi.org/10.3389/fmicb.2021.740482
Yongsawatdigul, J. , Worratao, A. , & Park, J. W. (2002). Effect of endogenous transglutaminase on threadfin bream surimi gelation. Journal of Food Science, 67(9), 3258–3263. https://doi.org/10.1111/j.1365-2621.2002.tb09575.x
Yoshioka, T. , Konno, Y. , & Konno, K. (2019). Below-zero storage of fish to suppress loss of freshness. Fisheries Science, 85(3), 601–609. https://doi.org/10.1007/s12562-019-01294-3
Zamani, A. , & Benjakul, S. (2016). Trypsin from unicorn leatherjacket (*Aluterus monoceros*) pyloric caeca: Purification and its use for preparation of fish protein hydrolysate with antioxidative activity. Journal of the Science of Food and Agriculture, 96(3), 962–969. https://doi.org/10.1002/jsfa.7172
Zamorano, J.-P. , Martínez-Álvarez, O. , Montero, P. , & Gómez-Guillén, M. D. C. (2009). Characterisation and tissue distribution of polyphenol oxidase of deepwater pink shrimp (*Parapenaeus longirostris*). Food Chemistry, 112(1), 104–111. https://doi.org/10.1016/j.foodchem.2008.05.061
Zhang, J. , Bai, S. , Zhang, X. , Nagase, H. , & Sarras, M. P. (2003). The expression of gelatinase A (MMP-2) is required for normal development of zebrafish embryos. Development Genes and Evolution, 213(9), 456–463. https://doi.org/10.1007/s00427-003-0346-4
Zhang, R. , Qiu, W. , Zhang, M. , Ho Row, K. , Cheng, Y. , & Jin, Y. (2018). Effects of different heating methods on the contents of nucleotides and related compounds in minced Pacific white shrimp and Antarctic krill. LWT, 87, 142–150. https://doi.org/10.1016/j.lwt.2017.08.078
Zhang, Y. , He, S. , & Simpson, B. K. (2017). A cold active transglutaminase from Antarctic krill (*Euphausia superba*): Purification, characterization and application in the modification of cold-set gelatin gel. Food Chemistry, 232, 155–162. https://doi.org/10.1016/j.foodchem.2017.03.135
Zhou, L. , Budge, S. M. , Ghaly, A. E. , Brooks, M. S. , & Dave, D. (2011). Extraction, purification and characterization of fish chymotrypsin: A review. American Journal of Biochemistry and Biotechnology, 7(3),

104–123.
Zhou, Q. , Fu, X.-P. , Zhang, L.-J. , Su, W.-J. , & Cao, M.-J. (2007). Purification and characterization of sea bream (*Sparus latus Houttuyn*) pepsinogens and pepsins. Food Chemistry, 103(3), 795–801. https://doi.org/10.1016/j.foodchem.2006.09.021
Zhou, Q. , Liu, G.-M. , Huang, Y.-Y. , Weng, L. , Hara, K. , Su, W.-J. , & Cao, M.-J. (2008). Pepsinogens and pepsins from Mandarin fish (*Siniperca chuatsi*). Journal of Agricultural and Food Chemistry, 56(13), 5401–5406. https://doi.org/10.1021/jf800458n
Zhou, Z. , Qiu, R. , & Zhang, J. (2015). Molecular characterization of the cathepsin B of turbot (*Scophthalmus maximus*). Fish Physiology and Biochemistry, 41(2), 473–483. https://doi.org/10.1007/s10695-014-9998-4
Zhu, B. , & Yin, H. (2015). Alginate lyase: Review of major sources and classification, properties, structure-function analysis and applications. Bioengineered, 6(3), 125–131. https://doi.org/10.1080/21655979.2015.1030543
Zhu, J. , Zhao, A. , Feng, L. , & Gao, H. (2016). Quorum sensing signals affect spoilage of refrigerated large yellow croaker (*Pseudosciaena crocea*) by Shewanella baltica. International Journal of Food Microbiology, 217, 146–155. https://doi.org/10.1016/j.ijfoodmicro.2015.10.020
Zhu, S. , Wu, H. , Zeng, M. , Liu, Z. , & Wang, Y. (2015). The involvement of bacterial quorum sensing in the spoilage of refrigerated Litopenaeus vannamei. International Journal of Food Microbiology, 192, 26–33. https://doi.org/10.1016/j.ijfoodmicro.2014.09.029

Nucleotides and Nucleosides

Alasalvar, C. , Taylor, K.D.A. , Öksüz, A. et al. Comparison of freshness quality of cultured and wild sea bass (*Dicentrarchus labrax*). J. Food Sci. 67, 3220–3226, 2002.
Arase, S. , Kimura, S. , Ikegami, T. Method optimization of hydrophilic interaction chromatography separation of nucleotides using design of experiment approaches I: Comparison of several zwitterionic columns. J. Pharm. Biomed. Anal. 158, 307–316, 2018.
Aubourg, S.P. , Quitral, V. , Larrain, M.A. et al. Autolytic degradation and microbiological activity in farmed Coho salmon (Oncorhynchus kisutch) during chilled storage. Food Chem. 104, 369–375, 2007.
Borgese, T.A. , Nagel, R.L. , Roth, E. et al. Guanosine triphosphate (GTP): The major organic phosphate in the erythrocytes of the elasmobranch Mustelus canis (*Smooth dogfish*). Comp. Biochem. Physiol. 60, 317–321, 1978.
Carr, A.F. , Patel, D.C. , López, D. et al. Comparison of reversed-phase, anion-exchange, and hydrophilic interaction HPLC for the analysis of nucleotides involved in biological enzymatic pathways. J. Liq. Chromatogr. Relat. Technol. 42, 184–193, 2019.
Carsol, M.-A. , Volpe, G. , Mascini, M. Amperometric detection of uric acid and hypoxanthine with xanthine oxidase immobilized and carbon based screen-printed electrode. Application for fish freshness determination. Talanta 44, 2151–2159, 1997.
Castillo-Yáñez, F.J. , Pacheco-Aguilar, R. , Márquez-Ríos, E. et al. Freshness loss in sierra fish (*Scomberomorus sierra*) muscle stored in ice as affected by postcapture handling practices. J. Food Biochem. 31, 56–67, 2007.
Cela-Pérez, M.C. , Barbosa-Pereira, L. , Vecino, X. et al. Selective removal of ATP degradation products from food matrices II: Rapid screening of hypoxanthine and inosine by molecularly imprinted matrix solid-phase dispersion for evaluation of fish freshness. Talanta 135, 58–66, 2015.
Cho, Y.J. , Im, Y.S. , Kim, S.M. et al. Enzymatic method for measuring ATP related compounds in fish sauces. J. Korean Fish. Soc. 32, 385–390, 1999.
Dong, M. , Qin, L. , Ma, L.-X. et al. Postmortem nucleotide degradation in turbot mince during chill and partial freezing storage. Food Chem. 311, 125900, 2020.
Fujita, T. , Hori, Y. , Otani, T. et al. Applicability of the K0 value as an index of freshness for porcine and chicken muscles. Agric. Biol. Chem. 52, 107–112, 1988.
Gao, R. , Xue, C. , Yuan, L. et al. Determination of the big head carp myofibrillar (*Aristichthys nobilis*) adenosine triphosphatase activity by ion chromatography. J. Chromatogr. A 1118, 278–280, 2006.
García-Gómez, D. , Rodríguez-Gonzalo, E. , Carabias-Martínez, R. Stationary phases for separation of nucleosides and nucleotides by hydrophilic interaction liquid chromatography. Trends Anal. Chem. 47, 111–128, 2013.
Gill, B.D. , Indyk, H.E. , Manley-Harris, M. Analysis of nucleosides and nucleotides in infant formula by liquid chromatography-tandem mass spectrometry. Anal. Bioanal. Chem. 405, 5311–5319, 2013.
Hartwick, R.A. , Brown, P.R. The performance of microparticle chemically-bonded anion-exchange resins in the analysis of nucleotides. J. Chromatogr. A 112, 651–662, 1975.
Howgate, P. A review of the kinetics of degradation of inosine monophosphate in some species of fish during chilled storage. Int. J. Food Sci. Technol. 41, 341–353, 2006.

Jones, N.R. , Murray, J. Degradation of adenine- and hypoxanthine nucleotide in the muscle of chill-stored, trawled cod (*Gadus callarius*). J. Sci. Food Agric. 13, 475–480, 1962.
Karim, N.U. , Kennedy, J.T. , Linton, M. et al. 2019. Determination of nucleotide and enzyme degradation in haddock (*Melanogrammus aeglefinus*) and herring (*Clupea harengus*) after high pressure processing. Peer J. 7, e7527, 2019.
Karube, I. , Matsuoka, H. , Suzuki, S. et al. Determination of fish freshness with an enzyme sensor system. J. Agric. Food Chem. 32, 314–319, 1984.
Kuda, T. , Fujita, M. , Goto, H. et al. Effects of freshness on ATP-related compounds in retorted chub mackerel Scomber japonicus. LWT-Food Sci. Technol. 40, 1186–1190, 2007.
Kuda, T. , Fujita, M. , Goto, H. et al. Effects of retort conditions on ATP-related compounds in pouched fish muscle. LWT-Food Sci. Technol. 41, 469–473, 2008.
Li, R. , Sun, Z. , Zhao, Y. et al. Application of UHPLC-Q-TOF-MS/MS metabolomics approach to investigate the taste and nutrition changes in tilapia fillets treated with different thermal processing methods. Food Chem. 356, 129737, 2021.
Logotheti, M. , Theochari, K. , Kostakis, M. Development and validation of a HILIC-UV method for the determination of nucleotides in fish samples. Food Chem. 248, 70–77, 2018.
Luong, H.T. , Male, K.B. , Nguyen, A.L. Enzyme-based biosensor system for monitoring the freshness of fish. United States Patent 5288613, 1994. https://www.freepatentsonline.com/5288613.html
Luong, J.H.T. , Male, K.B. Development of a new biosensor system for the determination of the hypoxanthine ratio, an indicator of fish freshness. Enzyme Microb. Technol. 14, 125–130, 1992.
Luong, J.H.T. , Male, K.B. , Masson, C. et al. Hypoxanthine ratio determination in fish extract using capillary electrophoresis and immobilized enzymes. J. Food Sci. 57(1), 77–81, 1992.
Márquez-Ríos, E. , Morán-Palacio, E.F. , Lugo-Sánchez, M.E. et al. Postmortem biochemical behavior of giant squid (Dosidicus gigas) mantle muscle stored in ice and its relation with quality parameters. J. Food Sci. 72, C356–C362, 2007.
Massa, A.E. , Palacios, D.L. , Paredi, M.E. et al. Postmortem changes in quality indices of ice-stored flounder (*Paralichthys patagonicus*). J. Food Biochem. 29, 570–590, 2005.
Massa, A.E. , Paredi, M.E. , Crupkin, M. Nucleotide catabolism in cold stored adductor muscle of scallop (Zygochlamys patagonica). J. Food Biochem. 26, 295–305, 2002.
Mateos-Vivas, M. , Rodríguez-Gonzalo, E. , García-Gómez, D. et al. Hydrophilic interaction chromatography coupled to tandem mass spectrometry in the presence of hydrophilic ion-pairing reagents for the separation of nucleosides and nucleotide mono-, di- and triphosphates. J. Chromatogr. A 1414, 129–137, 2015.
Mello, L.D. , Kubota, L.T. Review of the use of biosensors as analytical tools in the food and drink industries. Food Chem. 77, 237–256, 2002.
Mendes, R. , Quinta, R. , Nunes, M.L. Changes in baseline levels of nucleotides during ice storage of fish and crustaceans from the Portuguese coast. Eur. Food Res. Tecnol. 212, 141–146, 2001.
Meynial, I. , Paquet, V. , Combes, D. Simultaneous separation of nucleotides and nucleotide sugars using an ion-pair reversed-phase HPLC: Application for assaying glycosyltransferase activity. Anal. Chem. 67, 1627–1631, 1995.
Mustafa, F. , Othman, A. , Andreescu, S. Cerium oxide-based hypoxanthine biosensor for Fish spoilage monitoring. Sens. Actuators B Chem. 332, 129435, 2021.
Nguyen, A.L. , Luong, J.H.T. , Masson, C. Determination of nucleosides in fish tissues using capillary electrophoresis. Anal. Chem. 62, 2490–2493, 1990a.
Nguyen, A.L. , Luong, J.H.T. , Yacynych, A.M. Retention of enzyme by electropolymerized film: A new approach in developing a hypoxanthine byosensors. Biotech. Bioeng. 37, 729–735, 1990b.
Okuma, H. , Takahashi, H. , Yazawa, S. et al. Determination of a system with double enzyme reactors for the determination of fish freshness. Anal. Chim Acta. 260, 93–98, 1992.
Okuma, H. , Watanabe, E. Flow system for freshness determination based on double multi-enzyme reactor electrodes. Biosens. Bioelectron. 17, 367–372, 2002.
Ornatska, M. , Sharpe, E. , Andreescu, D. et al. Paper bioassay based on ceria nanoparticles as colorimetric probes. Anal. Chem. 83, 4273–4280, 2011.
Özogul, F. , Özden, Ö. , Özogul, Y. et al. The effects of gamma-irradiation on the nucleotide degradation compounds in sea bass (*Dicentrarchus labrax*) stored in ice. Food Chem. 122, 789–794, 2010.
Özogul, F. , Özogul, Y. , Kuley, E. Nucleotide degradation in sardine (*Sardina pilchardus*) stored in different storage condition at 4°C. J. Fish. Sci. 1, 13–19, 2007.
Özogul, F. , Taylor, K.D.A. , Quantick, P.C. et al. A rapid HPLC-determination of ATP-related compounds and its application to herring stored under modified atmosphere. Int. J. Food Sci. Technol. 35, 549–554, 2000.
Park, I.-S. , Kim, N. Simultaneous determination of hypoxanthine, inosine and inosine 5′-monophosphate with serially connected three enzyme reactors. Anal. Chim. Acta. 394, 201–221, 1999.
Prodomidis, M.I. , Karayannis, M.I. Enzyme based amperometric biosensors for food analysis. Electroanalysis 14, 214–261, 2002.
Quin, X. , Wang, X. Quantification of nucleotides and their sugar conjugates in biological samples: Purposes, instruments and applications. J. Pharm. Biomed. Anal. 158, 280–287, 2018.

Roberts, B. , Morris, B.A. , Clifford, M.N. Comparison of radioimmunoassay and spectrophotometric analysis for the quantitation of hypoxanthine in fish muscle. Food Chem. 42, 1–17, 1991.
Ryder, J.M. Determination of adenosine triphosphate and its breakdown products in fish muscle by high-performance liquid chromatography. J. Agric. Food Chem. 33(4), 678–680. 1985
Saito, T. , Arai, K. , Matsuyoshi, M. A new method for stimating the freshness of fish. Bull. Japan. Soc. Sci. Fish. 24, 749–750, 1959.
Surette, M.E. , Gill, T.A. , LeBlanc, P.J. Biochemical basis of postmortem nucleotide catabolism in cod (*Gadus morhua*) and its relationship to spoilage. J. Agric. Food Chem. 36, 19–22, 1988.
Van der Thillart, G. , Van Waarde, A. , Muller, H.J. et al. Determination of high-energy phosphate compounds in fish muscle: 31P-NMR spectroscopy and enzymatic methods. Comp. Biochem. Physiol. Part B Biochem. Mol. Biol. 95, 789–795, 1990.
Veciana-Nogués, M.T. , Izquierdo-Pulido, M. , Vidal-Carou, M.C. Determination of ATP related compounds in fresh and canned tuna fish by HPLC. Food Chem. 59, 467–472, 1997.
Volpe, G. , Mascini, M. Enzyme sensors for determination of fish freshness. Talanta 43, 283–289, 1996.
Wang, X.Z. , Wu, H. , Li, N. et al. Rapid determination of free amino acids, nucleosides, and nucleobases in commercial clam species harvested at different seasons in Jiangsu, China, using UFLC-MS/MS. Food Anal. Methods 9, 1520–1531, 2016.
Yano, Y. , Kataho, N. , Watanabe, M. et al. Evaluation of beef ageing by determination of hypoxanthine contents: Application of a xanthine sensor. Food Chem. 52, 439–445, 1995.
Zhang, R. , Qiu, W. , Zhang, M. et al. Effects of different heating methods on the contents of nucleotides and related compounds in minced Pacific white shrimp and Antarctic krill. LWT Food Sci. Technol. 87, 142–150, 2018.

Lipid Compounds

Small, D. , Handbook of Lipid Research, The Physical Chemistry of Lipids, Plenum Press, New York, 1986, Vol. 4, p. 89.
Christie, W. , Lipid Analysis, 2nd ed., Pergamon Press, Oxford, UK, 1982, p. 17.
Simopoulos, A. , Nutritional aspects of fish, in Seafood from Producer to Consumer, Integrated Approach to Quality, Luten, J. , Börrensen, T. , and Oehlenschläger, J. , eds., Elsevier Science, London, UK, 1997, p. 589.
Ackman, R. , Fatty Acids , in Marine Biogenic Lipids, Fats, and Oils, Ackman, R. , ed., CRC Press, Boca Raton, FL, 1989, Vol. 1, p. 103.
Pearson, A. , Love, J. , and Shorland, F. , “Warmed-over” flavor in meat, poultry and fish. Adv. Food Res., 23, 2, 1977.
Vaskowski, V. , Phospholipids, in Marine Biogenic Lipids, Fats, and Oils, Ackman, R. , ed., CRC Press, Boca Raton, FL, 1989, p. 199.
Sieiro, M. , Aubourg, S. P. , and Rocha, F. , Seasonal study of the lipid composition in different tissues of the common octopus (*Octopus vulgaris*). Eur. J. Lipid Sci. Technol., 108, 479, 2006.
Folch, J. , Lees, M. , and Stanley, G. , A simple method for the isolation and purification of total lipids from animal tissue, J. Biol. Chem., 226, 497, 1957.
Bligh, E. and Dyer, W. , A rapid method of total extraction and purification. Can. J. Biochem. Physiol., 37, 911, 1959.
Pudtikajorn, K. and Benjakul, S. , Simple wet rendering method for extraction of prime quality oil from skipjack tuna eyeballs. Eur. J. Lipid Sci. Technol., 122, 2000077, 2020.
Honold, P. J. , Nouard, M. L. , and Jacobsen, C. , Fish oil extracted from fish-fillet by-products is weakly linked to the extraction temperatures but strongly linked to the omega-3 content of the raw material. Eur. J. Lipid Sci. Technol., 118, 874, 2016.
Rodríguez, A. , Trigo, M. , Aubourg, S. P. , and Medina, I. , Optimisation of healthy-lipid content and oxidative stability during oil extraction from squid (*Illex argentinus*) viscera by green processing. Marine Drugs, 19, 616, 2021.
Ferraz de Arruda, L. , Borghesi, R. , and Oetterer, M. , Use of fish waste as silage: A review. Brazilian Arch. Biol. Technol., 50, 879, 2007.
Bonilla-Méndez, J. R. and Hoyos-Concha, J. L. , Methods of extraction, refining and concentration of fish oil as a source of omega-3 fatty acids. Corpoica Ciencia y Tecnología Agropecuaria, Mosquera (Colombia), 19, 645, 2018.
Rubio-Rodríguez, N. , de Diego, S. M. , Beltrán, S. , Jaime, I. , Sanz, M. T. , and Rovira, J. , Supercritical fluid extraction of fish oil from fish by-products: A comparison with other extraction methods. J. Food Eng., 109, 238, 2012.
Singh, S. , Verma, D. K. , Thakur, M. , Tripathy, S. , Patel, A. R. , Shah, N. , Utama, G. L. , Srivastav, P. P. , Benavente-Valdés, J. R. , Chavez-González, M. L. , and Aguilar, C. N. , Supercritical fluid extraction (SCFE) as green extraction technology for high-value metabolites of algae, its potential trends in food and human health.

Food Res. Int., 150. 110746, 2021.
Gigliotti, J. C. , Davenport, M. P. , Beamer, S. K. , Tou, J. C. , and Jaczynski, J. , Extraction and characterisation of lipids from Antarctic krill (*Euphausia superba*). Food Chem., 125, 1028, 2011.
Li, C. J. , Xin, M. R. , and Sun, Z. L. , Selection of extraction solvents for edible oils from microalgae and improvement of the oxidative stability. J. Biosci. Bioeng., 132, 365, 2021.
Aubourg, S. P. , Trigo, M. , González, M. J. , Lois, S. , and Medina, I. , Comparative study of bioactive lipid extraction from squid (*Doryteuthis gahi*) by-products by green solvents. Foods, 11, 2188, 2022.
Bhat, Z. F. , Morton, J. D. , Mason, S. L. , and Bekhit, A. D. , Current and future prospects for the use of pulsed electric field in the meat industry. Crit. Rev. Food Sci. Nutr., 59, 1660, 2019.
Gulzar, S. and Benjakul, S. , Impact of pulsed electric field pretreatment on yield and quality of lipid extracted from cephalothorax of Pacific white shrimp (*Litopenaeus vannamei*) by ultrasound-assisted process. Int. J. Food Sci. Technol., 55, 619, 2020.
Ahmmed, M. K. , Carne, A. , Tian, H. , and Bekhit, A. , The effect of pulsed electric fields on the extracted total lipid yield and the lipidomic profile of hoki roe. Food Chem., 384, 132476, 2022.
Wells, M. and Dittmer, J. , The use of sephadex for the removal of nonlipid contaminants from lipid extracts. Biochem., 2, 1259, 1963.
Wuthier, R. , Purification of lipids from nonlipid contaminants on sephadex bead columns. J. Lipid Res., 7, 558, 1966.
Prost, E. and Wrebiakowski, H. , Evaluation of soxhlet's and Bligh and Dyer's methods in the determination of fat in meat. Z. Lebensm. Unters. Forsch., 149, 193, 1972.
Nielsen, D. , Hyldig, G. , Nielsen, J. , and Nielsen, H. , Lipid content in herring (Clupea harengus, L.). Influence of biological factors and comparison of different methods of analyses: Solvent extraction, Fatmeter, NIR and NMR. Food Sci. Technol., 38, 537, 2005.
Kuksis, A. , Separation and determination of structure of fatty acids, in Handbook of Lipid Research, Fatty Acids and Glycerides, Kuksis, A. , ed., Plenum Press, New York, 1978, Vol. 1, p. 1.
Christie, W. , Lipid Analysis, 3rd ed., The Oily Press, Bridgwater, 2003, p. 37.
Lepage, G. and Roy, C. , Direct transesterification of all classes of lipids in a one-step reaction. J. Lipid Res., 27, 114, 1986.
Hammond, E. , Packed-column gas chromatography, in Analysis of Oils and Fats, Hamilton, R. and Rossell, J. , eds., Elsevier Applied Science, London, UK and New York, 1986, p. 113.
Ackman, R. , WCOT (capillary) gas-liquid chromatography, in Analysis of Oils and Fats, Hamilton, R. and Rossell, J. , eds., Elsevier Applied Science, London, UK and New York, 1986, p. 137.
Le Quéré, J. , Gas chromatography-mass spectrometry and tandem mass spectrometry in the analysis of fatty acids, in New Trends in Lipid and Lipoprotein Analyses, Sebedio, J. and Perkins, E. , eds., AOCS Press, Champaign, IL, 1995, p. 191.
Medina, I. and Garrido, J. , One-step conversion of fatty acids into their 2-alkenyl-4,4,-dimethyloxazoline derivatives directly from total lipids. J. Chrom. A, 673, 101, 1994.
Araujo, P. , Tilahun, E. , and Zeng, Y. , A novel strategy for discriminating marine oils by using the positional distribution (sn-1, sn-2, sn-3) of omega-3 polyunsaturated fatty acids in triacylglycerols. Talanta, 182, 32, 2018.
Saliu, F. , Magoni, C. , Lasagni, M. , Della Pergola, R. , and Labra, M. , Multi-analytical characterization of perigonadal fat in bluefin tuna: From waste to marine lipid source. J. Sci. Food Agric., 99, 4571, 2019.
Amorim, T. L. , Duarte, L. M. , de la Fuente, M. A. , de Oliveira, M. A. L. , and Gómez-Cortés, P. , Fast capillary electrophoresis method for determination of docosahexaenoic and eicosapentaenoic acids in marine oils omega-3 supplements. J. Chrom. A, 1613, 460641, 2020.
Huang, T. , Chen, C. , Wefler, V. , and Raftery, A. , A stable reagent for the Liebermann-Buchardt reaction. Anal. Chem., 33, 1405, 1961.
Teshima, S. , Sterols and crustaceans, mollusks and fish, in Physiology and Biochemistry of Sterols, Patterson, G. and Nes, W. , eds., American Oil Chemists' Society Press, Champaign, IL, 1990, p. 229.
Hoving, E. , Chromatographic methods in the analysis of cholesterol and related lipids. J. Chrom. B, 671, 341, 1995.
Aubourg, S. P. , Pérez-Martín, R. , and Gallardo, J. M. , Stability of lipids of frozen albacore (*T. alalunga*) during steam cooking. Int. J. Food Sci. Technol., 24, 341, 1989.
Krzynowek, J. and Panunzio, L. , Cholesterol and fatty acids in several species of shrimp. J. Food Sci., 54, 237, 1989.
Joseph, J. , Distribution and composition of lipids in marine invertebrates, in Marine Biogenic Lipids, Fats and Oils, Ackman, R. , ed., CRC Press Inc., Boca Raton, FL, 1989, Vol. 2, p. 49.
Fenton, M. , Chromatographic separation of cholesterol in foods. J. Chrom., 624, 369, 1992.
Ohshima, T. , Formation and content of cholesterol oxidation products in seafood and seafood products, in Cholesterol and Phytosterol Oxidation Products, Guardiola, F. , Dutta, P. , Codony, R. and Savage, G. , eds., American Oil Chemists' Society Press, Champaign, IL, 2002, p. 186.
Lebovics, V. , Lugasi, A. , Hóvári, J. , and Aubourg, S. P. , Partial inhibition of cholesterol oxides formation in frozen fish pre-treated with a plant extract. Int. J. Food Sci. Technol., 44, 342, 2009.

Zhang, X. L. , Wang, C. , Chen, Z. , Zhang, P. Y. , and Liu, H. B. , Development and validation of quantitative 1H NMR spectroscopy for the determination of total phytosterols in the marine seaweed Sargassum. J. Agric. Food Chem., 64, 6228, 2016.
Hayashi, K. , Occurrence of diacyl glycerol ethers in liver lipids of gonatid squid *Gonatopsis borealis* . Nippon Suisan Gakkaishi, 55, 1383, 1989.
Sargent, J. , Ether-linked glycerides in marine animals, in Marine Biogenic Lipids, Fats and Oils, Ackman, R. , ed., CRC Press Inc., Boca Raton, FL, 1989, Vol. 1, p. 175.
Urata, K. and Takaishi, N. , Ether lipids based on the glyceryl ether skeleton: Present state, future potential. J. Amer. Oil Chem. Soc., 73, 819, 1996.
Harvey, D. , Nicotinylidene derivatives for the structural elucidation of glycerol mono-ethers and mono-esters by gas chromatography/mass spectrometry. Biol. Mass Spectrom., 20, 87, 1991.
Borch-Jensen, C. , Magnussen, M. , and Mollerup, J. , Capillary supercritical fluid chromatographic analysis of shark liver oils. J. Amer. Oil Chem. Soc., 74, 497, 1997.
Medina, I. , Aubourg, S. P. , and Pérez-Martín, R. , Analysis of 1-O-alk-1-enyl glycerophospholipids of albacore tuna (*Thunnus alalunga*) and their alterations during thermal processing. J. Agric. Food Chem., 41, 2395, 1993.
Lowry, R. and Tinsley, I. , Rapid colorimetric determination of free fatty acids. J. Amer. Oil Chem. Soc., 53, 470, 1976.
Zhang, H. and Lee, T. , Rapid near-infrared spectroscopic method for the determination of free fatty acid in fish and its application in fish quality assessment. J. Agric. Food Chem., 45, 3515, 1997.
Barlett, G. , Phosphorus assay in column chromatography. J. Biol. Chem., 234, 466, 1959.
Raheja, R. , Kaur, C. , Singh, A. , and Bhatia, I. , New colorimetric method for the quantitative determination of phospholipids without digestion. J. Lipid Res., 14, 695, 1973.
Vioque, E. and Holman, R. , Quantitative estimation of esters by thin-layer chromatography. J. Amer. Oil Chem. Soc., 39, 63, 1962.
Gallardo, J. M. , Aubourg, S. P. , and Pérez-Martín, R. , Lipid classes and their fatty acids at different loci of albacore (*Thunnus alalunga*): Effects of the pre-cooking. J. Agric. Food Chem., 37, 1060, 1989.
Aubourg, S. P. , Sotelo, C. , and Gallardo, J. M. , Zonal distribution of fatty acids in albacore (*Thunnus alalunga*) triglycerides and their changes during cooking. J. Agric. Food Chem., 38, 255, 1990.
Christie, W. , Stereospecific analysis of triacyl-sn-glycerols, in New Trends in Lipid and Lipoprotein Analyses, Sebedio, J. and Perkins, E. , eds., AOAC Press, Champaign, IL, 1995, p. 93.
Myher, J. , Kuksis, A. , Geher, K. , Park, P. , and Diersen-Schade, D. , Stereospecific analysis of triacylglycerols rich in long-chain polyunsaturated fatty acids. Lipids, 31, 207, 1996.
Brockerhoff, H. , Determination of the positional distribution of fatty acids in glycerolipids. Methods Enzymol., 35, 315, 1975.
Aubourg, S. P. , Medina, I. , and Pérez-Martín, R. , Polyunsaturated fatty acids in tuna phospholipids: Distribution in the sn-2 location and changes during cooking. J. Agric. Food Chem., 44, 585, 1996.
Hemming, F. and Hawthorne, J. , Lipid Analysis, Editorial Acribia, S. A., Zaragoza (Spain), 2001, p. 5.
Hamilton, R. , Thin layer chromatography and high-performance liquid chromatography, in Analysis of Oils and Fats, Hamilton, R. and Rossell, J. , eds., Elsevier Applied Science, London, UK, 1986, p. 243.
Shukla, V. , Thin-layer chromatography of lipids, in New Trends in Lipid and Lipoprotein Analyses, Sebedio, J. and Ackman, R. , eds., AOCS Press, Champaign, IL, 1995, p. 17.
Nakamura, T. , Fukuda, M. , and Tanaka, R. , Estimation of polyunsaturated fatty acid content in lipids of aquatic organisms using thin-layer chromatography on a plain silica gel plate. Lipids, 31, 427, 1996.
Shantha, N. and Napolitano, G. , Lipid analysis using thin-layer chromatography and the Iatroscan, in Lipid Analysis in Oils and Fats, Hamilton, R. , ed., Blackie Academic and Professional, London, UK, 1998, p. 1.
Shukla, V. , High-performance liquid chromatography: Normal-phase, reverse-phase detection methodology, in New Trends in Lipid and Lipoprotein Analyses, Sebedio, J. and Ackman, R. , eds., AOCS Press, Champaign, IL, 1995, p. 38.
Perona, J. and Ruiz-Gutiérrez, V. , Characterization of the triacylglycerol molecular species of fish oil by reversed-phase high performance liquid chromatography. J. Liq. Chrom. Rel. Technol., 22, 1699, 1999.
Medina, I. , Aubourg, S. P. , and Pérez-Martín, R. , Composition of phospholipids of white muscle of six tuna species. Lipids, 30, 1127, 1995.
Restuccia, D. , Spizzirri, G. , Puoci, F. , Cirillo, G. , Vinci, G. , and Picci, N. , Determination of phospholipids in food samples. Food Rev. Int., 28, 1, 2012.
Zhang, Y. Y. , Qin, L. , Liu, Y. X. , Zhou, D. Y. , Xu, X. B. , Du, M. , Zhu, B. W. , and Thornton, M. , Evaluation of lipid profile in different tissues of Japanese abalone *Haliotis discus hannai* Ino with UPLC-ESI-Q-TOF-MS-based lipidomic study. Food Chem., 265, 49, 2018.
Nikolova-Damyanova, B. , Lipid analysis by silver ion chromatography, in Advances in Lipid Methodology-Five, Adlof, R. , ed., The Oily Press, Bridgwater, England, 2003, p. 43.
Joh, Y. , Elenkov, I. , Stefanov, K. , Popov, S. , Dobson, G. , and Christie, W. , Novel di-, tri- and tetraenoic fatty acids with bis-methylene-interrupted double-bond systems from the sponge Haliclona cinerea. Lipids, 32, 13, 1997.

Yan, Y. , Wang, X. , Liu, Y. , Xiang, J. , Wang, X. , Zhang, H. , Yao, Y. , Liu, R. , Zou, X. , Huang, J. , and Jina, Q. , Combined urea-thin layer chromatography and silver nitrate-thin-layer chromatography for micro separation and determination of hard-to-detect branched chain fatty acids in natural lipids. J. Chrom. A, 1425, 293, 2015.

Laakso, P. and Christie, W. , Combination of silver ion and reversed-phase high-performance liquid chromatography in the fractionation of herring oil triacylglycerols. J. Amer. Oil Chem. Soc., 68, 213, 1991.

Czajkowska-Mysłek, A. , Siekierko, U. , and Gajewska, M. , Application of silver ion high performance liquid chromatography for quantitative analysis of selected n-3 and n-6 PUFA in oil supplements. Lipids, 51, 413, 2016.

Beccaria, M. , Costa, R. , Sullini, G. , Grasso, E. , Cacciola, F. , Dugo, P. , and Mondello, L. Determination of the triacylglycerol fraction in fish oil by comprehensive liquid chromatography techniques with the support of gas chromatography and mass spectrometry data. Anal. Bioanal. Chem., 407, 5211, 2015.

Blomberg, L. , Demirbuker, M. , and Andersson, M. , Characterization of lipids by supercritical fluid chromatography and supercritical fluid extraction, in Lipid Analysis in Oils and Fats, Hamilton, R. , ed., Blackie Academic and Professional, London, UK, 1998, p. 34.

King, J. , Supercritical fluid chromatography (SFC)-global perspective and applications in lipid technology, in Advances in Lipid Methodology-Five, Adlof, R. , ed., The Oily Press, Bridgwater, England, 2003, p. 301.

Kallio, H. , Vauhkonen, T. , and Linko, R. , Thin-layer silver ion chromatography and supercritical fluid chromatography of Baltic herring (*Clupea harengus membras*) triacylglycerols. J. Agric. Food Chem., 39, 1573, 1991.

Staby, A. , Borch-Jensen, C. , Balchen, S. , and Mollerup, J. , Quantitative analysis of marine oils by capillary supercritical fluid chromatography. Chromatographia, 39, 697, 1994.

Alkio, M. , Gonzales, C. , Jäntti, K. , and Aaltonen, O. , Purification of polyunsaturated fatty acid esters from tuna oil with supercritical fluid chromatography. J. Amer. Oil Chem. Soc., 77, 315, 2000.

Ashraf-Khorassani, M. , Isaac, G. , Rainville, P. , Fountain, K. , and Taylor, L. T. , Study of ultra high performance supercritical fluid chromatography to measure free fatty acids without fatty acid ester preparation. J. Chrom. B, 997, 45, 2015.

Tyśkiewicz, K. , Gieysztor, R. , Maziarczyk, I. , Hodurek, P. , Rój, E. , and Skalicka-Woźniak, K. , Supercritical fluid chromatography with photodiode array detection in the determination of fat-soluble vitamins in hemp seed oil and waste fish oil. Molecules, 23, 1131, 2018.

Diehl, B. , Multinuclear high-resolution nuclear magnetic resonance, in Lipid Analysis in Oils and Fats, Hamilton, R. , ed., Blackie Academic and Professional, London, UK, 1998, p. 87.

Sacchi, R. , Medina, I. , Aubourg, S. P. , Addeo, R. , and Paolillo, L. , Proton nuclear magnetic resonance rapid and structure-specific determination of ω-3 polyunsaturated fatty acids in fish lipids. J. Amer. Oil Chem. Soc., 70, 225, 1993.

Gunstone, F. , High resolution NMR studies of fish oils. Chem. Phys. Lipids, 59, 83, 1991.

Aursand, M. , Rainuzzo, J. , and Grasdalen, H. , Studies of fatty acids in Atlantic salmon (*Salmo salar*) by 13C and 1H nuclear magnetic resonance (NMR) spectroscopy, in Quality Assurance in the Fish Industry, Huss, H. , ed., Elsevier Science Publishers B. V., Amsterdam, Holland, 1992, p. 407.

Sacchi, R. , Medina, I. , Aubourg, S. P. , Giudicianni, I. , Addeo, F. , and Paolillo, L. , Quantitative high resolution 13C-NMR analysis of lipids extracted from the white muscle of Atlantic tuna. J. Agric. Food Chem., 41, 1247, 1993.

Aursand, M. , Jørgensen, L. , and Grasdalen, H. , Positional distribution of ω3 fatty acids in marine lipid triacylglycerols by high-resolution 13C nuclear magnetic resonance spectroscopy. J. Amer. Oil Chem. Soc., 72, 293, 1995.

Sacchi, R. , Medina, I. , and Paolillo, L. , One and two-dimensional NMR study of plasmalogens (alk-1-enyl-phosphatidylethanolamine). Chem. Phys. Lipids, 76, 201, 1995.

Zhao, Y. , Wang, M. , Lindström, M. E. , and Li, J. , Fatty acid and lipid profiles with emphasis on n-3 fatty acids and phospholipids from *Ciona intestinalis* . Lipids, 50, 1009, 2015.

Amorim, T. L. , Granato, A. S. , Mendes, T. O. , de Oliveira, M. A. L. , Amarante, G. W. , de la Fuente, M. A. , and Gómez-Cortés, P. , Lipid classification of fish oil omega-3 supplements by 1H NMR and multivariate analysis. J. Food Comp. Anal., 102, 104060, 2021.

Ahmmed, M. K. , Carne, A. , Bunga, S. , Tian, H. , and Bekhit, A. , Lipidomic signature of Pacific lean fish species head and skin using gas chromatography and nuclear magnetic resonance spectroscopy. Food Chem., 365, 130637, 2021.

Kuksis, A. , Mass spectrometry of complex lipids, in Lipid Analysis in Oils and Fats, Hamilton, R. , ed., Blackie Academic and Professional, London, UK, 1998, p. 181.

Arpino, P. , On-line liquid chromatography/mass spectrometry? An odd couple! Trends Anal. Chem., 1, 154, 1982.

Byrdwell, W. , APCI-MS in lipid analysis, in Advances in Lipid Methodology-Five, Adlof, R. , ed., The Oily Press, Bridgwater, UK, 2003, p. 171.

Smith, T. K. , Lipidomic analysis of fats and oils – A lot more than just omega-3. Lipid Technol., 27, 7, 2015.

Chen, H. , Weil, F. , Dong, X. Y. , Xiang, J. Q. , Quek, S. Y. , and Wang, X. , Lipidomics in food science. Curr. Opinion Food Sci., 16, 80, 2017.

Wenk, M. R. , Lipidomics: New tools and applications. Cell, 143, 888, 2010.
Li, M. , Yang, L. , Bai, Y. , and Liu, H. , Analytical methods in lipidomics and their applications. Anal. Chem., 86, 161, 2014.
Oshima, T. , Li, N. , and Koizumi, C. , Oxidative decomposition of cholesterol in fish products. J. Amer. Oil Chem. Soc., 70, 595, 1993.
Garrido, J. and Medina, I. , Identification of minor fatty acids in mussels (*Mytillus galloprovincialis*) by GC-MS of their 2-alkenyl-4,4-dimethyloxazoline derivatives. Anal. Chim. Acta, 465, 409, 2002.
Rezanka, T. , Identification of very long chain fatty acids by atmospheric pressure chemical ionization liquid chromatography-mass spectrometry from green alga *Chlorella kesslerri* . J. Separation Sci., 25, 1332, 2002.
Melo, T. , Alves, E. , Azevedoa, V. , Martins, A. S. , Neves, B. , Domingues, P. , Calado, R. , Abreu, M. H. , and Domingues, M. R. , Lipidomics as a new approach for the bioprospecting of marine macroalgae - Unraveling the polar lipid and fatty acid composition of *Chondrus crispus* . Algal Res., 8, 181, 2015.
Wang, X. , Zhang, H. , Song, Y. , Cong, P. , Li, Z. , Xu, J. , and Xue, C. , Comparative lipid profile analysis of four fish species by ultraperformance liquid chromatography coupled with quadrupole time-of-flight mass spectrometry. J. Agric. Food Chem., 67, 9423, 2019.
Li, P. , Zhang, M. , Xie, D. , Zhang, X. , Zhang, S. , Gao, F. , Wang, Y. , Hsiao, C. D. , Li, X. , and Liu, K. , Characterization and bioactivities of phospholipids from squid viscera and gonads using ultra-performance liquid chromatography-Q-exactive orbitrap/mass spectrometry-based lipidomics and zebrafish models. Food Funct., 12, 7986, 2021.
Coniglio, D. , Bianco, M. , Ventura, G. , Calvano, C. D. , Losito, I. , and Cataldi, T. R. , Lipidomics of the edible brown alga wakame (*Undaria pinnatifida*) by liquid chromatography coupled to electrospray ionization and tandem mass spectrometry. Molecules, 26, 4480, 2021.
Wang, H. , Yang, L. , Wang, X. , Cong, P. , Xu, J. , and Xue, C. , Comprehensive lipidomic analysis of three edible brown seaweeds based on reversed-phase liquid chromatography coupled with quadrupole time-of-flight mass spectrometry. J. Agric. Food Chem., 70, 4138, 2022.

Lipid Oxidation

Abuzaytoun, R. , Budge, S. , Hansen, L. T. , & MacKinnon, S. (2020). Modification of the ferrous oxidation-xylenol orange method for determination of peroxide value in highly pigmented sea cucumber viscera lipid. Journal of the American Oil Chemists' Society, 97(5), 509–516. https://doi.org/10.1002/aocs.12344.
Andersen, M. L. & Skibsted, L. H. (2018). ESR Spectroscopy for the Study of Oxidative Processes in Food and Beverages, In Modern Magnetic Resonance, (Webb, G. Ed.) Springer, Cham. pp. 1781–1789. https://doi.org/10.1007/978-3-319-28388-3_25.
Anconi, A. C. S. A. , Brito, N. C. S. , & Nunes, C. A. (2022). Determination of peroxide value in edible oils based on digital image colorimetry. Journal of Food Composition and Analysis, 113, 104724.
AOCS . (1994). AOCS Official Method Cd 18-90, p-Anisidine Value. American Oil Chemists Society Press, Champaign, IL, USA.
AOCS . (1997). Calculated Iodine Value, Method Cd 1c-85. Official and Recommended Practices of the American Oil Chemists' Society, 5th ed., American Oil Chemists Society Press, Champaign, IL.
AOCS . (1998). AOCS Official Method Cd 1-25. Official Methods and Recommended Practices of the American Oils Chemists' Society. American Oil Chemists Society Press, Champaign. IL.
AOCS . (2003). AOCS Official Method Cd 8b-90: Peroxide Value. American Oil Chemists Society Press, Champaign, IL.
AOCS . (2011). AOCS Official Method Cd 8b-90: Peroxide Value Acetic Acid-Isooctane Method, Official Methods and Recommended Practices of the AOCS. American Oil Chemists Society Press, Champaign, IL, USA.
Aubourg, S. P. (1998). Lipid changes during long-term storage of canned tuna (Thunnus alalunga). Zeitschrift für Lebensmittel-untersuchung und -Forschung A, 206(1), 33–37.
Aubourg, S. P. (1999). Recent advances in assessment of marine lipid oxidation by using fluorescence. Journal of the American Oil Chemists' Society, 76(4), 409–419.
Barriuso, B. , Astiasarán, I. , & Ansorena, D. (2013). A review of analytical methods measuring lipid oxidation status in foods: A challenging task. European Food Research and Technology, 236(1), 1–15. https://doi.org/10.1007/s00217-012-1866-9.
Cropotova, J. , Mozuraityte, R. , Standal, I. B. , & Rustad, T. (2019). Assessment of lipid oxidation in Atlantic mackerel (*Scomber scombrus*) subjected to different antioxidant and sous-vide cooking treatments by conventional and fluorescence microscopy methods. Food Control, 104, 1–8. https://doi.org/10.1016/j.foodcont.2019.04.016.
Cropotova, J. & Rustad, T. (2020). A new fluorimetric method for simultaneous determination of lipid and protein hydroperoxides in muscle foods with the use of diphenyl-1-pyrenylphosphine (DPPP). LWT, 128, 109467. https://doi.org/10.1016/j.lwt.2020.109467.

Crowe, T. D. & White, P. J. (2001). Adaptation of the AOCS official method for measuring hydroperoxides from small-scale oil samples. Journal of the American Oil Chemists' Society, 78(12), 1267–1269. https://doi.org/10.1007/s11745-001-0424-7.
Domínguez, R. , Pateiro, M. , Gagaoua, M. , Barba, F. J. , Zhang, W. , & Lorenzo, J. M. (2019). A comprehensive review on lipid oxidation in meat and meat products. Antioxidants, 8, 429. https://doi.org/10.3390/antiox8100429.
De Las Heras, A. , Schoch, A. , Gibis, M. , & Fischer, A. (2003). Comparison of methods for determining malondialdehyde in dry sausage by HPLC and the classic TBA test. European Food Research and Technology, 217(2), 180–184. https://doi.org/10.1007/s00217-003-0728-x.
Falch, E. , Anthonsen, H. W. , Axelson, D. E. , & Aursand, M. (2004). Correlation between 1H NMR and traditional methods for determining lipid oxidation of ethyl docosahexaenoate. Journal of the American Oil Chemists' Society, 81, 1105–1110. https://doi.org/10.1007/s11746-004-1025-1.
Falch, E. & Aursand, M. (2008). Resonance Spectroscopy to Study Lipid Oxidation in Fish and Fish Products, In Modern Magnetic Resonance, (Webb, G. A. Ed.) Springer, Dordrecht, pp. 933–940. https://doi.org/10.1007/1-4020-3910-7_107.
Falch, E. , Velasco, J. , Aursand, M. , & Andersen, M. (2005). Detection of radical development by ESR spectroscopy techniques for assessment of oxidative susceptibility of fish oils. European Food Research & Technology, 221(5), 667–674. https://doi.org/10.1007/s00217-005-0009-y.
Frankel, E.N. (Ed). (2014). Stability methods, In Lipid oxidation, 2nd edition, Vol. 18, Food Science, Technology, Oily Press, Woodhead Publishing, Middlesex, UK. 18, pp. 165–186.
Hafer, E. , Holzgrabe, U. , Wiedemann, S. , Adams, K. M. , & Diehl, B. (2020). NMR spectroscopy: Determination of peroxide value in vegetable and krill oil by using triphenylphosphine as tagging reagent. European Journal of Lipid Science and Technology, 122(5), 1900442.
International Dairy Federation . (1991). Anhydrous Fat, Determination of Peroxide Value. International IDF Standard 74A. IDF, Brussels, Belgium.
Ismail, A. , Bannenberg, G. , Rice, H. B. , Schutt, E. , & MacKay, D. (2016). Oxidation in EPAand DHArich oils: An overview. Lipid Technology, 28(3–4), 55–59.
Jacobsen, C. , Garcia-Moreno, P. J. , Yesiltas, B. , & Sørensen, A.-D. M. (2021). Lipid Oxidation and Traditional Methods for Evaluation, In Omega-3 Delivery Systems: Production, Physical Characterization and Oxidative Stability, (García-Moreno, P. J. C. , Sørensen, A.-D. M. , & Yesiltas, B. Eds.) Elsevier, Amsterdam, pp. 183–200.
Jacobsen, C. & Hu, M. (2016). Oxidative Stability and Shelf Life of Foods Containing Oils and Fats. Academic Press and AOCS Press, San Diego, USA.
Kannaiyan, S. K. , Gunasekaran, J. , Kannuchamy, N. , Thachil, M. T. , & Gudipati, V. (2015). Antioxidant and antibacterial activities of dill extracts and their preservative effect on mackerel fillets during refrigerated storage. Indian Journal of Natural Products and Resources, 6(2), 106–113.
Koohikamali, S. & Alam, M. S. (2019). Improvement in nutritional quality and thermal stability of palm olein blended with macadamia oil for deep-fat frying application. Journal of Food Science and Technology, 56, 5063–5073. https://doi.org/10.1007/s13197-019-03979-0.
Kamvissis, V. N. , Barbounis, E. G. , Megoulas, N. C. , & Koupparis, M. A. (2008). A novel photometric method for evaluation of the oxidative stability of virgin olive oils. Journal of AOAC International, 91(4), 794–801. https://doi.org/10.1093/jaoac/91.4.794.
Karleskind, A. & Wolff, J.-P. (1996). Oils and Fats Manual. A Comprehensive Treatise: Properties, Production, Applications. Technique et Documentation. TEC&DOC Lavoisier, Paris, France. ISBN 139782743000875.
Kyriakidis, N. B. and Katsiloulis, T. (2000). Calculation of iodine value from measurements of fatty acid methyl esters of some oils: Comparison with the relevant American Oil Chemists Society method. Journal of the American Oil Chemists' Society, 77: 1235–1238.
Larssen, W. E. , Monteleone, E. , & Hersleth, M. (2018). Sensory description of marine oils through development of a sensory wheel and vocabulary. Food Research International, 106, 45–53. https://doi.org/10.1016/j.foodres.2017.12.045.
Leake, L. & Karel, M. (1985). Nature of fluorescent compounds generated by exposure of protein to oxidizing lipids. Journal of Food Biochemistry, 9, 117–136.
McClements, D. J. & Decker, E. A. (2017). Lipids, In Fennema's Food Chemistry. 5th ed., (Damodaran, S. & Parkin, K. L. Eds.). CRC Press, Boca Raton. pp. 171–233.
Merkx, D. W. H. , Plankensteiner, L. , Yu, Y. , Wierenga, P. A. , Hennebelle, M. , & Van Duynhoven, J. P. M. (2021). Evaluation of PBN spin-trapped radicals as early markers of lipid oxidation in mayonnaise. Food Chemistry, 334, 127578–127578. https://doi.org/10.1016/j.foodchem.2020.127578.
Mozuraityte, R. , Kristinova, V. , Standal, I. B. , Evensen, H. , & Rustad, T. (2017). Applicability of traditional and advanced methods for oxidative quality and stability on marine phospholipids. European Journal of Lipid Science and Technology, 119, 1600103. https://doi.org/10.1002/ejlt.201600103.
Mozuraityte, R. , Standal, I. B. , Cropotova, J. , Budźko, E. , & Rustad, T. (2021). Superchilled, chilled and frozen storage of Atlantic mackerel (Scomber scombrus) - Effect on lipids and low molecular weight metabolites. International Journal of Food Science and Technology, 56(4), 1918–1928. https://doi.org/10.1111/ijfs.14821.

Olafsdóttir, G. , Martinsdóttir, E. , Oehlenschläger, J. , Dalgaard, P. , Jensen, B. , Undeland, I. , Mackie, I. M. , Henehan, G. , Nielsen, J. , & Nilsen, H. (1997). Methods to evaluate fish freshness in research and industry. Trends in Food Science & Technology, 8(8), 258–265.

Saeed, S. , Fawthrop, S. A. , & Howell, N. (1999). Electron spin resonance (ESR) study on free radical transfer in fish lipid-protein interaction. Journal of the Science of Food and Agriculture, 79(13), 1809–1816. https://doi.org/10.1002/(SICI)1097-0010(199910)79:13<1809::AID-JSFA440>3.0.CO;2–V.

Schaich, K. M. (2008). Co-oxidations of Oxidizing Lipids: Reactions with Proteins, In Lipid Oxidation Pathways, (Kamal-Eldin, A. and Min, D. , Eds.), AOCS Press, Champaign, Chapter 8, Vol. 2, pp. 183–274.

Shimamoto, G. G. , Aricetti, J. A. , & Tubino, M. (2016). A simple, fast, and green titrimetric method for the determination of the iodine value of vegetable oils without Wijs solution (ICl). Food Analytical Methods, 9(9), 2479–2483. https://doi.org/10.1007/s12161-016-0401-1.

Sullivan, J. C. , Budge, S. M. , & St-Onge, M. (2011). Modeling the primary oxidation in commercial fish oil preparations. Lipids, 46(1), 87–93. https://doi.org/10.1007/s11745-010-3500-6.

Thomsen, M. K. , Jacobsen, C. , & Skibsted, L. H. (2000). Mechanism of initiation of oxidation in mayonnaise enriched with fish oil as studied by electron spin resonance spectroscopy. European Food Research and Technology, 211, 381.

Ueda, S. , Hayashi, T. , & Namiki, M. (1986). Effect of ascorbic acid on lipid autoxidation in a model food system. Agricultural and Biological Chemistry, 50, 1–7. ISSN 0002-1369.

Undeland, I. , Stading, M. , & Lingnert, H. (1998). Influence of skinning on lipid oxidation in different horizontal layers of herring (*Clupea harengus*) during frozen storage. Journal of the Science of Food and Agriculture, 78, 441–450. ISSN 0022-5142.

Warner, K. & Eskin, M. P. (1995). Conjugated Diene, Anisidine Value, and Carbonyl Value Analyses, In Methods to Assess Quality and Stability of Oils and Fat-Containing Foods, (Warner, K. & Eskin, M. Eds.) AOCS Publishing, Oxford, UK, pp. 159–178.

Xu, L. , Wu, G. , Zhang, Y. , Wang, Q. , Zhao, C. , Zhang, H. , Jin, Q. , & Wang, X. (2020). Evaluation of glycerol core aldehydes formation in edible oils under restaurant deep frying. Food Research International, 137, 109696–109696. https://doi.org/10.1016/j.foodres.2020.109696.

Yi, J. , Andersen, M. L. , & Skibsted, L. H. (2011). Interactions between tocopherols, tocotrienols and carotenoids during autoxidation of mixed palm olein and fish oil. Food Chemistry, 127(4), 1792–1797. https://doi.org/10.1016/j.foodchem.2011.02.061.

Volatile Aroma Compounds in Marine Resources

Huss, H.H. Quality and Quality Changes in Fresh Fish. FAO Fisheries Technical Paper, No. 348, FAO, Rome, 1995, 193p.

Botta, J.R. Evaluation of Seafood Freshness Quality. VCH Publishers Inc., New York, 1995, pp. 1–67.

Gram, L. , and Dalgaard, P. Fish spoilage bacteria - problems and solutions. Curr. Opin. Biotechnol. 13, 262, 2002.

Josephson, D.B. , Lindsay, R.C. , and Stuiber, D.C. Identification of compounds characterizing the aroma of fresh Whitefish (*Coregonus clupeaformis*). J. Agric. Food Chem., 31, 326, 1983.

Josephson, D.B. , Lindsay, R.C. , and Stuiber, D.C. Variations in the occurrences of enzymically derived volatile aroma compounds in salt- and freshwater fish. J. Agric. Food Chem., 32, 1344, 1984.

Hsieh, R.J. , German, J.B. , and Kinsella, J.E. Lipoxygenase in fish tissue: some properties of the 12-lipoxygenase from trout gill. J. Agric. Food Chem., 36, 680, 1988.

Richards, M.P. , and Hultin, H.O. Contributions of blood and blood components to lipid oxidation in fish muscle. J. Agric. Food Chem., 50, 555, 2002.

Lindsay, R.C. Fish flavours. Food Rev. Int., 6, 437, 1990.

Delbarre-Ladrat, C. , Verrez-Bagnis, V. , Noël, J. , and Fleurence, J. Relative contribution of calpain and cathepsins to protein degradation in muscle of sea bass (*Dicentrarchus labrax*). Food Chem., 88, 389, 2004.

German, J.B. , and Kinsella, J.E. Lipid oxidation in fish tissue. Enzymatic initiation via lipoxygenase. J. Agric. Food Chem., 33, 680, 1985.

German, J.B. , Buckner, G.B. , and Kinsella, J.E. Lipoxygenase in trout gill tissue acting on arachidonic, eicosapentaenoic and docosahexaenoic acids. Biochim. Biophys. Acta, 875, 12, 1986.

Hsieh, R.J. , and Kinsella, J.E. Lipoxygenase generation of specific volatile flavour carbonyl compounds in fish tissue. J. Agric. Food Chem., 37, 279, 1989.

Zhang, C.H. , Hirano, T. , Suzuki, T. , and Shirai, T. Enzymatically generated specific volatile compounds in ayu tissues. Nippon Suisan Gakkaishi, 58, 559, 1992.

Hirano, T. , Zhang, C.H. , Morishita, A. , Suzuki, T. , and Shirai, T. Identification of volatile compounds in ayu fish and its feeds. Nippon Suisan Gakkaishi, 58, 547, 1992.

Milo, C. , and Grosch, W. Changes in the odourants of boiled trout (*Salmo fario*) as affected by the storage of the raw material. J. Agric. Food Chem., 41, 2076, 1993.

Josephson, D.B. Seafood , in Volatile compounds in foods and beverages, Maarse, H. , Ed., Marcel Dekker, New York, 1991, p. 179.
Whitfield, F.B. , Shaw, K.J. , and Tindale, C.R. 2,6-dibromophenol: the cause of an iodoform-like off-flavour in some Australian crustacea. J. Sci. Food Agric., 46, 29, 1988.
Boyle, J.L. , Lindsay, R.C. , and Stuiber, D.A. Occurrence and properties of flavour-related bromophenols found in the marine environment: a review. J. Aquat. Food Prod. Technol., 2, 75, 1993.
Ólafsdóttir, G. , Martinsdóttir, E. , Jónsson, E.H. Gas sensor and GC measurements of volatile compounds in capelin (*Mallotus villosus*), in Seafood from Producer to Consumer, Integrated Approach to Quality, Luten, J.B. , Börresen, T. , and Oehlenschläger, J. , Eds., Elsevier, Amsterdam, 1997, p. 507.
Kaewsrithong, J. , Ushio, H. , Ohshima, T. Seasonal variation of phosphatidylcholine hydroperoxides in blood of sweet smelt *Plecoglossus altivelis* . Comp. Biochem. Physiol. B, 130, 33, 2001.
Ólafsdóttir, G. Volatile compounds as quality indicators in fish during chilled storage: evaluation of microbial metabolites by an electronic nose. PhD Thesis. Faculty of Science, University of Iceland, Reykjavík, 2005.
Ólafsdóttir, G. , Jónsdóttir, R. , Lauzon, H.L. , Luten, J. , and Kristbergsson, K. Characterization of volatile compounds in chilled cod (*Gadus morhua*) fillets by gas chromatography and detection of quality indicators by an electronic nose. J. Agric. Food Chem., 53, 10140, 2005.
Jónsdóttir, R. , Ólafsdóttir, G. , Chanie, E. , and Haugen, J.E. Variation in the occurrence of volatile compounds in cold smoked salmon (*Salmo salar*) during storage. Food Chem., 109, 184, 2008. doi:10.1016/j.foodchem.2007.12.006.
Josephson, D.B. , Lindsay, R.C. , and Ólafsdóttir, G. Measurement of volatile aroma constituents as a means for following sensory deterioration of fresh fish and fishery products, in Proceedings of the International Symposium on Seafood Quality Determination, Kramer, D.E. , and Liston, J. , Eds., Elsevier Science Publishers BV, Amsterdam, 1986, p. 27.
Lindsay, R.C. , Josephson, D.B. , and Ólafsdóttir, G. Chemical and biochemical indices for assessing the quality of fish packaged in controlled atmospheres, in Proceedings of the International Symposium on Seafood Quality Determination. Kramer, D.E. , and Liston, J. , Eds., Elsevier Science Publishers, The Netherlands, 1986, p. 221.
Ólafsdóttir, G. , and Fleurence, J. Evaluation of fish freshness using volatile compounds-classification of volatile compounds in fish, in Methods to Determine the Freshness of Fish in Research and Industry. Proc. of the final meeting of the concerted action “Evaluation of Fish Freshness” AIR3 CT94 2283, Ólafsdóttir, G. , Luten, J. , Dalgaard, P. , Careche, M. , Verrez-Bagnis, V. , Martinsdóttir, E. , and Heia, K. , Eds., International Institute of Refrigeration, Paris, 1998, p. 55.
Oehlenschläger, J. Evaluation of some well established and some underrated indices for the determination of freshness and/or spoilage of ice stored wet fish, in Quality Assurance in the Fish Industry, Huss, H.H. , Jakobsen, M. , and Liston, J. , Eds., Elsevier Science Publisher, Amsterdam, 1992, p. 339.
Jørgensen, L.V. , Huss, H.H. , and Dalgaard, P. Significance of volatile compounds produced by spoilage bacteria in vacuum-packed cold-smoked salmon (*Salmo salar*) analyzed by GC-MS and multivariate regression. J. Agric. Food Chem., 49, 2376, 2001.
Alasalvar, C. , Taylor, K.D.A. , and Shahidi, F. Comparison of volatiles of cultured and wild sea bream (*Sparus aurata*) during storage in ice by dynamic headspace analysis gas chromatography mass spectrometry. J. Agric. Food Chem., 53, 2616, 2005.
Ólafsdóttir, G. , Martinsdóttir, E. , Oehlenschläger, J. , Dalgaard, P. , Jensen, B. , Undeland, I. , Mackie, I.M. , Henehan, G. , Nielsen, J. , and Nilsen, H. Methods to evaluate fish freshness in research and industry. Trends Food Sci. Technol., 8, 258, 1997.
Ólafsdóttir, G. Developing rapid olfaction arrays for determining fish quality, in Rapid and On-line Instrumentaiton for Food Quality Assurance, Tothill, I.E. , Ed., Woodhead Publishing Ltd, Cambridge, 2003, p. 339.
Ólafsdóttir, G. , Nesvadba, P. , Di Natale, C. , Careche, M. , Oehlenschläger, J. , Tryggvadóttir, S.V. , Schubring, R. , Kroeger, M. , Heia, K. , Esaiassen, M. , Macagnano, A. , and Jørgensen, B.M. Multisensor for fish quality determination. Trends Food Sci. Technol., 15, 86, 2004.
Ólafsdóttir, G. , Lauzon, H. , Martinsdóttir, E. , and Kristbergsson, K. Influence of storage temperature on microbial spoilage characteristics of haddock fillets (*Melanogrammus aeglefinus*) evaluated by multivariate quality prediction. Int. J. Food Microbiol., 111, 112, 2006.
Ólafsdóttir, G. , Lauzon, H. , Martinsdóttir, E. , Oehlenschläger, J. , and Kristbergsson, K. Evaluation of shelf-life of superchilled cod (*Gadus morhua*) fillets and influence of temperature fluctuations on microbial and chemical quality indicators. J. Food Sci., 71, 97, 2006.
Ólafsdóttir, G. , Chanie, E. , Westad, F. , Jónsdóttir, R. , Thalman, C. , Bazzo, S. , Labreche, S. , Marcq, P. , Lundby, F. , and Haugen, J.E. Prediction of microbial and sensory quality of cold smoked Atlantic salmon (*Salmo salar*) by electronic nose. J. Food Sci., 70, 563, 2005.
Haugen, J. , Chanie, E. , Westad, F. , Jónsdóttir, R. , Bazzo, S. , Labreche, S. , Marcq, P. , Lundby, F. , and Ólafsdóttir, G. Rapid control of smoked Atlantic salmon quality by electronic nose: correlation with classical evaluation methods. Sensors Actuat. B, 116, 72, 2006.
Castell, C.H. , and Greenough, M.F. The action of *Pseudomonas* on fish muscle: 1. organisms responsible for odour produced during incipient spoilage of chilled fish muscle. J. Fish. Res. Board Can., 12, 617, 1957.

Miller III, A. , Scanlan, R.A. , Lee, J.S. , and Libbey, L.M. Identification of the volatile compounds produced in sterile fish muscle (*Sebastes melanops*) by Pseudomonas fragi. Appl. Microbiol., 25, 952, 1973.
Miller III, A. , Scanlan, R.A. , Lee, J.S. , and Libbey, L.M. Volatile compounds produced by Pseudomonas putrefaciens, Pseudomonas fluorescens and an Achromobacter Species. Appl. Microbiol., 26, 18, 1973.
Karahadian, C. , and Lindsay, R.C. Evaluation of compounds contributing fishy flavors in fish oils. J. Am. Oil Chem Soc., 66, 953, 1989.
Herbert, R.A. , Ellis, J.R. , and Shewan, J.M. Isolation and identification of the volatile sulphides produced during chill-storage of North Sea Cod (*Gadus morhua*). J. Sci. Food Agric., 26, 1195, 1975.
Milo, C. , and Grosch, W. Detection of defects in boiled cod and trout by gas chromatography-olfactometry of headspace samples. J. Agric. Food Chem., 43, 459, 1995.
Yamanaka, H. Offensive odour of fish and shellfish, in Odour of Marine Products, Koizumi, C. , Ed., Koseisha-Koseikaku, Tokyo, 1989, p. 53.
Decker, E.A. , and Xu, Z. Minimizing rancidity in muscle foods. Trends Food Sci. Technol., 9, 241, 1998.
Frankel, E.M. Lipid Oxidation. The Oily Press, Dundee, 1998.
Hultin, H.O. Oxidation of lipids in seafoods, in Seafoods: Chemistry, Processing Technology and Quality, Shahidi, F. , and Botta, J.F. , Eds., Blackie Academic and Professional, Glasgow, 1994, p. 49.
McGill, A.S. , Hardy, T. , Burt, R.J. , and Gunstone, F.D. Hept-cis-4-enal and its contribution to the off-flavour of cold-stored cod. J. Sci. Food Agric., 25, 1477, 1974.
Jónsdóttir, R. , and Ólafsdóttir, G. , “Oxidation in fish muscle - The role of phospholipids, proteins, antioxidants and the effect of boiling on oxidation in fish muscle”, Authors own data from the OXIFISH project funded by Icelandic Research Center, 2004.
Refsgaard, H.H.F. , Brockhoff, P.B. , and Jensen, B. Sensory and chemical changes in farmed Atlantic salmon (*Salmo salar*) during frozen storage. J. Agric. Food Chem., 46, 3473, 1998.
Hardy, R. , McGill, A.S. , and Gunstone, F.D. Lipid and autoxidative changes in cold stored cod (*Gadus morhua*). J. Sci. Food Agric., 28, 999, 1979.
Josephson, D.B. , and Lindsay, R.C. Retro-aldol degradations of unsaturated aldehydes: role in the formation of c4-heptenal from t2,c6-nonadienal in fish, oyster, and other flavours. J. Food Sci., 64, 1186, 1987.
Josephson, D.B. , and Lindsay, R.C. C4-heptenal: an influential volatile compound in boiled potato flavour. J. Food Sci., 52, 328, 1987.
Aro, T. , Tahvonen, R. , Koskinen, L. , and Kallio, H. Volatile compounds of Baltic herring analysed by dynamic headspace sampling-gas chromatography-mass spectrometry. Eur. Food Res. Technol., 216, 483, 2003.
Milo, C. , and Grosch, W. Changes in the odourants of boiled salmon and cod as affected by the storage of the raw material. J. Agric. Food Chem., 44, 2366, 1996.
Decker, E.A. , Warner, K. , Richards, M.P. , and Shahidi, F. Measuring antioxidant effectiveness in food. J. Agric. Food Chem., 53, 4303, 2005.
Jacobsen, C. , Let, M.B. , Nielsen, N.S. , and Meyer, A.S. Antioxidant strategies for preventing oxidative flavour deterioration of foods enriched with n-3 polyunsaturated lipids: a comparative evaluation. Trends Food Sci. Technol., 19, 76, 2008.
Hultin, H.O. , and Kelleher, S.D. Surimi processing from dark muscle fish, in Surimi and Surimi Seafood, Park, J.W. , Ed., Marcel Dekker Inc., New York, 2000, p. 59.
Undeland, I. , Hall, G. , and Lingnert, H. Lipid oxidation in fillets of herring *(Clupea harengus)* during ice storage. J. Agric. Food Chem., 47, 524, 1999.
Richards, M.P. , and Hultin, H.O. Rancidity development in a fish model system as affected by phospholipids. J. Food Lipids, 8, 215, 2001.
Sohn, J.H. , Taki, Y. , Ushio, T. , Kohata, T. , Shioya, I. , and Ohshima, T. Lipid oxidations in ordinary and dark muscles of fish: influences on rancid off-odor development and colour darkening of yellowtail flesh during ice storage. J. Food Sci., 70(7), 490, 2005.
Undeland, I. , Kristinsson, H.G. , and Hultin, H.O. Hemoglobin-mediated oxidation of washed minced cod muscle phospholipids: effect of pH and hemoglobin source. J. Agric. Food Chem., 52, 4444, 2004.
Jónsdóttir, R. , Bragadóttir, M. , and Ólafsdóttir, G. The role of volatile compounds in odor development during hemoglobin-mediated oxidation of cod muscle membrane lipids. J. Aquat. Food Prod., 16, 67, 2007. doi:10.1300/J030v16n04_07.
Boyd, L.C. , King, M.F. , and Sheldon, B. A rapid method for determining the oxidation of n-3 fatty acids. J. Am. Oil Chem. Soc., 69, 325, 1992.
Jónsdóttir, R. , Bragadóttir, M. , and Ólafsdóttir, G. Oxidation in fish muscle: the role of phospholipids, proteins, pro-oxidants, antioxidants and the effect of heating. Matis Report 08, Reykjavík, 2008, p. 73.
Medina, I. , Gallardo, J.M. , Gonzalez, M.J. , Lois, S. , and Hedges, N. Effect of molecular structure of phenolic families as hydroxycinnamic acids and catechins on their antioxidant effectiveness in minced fish muscle. J. Agric. Food Chem., 55, 3889, 2007.
Jittrepotch, N. , Ushio, H. , and Ohshima, T. Effects of EDTA and a combined use of nitrite and ascorbate on lipid oxidation in cooked Japanese sardine (*Sardinops melanostictus*) during refrigerated storage. Food Chem., 99, 70, 2006.

Banerjee, S. Inhibition of mackerel (*Scomber scombrus*) muscle lipoxygenase by green tea polyphenols. Food Res. Int., 39, 486, 2006.
Baek, H.H. , and Cadwallader, K.R. Volatile compounds in flavour concentrates produced from crayfish-processing byproducts with and without protease treatment. J. Agric. Food Chem., 44, 3262, 1996.
Pan, B.S. , and Kuo, J.M. Flavour of shellfish and kamaboko flavourants, in Seafoods: Chemistry, Processing, Technology and Quality, Shahidi, F. , and Botta, J.R. , Eds., Blackie Academic and Professional, Glasgow, 1994, p. 85.
Jónsdóttir, R. , Ólafsdóttir, G. , Hauksson, S. , and Einarsson, J.E. Flavorants from seafood byproducts, in Handbook of Food Products Manufacturing: Health, Meat, Milk, Poultry, Seafood, and Vegetables, Vol. 2, Hui, Y.H. , Ed., John Wiley & Sons, Hoboken, 2007, p. 931.
Varlet, V. , Knockaert, C. , Prost, C. , and Serot, T. Comparison of odour-active volatile compounds of fresh and smoked salmon. J. Sci. Food Agric., 54, 3391, 2006.
Varlet, V. , Prost, C. , and Serot, T. Volatile aldehydes in smoked fish: analysis methods, occurrence and mechanisms of formation. Food Chem., 105, 1536, 2007.
Sérot, T. , Baron, R. , Knockaert, C. , and Vallet, J.L. Effect of smoke processes on the content of 10 major phenolic compounds in smoked fillets of herring (*Cuplea harengus*). Food Chem., 85, 111, 2004.
Guillén, M.D. , Errecalde, M.C. , Salmerón, J. , and Casas, C. Headspace volatile components of smoked swordfish (*Xiphias gladius*) and cod (*Gadus morhua*) detected by means of solid phase microextraction and gas chromatography-mass spectrometry. Food Chem., 94, 151, 2006.
Joffraud, J.J. , Leroi, F. , Roy, C. , and Berdagué, J.L. Characterisation of volatile compounds produced by bacteria isolated from the spoilage flora of cold-smoked salmon. Int. J. Food Microbiol., 66, 175, 2001.
Toldrá, F. Proteolysis and lipolysis in flavour development of dry-cured meat products. Meat Sci., 49, 101, 1998.
Toldrá, F. , and Flores, M. The role of muscle proteases and lipases in flavour development during the processing of dry-cured ham. Crit. Rev. Food Sci., 38, 331, 1999.
Toldrá, F. , Aristoy, M.C. , and Flores, M. Contribution of muscle aminopeptidases to flavour development in dry-cured ham. Food Res. Int., 33, 181, 2000.
Jónsdóttir, R. , Ólafsdóttir, G. , Martinsdóttir, E. , and Stefánsson, G. Flavour characterization of ripened cod roe by gas chromatography, sensory analysis and electronic nose. J. Agric. Food Chem., 52, 6250, 2004.
Triqui, R. , and Reineccius, G.A. Changes in flavour profiles with ripening of anchovy (*Engraulis encrasicholus*). J. Agric. Food Chem., 43, 1883, 1995.
Triqui, R. , and Guth, H. Determination of potent odourants in ripened anchovy (*Engraulis encrasicholus L.*) by aroma extract dilution analysis and by gas chromatography-olfactometry of headspace samples, in Flavour and Lipid Chemisty of Seafoods, Shahidi, F. , and Cadwallader, K.R. , Eds., ACS Symposium Series 674, American Chemical Society, Washington, DC, 1997, p. 31.
Jónsdóttir, R. , Sveinsdóttir, K. , Magnússon, H. , Arason, S. , Lauritzsen, K. , and Thorarinsdottir, K.A. Flavor and quality characteristics of salted and desalted cod (*Gadus morhua*) produced by different salting methods. J. Agric. Food Chem., 59(8), 3893–3904, 2011. doi:10.1021/jf104203p.
Lauritzesen, K. , and Olsen, R.L. Effects of antioxidants on copper induced lipid oxidation during salting of cod (*Gadus* morhua). J. Food Lipids, 1, 105, 2004.
Pickardt, C. , Czerny, M. , Ólafsdóttir, A. , and Jónsdóttir, R. Deliverable No. 1.1 Basic description and analysis. The Application of Edible Seaweed for TASTE Enhancement and Salt Replacement. FP7-SME-2012-315170. 2013.
Jensen, S. , Ólafsdóttir, A. , Einarsdóttir, B. , Hreggviðsson, G. Ó., Guðmundsson, H. , Jónsdóttir, L.B. , Friðjónsson, Ó.H. , Jónsdóttir, R. New wave of flavours - on new ways of developing and processing seaweed flavours. Int. J. Gastron. Food Sci., 29, 100566, 2022.
Kristjánsson, L. Íslenskir sjávarhættir. Bókaútgáfa Menningarsjóðs, Reykjavík, 1980.
Stévant, P. , Ólafsdóttir, A. , Déléris, P. , Dumay, J. , Fleurence, J. , Ingadóttir, B. , Jónsdóttir, R. , Ragueneau, É. , Rebours, C. , and Rustad, T. Ageing gracefully? Semi-dry storage as a maturation process to develop the sensory characteristics of the edible red seaweed dulse (*Palmaria palmata*). Algal Res., 51. 2020. doi:10.1016/j.algal.2020.102048.
Michel, F. , Priol, J. , Galaup, P. , Demaimay, M. , and Bigot, C. Effet de deux techniques de séchage sur les composés volatils de deux algues alimentaires Ulva sp et *Palmaria palmata* . Sci. Aliment., 17, 601–617, 1997.
Le Pape, M.A. Grua-Priol, J. , Prost, C. , and Demaimay, M. Optimization of dynamic headspace extraction of the edible red algae *Palmaria palmata* and identification of the volatile components. J. Agr. Food Chem., 52, 550–556, 2004.
López-Pérez, O , Picon, A. , and Nuñez, M. Volatile compounds and odour characteristics of seven species of dehydrated edible seaweeds. Food Res. Int., 99, 1002–1010, 2017. doi:10.1016/j.foodres.2016.12.013.
Peinado, I. , Girón, J. , Koutsidis, G. , and Ames, J. Chemical composition, antioxidant activity and sensory evaluation of five different species of brown edible seaweeds. Food Res. Int., 66, 36–44, 2014. doi:10.1016/j.foodres.2014.08.035.
Mouritsen, O.G. , Duelund, L. , Petersen, M.A. , Hartmann, A.L. , and Frøst, M.B. Umami taste, free amino acid composition, and volatile compounds of brown seaweeds. J. Appl. Phycol., 31, 1213–1232, 2019. doi:10.1007/s10811-018-1632-x.

Garicano Vilar, E. , O'Sullivan, M.G. , Kerry, J.P. , and Kilcawley, K.N. Volatile compounds of six species of edible seaweed: a review. Algal Res., 45, 101740, 2020. doi:10.1016/j.algal.2019.101740.
Jones, B.C. , Rocker, M.M. , Keast, R.S.J. , Callahan, D.L. , Redmond, H.J. , Smullen, R.P. , and Francis, D.S. Systematic review of the odorous volatile compounds that contribute to flavour profiles of aquatic animals. Rev. Aquac., 14, 1418–1477, 2022. doi:10.1111/raq.12657.
Wang, T. , Jónsdóttir, R. , Kristinsson, H.G. , Thorkelsson, G. , Jacobsen, C. , Hamaguchi, P.Y. , and Ólafsdóttir, G. Inhibition of haemoglobin-mediated lipid oxidation in washed cod muscle and cod protein isolates by Fucus vesiculosus extract and fractions. Food Chem., 123(2), 321–330, 2010. doi:10.1016/j.foodchem.2010.04.038.
García, M.R. , Férez-Rubio, J.A. , and Vilas, C. Assessment and prediction of fish freshness using mathematical modelling: a review. Foods, 11, 2312, 2022. doi:10.3390/foods11152312.

Microstructure

Aguilera, J. M. (2005). Why food micro structure? Journal of Food Engineering, 67(1–2), 3–11. https://doi.org/10.1016/j.jfoodeng.2004.05.050
Auty, M. A. E. (2018). Microscopy Techniques for Dairy Products – An Introduction. In M. El-Bakry , A. Sánchez , & B. M. Mehta (Eds.), Microstructure of Dairy Products (pp. 1–32). John Wiley & Sons Ltd. https://doi.org/10.1002/9781118964194.ch1
Batista de Vega, G. , Ceballos, J. A. , Anzalone, A. , Digman, M. A. , & Gratton, E. (2017). A laser-scanning confocal microscopy study of carrageenan in red algae from seaweed farms near the Caribbean entrance of the Panama Canal. Journal of Applied Phycology, 29(1), 495–508. https://doi.org/10.1007/s10811-016-0914-4
Böcker, U. , Kohler, A. , Aursand, I. G. , & Ofstad, R. (2008). Effects of brine salting with regard to raw material variation of Atlantic salmon (Salmo salar) muscle investigated by Fourier transform infrared microspectroscopy. Journal of Agricultural and Food Chemistry, 56(13), 5129–5137. https://doi.org/10.1021/jf703678z
Brüggemann, D. A. , & Lawson, M. A. (2005). The extracellular matrix of Gadus morhua muscle contains types III, V, VI and IV collagens in addition to type I. Journal of Fish Biology, 66(3), 810–821. https://doi.org/10.1111/j.0022-1112.2005.00650.x
Carton, I. , Bocker, U. , Ofstad, R. , Sørheim, O. , & Kohler, A. (2009). Monitoring secondary structural changes in salted and smoked salmon muscle myofiber proteins by FT-IR microspectroscopy. Journal of Agricultural and Food Chemistry, 57(9), 3563–3570. https://doi.org/10.1021/jf803668e
El-Bakry, M. , & Sheehan, J. (2014). Analysing cheese microstructure: A review of recent developments. Journal of Food Engineering, 125(1), 84–96. https://doi.org/10.1016/j.jfoodeng.2013.10.030
Farias, D. R. , Schmidt, E. , Simioni, C. , Bouzon, Z. L. , Hurd, C. L. , Eriksen, R. S. , & Macleod, C. K. (2017a). Photosynthetic and ultrastructural responses of Ulva australis to Zn stress. Micron, 103(August), 45–52. https://doi.org/10.1016/j.micron.2017.09.010
Farias, D. R. , Simioni, C. , Poltronieri, E. , Bouzon, Z. L. , & Macleod, C. K. (2017b). Fine-tuning transmission electron microscopy methods to evaluate the cellular architecture of Ulvacean seaweeds (Chlorophyta). Micron, 96, 48–56. https://doi.org/10.1016/j.micron.2017.02.003
Feng, X. , Hang, S. , Zhou, Y. , Liu, Q. , & Yang, H. (2018). Bromelain kinetics and mechanism on myofibril from golden pomfret (Trachinotus blochii). Journal of Food Science, 83(8), 2148–2158. https://doi.org/10.1111/1750-3841.14212
Gudmundsson, M. , & Hafsteinsson, H. (2001). Effect of electric field pulses on microstructure of muscle foods and roes. Trends in Food Science and Technology, 12(3–4), 122–128. https://doi.org/10.1016/S0924-2244(01)00068-1
Håseth, T. T. , Høy, M. , Egelandsdal, B. , & Sørheim, O. (2009). Nondestructive analysis of salt, water, and protein in dried salted cod using computed tomography. Journal of Food Science, 74(3), E147–E153. https://doi.org/10.1111/j.1750-3841.2009.01102.x
Hernando, I. , Llorca, E. , & Quiles., A. (2018). Emerging Techniques for Microstructural Analysis. In M. El-Bakry , A. Sánchez , & B. M. Mehta (Eds.), Microstructure of Dairy Products (pp. 67–88). John Wiley & Sons Ltd. https://doi.org/10.1002/9781118964194
Jiang, J. , Yang, M. , Xu, C. , Shi, W. , & Lu, Y. (2021). Effects of salt concentration on texture, microstructure and quality of wet-cured grass carp muscle. Food Science, 42(8), 40–45. doi:10.7506/spkx1002-6630-20200226-298
Jiang, Q. , Nakazawa, N. , Hu, Y. , Osako, K. , & Okazaki, E. (2019). Changes in quality properties and tissue histology of lightly salted tuna meat subjected to multiple freeze-thaw cycles. Food Chemistry, 293(April), 178–186. https://doi.org/10.1016/j.foodchem.2019.04.091
Jiang, Q. , Yin, T. , Yang, F. , Yu, D. , Xu, Y. , Tie, H. , Gao, P. , Wang, B. , & Xia, W. (2020). Effect of freezing methods on quality changes of grass carp during frozen storage. Journal of Food Process Engineering, 43(11), e13539. https://doi.org/10.1111/jfpe.13539

Kolstad, K. , Mørkøre, T. , & Thomassen, M. S. (2008). Quantification of dry matter % and liquid leakage in Atlantic cod (Gadus morhua) using computerised X-ray tomography (CT). Aquaculture, 275(1–4), 209–216. https://doi.org/10.1016/j.aquaculture.2007.12.011

Lampila, L. E. (1990). Comparative microstructure of red meat, poultry and fish muscle. Journal of Muscle Foods, 1(4), 247–267. https://doi.org/10.1111/j.1745-4573.1990.tb00369.x

Li, X. X. , Sun, P. , Ma, Y. , Cai, L. , & Li, J. R. (2019). Effect of ultrasonic thawing on the water-holding capacity, physicochemical properties and structure of frozen tuna (Thunnus tonggol) myofibrillar proteins. Journal of the Science of Food and Agriculture, 99(11), 5083–5091. https://doi.org/10.1002/jsfa.9752

Liu, J. W. , Liu, Y. X. , Zheng, R. , Wu, Z. X. , Yin, F. W. , & Zhou, D. Y. (2022). Mechanism of texture deterioration of cockle (Clinocardium californiense) during chilled storage. Journal of Food Processing and Preservation, 46(2), 1–15. https://doi.org/10.1111/jfpp.16231

Liu, X. , Feng, D. , Ji, L. , Zhang, T. , Xue, Y. , & Xue, C. (2018). Effects of microwave heating on the gelation properties of heat-induced Alaska Pollock (Theragra chalcogramma) surimi. Food Science and Technology International, 24(6), 497–506. https://doi.org/10.1177/1082013218768411

Llorca, E. , Hernando, I. , Pérez-Munuera, I. , Fiszman, S. M. , & Lluch, M. A. (2001). Effect of frying on the microstructure of frozen battered squid rings. European Food Research and Technology, 213(6), 448–455. https://doi.org/10.1007/s002170100382

Llorca, E. , Hernando, I. , Pérez-Munuera, I. , Quiles, A. , Larrea, V. , & Lluch, M. A. (2007). Protein breakdown during the preparation of frozen batter-coated squid rings. European Food Research and Technology, 225(5–6), 807–813. https://doi.org/10.1007/s00217-006-0485-8

Lluch, M. A. , Pérez-Munuera, I. , & Hernando, I. (2001). Proteins in Food Structures. In Z. E. Sikorski (Ed.), Chemical and Functional Properties of food proteins (pp. 13–34). CRC Press. https://doi.org/10.1201/9781482279047-8

Nanton, D. A. , Vegusdal, A. , Rørå, A. M. B. , Ruyter, B. , Baeverfjord, G. , & Torstensen, B. E. (2007). Muscle lipid storage pattern, composition, and adipocyte distribution in different parts of Atlantic salmon (Salmo salar) fed fish oil and vegetable oil. Aquaculture, 265(1–4), 230–243. https://doi.org/10.1016/j.aquaculture.2006.03.053

Ofstad, R. , Olsen, R. L. , Taylor, R. , & Hannesson, K. O. (2006). Breakdown of intramuscular connective tissue in cod (Gadus morhua L.) and spotted wolffish (Anarhichas minor O.) related to gaping. LWT, 39(10), 1143–1154. https://doi.org/10.1016/j.lwt.2005.06.019

Ong, L. , Dagastine, R. , Kentish, S. , & Gras, S. (2013). Microstructure and composition of full fat cheddar cheese made with ultrafiltered milk retentate. Foods, 2(3), 310–331. https://doi.org/10.3390/foods2030310

Pagano, M. R. , Paredi, M. E. , & Crupkin, M. (2005). Cytoskeletal ultrastructure and lipid composition of I-Z-I fraction in muscle from pre- and post-spawned female hake (Merluccius hubbsi). Comparative Biochemistry and Physiology - B Biochemistry and Molecular Biology, 141(1), 13–21. https://doi.org/10.1016/j.cbpc.2004.11.019

Pérez-Munuera, I. , Larrea, V. , Quiles, A. , & Lluch, M. A. (2008). Handbook of Muscle Foods Analysis. In L. M. L. Nollet & F. Toldra (Eds.), Handbook of Muscle Foods Analysis. CRC Press. https://doi.org/10.1201/9781420045307

Popelka, P. , Nagy, J. , Pipová, M. , Marcinčák, S. , & Lenhardt, L. (2014). Comparison of chemical*Microbiological and histological changes in fresh*Frozen and double frozen rainbow trout (Oncorhynchus mykiss). Acta Veterinaria Brno, 83(2), 157–161. https://doi.org/10.2754/avb201483020157

Ramos-Cabrer, P. , Van Duynhoven, J. P. M. , Timmer, H. , & Nicolay, K. (2006). Monitoring of moisture redistribution in multicomponent food systems by use of magnetic resonance imaging. Journal of Agricultural and Food Chemistry, 54(3), 672–677. https://doi.org/10.1021/jf052246z

Romvári, R. , Hancz, C. , Petrási, Z. , Molnár, T. , & Horn, P. (2002). Non-invasive measurement of fillet composition of four freshwater fish species by computer tomography. Aquaculture International, 10(3), 231–240. https://doi.org/10.1023/A:1022196413528

Sathasivam, R. , Radhakrishnan, R. , Hashem, A. , & Abd-Allah, E. F. (2019). Microalgae metabolites: A rich source for food and medicine. Saudi Journal of Biological Sciences, 26(4), 709–722. https://doi.org/10.1016/j.sjbs.2017.11.003

Schmidt, C. V. , Plankensteiner, L. , Clausen, M. P. , Walhter, A. R. , Kirkensgaard, J. J. K. , Olsen, K. , & Mouritsen, O. G. (2021). Gastrophysical and chemical characterization of structural changes in cooked squid mantle. Journal of Food Science, 86(11), 4811–4827. https://doi.org/10.1111/1750-3841.15936

Segtnan, V. H. , Høy, M. , Sørheim, O. , Kohler, A. , Lundby, F. , Wold, J. P. , & Ofstad, R. (2009). Noncontact salt and fat distributional analysis in salted and smoked salmon fillets using X-ray computed tomography and NIR interactance imaging. Journal of Agricultural and Food Chemistry, 57(5), 1705–1710. https://doi.org/10.1021/jf802080s

Shackira, A. M. , Jazeel, K. , & Puthur, J. T. (2021). Phycoremediation and Phytoremediation: Promising Tools of Green Remediation. In Sustainable Environmental Clean-up: Green Remediation. Elsevier. https://doi.org/10.1016/B978-0-12-823828-8.00013-X

Sigurgisladottir, S. , Ingvarsdottir, H. , Torrissen, O. J. , Cardinal, M. , & Hafsteinsson, H. (2000). Effects of freezing/thawing on the microstructure and the texture of smoked Atlantic salmon (Salmo salar). Food Research International, 33(10), 857–865. https://doi.org/10.1016/S0963-9969(00)00105-8

Sikorski, Z. E. (1990). Seafood: Resources, Nutritional Composition, and Preservation. CRC Press.
Verboven, P. , Defraeye, T. , & Nicolai, B. (2017). Measurement and Visualization of Food Microstructure. In Food Microstructure and Its Relationship with Quality and Stability. Elsevier. https://doi.org/10.1016/B978-0-08-100764-8.00001-0
Wang, X. Y. , Xie, J. , & Qian, Y. F. (2020). A non-invasive method for quantitative monitoring of quality changes and water migration in bigeye tuna (Thunnus obesus) during simulated cold chain logistics using low-field nuclear magnetic resonance coupled with PCA. Food Science and Technology International, 26(6), 475–484. https://doi.org/10.1177/1082013220903148
Wei, H. , Tian, Y. , Yamashita, T. , Ishimura, G. , Sasaki, K. , Niu, Y. , & Yuan, C. (2020). Effects of thawing methods on the biochemical properties and microstructure of pre-rigor frozen scallop striated adductor muscle. Food Chemistry, 319(February), 126559. https://doi.org/10.1016/j.foodchem.2020.126559
Wu, H. , Xiao, S. , Yin, J. , Zhang, J. , & Richards, M. P. (2021). Impact of lipid composition and muscle microstructure on myoglobin-mediated lipid oxidation in washed cod and pig muscle. Food Chemistry, 336(March 2020), 127729. https://doi.org/10.1016/j.foodchem.2020.127729
Xia, K. , Xu, W. , Huang, L. , Song, Y. , Zhu, B. W. , & Tan, M. (2018). Water dynamics of turbot flesh during frying, boiling, and stewing processes and its relationship with color and texture properties: Low-field NMR and MRI studies. Journal of Food Processing and Preservation, 42(1), 1–12. https://doi.org/10.1111/jfpp.13338
Zhao, X. , Zhou, Y. , Zhao, L. , Chen, L. , He, Y. , & Yang, H. (2019). Vacuum impregnation of fish gelatin combined with grape seed extract inhibits protein oxidation and degradation of chilled tilapia fillets. Food Chemistry, 294(May), 316–325. https://doi.org/10.1016/j.foodchem.2019.05.054

Physical Sensors and Techniques

Afsah-Hejri, L. , Hajeb, P. , Ara, P. , Ehsan, R.J. (2019). A comprehensive review on food applications of terahertz spectroscopy and imaging. Comprehensive Reviews in Food Science and Food Safety 18, 1563–1621.
Bec, K.B. , Grabska, J. , Huck, C.W. (2020a). Review near-infrared spectroscopy in bio-applications. Molecules 25, 2948. doi:10.3390/molecules25122948.
Beć, K.B. , Grabska, J. , Huck, C.W. (2020b). Biomolecular and bioanalytical applications of infrared spectroscopy – A review. Analytica Chimica Acta 1133, 150–177.
Bechmann, I.E. , Jorgensen, B.M. (1998). Rapid assessment of quality parameters for frozen cod using near infrared spectroscopy. Food Science and Technology-Lebensmittel-Wissenschaft & Technologie 31, 648–652.
Brodersen, K. , Bremner, H.A. (2001). Exploration of the use of NIR reflectance spectroscopy to distinguish and measure attributes of conditioned and cooked shrimp (Pandalus borealis). Lebensmittel-Wissenschaft Und-Technologie-Food Science and Technology 34, 533–541.
Brown, M.R. (2011). Rapid compositional analysis of oysters using visible-near infrared reflectance spectroscopy. Aquaculture 317, 233–239.
Bureau, S. , Cozzolino, D. , Clark, C.J. (2019). Contributions of Fourier-transform mid infrared (FT-MIR) spectroscopy to the study of fruit and vegetables: A review. Postharvest Biology and Technology 148, 1–14.
Cozzolino, D. (2019). Food for thought: The digital disruption and the future of food production. Current Research in Nutrition and Food Sciences 7, 607–609.
Crocombe, R.A. (2018). Portable spectroscopy. Applied Spectroscopy 72(12), 1701–1751.
Curro, S. , Balzan, S. , Serva, L. , Boffo, L. , Ferlito, J.C. , Novelli, E. , Fasolato, L. (2021). Fast and green method to control frauds of geographical origin in traded cuttlefish using a portable infrared reflective instrument. Food 10, 1678. https://dx.doi.org/10.3390/foods10081678.
Curro, S. , Fasolato, L. , Serva, L. , Boffo, L. , Ferlito, J.C. , Novelli, E. , Balzan, S. (2022). Use of a portable near-infrared tool for rapid on-site inspection of freezing and hydrogen peroxide treatment of cuttlefish (Sepia officinalis). Food Control 132, 108524.
Druy, M.A. , O'Brien, N.A. , Crocombe, R.A. , Hulse, C.A. , Friedrich, D.M. , Van Milligen, F.J. , Von Gunten, M.K. , Pfeifer, F. , Siesler, H.W. (2012). Miniature near-infrared (NIR) spectrometer engine for handheld applications. Proceedings of SPIE - The International Society for Optical Engineering, 8374, 3. doi: 10.1117/12.917983.
Erban, A. , Fehrle, I. , Martinez-Seidel, F. , Brigante, F. , Más, A.L. , Baroni, V. , Wunderlin, D. , Kopka, J. (2019). Discovery of food identity markers by metabolomics and machine learning technology. Science Reports, 9, 9697.
Feng, Y.Z. , Sun, D.W. (2012). Application of hyperspectral imaging in food safety inspection and control: A review. Critical Reviews in Food Science and Nutrition 52, 1039–1058.
Fluckiger, M. , Brown, M.R. , Ward, L.R. , Moltschaniwskyj, N.A. (2011). Predicting glycogen concentration in the foot muscle of abalone using near infrared reflectance spectroscopy (NIRS). Food Chemistry 126(4), 1817–1820. doi:10.1016/j.foodchem.2010.12.078. Epub 2010 Dec 23. PMID: 25213962.

Goodarzi, M. , Sharma, S. , Ramon, H. , Saeys, W. (2015). Multivariate calibration of NIR spectroscopic sensors for continuous glucose monitoring. TRAC Trends in Analytical Chemistry 67, 147–158.
Grassi, S. , Casiraghi, E. , Alamprese, C. (2018). Handheld NIR device: A non-targeted approach to assess authenticity of fish fillets and patties. Food Chemistry 243, 382–388. doi:10.1016/j.foodchem.2017.09.145.
Guo, X. , Cai, R. , Wang, S. , Tang, B. , Li, Y. , Zhao, W. (2018). Non-destructive geographical traceability of sea cucumber (Apostichopus japonicus) using near infrared spectroscopy combined with chemometric methods. Royal Society Open Science 5, 170714. doi:10.1098/rsos.170714.
Lv, Y. , Xie, J. (2022). Quality of cuttlefish as affected by different thawing methods. International Journal of Food Properties 25, 33–52.
Madigan, T. , Kiermeier, A. , Carragher, J. , Lopes, M.D.B. , Cozzolino, D. (2013). The use of rapid instrumental methods to assess freshness of half shell Pacific oysters, Crassostrea gigas: A feasibility study. Innovative Food Science & Emerging Technologies 19, 204–209.
Melado-Herreros, A. , Nieto-Ortega, S. , Olabarrieta, I. , Ramilo-Fernandez, G. , Sotelo, C.G. , Teixeira, B. , Velasco, A. , Mendes, R. (2022). Comparison of three rapid non-destructive techniques coupled with a classifier to increase transparency in the seafood value chain: Bioelectrical impedance analysis (BIA), near-infrared spectroscopy (NIR) and time domain reflectometry (TDR). Journal of Food Engineering 322, 110979. doi:10.1016/j.jfoodeng.2022.110979.
Peizi, S. , Junxin, L. , Xian, R. , Biao, Z. , Jiaxin, L. , Yanfen, Z. , Dongmei, L. (2022). Effect of heating on protein denaturation, water state, microstructure, and textural properties of antarctic krill (Euphausia superba) meat. Food and Bioprocess Technology 15, 2313–2326. doi:10.1007/s11947-022-02881-6.
Power, A. , Cozzolino, D. (2020). How fishy is your fish? Authentication, provenance and traceability in fish and seafood by means of vibrational spectroscopy. Applied Sciences 10 (12), 4150, 1–13.
Qin, J. , Vasefi, F. , Hellberg, R.S. , Akhbardeh, A. , Isaacs, R.B. , Yilmaz, A.G. , Hwang, C. , Baek, I. , Schmidt, W.F. , Kim, M.S. (2020). Detection of fish fillet substitution and mislabeling using multimode hyperspectral imaging techniques. Food Control 114, 107234. doi:10.1016/j.foodcont.2020.107234.
Qu, J.H. , Liu, D. , Cheng, J.H. , Sun, D.-W. , Ma, J. , Pu, H. , Zeng, X.-A. (2015). Applications of near infrared spectroscopy in food safety evaluation and control: A review of recent research advances. Critical Reviews in Food Science and Nutrition 55, 1939–1954.
Rehman, A.U. , Qureshi, S.A. (2020). A review of the medical hyperspectral imaging systems and unmixing algorithms' in biological tissues. Photodiagnosis and Photodynamic Theraphy 33, 102165.
Rohman, A. , Windarsih, A. , Lukitaningsih, E. , Rafi, M. , Betania, K. , Fadzillah, N.A. (2019). The use of FTIR and Raman spectroscopy in combination with chemometrics for analysis of biomolecules in biomedical fluids: A review. Biomedical Spectroscopy and Imaging 8, 55–71.
Sasic, S. , Ozaki, Y. (2011). Raman, Infrared, and Near-Infrared Chemical Imaging, 1st Edition, Kindle Edition, edited by Sasic, S. , Ozaki, Y. Kindle Edition. Wiley, 320 pp.
Szymanska, E. (2018). Modern data science for analytical chemical data: A comprehensive review. Analytica Chimica Acta 1028, 1–10.
Szymańska, E. , Gerretzen, J. , Engel, J. , Geurts, B. , Blanchet, L. , Buydens, L.M. (2015). Chemometrics and qualitative analysis have a vibrant relationship. TrAC Trends in Analytical Chemistry 69, 34–51.
Talari, A.C.S. , Martinez, M.A.G. , Movasaghi, Z. , Rehman, S. , Rehman, I.U. (2017). Advances in Fourier transform infrared (FTIR) spectroscopy of biological tissues. Applied Spectroscopy Reviews 52(5), 456–506.
Truong, V.K. , Dupont, M. , Elbourne, A. , Gangadoo, S. , Rajapaksha Pathirannahalage, P. , Cheeseman, S. , Chapman, J. , Cozzolino, D. (2019). From academia to reality check: A theoretical framework on the use of chemometric. Foods 8, 1–10.
Washburn, K.E. , Stormo, S.K. , Skjelvareid, M.H. , Heia, K. (2017). Non-invasive assessment of packaged cod freeze-thaw history by hyperspectral imaging. Journal of Food Engineering 205, 64–73. doi:10.1016/j.foodres.2013.12.018.
Xu, Z. , Zhu, S. , Wang, W. , Liu, S. , Zhou, X. , Dai, W. , Ding, Y. (2022). Rapid and non-destructive freshness evaluation of squid by FTIR coupled with chemometric techniques. Journal of the Science of Food and Agriculture 102, 3000–3009.
Zhang, X. , Sun, J. , Li, P. , Zeng, F. , Wang, H. (2021). Hyperspectral detection of salted sea cucumber adulteration using different spectral preprocessing techniques and SVM method. LWT-Food Science and Technology 152, 112295. doi:10.1016/j.lwt.2021.112295.

Methods for Measuring Seafood Freshness Quality and Deterioration

Branden, L. M. and Carroll, K. K. , Dietary polyunsaturated fats in relation to mammary carcinogenesis in rats. Lipids, 21, 285–288, 1986.
Kinsella, J. E. , Food components with potential therapeutic benefits: the n-3 polyunsaturated fatty acids in fish oils. Food Technol., 40, 89–97, 146, 1986.

Conner, W. E. , Importance of n-3 fatty acids in health and disease. Am. J. Clin. Nutr., 17 (1), 171S–175S, 2000.
Romano, C. , Cucchiara, S. , Barabino, A. , Roggero, P. , Sferlazzas, C. , and Annese, V. , 22 PS omega-3 fatty acids supplementation in pediatric Crohn’s disease Italian multicentric study. Dig. Liver Dis., 34 (Supplement 1), A82, 2002.
Leaf, A. , Kang, J. X. , Xiao, Y. F. , and Billman, G. E. , Clinical prevention of sudden cardiac death by n-3 polyunsaturated fatty acids and mechanism of prevention of arrththmias by n-3 fish oils. Circulation, 107 (21), 2632–2634, 2003.
Schmidt, E. B. , Arnesen, H. , de Caterina, R. , Rasmussen, L. H. , and Kristensen, S. D. , Marine n-3 polyunsaturated fatty acids and coronary heart disease: part I. Background, epidemiology, animal data, effects on risk factors and safety. Thrombosis Res., 115 (3), 163–170, 2005.
Martinsdóttir, E. , Quality management of stored Wsh. In: H. A. Bremner (Ed.), Safety and Quality Issues in Fish Processing (pp. 360–378). England: Woodhead Publishing Limited, 2002.
Chang, K. L. B. , Chang, J. , Shiau, C. Y. , and Pan, B. S. , Biochemical, microbiological and sensory changes of sea bass (*Lateolabrax japonicus*) under partial freezing and refrigerated storage. J. Agric. Food Chem., 46, 682–686, 1998.
Kyrana, V. R. and Lougovois, V. P. , Sensory, chemical and microbiological assessment of farm-raised European sea bass (*Dicentrarchus labrax*) stored in melting ice. Inter. J. Food Sci. Tech., 37, 319–328, 2002.
Yamanaka, H. , Shiomi, K. , and Kikuchi, T. , Cadaverine as a potential index for decomposition of salmonid fishes. J. Food Hyg. Soc., 30, 170–174, 1989.
Rodríguez, C. J. , Besteiro, I. , and Pascual, C. , Biochemical changes in freshwater rainbow trout (*Oncorhynchus mykiss*) during chilled storage. J. Sci. Food Agric., 79, 1473–1480, 1999.
Ozogul, F. , Polat, A. , and Ozogul, Y. , The effects of modified atmosphere packaging and vacuum packaging on chemical, sensory and microbiological changes of sardines (*Sardina pilchardus*). Food Chem., 85, 49–57, 2004.
Ozogul, Y. , Özyurt, G. , Ozogul, F. , Kuley, E. , and Polat, A. , Freshness assessment of European eel (*Anguilla anguilla*) by sensory, chemical and microbiological methods. Food Chem., 92, 745–751, 2005.
Nawar, W. W. , Lipids. In: O. R. Fennema (Ed.), Food Chemistry (pp. 225–320). New York: Marcel Dekker, 1996.
Hamilton, R. J. , In: J. C. Allen and R. C. Hamilton (Eds.), The chemistry of rancidity in foods. Rancidity in Foods, 3rd edn. (pp. 1–22). London: Chapman and Hall, 1994.
Huss, H. H. , Quality and Quality Changes in Fresh Fish. FAO, Rome, 195pp., 1995.
Connel, J. J. , Control of Fish Quality. Fishing News (Books) Ltd, Farnham, Surrey, 245pp, Ithaca, USA: Fishing News, 1995.
Hanna, J. , Rapid microbial methods and fresh fish quality assessment. In: G. Hall (Ed.), Fish Processing Technology (pp. 275–300). Glasgow: Blackie Academic and Professional, 1992.
Connel, J. J. and Shewan, J. M. , Sensory and nonsensory assessment of fish. In: J. J. Connell (Ed.), Advances in Fish Science and Technology (pp. 56–65). Farnham: Fishing News Books, 1980.
Botta, J. R. , Evaluation of Seafood Freshness Quality. VCH Publishers Ltd., U.K., pp. 9–23, 1995.
Martinsdóttir, E. , Sveinsdóttir, K. , Luten, J. , Schelvis-Smit, R. , and Hyldig, G. , Sensory evaluation of fish freshness. Reference Manual for the Fish Sector, QIM-Eurofish, Ijmuiden, The Netherlands, 2001.
Luten, J. B. and Martinsdóttir, E. , QIM: a European tool for fish freshness evaluation in the fishery chain. In: G. Olafsdóttir , J. Luten , P. Dalgaard , M. Careche , V. Verrez-Bagnis , E. Martinsdóttir , and K. Heia (Eds.), Methods to Determine the Freshness of Fish in Research and Industry. Proceedings of the Final Meeting of the Concerted Action “Evaluation of Fish Freshness”, AIR3CT942283 (FAIR Programme of the EU) Nantes Conference, November 12–14 (pp. 287–296). Paris: International Institute of Refrigeration, 1997.
Nielsen, J. , Sensory analysis in fish. In: G. Olafsdóttir , J. Luten , P. Dalgaard , M. Careche , V. Verrez-Bagnis , E. Martinsdóttir , and K. Heia (Eds.), Methods to Determine the Freshness of Fish in Research and Industry. Proceedings of the Final Meeting of the Concerted Action “Evaluation of Fish Freshness”, AIR3CT942283 (FAIR Programme of the EU) Nantes Conference, November 12–14 (pp. 279–286). Paris: International Institute of Refrigeration, 1997.
Howgate, P. , Johnston, A. , and Whittle, A. D. J. Multilingual Guide to EC Freshness Grades for Fishery Products. Tommy Research Station, Aberdeen, 1992.
Bremner, H. A. , A convenient, easy to use system for estimating the quality of chilled seafood. Fish Processing Bull., 7, 59–70, 1985.
Branch, A. C. and Vail, A. M. A. , Bringing fish inspection into the computer age. Food Tech. Australia, 37 (8), 352–355, 1985.
Hydilg, G. and Nielsen, J. , A rapid method for quality management. In: G. Olafsdóttir , J. Luten , P. Dalgaard , M. Careche , V. Verrez-Bagnis , E. Martinsdóttir , and K. Heia (Eds.), Methods to Determine the Freshness of Fish in Research and Industry. Proceedings of the Final Meeting of the Concerted Action “Evaluation of Fish Freshness”, AIR3CT942283 (FAIR Programme of the EU) Nantes Conference, November 12–14 (pp. 297–305). Paris: International Institute of Refrigeration, 1997.
Nielsen, J. , Hansen, T. K. , Jonsdóttir, S. , and Larsen, E. P. , Development of methods for quality index of fresh fish. FAR Meeting, Noordwijkerhout, Netherlands, 1992.

Hyldig, G. , Quality index method. An objective tool for determination of sensory quality. J. Aquat. Food Prod. Tech., 13 (4), 71–80, 2004.
Huidobro, A. , Pastor, A. , and Tejada, M. , Quality index method developed for raw gilthead seabream (*Sparus aurata*). J. Food Sci., 65 (7), 1202–1205, 2000.
Sveinsdottir, K. , Hyldig, G. , Martinsdottir, E. , Jørgensen, B. , and Kristbergsson, K. , Quality index method (QIM) scheme developed for farmed Atlantic salmon (*Salmo salar*). Food Qual. Prefer., 14, 237–245, 2003.
Bonilla, A. C. , Sveinsdottir, K. , and Martinsdottir, E. , Development of quality index method (QIM) scheme for fresh cod (*Gadus morhua*) fillets and application in shelf life study. Food Control, 18, 352–358, 2007.
Barbosa, A. and Vaz-Pires, P. , Quality index method (QIM): development of a sensorial scheme for common octopus (*Octopus vulgaris*). Food Control, 15 (3), 161–168, 2004.
Nielsen, D. and Hyldig, G. , Influence of handling procedures and biological factors on the QIM evaluation of whole herring (*Clupea harengus* L.). Food Res. Int., 37 (10), 975–983, 2004.
Jónsdóttir, S. , Quality standards for herring. In: Quality Standards for Fish: Final Report Phase II (pp. 37–59). Nordic Industrial Fund (in Danish), 1992.
Shewan, J. M. , Mackintosh, R. G. , Tucker, C. G. , and Ehrenberg, A. S. C. , The development of a numerical scoring system for the sensory assessment of the spoilage of wet white fish stored in ice. J. Sci. Food Agric., 4, 283–298, 1953.
Sveinsdóttir, K. , Martinsdóttir, E. , Hyldig, G. , Jorgensen, B. , and Kristbergsson, K. , Application of quality index method (QIM) scheme in shelf life study of farmed Atlantic salmon (*Salmo salar*). J. Food Sci., 67 (4), 1570–1579, 2002.
Coppes, Z. , Pavlisko, A. , and De Vecchi, S. , Texture measurements in fish and fish products. J. Aquat. Food Prod. Technol., 11 (1), 89–105, 2002.
Aksnes, A. , Effects of proteinase inhibitors from potato on the quality of stored herring. J. Sci. Food Agric., 49, 225–234, 1989.
Toyohara, H. , Sakata, T. , Yamashita, K. , Kinoshita, M. , and Shimizu, Y. , Degradation of oval-filefish meat gel caused by myofibrillar proteinases. J. Food Sci., 55, 364–368, 1990.
Chambers, E. N. and Bowers, J. R. , Consumer perception of sensory quality in muscle foods. Food Technol., 47 (11), 116–120, 1993.
Jain, D. , Pathare, P. B. , and Manikantan, M. R. Evaluation of texture parameters of Rohu fish (*Labeo rohita*) during iced storage. J. Food Eng., 81, 336–340, 2007.
Casas, C. , Martinez, O. , Guillen, M. D. , Pin, C. , and Salmeron, J. , Textural properties of raw Atlantic salmon (*Salmo salar*) at three points along the fillets, determined by different methods. Food Control, 17, 511–515, 2006.
Veland, J. O. and Torrissen, O. J. , The texture of Atlantic salmon (*Salmo salar*) muscle as measured instrumentally using TPA and Warner-Bratzler shear test. J. Animal Sci. Food Agric., 79, 1737–1746, 1999.
Huidobro, F. R. , Miguel, E. , Blázquez, B. , and Onega, E. , A comparison between two methods (Warner-Bratzler and texture profile analysis) for testing either raw meat or cooked meat. Meat Sci., 69, 527–536, 2005.
Burt, J. R. , Gibson, D. M. , Jason, A. C. , and Sanders, H. R. , Comparison of methods of freshness assessment of wet fish. Part III. Laboratory assessments of commercial fish. J. Food Technol., 11, 117–122, 1976.
Hattula, T. , Luoma, T. , Kostiainen, R. , Jouko Poutanen, J. , Kallio, M. , and Suuronen, P. , Effects of catching method on different quality parameters of Baltic herring (*Clupea harengus* L.). Fisheries Res., 23 (3–4), 209–221, 1995.
Lupin, H. M. , Giannini, D. H. , Soule, C. L. , Davidovich, L. A. , and Boeri, R. L. , Storage life of chilled Patagonian hake (*Merluccius hubbsi*). J. Food Technol., 15 (3), 285–300, 1980.
Barassi, C. A. , Boeri, R. L. , Crupkin, M. , Davidovich, L. A. , Giannini, D. H. , Soule, C. L. , Trucco, R. E. , and Lupín, H. M. , The storage life of iced southern blue whiting (*Micromesistius australis*). J. Food Technol., 16 (2), 185–197, 1981.
Pivarnik, L. F. , Kazantzis, D. , Karakoltsidis, P. A. , Constantinides, S. , Jhaveri, S. N. , and Rand, A. G. , Freshness assessment of six New England fish species using the Torrymeter. J. Food Sci., 55 (1), 79–82, 1990.
Lougovoisa, V. P. , Kyranas, E. R. , and Kyrana, V. R. , Comparison of selected methods of assessing freshness quality and remaining storage life of iced gilthead sea bream (*Sparus aurata*). Food Res. Int., 36, 551–560, 2003.
Tajeda, M. , De Las Heras, C. , and Kent, M. , Changes in the quality indices during ice storage of farmed Senegalese sole (*Solea senegalensis*). Eur. J. Food Res. Technol., 225, 225–232, 2007.
Oehlenschläger, J. , The intellectron fischtester VI – a neglected and underestimated powerful instrument for fish freshness/spoilage determination. TAFT Trans Atlantic Fisheries Technologies Conference 10–14 June 2003, Reykjavik, Iceland, 2003.
Dalgaard, P. , Freshness, quality and safety in seafoods F-Fe 380a/00 (May 2000). This Technical Manual Was Prepared For Flaır-Flow EUROPE, 2000.
Olafsdottir, G. , Hognadottir, A. , Martindottir, E. , and Jonsdottir, R. , Application of an electronic nose to predict total volatile bases in capelin (*Mallotus villosus*). For fish meal production. J. Agric. Food Chem., 48 (6), 2353–2359, 2000.

Gelman, A. , Drabkin, V. , and Glatman, L. , A rapid non-destructive method for fish quality control by determination of smell intensity. J. Sci. Food Agric., 83 (6), 580–585, 2002.

Nilsen, H. and Esaiassen, M. , Predicting sensory score of cod (*Gadus morhua*) from visible spectroscopy. LWT Food Sci. Technol., 38 (1), 95–99, 2005.

Downey, G. , Non-invasive and non-destructive percutaneous analysis of farmed salmon flesh by near infra-red spectroscopy. Food Chem., 55 (3), 305–311, 1996.

Wold, J. P. and Isaksson, T. , Non destructive determination of fat and moisture in whole Atlantic salmon by near-infrared diffuse spectroscopy. J. Food Sci., 62, 734–736, 1997.

Nortvedt, R. , Torrissen, O. J. , and Tuene, S. , Application of near-infrared transmittance spectroscopy in the determination of fat, protein and dry matter in Atlantic halibut filet. Chemometr. Intell. Lab. Sys., 42, 199–207, 1998.

Vogt, A. , Gormley, T. R. , Gerard Downey, G. , and Somersw, J. , A comparison of selected rapid methods for fat measurement in fresh herring (*Clupea harengus*). J. Food Compost. Anal., 15, 205–215, 2002.

Khodabux, K. , L'Omelette, M. S. S. , Jhaumeer-Laulloo, S. , Ramasami, P. , and Rondeau, P. , Chemical and near-infrared determination of moisture, fat and protein in tuna fishes. Food Chem., 102, 669–675, 2007.

Zhang, H. Z. and Lee, T. C. , Rapid near-infrared spectroscopic method for the determination of free fatty acid in fish and its application in fish quality assessment. J. Agric. Food Chem., 45 (9), 3515–3521, 1997.

Cozzolino, D. , Murraya, I. , Chreeb, A. , and Scaife, J. R. , Multivariate determination of free fatty acids and moisture in fish oils by partial least-squares regression and near-infrared spectroscopy. LWT Food Sci. Technol., 38, 821–828, 2005.

Bechmann, E. and Jørgensen, B. M. , Rapid assessment of quality parameters for frozen cod using near infrared spectroscopy. LWT Food Sci. Technol., 31 (7–8), 648–652, 1998.

Pink, J. , Naczk, M. , and Pink, D. , Evaluation of the quality of frozen minced red hake: use of Fourier transform infrared spectroscopy. J. Agric. Food Chem., 46, 3667–3672, 1998.

Bøknæs, N. , Jensen, K. N. , Andersen, C. M. , and Martens, H. , Freshness assessment of thawed and chilled cod fillets packed in modified atmosphere using near-infrared spectroscopy. LWT Food Sci. Technol., 35, 628–634, 2002.

Karlsdottir, M. G. , Arason, S. , Kristinsson, H. G. , and Sveinsdottir, K. , The application of near infrared spectroscopy to study lipid characteristics and deterioration of frozen lean fish muscles. Food Chem., 159, 420–427, 2014.

Cozzolino, D. , Chree, A. , Scaife, J. R. , and Murray, I. , Usefulness of near-infrared reflectance (NIR) spectroscopy and chemometrics to discriminate fishmeal batches made with different fish species. J. Agric. Food Chem., 53 (11), 4459–4463, 2005.

Tito, N. B. , Rodemann, T. , and Powell, S. M. , Use of near infrared spectroscopy to predict microbial numbers on Atlantic salmon. Food Microbiol., 32 (2), 431–436, 2012.

Trocino, A. , Xiccato, G. , Majolini, D. , Tazzoli, M. , Bertotto, D. , Pascoli, F. , and Palazzi, R. , Assessing the quality of organic and conventionally-farmed European sea bass (*Dicentrarchus labrax*). Food Chem., 131 (2), 427–433, 2012.

Rodriguez-Casado, A. , Carmona, P. , Moreno, P. , Sánchez-González, I. , Macagnano, A. , Di Natale, C. , and Careche, M. , Structural changes in sardine (*Sardina pilchardus*) muscle during iced storage: investigation by DRIFT spectroscopy. Food Chem., 103 (3), 1024–1030, 2007.

He, Y. , Xu, W. , Qu, M. , Zhang, C. , Wang, W. , and Cheng, F. , Recent advances in the application of Raman spectroscopy for fish quality and safety analysis. Compr. Rev. Food Sci. Food Saf., 21 (4), 3647–3672, 2022.

Nian, L. , Cao, A. , Cai, L. , Ji, H. , and Liu, S. , Effect of vacuum impregnation of red sea bream (*Pagrosomus major*) with herring AFP combined with CS@ Fe3O4 nanoparticles during freeze-thaw cycles. Food Chem., 291, 139–148, 2019.

Velioğlu, H. M. , Temiz, H. T. , and Boyaci, I. H. , Differentiation of fresh and frozen-thawed fish samples using Raman spectroscopy coupled with chemometric analysis. Food Chem., 172, 283–290, 2015.

Zhong, N. , Li, Y. P. , Li, X. Z. , Guo, C. X. , and Wu, T. , Accurate prediction of salmon storage time using improved Raman spectroscopy. J. Food Eng., 293, 110378, 2021.

Li, P. , Ma, J. , and Zhong, N. , Raman spectroscopy combined with support vector regression and variable selection method for accurately predicting salmon fillets storage time. Optik, 247, 167879, 2021.

Song, S. , Liu, Z. , Huang, M. , Zhu, Q. , Qin, J. , and Kim, M. S. , Detection of fish bones in fillets by Raman hyperspectral imaging technology. J. Food Eng., 272, 109808, 2020.

Bhalla, N. , Jolly, P. , Formisano, N. , and Estrela, P. , Introduction to biosensors. Essays Biochem., 30, 1–8, 2016.

Thakur, M. S. and Ragavan, K. V. , Biosensors in food processing. J. Food Sci. Technol., 50 (4), 625–641, 2013.

Tang, X. , Liu, Y. , Hou, H. , and You, T. , A nonenzymatic sensor for xanthine based on electrospun carbon nanofibers modified electrode. Talanta, 83 (5), 1410–1414, 2011.

Apetrei, I. M. and Apetrei, C. , Amperometric biosensor based on diamine oxidase/platinum nanoparticles/graphene/chitosan modified screen-printed carbon electrode for histamine detection. Sensors, 16 (4), 422, 2016.

Chen, Z. , Lin, Y. , Ma, X. , Guo, L. , Qiu, B. , Chen, G. , and Lin, Z. , Multicolor biosensor for fish freshness assessment with the naked eye. Sens. Actuat. B Chem., 252, 201–208, 2017.

Lee, M. Y. , Wu, C. C. , Sari, M. I. , and Hsieh, Y. H. , A disposable non-enzymatic histamine sensor based on the nafion-coated copper phosphate electrodes for estimation of fish freshness. Electrochim. Acta, 283, 772–779, 2018.

Fazial, F. F. , Tan, L. L. , and Zubairi, S. I. , Bienzymatic creatine biosensor based on reflectance measurement for real-time monitoring of fish freshness. Sens. Actuat. B Chem., 269, 36–45, 2018.

Boruah, S. K. , Agarwal, B. , Baruah, S. , and Boruah, P. K. , Nanostructured biosensor to estimate the freshness of fish. ADBU J. Eng. Technol., 7, 1–5, 2018.

Ghanbari, K. and Nejabati, F. , Construction of novel nonenzymatic xanthine biosensor based on reduced graphene oxide/polypyrrole/CdO nanocomposite for fish meat freshness detection. J. Food Meas. Charact., 13 (2), 1411–1422, 2019.

Erol, E. , Yildirim, E. , and Cete, S. , Construction of biosensor for hypoxanthine determination by immobilization of xanthine oxidase and uricase in polypyrrole-paratoluenesulfonate film. J. Solid. State. Electrochem., 24 (7), 1695–1707, 2020.

Mustafa, F. , Othman, A. , and Andreescu, S. , Cerium oxide-based hypoxanthine biosensor for fish spoilage monitoring. Sens. Actuat. B Chem., 332, 129435, 2021.

Mustafa, F. and Andreescu, S. , Based enzyme biosensor for one-step detection of hypoxanthine in fresh and degraded fish. ACS Sens., 5 (12), 4092–4100, 2020.

Fazial, F. F. and Tan, L. L. , Phenylalanine-responsive fluorescent biosensor based on graphene oxide-chitosan nanocomposites catalytic film for non-destructive fish freshness grading. Food Control, 125, 107995, 2021.

Yazdanparast, S. , Benvidi, A. , Abbasi, S. , and Rezaeinasab, M. , Enzyme-based ultrasensitive electrochemical biosensor using poly (l-aspartic acid)/MWCNT bio-nanocomposite for xanthine detection: a meat freshness marker. Microchem. J., 149, 104000, 2019.

Xue, G. , Yu, W. , Yutong, L. , Qiang, Z. , Xiuying, L. , Yiwei, T. , and Jianrong, L. , Construction of a novel xanthine biosensor using zinc oxide (ZnO) and the biotemplate method for detection of fish freshness. Anal. Methods, 11 (8), 1021–1026, 2019.

Chen, J. , Lu, Y. , Yan, F. , Wu, Y. , Huang, D. , and Weng, Z. , A fluorescent biosensor based on catalytic activity of platinum nanoparticles for freshness evaluation of aquatic products. Food Chem., 310, 125922, 2020.

Sharma, N. K. , Kaushal, A. , Thakur, S. , Thakur, N. , Kumar, D. , and Bhalla, T. C. , Nanohybrid electrochemical enzyme sensor for xanthine determination in fish samples. 3 Biotech., 11 (5), 1–7, 2021.

Alexi, N. , Hvam, J. , Lund, B. W. , Nsubuga, L. , de Oliveira Hansen, R. M. , Thamsborg, K. , Lofink, F. , Byrne, D. V. , and Leisner, J. J. , Potential of novel cadaverine biosensor technology to predict shelf life of chilled yellowfin tuna (*Thunnus albacares*). Food Control, 119, 107458, 2021.

Joon, A. , Ahlawat, J. , Aggarwal, V. , Jaiwal, R. , and Pundir, C. S. , An improved amperometric determination of xanthine with xanthine oxidase nanoparticles for testing of fish meat freshness. Sens. Bio Sens. Res., 33, 100437, 2021.

Xu, X. , Wu, X. , Zhuang, S. , Zhang, Y. , Ding, Y. , and Zhou, X. , Colorimetric biosensor based on magnetic enzyme and gold nanorods for visual detection of fish freshness. Biosensors, 12 (2), 135, 2022.

Thakur, D. , Pandey, C. M. , and Kumar, D. , Highly sensitive enzymatic biosensor based on polyaniline-wrapped titanium dioxide nanohybrid for fish freshness detection. Appl. Biochem. Biotechnol., 194, 1–14, 2022.

Alimelli, A. , Pennazza, G. , Santonico, M. , Paolesse, R. , Filippini, D. , D'Amico, A. , Lundström, I. , and Di Natale, C. , Fish freshness detection by a computer screen photoassisted based gas sensor array. Anal. Chim. Acta, 582 (2), 320–328, 2007.

Schweizer-Berberich, M. , Vahinger, S. , and Göpel, W. , Characterisation of food freshness with sensor array. Sens. Actuat. B, 18 (19), 282–290, 1994.

Ólafsdóttir, G. , Martinsdóttir, E. , and Jónsson, E. H. , Rapid gas sensor measurements to predict the freshness of capelin (*Mallotus villosus*). J. Agric. Food Chem., 45, 2654–2659, 1997a.

Olafsdottir, G. , Martinsdottir, E. , Oehlenschlager, J. , Dalgaard, P. , Jensen, B. , Undeland, I. , Mackie, I. M. , Henehan, G. , Nielsen, J. , and Nilsen, H. , Methods to evaluate fish freshness in research and industry. Trends Food Sci. Technol., 8 (8), 258–266(9), 1997b.

Di Natale, C. , Brunink, J. A. J. , Bungaro, F. , Davide, F. , D'Amico, A. , Paolesse, R. , Boschi, T. , Faccio, M. , and Ferri, G. , Recognition of fish storage time by a metallophorphyrins coated QMB sensor array. Meas. Sci. Technol., 7, 1103–1114, 1996.

Takao, Y. , Nakanishi, M. , Kawaguchi, T. , Shimizu, Y. , and Egashira, M. , Semiconductor dimethylamine gas sensors with high sensitivity and selectivity. Sens. Actuat. B, 25, 380–382, 1995.

Haugen, J. E. , Chanie, E. , Westad, F. , Jonsdottir, R. , Bazzo, S. , Labreche, S. , Marcq, P. , Lundby, F. , and Olafsdottir, G. , Rapid control of smoked Atlantic salmon (*Salmo salar*) quality by electronic nose: correlation with classical evaluation methods. Sens. Actuat. B Chem., 116 (1–2), 72–77, 2006.

Berna, A. , Metal oxide sensors for electronic noses and their application to food analysis. Sensors, 10 (4), 3882–3910, 2010.

Ankara, Z. , Kammerer, T. , Gramm, A. , and Schütze, A. , Low power virtual sensor array based on a micromachined gas sensor for fast discrimination between H2, CO and relative humidity. Sens. Actuat. B

Chem., 100 (1–2), 240–245, 2004.
Yavuzer, E. , Determination of fish quality parameters with low cost electronic nose. Food Biosci., 41, 100948, 2021.
Olafsdottir, G. , Li, X. , Lauzon, H. , and Jonsdottir, R. , Precision and application of electronic nose for freshness monitoring of whole redfish (*Sebastes marinus*) stored in ice and modified atmosphere bulk storage. J. Aquat. Food Prod. Technol., 11 (3/4), 229–249, 2002.
Tryggvadottir, S. V. and Olafsdottir, G. , Multisensor for fish: questionnaire on quality attributes and control methods, texture and electronic nose to evaluate fish freshness. Project Report 04-00 FAIR CT-98-4076, 2000.
Trggvadottir, S. V. , Olafsdottir, G. , and Einarsson, S. , Multisensor for fish: storage studies of cod in Reykjavik and Tromso; texture, electronic nose, FIGD analysis, RT-freshmeter and sensory analysis. Project Report 02-01 FAIR CT-98-4076, 2001.
Di Natale, C. , Olafsdottir, G. , Einarsson, S. , Martinelli, E. , Paolesse, R. , and D'Amico, A. , Comparision and integration of different electronic noses for freshness evaluation of cod-fillets. Sens. Actuat. B, 77, 572–578, 2001.
Di Natale, C. , Salimbeni, D. , Paolesse, R. , Macagnano, A. , and D'Amico, A. , Porphyrins-based opto-electronic nose for the volatile compounds detection. Sens. Actuat. B, 65, 220–226, 2000.
Suslick, K. , Rakow, N. , and Sen, A. , Colorimetric sensors array for molecular recognition. Tetrahedron, 60, 11133–11138, 2004.
Di Natale, C. , Mignani, A. G. , Paolesse, R. , Macagnano, A. , Mencaglia, A. , and D'Amico, A. , Array of opto-chemical sensors based on fiber optic spectroscopy. IEEE Sens. J., 5, 1165–1174, 2005.
Dickinson, T. A. , White, J. , Kauer, J. S. , and Walt, D. R. , A chemical detecting system based on a cross-reactive optical sensor array. Nature, 382, 697–700, 1996.
Drew, S. M. , Janzen, D. E. , Buss, C. E. , MacEwan, D. I. , Dublin, K. M. , and Mann, K. R. , Anelectronic nose transducer array of vapoluminescent platinum (II) double salt. J. Am. Chem. Soc., 123, 8414–8415, 2001.
Di Natale, C. , Macagnano, A. , Paolesse, R. , Mantini, A. , Tarizzo, E. , D'Amico, A. , Sinesio, F. , Bucarelli, F. M. , Moneta, E. , and Quaglia, G. B. , Electronic nose and sensorial analysis: comparison of performances in selected cases. Sens. Actuat. B Chem., 50 (3), 246–252, 1998.
Cheng, J. H. , Sun, D. W. , Zeng, X. A. , and Liu, D. , Recent advances in methods and techniques for freshness quality determination and evaluation of fish and fish fillets: a review. Crit. Rev. Food Sci. Nutr., 55 (7), 1012–1225, 2015.
Hasan, N. U. , Ejaz, N. , Ejaz, W. , and Kim, H. S. , Meat and fish freshness inspection system based on odor sensing. Sensors, 12, 15542–15557, 2012.
Grassi, S. , Benedetti, S. , Opizzio, M. , di Nardo, E. , and Buratti, S. , Meat and fish freshness assessment by a portable and simplified electronic nose system (Mastersense). Sensors, 19 (14), 3225, 2019.
Grassi, S. , Benedetti, S. , Magnani, L. , Pianezzola, A. , and Buratti, S. , Seafood freshness: e-nose data for classification purposes. Food Control, 138, 108994, 2022.
Güney, S. and Atasoy, A. , Freshness classification of horse mackerels with e-nose system using hybrid binary decision tree structure. Intern. J. Pattern. Recognit. Artif. Intell., 34 (03), 2050003, 2020.
Smyth, H. and Cozzolino, D. , Instrumental methods (spectroscopy, electronic nose, and tongue) as tools to predict taste and aroma in beverages: advantages and limitations. Chem. Rev., 113 (3), 1429–1440, 2013.
Tahara, Y. and Toko, K. , Electronic tongues-a review. IEEE Sens. J., 13 (8), 3001–3011, 2013.
Mimendia, A. , Gutiérrez, J. M. , Leija, L. , Hernández, P. R. , Favari, L. , Muñoz, R. , and del Valle, M., A review of the use of the potentiometric electronic tongue in the monitoring of environmental systems. Environ. Model. Softw., 25 (9), 1023–1030, 2010.
Gong, J. , Shen, H. , Zheng, J. Y. , Tao, N. P. , Gu, S. Q. , Huang, Y. , and Wang, M. , Identification of key umami-related compounds in Yangtze Coilia ectenes by combining electronic tongue analysis with sensory evaluation. RSC Adv., 6 (51), 45689–45695, 2016.
Mabuchi, R. , Ishimaru, A. , Tanaka, M. , Kawaguchi, O. , and Tanimoto, S. , Metabolic profiling of fish meat by GC-MS analysis, and correlations with taste attributes obtained using an electronic tongue. Metabolites, 9 (1), 1, 2018.
Shi, C. , Yang, X. , Han, S. , Fan, B. , Zhao, Z. , Wu, X. , and Qian, J. , Nondestructive prediction of tilapia fillet freshness during storage at different temperatures by integrating an electronic nose and tongue with radial basis function neural networks. Food Bioproc. Tech., 11 (10), 1840–1852, 2018.
Hu, Z. , Tong, Y. , Manyande, A. , and Du, H. , Effective discrimination of flavours and tastes of Chinese traditional fish soups made from different regions of the silver carp using an electronic nose and electronic tongue. Czech J. Food Sci., 38 (2), 84–93, 2020.
Kennish, J. M. and Kramer, E. , Review of high-pressure lipid chromatographic methods for measuring nucleotide degradation in fish muscle. In: D. F. Kramer and J. Liston (Eds.), Seafood Quality Determination (209pp.). New York: Elsevier Sci. Publishers, 1987.
Howgate, P. , Kinetics of degradation of adenosine triphosphate in chill-stored rainbow trout (*Oncorhynchus mykiss*). Inter. J. Food Sci. Technol., 40, 579–588, 2005.
Greene, D. H. , Babbitt, J. K. , and Reond, K. D. , Patterns of nucleotide catabolism as freshness indicators in flatfish from the Gulf of Alaska. J. Food Sci., 55 (5), 1236–1238, 1990.

Surette, M. , Gill, T. A. , and LeBlanc, P. J. , Biochemical basis of postmortem nucleotide catabolism in cod (*Gadus morhua*) and its relationship to spoilage. J. Agric. Food Chem., 36, 19–22, 1988.

Agustini, T. W. , Suzuki, T. , Hagiwara, T. , Ishizaki, S. , Tanaka, M. , and Takai, R. , Change of K value and water state of yellowfin tuna Thunnus albacares meat stored in a wide temperature range (20 to 84°C). Fish. Sci., 67, 306–313, 2001.

Kyrana, V. R. and Lougovois, V. P. , Sensory, chemical and microbiological assessment of farm-raised European sea bass (*Dicentrarchus labrax*) stored in melting ice. Inter. J. Food Sci. Technol., 37, 319–328, 2002.

Ozogul, Y. , Ozogul, F. , Kuley, E. , Ozkutuk, A. S. , Gokbulut, C. , and Kose, S. , Biochemical, sensory and microbiological attributes of wild turbot (*Scophthalmus maximus*), from the Black Sea, during chilled storage. Food Chem., 99, 752–758, 2006.

Kuda, T. , Fujita, M. , Goto, H. , and Yano, T. , Effects of freshness on ATP-related compounds in retorted chub mackerel, Scomber japonicas. LWT Food Sci. Tech., 40, 1186–1190, 2007.

Saito, T. , Arai, K. , and Matsuyoshi, M. , A new method for estimating the freshness of fish. Bull. Jpn. Soc. Sci. Fish., 24, 749–750, 1959.

Murata, M. and Sakaguchi, M. , Storage of yellowtail (*Seriola quinqueradiata*) white and dark muscle in ice: changes in content of adenine nucleotides and related compounds. J. Food Sci., 51, 321–326, 1986.

Ryder, J. M. , Buisson, D. H. , Scott, D. N. , and Fletcher, G. C. , Storage of New Zealand Jack mackerel (*Trachurus novaezelandiae*) in ice: chemical, microbiological and sensory assessment. J. Food Sci., 49, 1453–1456, 1477, 1984.

Jones, N. R. , Hypoxanthine and other purine-containing fractions in fish muscle as indices of freshness. In: R. Kreuzer (Ed.), The Technology of Fish Utilization (pp. 179–183). London: Fishing News Books Ltd., 1965.

Karube, I. , Matsuoka, H. , Suzuki, S. , Watanabe, E. , and Toyama, T. , Determination of fish freshness with an enzyme sensor system. J. Agric. Food Chem., 32, 314–319, 1984.

Greene, D. H. , and Bernatt-Byrne, E. I. , Adenosine triphosphate catabolites as flavor compounds and freshness indicators in Pacific cod (*Gadus macrocephalus*) and Pollock (*Theragra chalcogamma*). J. Food Sci., 55, 257–258, 1990.

Luong, J. H. T. , Male, K. B. , and Huynh, M. D. , Applications of polarography for assessment of fish freshness. J. Food Sci., 56, 335–340, 1991.

Burns, G. B. , Kee, P. J. , and Irvine, B. B. , Objective procedure for fish freshness evaluation based on nucleotide changes using a HPLC system. Can. Tech. Rep. Fish. Aqua. Sci., 1373, 35, 1985.

Luong, J. H. T. , Male, K. B. , Masson, C. , and Nguyen, A. L. , Hypoxanthine ratio determination in fish extract using capillary electrophoresis and immobilized enzymes. J. Food Sci., 57, 77–81, 1992.

Gill, T. A. , Thompson, J. W. , Gould, S. , and Sherwood, D. , Characterization of quality deterioration of yellow fin tuna. J. Food Sci., 52, 580–583, 1987.

Shahidi, F. , Chong, X. , and Dunajski, E. , Freshness quality of harp seal (*Phoca groenlandica*) meat. J. Agric. Food Chem., 42, 868–872, 1994.

Alasalvar, C. , Taylor, K. D. A. , and Shahidi, F. , Comparative quality assessment of cultured and wild sea bream (*Sparus aurata*) stored in ice. J. Agric. Food Chem., 50, 2039–2045, 2002.

Luong, J. H. T. and Male, K. B. , Development of a new biosensor system for the determination of the hypoxanthine ratio, an indicator of fish freshness. Enzyme Micro. Tech., 14, 125–130, 1992.

Erikson, U. , Beyer, A. R. , and Sigholt, T. , Muscle high-energy phosphate and stress affect K-values during ice storage of Atlantic salmon (*Salmo salar*). J. Food Sci., 62, 43–47, 1997.

Pagliarussi, R. S. , Freitas, L. A. , and Bastos, J. K. , A quantitative method for the analysis of xanthine alkaloids in *Paullinia cupana* (guarana) by capillary column gas chromatography. J. Sep. Sci., 25 (5–6), 371–374, 2002.

Clariana, M. , Gratacós-Cubarsí, M. , Hortós, M. , García-Regueiro, J. A. , and Castellari, M. , Analysis of seven purines and pyrimidines in pork meat products by ultra high performance liquid chromatography-tandem mass spectrometry. J. Chromatogr. A, 1217 (26), 4294–4299, 2010.

Chen, G. , Chu, Q. , Zhang, L. , and Ye, J. , Separation of six purine bases by capillary electrophoresis with electrochemical detection. Anal. Chim. Acta, 457 (2), 225–233, 2002.

Caussé, E. , Pradelles, A. , Dirat, B. , NegreSalvayre, A. , Salvayre, R. , and Couderc, F. , Simultaneous determination of allantoin, hypoxanthine, xanthine, and uric acid in serum/plasma by CE. Electrophoresis, 28 (3), 381–387, 2007.

Olojo, R. O. , Xia, R. H. , and Abramson, J. J. , Spectrophotometric and fluorometric assay of superoxide ion using 4-chloro-7-nitrobenzo-2-oxa-1,3-diazole. Anal. Biochem., 339 (2), 338–344, 2005.

Agyekum, A. A. , Kutsanedzie, F. Y. , Annavaram, V. , Mintah, B. K. , Asare, E. K. , and Wang, B. , FT-NIR coupled chemometric methods rapid prediction of K-value in fish. Vib. Spectrosc., 108, 103044, 2020.

Mietz, J. L. and Karmas, E. , Polyamine and histamine content of rockfish, salmon, lobster and shrimp as an indicator of decomposition. J. Assoc. Off. Anal. Chem., 61 (1), 139–145, 1978.

Yamanaka, H. , Shiomi, K. , and Kikuchi, T. , Cadaverine as a potential index for decomposition of salmonid fishes. J. Food Hyg. Soc., 30, 170–174, 1989.

Rodríguez, C. J. , Besteiro, I. , and Pascual, C. , Biochemical changes in freshwater rainbow trout (*Oncorhynchus mykiss*) during chilled storage. J. Sci. Food Agric., 79, 1473–1480, 1999.
Özogul, F. , Taylor, K. D. A. , Quantick, P. , and Özogul, Y. , Biogenic amines formation in Atlantic herring (Clupea harengus) stored under modified atmosphere packaging using a rapid HPLC method. Inter. J. Food Sci. Technol., 37, 515–522, 2002.
Da Silva, M. V. , Pinho, O. , Ferreira, I. , Plestilová, L. , and Gibbs, P. A. , Production of histamine and tyramine by bacteria isolated from Portuguese vacuum-packed cold-smoked fish. Food Control, 13, 457–461, 2002.
Özogul, F. and Özogul, Y. , Biogenic amine content and biogenic amine quality indices of sardines (*Sardina pilchardus*) stored in modified atmosphere packaging and vacuumpackaging. Food Chem., 99 (3), 574–578, 2006.
Rawles, D. D. and Flick, G. J. , Biogenic amines in fish and shellfish. Adv. Food Nutrit. Res., 39, 329–365, 1996.
Mackie, I. M. , Pirie, L. , Ritchie, A. H. , and Yamanaka, H. , The formation of non-volatile amines in relation to concentrations of free basic amino acids during postmortem storage of the muscle of scallop (*Pecten maximus*), herring (*Clupea harengus*) and mackerel (*Scomber scombrus*). Food Chem., 60 (3), 291–295, 1997.
Gill, T. A. , Objective analysis of seafood quality. Food Rev. Inter., 6 (4), 681, 1990.
Morrow, J. D. , Margolis, G. R. , Rowland, J. , and Roberts, L. J. , Evidence that histamine the causative toxin of scombroid fish poisoning. N. Eng. J. Med., 324, 716–720, 1991.
Taylor, S. L. , Histamine poisoning associated with fish, cheese and other foods. Monograph, World Health Organization. VPH/FOS/85.1. Geneva, 1985.
Bodmer, S. , Imark, C. , and Kneubühl, M. , Biogenic amines in food. Histamine and food processing. Inflamm. Res., 48, 296–300, 1999.
FDA., Decomposition and histamine in raw, frozen tuna and mahi-mahi, canned tuna and related species. Compliance Policy Guides, 7108.240, sec. 540.525 , 1996.
EEC., Laying down the health conditions for the production and the placing on the market of fishery products. Council Directive (EEC) 91/493/EEC, 1991, July.
Moret, S. and Conte, L. S. , High-performance liquid chromatographic evaluation of biogenic amines in foods. An analysis of different methods of sample preparation in relation to food characteristics. J. Chromatogr. A, 729, 363–369, 1996.
Mietz, J. L. and Karmas, E. , Chemical quality index of canned tuna as determined by high-pressure liquid chromatography. J. Food Sci., 42, 155–158, 1977.
Veciana-Nogues, M. T. , Marine-Font, A. , and Vidal-Carou, M. C. , Biogenic amines in fresh and canned tuna. Effects of canning on biogenic amine contents. J. Agric. Food Chem., 45, 4324–4328, 1997.
Spinelli, A. M. , Lakritz, L. , and Wasserman, A. E. , Effects of processing on the amine content of pork bellies. J. Agric. Food Chem., 22, 1026–1029, 1974.
Shalaby, A. R. , Multidetection, semiquantitative method for determining biogenic amines in foods. Food Chem., 52, 367–372, 1995.
Yamanaka, H. , Shimakura, K. , Shiomi, K. , Kikuchi, T. , Iida, H. , and Nakamara, K. , Concentrations of polyamines in fresh water fishes. Nihon Suisan Gakkaishi, 53, 2041–2044, 1987.
Hwang, D.-F. , Chang, S.-H. , Shiua, C.-Y. , and Chai, T.-J. , High-pressure liquid chromatographic determination of biogenic amines in fish implicated in food poisoning. J. Chromatogr. B, 693, 23–30 1997.
Taylor, S. L. and Sumner, S. S. , Determination of histamine, putrescine and cadaverine. In: D. E. Kramer and J. Liston (Eds.), Seafood Quality Determination. Proceeding of an International Symposium (pp. 235–245). Amsterdam: Elsevier Science Publisher, B. V., 1986.
Feier, U. and Goetsch, P. H. , Inter-laboratory studies on precision characteristics of analytical methods. Determination of biogenic amines in fish and fish products-HPLC method. Archiv Fur Lebensmittelhygiene, 44 (6), 134–135, 1993.
Wang, Y. , Enriquez-Ibarra, L. G. , Bonilla, M. , McNair, H. H. , and Flick, G. J. , Analysis of Biogenic Amines in Finfish. A Progress Report. Virginia Tech, Blacksburg, VA, 1994.
Arce, L. , Rios, A. , and Valcarcel, M. , Selective and rapid determination of biogenic amines by capillary zone electrophoresis. Chromatographia, 46, (3/4). 170–176, 1997.
Mascini, M. , Biosensor for food freshness. Life Chem. Rep., 11, 289–301, 1994.
Ohashi, M. , Nomura, F. , Suzuki, M. , Otsuka, M. , Adachi, O. , and Arakawa, N. , Oxygensensor-based simple assay of histamine in fish using purified amine oxidase. J. Food Sci., 59, 519–522, 1994.
Poli, B. M. , Zampacavallo, G. , Parisi, G. , Poli, A. , and Macsini, M. , Biosensors applied to biochemical fish quality indicators in refrigerated and frozen sea bass reared ın aerated or hyperoxic conditions. Aquac. Int., 8, 335–348, 2000.
Greaser, M. L. and Pearson, A. M. , Flesh foods and their analogues. In: A. J. Rosenthal (Ed.), Food Texture Measurement and Perception (pp. 236–246). Gaithersburg, Maryland: Aspen Publication, 1999.
Haard, N. , The role of enzymes in determining seafood color, flavor and texture. In: H. A. Bremner (Ed.), Safety and Quality Issues in Fish Processing (pp. 221–254). England: Woodhead Publishing Limited, 2002.
Simeonidou, S. , Govaris, A. , and Vareltzis, K. , Quality assessment of seven Mediterranean fish species during storage on ice. Food Res. Int., 30 (7), 479–484, 1998.

Azam, K. , Mackie, I. M. , and Smith, J. , The effect of slaughter method on the quality of rainbow trout (Salmo gairdneri) during storage on ice. Inter. J. Food Sci. Technol., 24, 69–79, 1989.
Marx, H. , Brunner, B. , Weinzierl, W. , Hofmann, R. , and Stolle, A. , Methods of stunning freshwater fish: impact on meat quality and aspects of animal welfare. Zeitschrift fur Lebensmittel-Untersuchung Und-Forschung, 204A, 282–286, 1997.
Van de Vis, J. V. , Oehlenschläger, J. , Kuhlmann, H. , Münkner, W. , Robb, D. H. F. , and Schelvis-Smit, A. A. M. , Effect of commercial and experimental slaughter of eels (Anguilla anguilla L.) on quality and welfare. In: S. C. Kestin and P. D. Warriss (Eds.), Farmed Fish Quality (pp. 234–248). Oxford: Fishing News Book, 2001.
Morzel, M. and Van de Vis, H. , Effect of the slaughter method on the quality of raw and smoked eels (*Anguilla anguilla* L.). Aquac. Res., 34, 1–11, 2003.
Rehbein, H. and Oehlenschlager, J. , Zur zusammensetzung der TVB-N fraktion in sauren extrakten und alkalischen destillaten von seefishfillet. Archiv Fur Lebensmittelhygiene, 33, 44–48, 1982.
Huss, H. H. , Fresh Fish: Quality and Quality Changes. Food and Agriculture Organization (FAO) of the United Nations, Rome, p. 132, 1988.
Perez-Villarreal, B. and Howgate, P. , Composition of European hake, Merluccius. J. Sci. Food Agric., 40, 347–356, 1987.
Botta, J. R. , Lauder, J. T. , and Jewer, M. A. , Effect of methodology on total volatile basic nitrogen (TVB-N) determination as an index of quality of fresh Atlantic cod (Gadus morhua). J. Food Sci., 49, 734–736, 750, 1984.
Ababouch, L. H. , Souibri, L. , Rhaliby, K. , Ouadhi, O. , Battal, M. , and Busta, F. F. , Quality changes in sardines (Sardina pilchardus) stored in ice and at ambient temperatures. Food Micro., 13, 123–132, 1996.
Özoğul, Y. , Özogul, F. , Özkütük, A. S. , and Küley, E. , Hydrolysis and oxidation of European eel oil during frozen storage for 48 weeks. Eur. Food Res. Technol., 224, 33–37, 2006.
Özyurt, G. , Özogul, Y. , Özyurt, C. E. , Polat, A. , Özogul, F. , Gökbulut, G. , Ersoy, B. , and Küley, E. , Determination of the quality parameters of pike perch Sander lucioperca caught by gillnet, longline and harpoon in Turkey. Fish. Sci., 73, 412–420, 2007.
Tejada, M. and Huidobro, A. , Quality of farmed gilthead sea bream (Sparus aurata) during ice storage related to the slaughter method and gutting. Eur. Food Res. Technol., 215, 1–7, 2002.
Baixas-Nogueras, S. , Bover-Cid, S. , Veciana-Nogués, M. , and Vidal-Carou, M. , Chemical and sensory changes in Mediterranean hake (*Merluccius merluccius*) under refrigeration (6–8°C) and stored in ice. J. Agric. Food Chem., 50, 6504–6510, 2002.
Vyncke, W. , Comparison of the official EC method for the determination of total volatile bases in fish with routine methods. Archiv für Lebensmittelhygiene, 47, 110–112, 1996.
Huang, X. , Xin, J. , and Zhao, J. , A novel technique for rapid evaluation of fish freshness using colorimetric sensor array. J. Food Eng., 105 (4), 632–637, 2011.
Wells, N. , Yusufu, D. , and Mills, A. , Colourimetric plastic film indicator for the detection of the volatile basic nitrogen compounds associated with fish spoilage. Talanta, 194, 830–836, 2019.
Liu, X. , Chen, K. , Wang, J. , Wang, Y. , Tang, Y. , Gao, X. , Zhu, L. , Li, X. , and Li, J. , An on-package colorimetric sensing label based on a sol-gel matrix for fish freshness monitoring. Food Chem., 307, 125580, 2020.
Guo, L. , Wang, T. , Wu, Z. , Wang, J. , Wang, M. , Cui, Z. , Ji, S. , Cai, J. , Xu, C. , and Chen, X. , Portable foodfreshness prediction platform based on colorimetric barcode combinatorics and deep convolutional neural networks. Adv. Mater., 32 (45), 2004805, 2020.
Cheng, J. H. , Sun, D. W. , Zeng, X. A. , and Liu, D. , Recent advances in methods and techniques for freshness quality determination and evaluation of fish and fish fillets: a review. Crit. Rev. Food Sci. Nutr., 55 (7), 1012–1225, 2015.
Zhou, J. , Wu, X. , Chen, Z. , You, J. , and Xiong, S. , Evaluation of freshness in freshwater fish based on near infrared reflectance spectroscopy and chemometrics. LWT Food Sci. Technol., 106, 145–150, 2019.
ElMasry, G. , Nagai, H. , Moria, K. , Nakazawa, N. , Tsuta, M. , Sugiyama, J. , Okazaki, E. , and Nakauchi, S. , Freshness estimation of intact frozen fish using fluorescence spectroscopy and chemometrics of excitation-emission matrix. Talanta, 143, 145–156, 2015.
Bhadra, S. , Narvaez, C. , Thomson, D. J. , and Bridges, G. E. , Non-destructive detection of fish spoilage using a wireless basic volatile sensor. Talanta, 134, 718–723, 2015.
Chang, L. Y. , Chuang, M. Y. , Zan, H. W. , Meng, H. F. , Lu, C. J. , Yeh, P. H. , and Chen, J. N. , One-minute fish freshness evaluation by testing the volatile amine gas with an ultrasensitive porous-electrode-capped organic gas sensor system. ACS Sens., 2 (4), 531–539, 2017.
Lv, R. , Huang, X. , Aheto, J. H. , Mu, L. , and Tian, X. , Analysis of fish spoilage by gas chromatography-mass spectrometry and electronic olfaction bionic system. J. Food Safe., 38 (6), e12557, 2018.
Simeonidou, S. , Govaris, A. , and Vareltzis, K. , Effect of frozen storage on the quality of whole fish and fillets of horse mackerel (*Trachurus trachurus*) and mediterranean hake (*Merluccius mediterraneus*). Z. Lebensm. Unters. Forsch. A, 204, 405–410, 1997.
Nielsen, M. K. , Havemeister, W. , Rehbein, H. , Sotelo, C. G. , and Jørgensen, B. M. , A sensitive trimethylamine-N-oxide aldolase assay in two steps without deproteinisation. J. Sci. Food Agric., 80, 197, 2000.

Hebard, C. E. , Flick, G. J. , and Martin, R. E. , Occurrence and significance of trimethylamine oxide and its derivatives in fish and shellfish. In: R. E. Martin , G. J. Flick , C. E. Hebard , and D. R. Ward (Eds.), Chemistry and Biochemistry of Marine Food Products (pp. 149–304). Westport, CO: AVI, 1982.

Lindsay, R. C. , Flavour of fish. In: F. Shahidi and J. R. Botta (Eds.), Seafoods Chemistry, Processing Technology and Quality (pp. 75–82). G. Britain: Chapman and Hall, London, 1994.

Bonnell, A. D. , Quality Assurance in Seafood Processing: A Practical Guide. Chapman and Hall, London, pp. 74–75, 1994.

Gill, T. A. and Paulson, A. T. , Localization, characterization and partial purification of TMAO-ase. Comp. Biochem. Physiol., 71B, 49–56, 1982.

Joly, A. , Cottin, P. , Hanching, L. , and Ducastaing, A. , Trimethlyamine N-oxide demethylase (TMAO-ase) of saithe (Pollachius-virens) kidney-a study of some physicochemical and enzymatic properties. J. Sci. Food Agric., 59, 261–267, 1992.

Malle, P. and Tao, S. , Rapid quantitative determination of trimethylamine using steam distillation. J. Food Protec., 50, 756–760, 1987.

Conway, E.J. , Microdiffusion Analysis and Volumetric Error. Crosby Lockwood and Sons, London, 1947.

AOAC ., Official Method 971.14. Trimethylamine Nitrogen in Seafood. AOAC Official Methods of Analysis, Arlington, VA, p. 7, 1995.

Zhi, Z. L. , Rios, A. , and Valcarcel, M. , Direct determination of trimethylamine in fish in the flow-reversal injection mode using a gas extraction sampling device. Anal. Chem., 67, 871–877, 1995.

Malle, P. and Valle, M. , Assay of biogenic amines involved in fish decomposition. J. Assoc. Off. Anal. Chem., 79, 43–49, 1996.

Ann daCosta, K. , Vrbanac, J. J. , and Zeisel, S. H. , The measurement of dimethylamine, trimethylamine, and trimethylamine N-oxide using capillary gas chromatography-mass spectrometry. Anal. Biochem., 187 (2), 234–239, 1990.

Veciana-Nogues, M. T. , Albala-Hurtado, M. S. , Izquierdo-Pulido, M. , and Vida-Carou, M. C. , Validation of a gas-chromatographic method for volatile amine determination in fish samples. Food Chem., 57, 569–573, 1996.

Timm, M. and Jørgensen, B. M. , Simultaneous determination of ammonia, dimethylamine, trimethylamine and trimethylamine-imageoxide in fish extracts by capillary electrophoresis with indirect UVdetection. Food Chem., 76, 509–518, 2002.

Hammond, J. , Marquis, B. , Micheals, R. , Oickle, B. , Segee, B. , and Vetelino, J. , A semiconducting metal-oxide array for monitoring fish freshness. Sens. Actuat. B, 84, 113–122, 2002.

Dhaouadi, A. , Monser, L. , Sadok, S. , and Adhoum, N. , Validation of a flow-injection-gas diffusion method for total volatile basic nitrogen determination in seafood products. Food Chem., 103 (3), 1049–1053, 2007.

Mitsubayashi, K. , Kubotera, Y. , Yano, K. , Hashimoto, Y. , Kon, T. , and Nakakura, S. , Trimethylamine biosensor with flavin-containing monooxygenase type 3 (FMO3) for fish-freshness analysis. Sens. Actuat. B, 103, 463–467, 2004.

Pacquit, A. , Lau, K. T. , McLaughlin, H. , Frisby, J. , Quilty, B. , and Diamonda, D. , Development of a volatile amine sensor for the monitoring of fish spoilage. Talanta, 69, 515–520, 2006.

Veyrat-Durebex, C. , Benz-de-Bretagne, I. , Clavier, V. , Bruno, C. , Andres, C. R. , Antar, C. , Hennart, B. , Maillot, F. , Nadal-Desbarats, L. , and Blasco, H. , Quality consideration for the validation of urine TMA and TMAO measurement by nuclear magnetic resonance spectroscopy in fish odor syndrome. Anal. Biochem., 630, 114330, 2021.

Chang, L. Y. , Chuang, M. Y. , Zan, H. W. , Meng, H. F. , Lu, C. J. , Yeh, P. H. , and Chen, J. N. , One-minute fish freshness evaluation by testing the volatile amine gas with an ultrasensitive porous-electrode-capped organic gas sensor system. ACS Sens., 2 (4), 531–539, 2017.

Rey-Mansilla, M. , Del, M. , Sotelo, C. G. , Aubourg, S. P. , Rehbein, H. , Havemeister, W. , Jørgensen, B. , and Nielsen, M. K. , Localization of formaldehyde production during frozen storage of European hake (*Merluccius merluccius*). Eur. Food. Res. Technol., 213, 43–47, 2001.

Nielsen, M. K. and Jørgensen, B. M. , Quantitative relationship between trimethylamine oxide aldolase activity and formaldehyde accumulation in white muscle gadiform fish during frozen storage. J. Agric. Food. Chem., 52, 3814–3822, 2004.

Sikorski, Z. E. and Kolakowska, A. , Changes in protein in frozen stored fish. In: Z. E. Sikorski , B. S. Pan , and F. Shahidi (Eds.), Seafood Proteins (pp. 99–112). New York: Chapman and Hall, 1994.

Murtini, J. T. , Riyanto, R. , Priyanto, N. , and Hermana, I. , Pembentukan formaldehid alami pada beberapa jenis ikan laut selama penyimpanan dalam es curai. Jurnal Pascapanen dan Bioteknologi Kelautan dan Perikanan, 9 (2), 143–151, 2014.

Putri, A. K. , Anissah, U. , Ariyani, F. , and Wibowo, S. , Probabilistic health risk assessment due to natural formaldehyde ıntake through opah fish (*Lampris guttatus*) consumption in Indonesia. Squalen Bull. Mar. Fish. Postharvest Biotechnol., 13(2), 69–78, 2018.

Hsieh, R. and Kinsella, J. , Oxidation of polyunsaturated fatty acids: mechanisms, products, and inhibition with emphasis on fish. Adv. Food Res. Nutr. Res., 33, 233–341, 1989.

Mackie, I. M. , The effects of freezing on flesh proteins. Food Rev. Int., 9, 575–610, 1993.

Castrillón, A. , Álvarez-Pontes, E. , García, M. T. , and Navarro, P. , Influence of frozen storage and defrosting on the chemical and nutritional quality of sardine (*Clupea pilchardus*). J. Sci. Food Agric., 70, 29–34, 1996.

Undeland, I. and Lingnert, H. , Lipid oxidation in fillets of herring (Clupea harengus) during frozen storage. Influence of prefreezing storage. J. Agric. Food Chem., 47, 2075–2081, 1999.

Saeed, S. and Howell, N. K. , Effect of lipid oxidation and frozen storage on muscle proteins of Atlantic mackerel (*Scomber scombrus*). J. Sci. Food Agric., 82, 579–586, 2002.

Chan, H. W. S. , The mechanism of autoxidation. In: H. W. S. Chan (Ed.), Autoxidation of Unsaturated Lipids. Food Science and Technology. Series of Monographs (pp. 1–16). London, UK: Academic Press, 1987.

Borquez, R. , Kolle, W. D. , Wolf, W. , and Spie, W. E. L. , A rapid method to determine the oxidation kinetics of n-3 fatty acids in fish oil. Food Sci. Technol., 30, 502–507, 1997.

Chantachum, S. , Benjakul, S. , and Sriwirat, N. , Separation and quality of fish oil from pre-cooked and non pre-cooked tuna heads. Food Chem., 69, 289–294, 2000.

Deman, J. M. , Principles of Food Chemistry, 2nd edn. An AVI book, Gaithersburg, USA, pp. 38–80. 1990.

Hamilton, R. J. , Kalu, C. , Prisk, E. , Padley, F. B. , and Pierce, H. , Chemistry of free radicals in lipids. Food Chem., 60 (2), 193–199, 1997.

Tucker, B. W. , Overview of current seafood nutritional issues: formation of potentially toxic products. In: F. Shahidi , Y. Jones , and D. D. Kitts (Eds.), Seafood Safety, Processing and Biotechnology (pp. 5–10). Lancaster, USA: Technomic Publishing Company, 1997.

Melton, S. , Methodology for following lipid oxidation in muscle foods. Food Technol., 37 (7), 111–116, 1983.

Aubourg, S. P. , Piñeiro, C. , and González, M. J. , Quality loss related to rancidity development during frozen storage of horse mackerel (*Trachurus trachurus*). JAOCS, 81 (7), 671–678, 2004.

Kim, R. and Labella, F. , Comparison of analytical methods for monitoring autoxidation profiles of authentic lipids. J. Lipid Res. 28, 1110–1117, 1987.

Leake, L. and Karel, M. , Nature of fluorescent compounds generated by exposure of protein to oxidizing lipids. J. Food Biochem., 9, 117–136, 1985.

Aubourg, S. P. , Sotelo, C. G. , and Pérez-Martín, R. , Assessment of quality changes in frozen sardine (*Sardina pilchardus*) by fluorescence detection. JAOCS, 75 (5), 575–580, 1998.

Cozzolino, D. , Murraya, I. , Chreeb, A. , and Scaife, J. R. , Multivariate determination of free fatty acids and moisture in fish oils by partial least-squares regression and near-infrared spectroscopy. LWT Food Sci. Technol., 38, 821–828, 2005.

Ma, K. , Van de Voort, F. R. , Sedman, J. , and Ismail, A. A. , Stoichiometric determination of hydroperoxides in fats and oils by Fourier transform ınfrared spectroscopy. J. Am. Oil Chem. Soc., 74, 897–906, 1997.

Guillèn, M. D. and Cabo, N. , Usefulness of thefrequency data of the Fourier transform ınfrared spectra to evaluate the degree of oxidation of edible oils. J. Agric. Food Chem., 47, 709–719, 1999.

Sugino, K. , Simultaneous determination of different classes of lipid hydroperoxides by high-performance liquid chromatography with post-column detection by a ferrous/xylenol orange reagent. Biosci. Biotechnol. Biochem., 63, 773–775, 1999.

Christensen, T. C. and Hoelmer, G. , Lipid oxidation determination in butter and dairy spreads by HPLC. J. Food Sci., 61, 486–489, 1996.

Nourooz-Zadeh, J. , Tajaddini-Sarmadi, J. , and Wolff, S. P. , Measurement of hydroperoxides in edible oils using the ferrous oxidation in xylenol orange assay. J. Agric. Food Chem., 43, 17–21, 1995.

Grau, A. , Codony, R. , Rafecas, M. , Barroeta, A. C. , and Guardiola, F. , Lipid hydroperoxide determination in dark chicken meat through a ferrous oxidation-xylenol orange method. J. Agric. Food Chem., 48, 4136–4143, 2000.

Yıldız, G. , Wehling, R. L. , and Cuppett, S. L. , Comparison of four analytical methods for the determination of peroxide value in oxidized soybean oils, oxidized soybean oils. J. Am. Oil Chem. Soc., 80, 103–107, 2006.

Tarladgis, B. G. , Watts, B. M. , Younathan, M. T. , and Dugan Jr., L. R. , A distillation method for the quantitative determination of malonaldehyde in rancid flavor. J. Am. Oil Chem Soc., 37, 44–48, 1960.

Kakuda, Y. , Stanley, D. W. , and Van De Voort, F. R. , Determination of TBA number by high performance liquid chromatography. J. Am. Oil Chem. Soc., 58, 773–775, 1981.

Wong, S. H. , Knight, J. A. , Hopfer, S. M. , Zaharia. O. , Leach Jr, C. N. , and Sunderman Jr, F. W. , Lipoperoxides in plasma as measured by liquidchromatography separation of malondialdehyde-thiobarbituric acid adduct. Clin. Chem., 33, 214–220, 1987.

Tatum, V. L. , Changchit, C. , and Chow, C. K. , Measurement of malondialdehyde by HPLC with fluorescence detection. Lipids, 25, 226–229, 1990.

Ang, C. Y. W. and Young, L. L. , Rapid headspace gas chromatographic method for assessment of oxidative stability of cooked chicken meat. J. Assoc. Off. Anal. Chem., 72, 277–281, 1989.

Frankel, E. N. and Neff, W. E. , Formation of malonaldehyde from lipid oxidation products. Biochim. Biophys. Acta, 754, 264–270, 1983.

Ichinose, T. , Miller, M. G. , and Shibamoto, T. , Gas chromatography analysis of free and bound malonaldehyde in rat liver homogenates. Lipids, 24, 895–898, 1989.

Xu, J. L. , Riccioli, C. , and Sun, D. W. , Efficient integration of particle analysis in hyperspectral imaging for rapid assessment of oxidative degradation in salmon fillet. J. Food Eng., 169, 259–271, 2016.

Pacheco-Aguilar, R. , Lugo-Sánchez, M. E. , and Robles-Burgueño, M. R. , Postmortem biochemical and functional characteristic of monterey sardine muscle stored at 0°C. J. Food Sci., 65 (1), 40–47, 2000.

Medina, I. , Sacchi, R. , and Aubourg, S. , A 13C-NMR study of lipid alterations during fish canning: effect of filling medium. J. Sci. Food Agric., 69, 445–450, 1995.

Aubourg, S. P. and Ugliano, M. , Effect of brine pre-treatment on lipid stability of frozen horse mackerel (*Trachurus trachurus*). Eur. Food Res. Technol., 215, 91–95, 2002.

Aubourg, S. , Rey-Mansilla, M. , and Sotelo, C. , Differential lipid damage in various muscle zones of frozen hake. Eur. Food Res. Technol., 208, 189–193, 1999.

Aubourg, S. and Medina, I. , Influence of storage time and temperature on lipid deterioration during cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) frozen storage. J. Sci. Food Agric., 79, 1943–1948, 1999.

Kaneniwa, M. , Miao, S. , Yuan, C. , Lida, H. , and Fukuda, Y. , Lipid components and enzymatic hydrolysis of lipids in muscle of Chinese freshwater fish. J. Am. Oil Chem. Soc., 77 (8), 825–831, 2007.

Osawaa, C. C. , Goncalves, L. A. G. , and Ragazzi, S. , Correlation between free fatty acids of vegetable oils evaluated by rapid tests and by the official method. J. Food Compost. Anal., 20, 523–528, 2007.

Wang, H. , Suo, Y. , Wang, X. , Li, Y. , You, J. , and Zhao, X. , Extraction of *Nitraria tangutorum* seed oil by supercritical carbon dioxide and determination of free fatty acids by HPLC/APCI/MS with fluorescence detection. Sep. Purif. Technol., 56, 371–377, 2007.

Lacaze, J. P. C. L. , Stobo, L. A. , Turrell, E. A. , and Quilliam, M. A. , Solid-phase extraction and liquid chromatography-mass spectrometry for the determination of free fatty acids in shellfish. J. Chromatogr. A, 1145, 51–57, 2007.

Corry, J. E. L. , Hedgesb, A. J. , and Jarvisc, B. , Measurement uncertainty of the EU methods for microbiological examination of red meat. Food Microbiol., 24, 652–657, 2007.

ICMSF ., Micro-organisms in Foods 7. Microbiological Testing in Food Safety Management, Amsterdam, Kluwer, 2002.

Gram, L. and Huss, H. H. , Microbiological spoilage of fish and fish products. Int. J. Food Microbiol., 33, 121–137, 1996.

Dalgaard, P. , Modelling of microbial activity and prediction of shelf life of packed fresh fish. Int. J. Food Microbiol., 19, 305–318, 1995.

McClure, P. J. , Baranyi, J. , Boogard, E. , Kelly, T. M. , and Roberts, T. A. , A predictive model for the combined effect of pH, sodium chloride and storage temperature on the growth of Brochothrix thermosphacta. Int. J. Food Microbiol., 19, 161–178, 1993.

Carrasco, E. , Valero, A. , Pérez-Rodríguez, F. , García-Gimeno, R. M. , and Zurera, G. , Management of microbiological safety of ready-to-eat meat products by mathematical modelling: listeria monocytogenes as an example. Int. J. Food Microbiol., 114, 221–226, 2007.

Juneja, V. K. , Huang, L. , and Thippareddi, H. H. , Predictive model for growth of Clostridium perfringens in cooked cured pork. Int. J. Food Microbiol., 110, 85–92, 2006.

Koutsoumanis, K. P. , Taoukis, P. , Drosinos, E. H. , and Nychas, G.-J. E. , Applicability of an Arrhenius model for the combined effect of temperature and CO2 packaging on the spoilage microflora of fish. Appl. Environ. Microbiol., 66, 3528–3534 2000.

Koutsoumanis, K. , Lambropoulou, K. , and Nychas, G.-J. E. , A predictive model for the non-thermal inactivation of Salmonella enteritidis in a food model system supplemented with a natural antimicrobial. Int. J. Food Microbiol., 49 (1–2), 63–74, 1999.

Han, F. , Huang, X. , Teye, E. , Gu, F. , and Gu, H. , Nondestructive detection of fish freshness during its preservation by combining electronic nose and electronic tongue techniques in conjunction with chemometric analysis. Anal. Methods, 6 (2), 529–536, 2014.

Senapati, M. and Sahu, P. P. , Onsite fish quality monitoring using ultra-sensitive patch electrode capacitive sensor at room temperature. Biosens. Bioelectron., 168, 112570, 2020.

Tonezzer, M. , Thai, N. X. , Gasperi, F. , Van Duy, N. , and Biasioli, F. , Quantitative assessment of trout fish spoilage with a single nanowire gas sensor in a thermal gradient. Nanomaterials, 11 (6), 1604, 2021.

Ogden, I. D. , Use of conductance methods to predict bacterial counts in fish. J. Appl. Bacteriol., 61, 263–268, 1986.

Firstenberg-Eden, R. and Klein, C. S. , Evaluation of a rapid impedimetric procedure for the quantitative estimation of coliforms. J. Food Sci., 48, 1307–1311, 1983.

Bullock, R. D. and Frodsham, D. , Rapid impedance detection of salmonella in confectionery using modified LICNR broth. J. Appl. Bacteriol., 66, 385–391, 1989.

Wu, J. J. , Huang, A. H. , Dai, J. H. , and Chang, T. C. , Rapid detection of oxacillin-resistant staphylococcus aureus in blood cultures by an impedance method. J. Clinical Microbiol., 35 (6), 1460–1464, 1997.

Amagliani, G. , Giammarini, C. , Omiccioli, E. , Brandi, G. , and Magnani, M. , Detection of *Listeria monocytogenes* using a commercial PCR kit and different DNA extraction methods. Food Control, 18, 1137–1142, 2007.

Landete, J. M. , Rivas, B. D. L. , Marcobal, A. , and Muñoz, R. , Molecular methods for the detection of biogenic amine-producing bacteria on foods. Int. J. Food Microbiol., 117, 258–269, 2007.

Nowak, B. , Müffling, T. V. , Chaunchom, S. , and Hartung, J. , Salmonella contamination in pigs at slaughter and on the farm: a field study using an antibody ELISA test and a PCR technique. Int. J. Food Microbiol., 115, 259–267, 2007.

Lee, C. Y. , Panicker, G. , and Bej, A. K. , Detection of pathogenic bacteria in shellfish using multiplex PCR followed by CovaLinkk NH microwell plate sandwich hybridization. J. Microbiol. Methods, 53, 199–209, 2003.
Gehring, A. G. , Irwin, P. L. , Reed, S. A. , Tu, S. , Andreotti, P. E. , Akhavan-Tafti, H. , and Handley, R. S. , Enzyme-linked immunomagnetic chemiluminescent detection of Escherichia coli O157: H7. J. Immunol. Methods, 293, 97–106, 2004.
Lida, K. , Abe, A. , Matsui, H. , Danbara, H. , Wakayama, S. , and Kawahara, K. , Rapid and sensitive method for detection of Salmonella strains using a combination of polymerase chain reaction and reverse dot-blot hybridization. FEMS Microbiol. Lett., 114 (2), 167–172, 1993.

Detection of Species and Geographic Origin of Fishery Products

A. Kijima , Y. Fujio : Genetic control of isocitrate dehydrogenase isozymes in chum salmon. Tohoku J. Agri. Res., 28 (2), 96–102 (1977).
Y. Takashima , J. Iguchi , A. Namikoshi , Y. Yamashita , M. Yamashita : DNA analysis for identification of species and geographical origins of fishery products. Bunseki Kagaku, 63, 797–807 (2014).
S. Ichikawa : Fish species identification using species specificity of myosin light chain. Two-dimensional electrophoresis of urea and SDS. J. Fish Sausage, 226, 13 (1993).
S. Anderson , A. T. Bankier , B. G. Barrell , M. H. L. de Bruijn , A. R. Coulson , J. Drouin , I. C. Eperon , D. P. Nierlich , B. A. Roe , F. Sanger , P. H. Schreier , A. J. H. Smith , R. Staden , I. G. Young : Sequence and organization of the human mitochondrial genome. Nature, 290, 457(1981).
M. J. Bibb , R. A. Van Etten , C. T. Wright , M. W. Walberg , D. A. Clayton : Sequence and gene organization of mouse mitochondrial DNA. Cell, 26, 167(1981).
S. Anderson , M. H. L. de Bruijin , A. R. Coulson , I. C. Eperon , F. Sanger , I. G. Young : Sequence and organization of the human mitochondrial genome. J. Mol. Biol., 156, 683(1982).
B. A. Roe , D. P. Ma , R. K. Wilson , J. F. Wong : Mapping of the displacement loop within the nucleotide sequence of Xenopus laevis mitochondrial DNA. J. Biol. Chem., 260, 9759(1985).
M. Miya , M. Nishida : Use of mitogenomic information in teleostean molecular phylogenetics: a tree-based exploration under the maximum-parsimony optimality criterion. Mol. Phylogent. E, 17 (3), 437 (2000).
M. Miya , H. Takeshima , H. Endo , N. B. Ishiguro , J. G. Inoue , T. Mukai , T. P. Satoh , M. Yamaguchi , A. Kawaguchi , K. Mabuchi , S. M. Shirai , M. Nishida : Major patterns of higher teleostean phylogenies: a new perspective based on 100 complete mitochondrial DNA sequences. Mol. Phyl. E, 26, 121(2003).
T. D. Kocher , W. K. Thomas , A. Meyer , S. V. Edwards , S. F. Pääbo , F. S. Villablanca , A. C. Wilson : DNA analysis for identification of species and geographical origins of fishery products. Proc. Natl. Acad. Sci., 86, 6196(1989).
O. Folmer , M. Black , W. Hoeh , R. Lutz , R. Vrijenhoek : DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Mol. Mar. Biol. Biotechnol., 3, 294(1994).
S. R. Palumbi : Molecular Systematics, 2nd ed., edited by D. M. Hillis , C. Moritz , B. K. Mable , p. 205 (1996), (Sinauer & Associates Inc., Sunderland).
S. E. Bartlett , W. S. Davidson : FINS (forensically informative nucleotide sequencing): a procedure for identifying the animal origin of biological specimens. Biotechniques, 12, 408(1992).
P. D. N. Hebert , A. Cywinska , S. L. Ball , J. R. deWaard : Biological identifications through DNA barcodes. Proc. R. Soc. Lond. B., 270, 313(2003).
R. D. Ward , T. S. Zemlak , B. H. Innes , P. R. Last , P. D. N. Hebert : DNA barcoding Australia’s fish species. Phil. Trans. R. Soc. B, 360, 1847(2005).
F. J. Santaclara , M. Espiñeira , J. M. Vieites : Genetic identification of squids. Agric. Food Chem., 55, 9913(2007).
M. Espiñeira , N. González-Lavín , J. M. Vieites , F. J. Santaclara : Centro de Investigación en Alimentación y Desarrollo, A.C. J. Agric. Food Chem., 56, 10594(2008).
S. Arami , E. Sato , S. Futo: Applicability of DNA barcode for identification of fish species. Shokuhin Eiseigaku Zasshi, 52, 205(2010).
W. Iwasaki , T. Fukunaga , R. Isagozawa , K. Yamada , Y. Maeda , T. P. Satoh , T. Sado , K. Mabuchi , H. Takeshima , M. Miya , M. Nishida: MitoFish and MitoAnnotator: a mitochondrial genome database of fish with an accurate and automatic annotation pipeline. Mol. Biol. E, 30, 2531(2013).
Ministry of Health, Labour and Welfare: No. 1017004 (October 17, 2007).
I. Ohara , K. Hoshino , Y. Takashima , T. Kobayashi , K. Saito , H. Shigenobu: Identification of 6 fish species in genus Decapterus by using partial sequences of cytochrome b. DNA Polymorphism, 18, 98(2010).
J. V. Russell , L. G. Hold , E. S. Pryde , H. Rehbein , J. Quinteiro , M. Rey-Mendez , G. C. Sotelo , I. R. Perez-Martin , T. A. Santos , C. Rosa : Use of restriction fragment length polymorphism to distinguish between salmon species. J. Agric. Food Chem., 48, 2184(2000).
T. Maki , T. Koiwa , K. Imada , A. Tsumura , T. Sugimura , T. Sugomura , Y. Takashima , T. Morita , M. Yamashita : Species identification of Japanese Sea Bass, Chinese Sea Bass and Nile Perch by PCR-based

DNA analysis using the mitochondrial cytochrome b gene. Food Sci. Technol. Res., 51, 471(2004).
T. Maki , T. Koiwa , K. Imada , M. Toyoda , T. Sugimura , T. Ikeda , H. Ikeda : Species identification of ‘sea bream’ (Pagrus major, Evynnis japonica and Dentex tumifrons) by PCR-based DNA analysis using the mitochondrial cytochrome b gene. Food Sci. Technol. Res., 52, 366(2005).
T. Wakao , Y. Hikida , T. Tsuneyoshi , M. Kaji , H. Kubota , T. Kubota : A simple DNA analysis for identifying eel species by using polymerase chain reaction-restriction fragment length polymorphism method. Nippon Suisan Gakkaishi, 65, 391(1999).
K. Sezaki , S. Itoi , S. Watabe : A simple method to distinguish two commercially valuable eel species in Japan Anguilla japonica and A. anguilla using polymerase chain reaction strategy with a species-specific primer. Fish. Sci., 71, 414(2005).
T. Akasaki , M. Nikaido , K. Tsuchiya , S. Segawa , M. Hasegawa , N. Okada : Extensive mitochondrial gene arrangements in coleoid cephalopoda and their phylogenetic implications. Mol. Phyl. E, 38, 648(2006).
K. Takemoto , M. Yamashita : Complete nucleotide sequences of mitochondrial DNA of long-finned squid Loligo edulis. Fish. Sci., 78, 1031(2012).
K. Touhata , A. Namikoshi , T. Suzuki , J. Iguchi , N. Mizusawa , T. Hara , S. Imamura , T. Yabu , Y. Yamashita , M. Yamashita : Origin identification of dried seaweed product “nori” by PCR-RFLP analysis of *Pyropia yezoensis* in the internal transcribed spacer ITS-1 region. Fish. Sci., 79, 865(2013).
M. Hara , M. Noguchi , E. Naitou , A. Dewa , H. Yamauchi : Ribosomal RNA gene typing of fish genome using PCR-SSCP method. Bull. Jpn. Sea Reg. Fish. Res. Lab., 44, 131(1994).
R. Perez-Enriquez , N. Taniguchi : Genetic structure of red sea bream (Pagrus major) population off Japan and the Southwest Pacific, using microsatellite DNA markers. Fish. Sci., 65, 23(1999).
S. Chow , S. Inoue : Intra-and interspecific restriction fragment length polymorphism in mitochondrial genes of *Thunnus* tuna species. Bull. Natl. Res. Inst. Far Seas Fish., 30, 619(1993).
S. Chow , K. Nohara , T. Tanabe , T. Itoh , S. Tsuji , Y. Nishikawa , S. Uyeyanagi , K. Uchikawa : Genetic and morphological identification of larval and small juvenile tunas (Pisces: Scombridae) caught by a mid-water trawl in the western Pacific. Bull. Fish. Res. Agen., 8, 1(2003).
H. Takeyama , S. Chow , H. Tsuzuki , T. Matsunaga : Mitochondrial DNA sequence variation within and between Thunnus tuna species and its application to species identification. J. Fish Biol., 58, 1646(2001).
H. Kishino , S. Chow : Phylogenetic relationships between tuna species of the genus *Thunnus* . J. Mol. E, 41, 741 (1995).
Y. Takashima , T. Morita , M. Yamashita : Complete mitochondrial DNA sequence of Atlantic horse mackerel Trachurus trachurus and molecular identification of two commercially important species T. trachurus and T. japonicus using PCR-RFLP. Fish. Sci., 72, 1054(2006).
Manual for identification of fish species of the genus Mackerel, food and agricultural materials inspection center ; Nov 19 (2007). https://manualzilla.com/doc/6608401. (last accessed: November 23, 2023).
K. Sezaki , Y. Kuboshima , I. Mitani , A. Fukui , S. Watabe : Identification of chub and spotted mackerels with mitochondrial cytochrome b gene and its application to respective pelagic eggs fixed with formalin. Fish. Sci., 67, 17(2001).
A. Namikoshi , Y. Takashima , J. Iguchi , T. Yanagimoto , M. Yamashita : Species identification of Alaska pollock, Gadus spp., and Micromesistius spp. in cod roe products using a PCR-based method. Fish. Sci., 77, 671(2011).
J. Iguchi , Y. Takashima , A. Namikoshi , M. Yamashita : Species identification method for marine products of Seriola and related species. Fish. Sci., 78, 197(2012).
J. Iguchi , Y. Takashima , A. Namikoshi , Y. Yamashita , M. Yamashita : Origin identification method by multiple trace elemental analysis of short-neck clams produced in Japan, China, and the Republic of Korea. Fish Sci., 79, 977–982 (2013).
J. Iguchi , M. Isshiki , Y. Takashima , Y. Yamashita , M. Yamashita : Identifying the origin of *Corbicula* clams using trace element analysis. Fish Sci., 80, 1089–1096 (2014).
J. Iguchi , Y. Yamashita , K. Touhata , T. Yabu , M. Yamashita : Origin identification method by multiple trace elemental analysis of intermuscular bones in grilled eel products produced in Japan, China, and Taiwan. Fish Sci., 79, 531–536 (2013).

Smoke Flavourings Technology in Seafood

Gomaa, E.A. , Ian Gray, J. , Rabie, S. , LopezBote, C. , Booren, A.M. , Polycyclic aromatic hydrocarbons in smoked food products and commercial liquid smoke flavourings, Food Addit. Contam., 10 (5), 503–521, 1993.
Šimko, P. , Factors affecting elimination of polycyclic aromatic hydrocarbons from smoked meat foods and liquid smoke flavourings, Mol. Nutr. Food Res., 49, 637–647, 2005.
Pszczola, D.E. , Tour highlights production and uses of smoke-based flavors, Food Technol., 49 (1), 70–74, 1995.

Guillén, M.D. , Manzanos, M.J. , Zabala, L. , Study of a commercial liquid smoke flavoring by means of gas chromatography/mass spectrometry and Fourier transform infrared spectroscopy, J. Agric. Food Chem., 43, 463–468, 1995.
Xin, X. , Bissett, A. , Wang, J. , Gan, A. , Dell, K. , Baroutian, S. , Production of liquid smoke using fluidised-bed fast pyrolysis and its application to green lipped mussel meat, Food Control, 124, 107874, 2021.
Xin, X. , Dell, K. , Udugama, I.A. , Young, B.R. , Baroutian, S. , Transforming biomass pyrolysis technologies to produce liquid smoke food flavouring, J. Clean. Prod., 294, 125368, 2021.
Guillén, M.D. , Manzanos, M.J. , Study of the components of a solid smoke flavouring preparation, Food Chem., 55, 251–257, 1996.
Miler, K.B.M. , Sikorski, Z.E. , Smoking, in Seafood: Resources, Nutritional Composition, and Preservation, Sikorski, Z.E. , Ed., CRC Press, Boca Raton, FL, 1990, p. 163.
Kurko, V.I. , Principles of Smokeless Smoke Curing, Legkaja i Pishchevaja Promyshlennost, Moscow, 1984.
Foster, W.W. , Simpson, T.H. , Campbell, D. , Studies of the smoking process for foods. The role of smoke particles, J. Sci. Food Agric., 9, 363–374, 1961.
Hollenbeck, C.M. , Novel concepts in technology and design of machinery for production and application of smoke in the food industry, Pure Appl. Chem., 49, 1687–1702, 1977.
Maga, J.A. , The flavor chemistry of wood smoke, Food Rev. Int., 3 (1&2), 139–183, 1987.
Simon, R. , de la Calle, B. , Palme, S. , Meier, D. , Anklam, E. , Composition and analysis of liquid smoke flavouring primary products, J. Sep. Sci., 28, 871–882, 2005.
Guillén, M.D. , Manzanos, M.J. , Smoke and liquid smoke. Study of an aqueous smoke flavouring from the aromatic plant *Thymus vulgaris* L., J. Sci. Food Agric., 79, 1267–1274, 1999.
Varlet, V. , Serot, T. , Cardinal, M. , Knockaert, C. , Prost, C. , Olfactometric determination of the most potent odor-active compounds in salmon muscle (*Salmo salar*) smoked by using four smoke generation techniques, J. Agric. Food Chem., 55, 4518–4525, 2007.
Kostyra, E. , Baryłko-Pikielna, N. , Volatiles composition and flavour profile identity of smoke flavourings, Food Qual. Pref., 17 (1–2), 85–95, 2005.
Guillén, M.D. , Manzanos, M.J. , Study of the volatile composition of an aqueous oak smoke preparation, Food Chem., 79, 283–292, 2002.
Guillén, M.D. , Ibargoitia, M.L. , Relationships between the maximum temperature reached in the smoke generation processes from *vitis vinifera* L. shoot sawdust and composition of the aqueous smoke flavoring preparations obtained, J. Agric. Food Chem., 44, 1302–1307, 1996.
Jira, W. , Chemical reactions of smoking, Fleischwirtschaft Int., 84 (5), 235–239, 2004.
Alén, R. , Kuoppala, E. , Oesch, P. , Formation of the main degradation compound groups from wood and its components during pyrolysis, J. Anal. Appl. Pyrolysis, 36, 137–148, 1996.
Nonier, M.F. , Vivas, N. , Vivas de Gaulejac, N. , Absalon, C. , Soulié, P. , Fouquet, E. , Pyrolysis-gas chromatography/mass spectrometry of *Quercus* sp. wood. Application to structural elucidation of macromolecules and aromatic profiles of different species, J. Anal. Appl. Pyrolysis, 75 (2), 181–193, 2005.
Guillén, M.D. , Ibargoitia, M.L. , Influence of the moisture content on the composition of the liquid smoke produced in the pyrolysis process of *Fagus sylvatica* L. wood, J. Agric. Food Chem., 47, 4126–4136, 1999.
Lantz, A.W. , Vaisey, M. , Flavor effects of different woods on whitefish smoked in a kiln with controlled temperature, humidity, and air velocity, J. Fish. Res. Board Canada, 27 (7), 1201–1207, 1970.
Chan, W.S. , Toledo, R.T. , Effect of smokehouse temperature, humidity and air flow on smoke penetration into fish muscle, J. Food Sci., 40, 240–242, 1975.
Rusz, J. , Miler, K.B.M. , Physical and chemical processes involved in the production and application of smoke, Pure Appl. Chem., 49, 1639–1654, 1977.
Clifford, M.N. , Tang, S.L. , Eyo, A.A. , Smoking of foods, Process Biochem., June/July, 8–26, 1980.
Ojeda, M. , Bárcenas, P. , Pérez-Elortondo, F.J. , Albisu, M. , Guillén, M.D. , Chemical references in sensory analysis of smoke flavourings, Food Chem., 78 (4), 433–442, 2002.
Sérot, T. , Baron, R. , Knockaert, C. , Vallet, J.L. , Effect of smoking processes on the contents of 10 major phenolic compounds in smoked fillets of herring (*Cuplea harengus*), Food Chem., 85, 111–120, 2004.
Bratzler, L.J. , Spooner, M. , Weathersponn, J.B. , Maxey, J.A. , Smoke flavor as related to phenol, carbonyl and acid content of bologna, J. Food Sci., 34, 146–148, 1969.
Cardinal, M. , Cornet, J. , Sérot, T. , Baron, R. , Effects of the smoking process on odour characteristics of smoked herring (*Cuplea harengus*) and relationships with phenolic compound content, Food Chem., 96, 137–146, 2006.
Varlet, V. , Prost, C. , Serot, T. , Volatile aldehydes in smoked fish: analysis methods, occurrence and mechanisms of formation, Food Chem., 105 (4), 1536–1556, 2007.
Varlet, V. , Serot, T. , Cardinal, M. , Courcoux, P. , Cornet, J. , Knockaert, C. , Prost, C. Relationships between odorant characteristics and the most odorant volatile compounds of salmon smoked by four industrial smoking techniques. Actes du colloque EUROFOODCHEM XIV, Congress 29–31 August 2007, Paris, 2007.
Daun, H. , Sensory properties of phenolic compounds isolated from curing smoke as influenced by its generation parameters, Lebensm. Wiss. Technol., 5 (3), 102–105, 1972.

Fiddler, W. , Wasserman, A.E. , Doerr, R.C. , A “smoke” flavor fraction of a liquid smoke solution, J. Agric. Food Chem., 18 (5), 934–936, 1970.
Kim, K. , Kurata, T. , Fujimaki, M. , Identification of flavour constituents in carbonyl, non-carbonyl neutral and basic fractions of aqueous smoke condensates, Agric. Biol. Chem., 38, 53–63, 1974.
Radecki, A. , Grzybowski, J. , Halkiewicz, J. , Lamparczyk, H. , Isolation and identification of some components of the lower-boiling fraction of commercial smoke flavourings, Acta Aliment. Pol., 3, 203–207, 1977.
Guillén, M.D. , Manzanos, M.J. , Ibargoitia, M.L. , Carbohydrate and nitrogenated compounds in liquid smoke flavorings, J. Agric. Food Chem., 49, 2395–2403, 2001.
Wasserman, A.E. , Organoleptic evaluation of three phenols present in wood smoke, J. Food Sci., 31, 1005–1010, 1966.
Toth, L. , Potthast, K. , Chemical aspects of the smoking of meat and meat products, Adv. Food Res., 29, 87–158, 1984.
Olsen, C.Z. , Chemical composition and application of smoke flavor, Proc. Eur. Meet. Meat Res. Workers, 22, F7, 1976.
Burdock, G.A. , Fenaroli’s Handbook of Flavor Ingredients, CRC Press LLC, Boca Raton, FL, 2002.
Metz, B. , Kersten, G. , Hoogerhout, P. , Brugghe, H.F. , Timmermans, H.A.M. , de Jong, A. , Meiring, H. , Ten Hove, J. , Hennink, W.E. , Crommelin, D.J.A. , Jiskoot, W. , Identification of formaldehyde-induced modifications in proteins: reactions with model peptides, J. Biol. Chem., 279, 6235–6243, 2004.
Sainclivier, M. , L’industrie alimentaire halieutique. Des techniques ancestrales à leurs réalisations contemporaines: salage, séchage, fumage, marinage, hydrolysats, Bulletin scientifique et technique de l’Ecole Nationale Supérieure Agronomique Centre de Recherches de Rennes, 219, 1985.
Tilgner, D.J. , The phenomena of quality in the smoke curing process, Pure Appl. Chem., 49, 1629–1638, 1977.
Müller, W.D. , Curing and smoking, Fleischwirtschaft, 71 (1), 61–65, 1991.
Girard, J.P. , La fumaison, in Technologie de la viande et des produits carnés, Lavoisier, Paris, 1988, p. 171.
Varlet, V. , Prost, C. , Sérot, T. , Volatile aldehydes in smoked fishes: analysis methods, occurrence and mechanisms of formation, Food Chem., 105, 1536–1556, 2007.
Suñen, E. , Aristimuño, C. , Fernandez-Galian, B. , Activity of smoke wood condensates against *Aeromonas hydrophila* and *Listeria monocytogenes* in vacuum-packaged, cold-smoked rainbow trout stored at 4°C, Food Res. Int., 36, 111–116, 2003.
Suñen, E. , Fernandez-Galian, B. , Aristimuño, C. , Antibacterial activity of smoke wood condensates against *Aeromonas hydrophila, Yersinia enterocolitica*, and *Listeria monocytogenes* at low temperature, Food Microbiol., 18, 387–393, 2001.
Baird, W.M. , Hooven, L.A. , Mahadevan, B. , Carcinogenic polycyclic aromatic hydrocarbon-DNA adducts and mechanism of action, Environ. Mol. Mutagen., 45, 106–114, 2005.
Nyman, P.J. , Perfetti, G.A. , Joe, F.L. , Diachenko, G.W. , Comparison of two clean-up methodologies for the gas chromatographic/mass spectrometric determination of low nanogram/gram levels of polynuclear aromatic hydrocarbons in seafood, Food Addit. Contam., 10 (5), 489–501, 1993.
Scientific Committee on Food (SCF), Opinion of the Scientific Committee on Food on the risks to human health of Polycyclic Aromatic Hydrocarbons in food (expressed on 4 December 2002), SCF/CS/CNTM/PAH/29 final , 2002.
Stołyhwo, A. , Sikorski, Z.E. , Polycyclic aromatic hydrocarbons in smoked fish - a critical review, Food Chem., 91 (2), 303–311, 2005.
Mottier, P. , Parisod, V. , Turesky, R.J. , Quantitative determination of polycyclic aromatic hydrocarbons in barbecued meat sausages by gas chromatography coupled to mass spectrometry, J. Agric. Food Chem., 48, 1160–1166, 2000.
Chen, B.H. , Wang, C.Y. , Chiu, C.P. , Evaluation of analysis of polycyclic aromatic hydrocarbons in meat products by liquid chromatography, J. Agric. Food Chem., 44, 2244–2251, 1996.
Jira, W. , A GC/MS method for the determination of carcinogenic polycyclic aromatic hydrocarbons (PAH) in smoked meat products and liquid smokes, Eur. Food Res. Technol., 218, 208–212, 2004.
Šimko, P. , Changes of benzo(a)pyrene contents in smoked fish during storage, Food Chem., 40, 293–300, 1991.
Simon, R. , Palme, S. , Anklam, E. , Validation (in-house and collaborative) of a method based on liquid chromatography for the quantitation of 15 European-priority polycyclic aromatic hydrocarbons in smoke flavourings: HPLC-method validation for 15 EU priority PAH in smoke condensates, Food Chem., 104 (2), 876–887, 2007.
Guillén, M.D. , Sopelana, P. , Partearroyo, M.A. , Study of several aspects of a general method for the determination of polycyclic aromatic hydrocarbons in liquid smoke flavourings by gas chromatography-mass spectrometry, Food Addit. Contamin., 17(1), 27–44, 2000.
Guillén, M.D. , Sopelana, P. , Partearroyo, M.A. , Determination of polycyclic aromatic hydrocarbons in commercial liquid smoke flavorings of different compositions by gas chromatography - mass spectrometry, J. Agric. Food Chem., 48, 126–131, 2000.
Simon, R. , Palme, S. , Anklam, E. , Single-laboratory validation of a gas chromatography-mass spectrometry method for quantitation of 15 European priority polycyclic aromatic hydrocarbons in spiked smoke flavourings,

J. Chromatogr. A, 1103, 307–313, 2006.
Šimko, P. , Determination of polycyclic aromatic hydrocarbons in smoked meat products and smoke flavourings additives. J. Chromatogr. B., 770, 3–18, 2002.
Wang, G. , Lee, A.S. , Lewis, M. , Kamath, B. , Archer, R.K. Accelerated solvent extraction and gas chromatography/mass spectrometry for determination of polycyclic aromatic hydrocarbons in smoked food samples, J. Agric. Food Chem., 47, 1062–1066, 1999.
Järvenpää, E. , Huopalahti, R. , Tapanainen, P. , Use of supercritical fluid extraction-high performance chromatography in the determination of polynuclear aromatic hydrocarbons from smoked and broiled fish, J. Liq. Chrom. Rel. Technol., 19 (9), 1473–1482, 1996.
Popp, P. , Bauer, C. , Möder, M. , Paschke, A. , Determination of polycyclic aromatic hydrocarbons in waste water by off-line coupling of solid-phase microextraction with column liquid chromatography, J. Chromatogr. A, 897 (1–2), 153–159, 2003.
King, A.J. , Readman, W. , Zhou, J.L. , Determination of polycyclic aromatic hydrocarbons in water by solid-phase microextraction-gas chromatography-mass spectrometry, Anal. Chim. Acta, 523 (2), 259–267, 2004.
Pimenta, A.S. , Bayona, J.M. , Garcia, M.T. , Solanas, A.M. , Evaluation of acute toxicity and genotoxicity of liquid products from pyrolysis of *Eucalyptus grandis* wood, Arch. Environ. Contam. Toxicol., 38, 169–175, 2000.
Varlet, V. , Serot, T. , Monteau, F. , Le Bizec, B. , Prost, C. , Determination of PAH profiles by GC-MS/MS in salmon muscle processed according to four different smoking techniques, Food Addit. Contam., 24 (7), 744–757, 2007.
Purcaro, G. , Morisson, P. , Moret, S. , Conte, L.S. , Marriott, P.J. , Determination of polycyclic aromatic hydrocarbons in vegetable oils using solid-phase microextraction - comprehensive two-dimensional gas chromatography coupled with time-of-flight mass spectrometry, J. Chromatogr. A., 1161, 284–291, 2007.
Moret, S. , Conte, L. , Dean, D. , Assessment of polycyclic aromatic hydrocarbon content of smoked fish by means of a fast HPLC/HPLC method, J. Agric. Food Chem., 47, 1367–1371, 1999.
Sun, Y. , Wu, S. , Gong, G. , Trends of research on polycyclic aromatic hydrocarbons in food: a 20-year perspective from 1997 to 2017, Trends Food Sci. Technol., 83, 86–98, 2019.
Plaza-Bolaños, P. , Garrido Frenich, A. , Martínez Vidal, J.L. , Polycyclic aromatic hydrocarbons in food and beverages. Analytical methods and trends, J. Chromatogr. A, 1217 (41), 6303–6326, 2010.
Araki, R.Y. , Dodo, G.H. , Reimer, S.H. , Knight, M.M. , Protocol for the determination of selected neutral and acidic semi-volatile organic contaminants in fish tissue, J. Chromatogr. A, 923 (1–2), 177–185, 2001.
Janska, M. , Tomaniova, M. , Hajšlova, J. , Kocourek, V. , Appraisal of "classic" and "novel" extraction procedure efficiencies for the isolation of polycyclic aromatic hydrocarbons and their derivatives from biotic matrices, Anal. Chim. Acta, 520 (1–2), 93–103, 2004.
Guillen, M.D. , Errecalde, M.C. , Volatile components of raw and smoked black bream (Brama raii) and rainbow trout (Oncorhynchus mykiss) studied by means of solid phase microextraction and gas chromatography/mass spectrometry. J. Sci. Food Agric., 82, 945–952, 2002.
Pena, T. , Pensado, L. , Casais, C. , Mejuto, C. , Phan-Tan-Luu, R. , Cela, R. , Optimization of a microwaveassisted extraction method for the analysis of polycyclic aromatic hydrocarbons from fish samples, J. Chromatogr. A, 1121 (2), 163–169, 2006.
Joao Ramalhosa, M. , Paiga, M. , Morais, P. , Delerue-Matos, S. , Prior Pinto Oliveira , M.B., Analysis of polycyclic aromatic hydrocarbons in fish: evaluation of a quick, easy, cheap, effective, rugged, and safe extraction method, J. Sep. Sci., 32, 3529–3538, 2009.
Pensado, L. , Casais, M.C. , Cela, M.R. , Application of matrix solid-phase dispersion in the analysis of priority polycyclic aromatic hydrocarbons in fish samples. J. Chromatogr. A, 1077 (2), 103–109, 2005.
Anyakora, C. , Ogbeche, A. , Palmer, P. , Coker, H. , Determination of polynuclear aromatic hydrocarbons in marine samples of Sokolo fishing settlement, J. Chromatogr. A, 1073 (1–2), 323–330, 2005.
Perugini, M. , Visciano, P. , Manera, M. , Turnoa, G. , Lucisano, A. , Amorean, M. , Polycyclic aromatic hydrocarbons in marine organisms from the Gulf of Naples, Tyrrhenian Sea. J. Agric. Food Chem., 55 (5), 2049–2054, 2007.
Navarro, P. , Cortazar, E. , Bartolome, L. , Deusto, M. , Raposo, J.C. , Zuloaga, O. , Arana, G. , Etxebarria, N. , Comparison of solid phase extraction, saponification and gel permeation chromatography for the clean-up of microwave-assisted biological extracts in the analysis of polycyclic aromatic hydrocarbons, J. Chromatogr. A, 1128 (1–2), 10–16, 2006.
Aguinaga, N. , Campillo, N. , Vinas, P. Hernandez-Cordoba, M. , Evaluation of solid-phase microextraction conditions for the determination of polycyclic aromatic hydrocarbons in aquatic species using gas chromatography, Anal. Bioanal. Chem., 391, 1419–1424, 2008.
Al-Omair, A. , Helaleh, M.I.H. Selected-ion storage GC-MS analysis of polycyclic aromatic hydrocarbons in palm dates and tuna fish. Chromatographia, 59 (11), 715–719, 2004.
Jie, F. , Kai-Xiong, W. , Multiresidual analysis of organochlorine pesticides, polychlorinated biphenyls and polycyclic aromatic hydrocarbons in marine shellfishes by gas chromatography-ion trap mass spectrometry, Chin. J. Anal. Chem., 35 (11), 1607–1613, 2007.
Martinez, E. , Gros, M. , Lacorte, S. , Barcelo, D. , Simplified procedures for the analysis of polycyclic aromatic hydrocarbons in water, sediments and mussels, J. Chromatogr. A, 1047 (2), 181–188, 2004.

Stołyhwo, A. , Sikorski, Z.E. , Polycyclic aromatic hydrocarbons in smoked fish - a critical review, Food Chem., 91 (2), 303–311, 2005.
Cunha, S.C. , Siminel, D. , Guàrdia, M.D. , López de Alda , M., López-Garcia, E. , Muñoz, I. , Ferreira, R. , Eljarrat, E. , Fernandes, J.O. , Effect of processing smoked salmon on contaminant contents, Food Chem. Toxicol., 153, 112276, 2021.
Gratz, S. , Mohrhaus, A. , Gamble, B. , Gracie, J. , Jackson, D. , Roetting, J. ,. & Fricke, F. Screen for the presence of polycyclic aromatic hydrocarbons in select seafoods using LC-fluorescence. Lab. Info. Bull, 4475, 1–39, 2010.
https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32003R2065&from=EN
Italian Law Decree 25/01/1992 n. 107
Dos Santos Barbosa, J.M. , Ré-Poppi, N. , Santiago-Silva, M. , Polycyclic aromatic hydrocarbons from wood pyrolysis in charcoal production furnaces. Environ. Res., 101, 304–311, 2006.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32020R1255
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2006.364.01.0005.01.ENG&toc=OJ%3AL%3A2006%3A364%3ATOC
https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:215:0004:0008:EN:PDF
https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:31993R0315&from=EN
https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32003R1882&from=EN
https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32009R0596&from=EN
https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2013:333:0054:0067:EN:PDF
https://www.fsai.ie/uploadedFiles/Legislation/Food_Legisation_Links/EU/REGULATION%20(EC)%20No%20596_2009.pdf
https://www.fsai.ie/uploadedFiles/Commission_Regulation_EC_No_627_2006.pdf
Wenzl, T. , Simon, R. , Anklam, E. , Kleiner, J. , Analytical methods for polycyclic aromatic hydrocarbons (PAHs) in food and the environment needed for new food legislation in the European Union, TrAC Trends Anal. Chem., 25 (7), 716–725, 2006.
https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=101.22
https://www.ecfr.gov/current/title-21/chapter-I/subchapter-E/part-501

Composition and Calories

FAO , ASFIS list of species for fishery statistics purposes. [2022 05.12.2022]; Available from: https://www.fao.org/fishery/en/collection/asfis/en.
Sikorski, Z.E. , A. Kołakowska , and B. Sun Pan , The nutritive composition of the major groups of marine food organisms, In Seafood: Resources, Nutritional Composition, and Preservation: Resources, Nutritional Composition, and Preservation, Z.E. Sikorski , Editor. 1990, CDC Press: Boca Raton. pp. 29–54.
FAO, FAO/INFOODS global food composition database for fish and shellfish, version 1.0- uFiSh1.0 . [2016 05.12.2022]; Available from: https://www.fao.org/infoods/infoods/tables-and-databases/faoinfoods-databases/en/.
Solberg, C. , NIR - a rapid method for quality control, In Seafood from Producer to Consumer, Integrated Approach to Quality, J.B. Luten , T. Borresen , and J. Oehlenschlager , Editors. 1997, Elsevier Science: Amsterdam, the Netherlands. pp. 529–534.
Downey, G. , Non-invasive and non-destructive percutaneous analysis of farmed salmon flesh by near infra-red spectroscopy. Food Chemistry, 1996. 55: 305–311.
Wold, J.P. and T. Isaksson , Non-destructive determination of fat and moisture in whole Atlantic salmon by near-infrared diffuse spectroscopy. Journal of Food Science, 1997. 62(4): 734–736.
Solberg, C. , et al ., Determination of fat in live farmed Atlantic salmon using non-invasive NIR techniques. Journal of the Science of Food and Agriculture, 2003. 83(7): 692–696.
Uddin, M. , et al ., NIR spectroscopy: a non-destructive fast technique to verify heat treatment of fish-meat gel. Food Control, 2006. 17(8): 660–664.
Aitken, A. and M.P. Learmonth , Protein determination by UV absorption, In The Protein Protocols Handbook, J.M. Walker , Editor. 2002, Humana Press Inc.: Totowa, NJ pp. 3–6.
Ghaedian, R. , et al ., Ultrasonic determination of fish composition. Journal of Food Engineering, 1998. 35(3): 323–337.
Suvanich, V. , et al ., Prediction of proximate fish composition from ultrasonic properties: catfish, cod, flounder, mackerel and salmon. Journal of Food Science, 1998. 63(6): 966–968.
Sigfusson, H. , E.A. Decker , and D.J. McClements , Ultrasonic characterisation of Atlantic mackerel (Scomber scombrus). Food Research International, 2001. 43: 15–23.
Shannon, R.A. , et al ., Ultrasound velocity measurement to determine lipid content in salmon muscle; the effects of myosepta. Food Research International, 2004. 37(6): 611–620.

Novinger, D.C. and C.M. Del Rio , Failure of total body electrical conductivity to predict lipid content of brook trout. North American Journal of Fisheries Management, 1999. 19(4): 942–947.
Jaramillo, F. , et al ., Application of electrical-conductivity for nondestructive measurement of channel Catfish, Ictalurus punctatus, body-composition. Aquatic Living Resources, 1994. 7: 87–91.
Hancz, C. , G. Milisits , and P. Horn , In vivo measurement of total body lipid content of common carp (Cyprinus carpio L.) by electrical conductivity. Archives Tierzucht-Archives of Animal Breeding, 2003. 46: 397–402.
Lantry, B.F. , et al ., Evaluation of total body electrical conductivity to estimate whole body water content of yellow perch (Perca flavescens) and alewife (Alosa pseudoharengu). Fishery Bulletin, 1999. 97: 71–79.
Lundby, F. , G.H. Sorland , and S. Eilertsen . Determination of fat, moisture and protein in fish powder within 30 min, by combining low resolution NMR techniques and microwave technology. Proceedings of the 8th International Conference on the Applications of Magnetic Resonance in Food Science. 2006. Nottingham, U.K.
Veliyulin, E. , et al ., In vivo determination of fat content in Atlantic salmon (Salmo salar) with a mobile NMR spectrometer. Journal of the Science of Food and Agriculture, 2005. 85(8): 1299–1304.
Aursand, I. , E. Veliuylin , and U. Erikson , Low-field NMR studies of Atlantic salmon (Salmo salar), In Modern Magnetic Resonance, Modern Magnetic Resonance. Part 1: Applications in Chemistry, Biological and Marine Sciences, G.A. Webb, Editor. 2006, Springer: Dordrecht, the Netherlands. pp. 895–903.
Minor, R.K. , et al ., Calorie restriction alters physical performance but not cognition in two models of altered neuroendocrine signaling. Behavioural Brain Research, 2008. 189(1): 202–211.
Primeaux, S.D. , M. Tong , and G.M. Holmes , Effects of chronic spinal cord injury on body weight and body composition in rats fed a standard chow diet. American Journal of Physiology: Regulatory, Integrative, and Comparative Physiology, 2007. 293(3): R1102–R1109.
Grimshaw, A. , P.H. Krygsman , and Z.H. Xie . Simultaneous determination of fat, moisture and protein in raw meat or meat products by TD-NMR, poster from Bruker Optics demonstrating the minispec.
Veliuylin, E. , et al ., Post-mortem studies of fish using magnetic resonance imaging, In Modern Magnetic Resonance, Modern Magnetic Resonance. Part 1: Applications in Chemistry, Biological and Marine Sciences, G.A. Webb, Editor. 2006, Springer: Dordrecht, the Netherlands. pp. 949–956.
Toussaint, C.A. , et al ., Determination of the lipid content in fish muscle by a self-calibrated NMR relaxometry method: comparison with classical chemical extraction methods. Journal of the Science of Food and Agriculture, 2002. 82(2): 173–178.
Ewald, G. , G. Bremle , and A. Karlsson , Differences between Bligh and Dyer and Soxhlet extractions of PCBs and lipids from fat and lean fish muscle: implications for data evaluation. Marine Pollution Bulletin, 1998. 36(3): 222–230.
Bligh, E.G. and W.J. Dyer , A rapid method of total lipid extraction and purification. Canadian Journal of Biochemistry and Physiology, 1959. 37(8): 911–917.
Folch, J. , et al ., Preparation of lipid extracts from brain tissue. The Journal of Biological Chemistry, 1951. 191(2): 833–841.
Iverson, S.J. , S.L. Lang , and M.H. Cooper , Comparison of the Bligh and Dyer and Folch methods for total lipid determination in a broad range of marine tissue. Lipids, 2001. 36(11): 1283–1287.
Lee, C.M. , B. Trevino , and M. Chaiyawat , A simple and rapid solvent extraction method for determining total lipids in fish tissue. Journal of AOAC International, 1996. 79(2): 487–492.
Saini, R.K. , et al ., Advances in lipid extraction methods-a review. International Journal of Molecular Sciences, 2021. 22(24): 13643.
Toge, Y. and K. Miyashita , Lipid extraction with electrolyzed cathode water from marine products. Journal of Oleo Science, 2003. 52(1): 1–6.
Smedes, F. and T.K. Askland , Revisiting the development of the Bligh and Dyer total lipid determination method. Marine Pollution Bulletin, 1999. 38: 193–201.
Vogt, A. , et al ., A comparison of selected rapid methods for fat measurement in fresh herring (Clupea harengus). Journal of Food Composition and Analyses, 2002. 15: 205–215.
Clerjon, S. and J.L. Damez , Microwave sensing for meat and fish structure evaluation. Measurement Science and Technology, 2007. 18(4): 1038–1045.
Nielsen, D. , et al ., Lipid content in herring (Clupea harengus L.)-influence of biological factors and comparison of different methods of analyses: solvent extraction, Fatmeter, NIR and NMR. Lebensmittel-Wissenschaft und -Technologie. Food Science and Technology, 2005. 38: 537–548.
Kent, M. , Hand-held instrument for fat/water determination in whole fish. Food Control, 1990. 1(1): 47–53.
Kent, M. , A. Lees , and R.H. Christie , Seasonal variation in the calibration of a microwave fat: water content meter for fish flesh. International Journal of Food Science & Technology, 1992. 27(2): 137–143.
Collewet, G. , et al ., Rapid quantification of muscle fat content and subcutaneous adipose tissue in fish using MRI. Food Chemistry, 2013. 138(2–3): 2008–2015.
Khodabux, K. , et al ., Chemical and near-infrared determination of moisture, fat and protein in tuna fishes. Food Chemistry, 2007. 102(3): 669–675.
Mæhre, H.K. , et al ., Protein determination-method matters. Foods, 2018. 7(1). doi:10.3390/foods7010005.
Owusu-Apeten, R.K. , Food Protein Analysis. 2002, New York: Marcel Dekker, Inc.

Miller, E.L. , et al ., Repeatability and reproducibility of determination of the nitrogen content of fishmeal by the combustion (Dumas) method and comparison with the Kjeldahl method: interlaboratory study. Journal of AOAC International, 2007. 90(1): 6–20.
Dorresteijn, R.C. , et al ., Determination of amino acids using o-phthalaldehyde-2-mercaptoethanol derivatization effect of reaction conditions. Journal of Chromatography A, 1996. 724(1): 159–167.
Sarwar, G. and H.G. Botting , Evaluation of liquid chromatographic analysis of nutritionally important amino acids in food and physiological samples. Journal of Chromatography, 1993. 615(1): 1–22.
Fekkes, D. , State-of-the-art of high-performance liquid chromatographic analysis of amino acids in physiological samples. Journal of Chromatography B: Biomedical Sciences and Applications, 1996. 682(1): 3–22.
Heems, D. , et al ., Fully automated precolumn derivatisation, on line dialysis and high performance liquid chromatographic analysis of amino acids in food, beverages and feedstuff. Journal of Chromatography Part A, 1998. 798: 9–17.
Bjorklund, J. , et al ., Automated amino acid determination by high-performance liquid chromatography with 2-(9-antryl)ethyl chloroformate as precolumn reagent. Journal of Chromatography Part A, 1998. 798: 1–8.
Bolden, M.E. and N.D. Danielson , Liquid chromatography of aromatic amines with photochemical derivatization and tris(bipyridine)ruthenium(III) chemiluminescence detection. Journal of Chromatography A, 1998. 828(1–2): 421–430.
Molnár-Perl, I. , Tryptophan analysis in peptides and proteins, mainly by liquid chromatography. Journal of Chromatography A, 1997. 763(1): 1–10.
AOAC International, AOAC Official Method 950 . 46 Moisture in Meat, In Official Methods of Analysis. 2019. 21st Edition, Chapter 4, Section 4.1.03 2019, 1: 4–5. AOAC, Rockville, Maryland, USA.
Christie, R. , M. Kent , and A. Lees , Microwave and infra-red drying versus conventional oven drying methods for moisture determination in fish flesh. International Journal of Food Science & Technology, 1985. 20(2): 117–127.
Aursand, I.G. , et al ., Water distribution in brine salted cod (Gadus morhua) and salmon (Salmo salar): a low-field 1H NMR study. Journal of Agricultural and Food Chemistry, 2008. 56(15): 6252–6260.
DuBois, M. , et al ., Colorimetric method for determination of sugars and related substances. Analytical Chemistry, 1956. 28(3): 350–356.
Maguire, J.A. , P.G. Fleury , and G.M. Burnell , Some methods for quantifying quality in the scallop Pecten maximus (L.). Journal of Shellfish Research, 1999. 18: 59–66.
Gerhardt, P. , et al ., Chemical analysis, in Methods for General and Molecular Bacteriology, A.S. Microbiol, Editor. 1994. pp. 518–520. American Society for Microbiology: Washington DC.
Shimamoto, J. , et al ., Rapid non-destructive determination of fat content in frozen skipjack using a portable near infrared spectrophotometer. Fisheries Science, 2003. 69(4): 856–860.
Solberg, C. Rapid on line non-destructive measurement of fat in live and filleted salmon, In Near Infrared Spectroscopy: The 11th International Conference. A.M.C. Davies and A. Garrido-Varo (Eds.) 2004, NIR Publications: Sussex, U.K. pp. 83–86.
Uddin, M. , et al ., Non-destructive visible/NIR spectroscopy for differentiation of fresh and frozen-thawed fish. Journal of Food Science, 2005. 70(8): c506–c510.
Osborne, B.G. , T. Fearn , and P.H. Hindle , Practical NIR Spectroscopy with Applications in Food and Beverage Analysis. F.M.a.B.R. Association, Editor. 1993, Harlow: Longman Scientific and Technical. p. 227.
Harayama, T. and H. Riezman , Understanding the diversity of membrane lipid composition. Nature Reviews Molecular Cell Biology, 2018. 19(5): 281–296.
Calder, P.C. , Very long chain omega-3 (n-3) fatty acids and human health. European Journal of Lipid Science and Technology, 2014. 116(10): 1280–1300.
Calder, P.C. , Marine omega-3 fatty acids and inflammatory processes: effects, mechanisms and clinical relevance. Biochim Biophys Acta, 2015. 1851(4): 469–484.
Calder, P.C. , n-3 PUFA and inflammation: from membrane to nucleus and from bench to bedside. Proceedings of the Nutrition Society, 2020. 79(4): 404–416.
Saini, R.K. and Y.-S. Keum , Omega-3 and omega-6 polyunsaturated fatty acids: dietary sources, metabolism, and significance - a review. Life Sciences, 2018. 203: 255–267.
Fahy, E. , et al ., Update of the LIPID MAPS comprehensive classification system for lipids. Journal of Lipid Research, 2009. 50: S9–S14.
Burton, G.W. , A. Webb , and K.U. Ingold , A mild, rapid, and efficient method of lipid extraction for use in determining vitamin E/lipid ratios. Lipids, 1985. 20(1): 29–39.
Hara, A. and N.S. Radin , Lipid extraction of tissues with a low-toxicity solvent. Analytical Biochemistry, 1978. 90(1): 420–426.
Jensen, S. , et al ., A quantitative lipid extraction method for residue analysis of fish involving nonhalogenated solvents. Journal of Agricultural and Food Chemistry, 2003. 51(19): 5607–5611.
Undeland, I. , M. Härröd , and H. Lingnert , Comparison between methods using low-toxicity solvents for the extraction of lipids from herring (Clupea harengus). Food Chemistry, 1998. 61(3): 355–365.

Woitke, P. , M. Haarich , and U. Harms , Cofactors in Biota: results of a German interlaboratory exercise on the determination of total lipids in fish tissue. Accreditation and Quality Assurance, 2000. 5(12): 499–503.
Christie, W.W. , Advances in Lipid Methodology-Two. 1993, Dundee: Oily Press.
Standard Norway SN, NS 9402-1994 , Atlantic Salmon: Measurement of Colour and Fat. 1994, Oslo, Norway. p.12.
AOAC International . Fat (crude) or ether extract in meat. In Official methods of analysis of AOAC International,15th edn.,Vol. 1, Method 960.39, 1990. Arlington, VA: AOAC International. pp. 69–70.
Bremle, G. , L. Okla , and P. Larsson , Uptake of PCBs in fish in a contaminated river system: bioconcentration factors measured in the field. Environmental Science & Technology, 1995. 29(8): 2010–2015.
Virot, M. , et al ., New microwave-integrated Soxhlet extraction. An advantageous tool for the extraction of lipids from food products. Journal of Chromatography A, 2007. 1174(1–2): 138–144.
Kent, M. , Measurement of dielectric properties of herring flesh using transmission time domain spectroscopy. International Journal of Food Science & Technology, 1990. 25(1): 26–38.
Aursand, M. , et al ., Lipid distribution and composition of commercially farmed Atlantic salmon (Salmo salar). Journal of the Science of Food and Agriculture, 1994. 64(2): 239–248.
Katikou, P. , S.I. Hughes , and D.H.F. Robb , Lipid distribution within Atlantic salmon (Salmo salar) fillets. Aquaculture, 2001. 202(1): 89–99.
Toussaint, C. , et al ., Description of the heterogeneity of lipid distribution in the flesh of brown trout (Salmo trutta) by MR imaging. Aquaculture, 2005. 243(1): 255–267.
Undeland, I. , G. Hall , and H. Lingnert , Lipid oxidation in fillets of herring (Clupea harengus) during ice storage. Journal of Agricultural and Food Chemistry, 1999. 47(2): 524–532.
Jepsen, S.M. , H.T. Pedersen , and S.B. Engelsen , Application of chemometrics to low-field 1H NMR relaxation data of intact fish flesh. Journal of the Science of Food and Agriculture, 1999. 79(13): 1793–1802.
Shimamoto, J. , et al ., Non-destructive determination of fat content in frozen and thawed mackerel by near infrared spectroscopy. Fisheries Science, 2004. 70: 345–347.
Aursand, M. , J.R. Rainuzzo , and H. Grasdalen , Quantitative high-resolution 13C and 1H nuclear magnetic resonance of ω3 fatty acids from white muscle of Atlantic salmon (Salmo salar). Journal of the American Oil Chemists' Society, 1993. 70: 971–981.
Falch, E. , T.R. Størseth , and M. Aursand , Multi-component analysis of marine lipids in fish gonads with emphasis on phospholipids using high resolution NMR spectroscopy. Chemistry and Physics of Lipids, 2006. 144(1): 4–16.
Solberg, C. and G. Fredriksen , Analysis of fat and dry matter in capelin by near infrared transmission spectroscopy. Journal of Near Infrared Spectroscopy, 2001. 9(3): 221–228.
McAdams, D. , Measuring fat by meter. Seafood Int, 1996. 11: 35.
Acton, J.C. and C.L. Rudd , Protein quality methods for seafoods, In Seafood Quality Determination, D.E. Kramer and J. Liston , Editors. 1983, Elsevier: Amsterdam, the Netherlands. pp. 149–166.
De Bhowmick, G. and M. Hayes , In vitro protein digestibility of selected seaweeds. Foods, 2022. 11, doi:10.3390/foods11030289.
FAO/WHO/UNU, FAO/WHO/UNU Expert consultation, energy and protein requirements . World Health Organization Technical Report Series. 1985: Geneva, Switzerland.
Pellett, P.L. and V.R. Young , Nutritional Evaluation of Protein Foods. Publication no. WHTR-3/UNUP-129. 1980, Tokyo, Japan: United Nations University.
Mambrini, M. and S.J. Kaushik , Indispensable amino acid requirements of fish: correspondence between quantitative data and amino acid profiles of tissue proteins. Journal of Applied Ichthyology-Z. Angew. Ichtyol., 1995. 11: 240–247.
Wilson, R.P. , Amino acids and proteins, San Diego, California, In Fish Nutrition, J.E. Halver and R.W. Hardy , Editors. 2002, Academic Press: San Diego, CA. pp. 144–179.
Makkar, H.P.S. , et al ., Seaweeds for livestock diets: a review. Animal Feed Science and Technology, 2016. 212: 1–17.
Alboofetileh, M. , A. Hamzeh , and M. Abdollahi , Seaweed proteins as a source of bioactive peptides. Current Pharmaceutical Design, 2021. 27(11): 1342–1352.
Greenfield, H. and D.A.T. Southgate (Eds.), Chapter 4: Selection of nutrients and other components, In: Food composition data. Production, management, and use, Food and Agriculture Organization of the United Nations (FAO), Rome, 2003, pp 47–62.
Kjeldahl, J. , A new method for the determination of nitrogen in organic matter. Zeitschrift für Analytische Chemie, 1883. 22: 366–382.
Dumas, J.B.A. , Procedes de l'analyse organique. Annals of Chemistry and of Physics, 1831. 247: 198–213.
Simonne, A.H. , et al ., Could the Dumas method replace the Kjeldahl digestion for nitrogen and crude protein determinations in foods? Journal of the Science of Food and Agriculture, 1997. 73(1): 39–45.
Thompson, M. , et al ., A comparison of the Kjeldahl and Dumas methods for the determination of protein in foods, using data from a proficiency testing scheme. Analyst, 2002. 127(12): 1666–1668.
Jung, S. , et al ., Comparison of Kjeldahl and Dumas methods for determining protein contents of soybean products. Journal of the American Oil Chemists' Society, 2003. 80: 1169–1173.

Sosulski, F.W. and G.I. Imafidon , Amino acid composition and nitrogen-to-protein conversion factors for animal and plant foods. Journal of Agricultural and Food Chemistry, 1990. 38(6): 1351–1356.
Gnaiger, E. and G. Bitterlich , Proximate biochemical composition and caloric content calculated from elemental CHN analysis: a stoichiometric concept. Oecologia, 1984. 62(3): 289–298.
Salo-Vaananen, P.P. and P.E. Koivistoinen , Determination of protein in foods: comparison of net protein and crude protein (N × 6.25) values. Food Chemistry, 1996. 57: 27–31.
Jones, D.B. , V.E. Munsey , and L.E. Walker , Report of committee on protein factors. Journal of the Association of Official Agricultural Chemists, 1942. 25: 118–120.
Kamalesh, R. , Seaweeds, an aquatic plant-based protein for sustainable nutrition - a review. Future foods, 2022. 5: 100142.
Forbord, S. , et al ., Latitudinal, seasonal and depth-dependent variation in growth, chemical composition and biofouling of cultivated Saccharina latissima (Phaeophyceae) along the Norwegian coast. Journal of Applied Phycology, 2020. 32(4): 2215–2232.
Lourenço, S.O. , et al ., Amino acid composition, protein content and calculation of nitrogen-to-protein conversion factors for 19 tropical seaweeds. Phycological Research, 2002. 50(3): 233–241.
Lourenço, S.O. , et al ., Distribution of intracellular nitrogen in marine microalgae: calculation of new nitrogen-to-protein conversion factors. European Journal of Phycology, 2004. 39(1): 17–32.
Orban, E. , et al ., New trends in the seafood market. Sutchi catfish (Pangasius hypophthalmus) fillets from Vietnam: nutritional quality and safety aspects. Food Chemistry, 2008. 110(2): 383–389.
Cinquina, A.L. , et al ., Determination of biogenic amines in fish tissues by ion-exchange chromatography with conductivity detection. Journal of Chromatography A, 2004. 1032(1–2): 73–77.
Doeun, D. , M. Davaatseren , and M.S. Chung , Biogenic amines in foods. Food Science and Biotechnology, 2017. 26(6): 1463–1474.
Waterborg, J.H. , The Lowry method for protein quantitation, In The Protein Protocols Handbook, J.M. Walker , Editor. 2002, Humana Press Inc.: Totowa, NJ. pp. 7–10.
Flynn, K.J. , Some practical aspects of measurements of dissolved free amino acids in natural waters and within microalgae by the use of HPLC. Chemistry and Ecology, 1988. 3(4): 269–293.
Qureshi, G.A. and A.R. Qureshi , Determination of free amino acids in biological samples: problems of quantitation. Journal of Chromatography, 1989. 491(2): 281–289.
Duun, A.S. and T. Rustad , Quality changes during superchilled storage of cod (Gadus morhua) fillets. Food Chemistry, 2007. 105(3): 1067–1075.
Ishida, Y. , T. Fujita , and K. Asai , New detection and separation method for amino acids by high-performance liquid chromatography. Journal of Chromatography, 1981. 204: 143–148.
Blundell, G. and W.G. Brydon , High performance liquid chromatography of plasma amino acids using orthophthalaldehyde derivatisation. Clinica Chimica Acta, 1987. 170: 79–84.
Butikofer, U. , et al ., Automated HPLC-amino acid determination of protein hydrolysates by precolumn derivatisation with OPA and FMOC and comparison with classical ion exchange chromatography. Chromatographia, 1991. 31: 441–447.
Wu, T. and L. Mao , Influences of hot air drying and microwave drying on nutritional and odourous properties of grass carp (Ctenopharyngodon idellus) filets. Food Chemistry, 2008. 110: 647–653.
Hamilton, P.B. and R.A. Anderson , Ion-exchange chromatography of amino acids-semi-automatic method of operation with cationic-exchange resin columns. Analytical Chemistry, 1959. 31: 1504–1512.
Benson, J.R. and P.E. Hare , O-phthalaldehyde: fluorogenic detection of primary amines in the picomole range. Comparison with fluorescamine and ninhydrin. Proceedings of the National Academy of Sciences United States of America, 1975. 72(2): 619–622.
Schuster, R. , Determination of amino acids in biological, pharmaceutical, plant and food samples by automated precolumn derivatization and high-performance liquid chromatography. Journal of Chromatography, 1988. 431(2): 271–284.
Adams, E. and L. Frank , Metabolism of proline and the hydroxyprolines. Annual Review of Biochemistry, 1980. 49: 1005–1061.
Dugan, M.E.R. , et al ., Analysis of 4-hydroxyproline using 4-chloro-7-nitrobenzo-2-oxa-1,3-diazol derivatization and micellar electrokinetic chromatography combined with laser-induced fluorescence detection. Journal of Chromatography B: Biomedical Sciences and Applications, 2000. 744(1): 195–199.
Welch, R.W. , I. Acworth , and M. Levine , Coulometric electrochemical detection of hydroxyproline using 7-chloro-4-nitrobenzo-2-oxa-1,3-diazole. Analytical Biochemistry, 1993. 210(1): 199–205.
Langrock, T. , N. García-Villar , and R. Hoffmann , Analysis of hydroxyproline isomers and hydroxylysine by reversed-phase HPLC and mass spectrometry. Journal of Chromatography. B Analytical Technologies in Biomedical and Life Sciences, 2007. 847(2): 282–288.
Wold, J.P. , F. Lundby , and B. Egelandsdal , Quantification of connective tissue (hydroxyproline) in ground beef by autofluorescence spectroscopy. Journal of Food Science, 1999. 64(3): 377–383.
Intarasirisawat, R. , et al ., Autolysis study of big eye snapper (Priacanthus macracanthus) skin and its effects on gelatin. Food Hydrocolloids, 2007. 21: 537–544.

Bergman, I. and R. Loxley , Two improved and simplified methods for the spectrophotometric determination of hydroxyproline. Analytical Chemistry, 1963. 35: 1961–1965.
Simpson, R.J. , M.R. Neuberger , and T.Y. Liu , Complete amino acid analysis of proteins from a single hydrolysate. Journal of Biological Chemistry, 1976. 251(7): 1936–1940.
Chiou, S.H. and K.T. Wang , Simplified protein hydrolysis with methanesulphonic acid at elevated temperature for the complete amino acid analysis of proteins. Journal of Chromatography, 1988. 448(3): 404–410.
Campanella, L. , G. Crescentini , and P. Avino , Simultaneous determination of cysteine, cystine and 18 other amino acids in various matrices by high-performance liquid chromatography. Journal of Chromatography A, 1999. 833(2): 137–145.
Rutherfurd, S.M. , Amino acids analysis of plant products, In Amino Acids in Higher Plants, J.P.F. D’Mello, Editor. 2015, CABI, Wallingford, UK. pp. 1–29.
Vacha, F. , M. Krizek , and T. Pavlieck , Content of biogenic amines in common carp (Cyprinus carpio). Towards a Predictable Quality. Aquaculture Europe. 1999: Trondheim, Norway.
Özogul, F. , et al ., Biogenic amines formation in Atlantic herring (Clupea harengus) stored under modified atmosphere packaging using a rapid HPLC method. International Journal of Food Science & Technology, 2002. 37(5): 515–522.
Korös, A. , et al ., Analysis of amino acids and biogenic amines in biological tissues as their o-phthalaldehyde/ethanethiol/fluorenylmethyl chloroformate derivatives by high-performance liquid chromatography. A deproteinization study. Journal of Chromatography A, 2007. 1149(1): 46–55.
Krause, I. , et al ., Simultaneous determination of amino acids and biogenic amines by reversed-phase high-performance liquid chromatography of the dabsyl derivatives. Journal of Chromatography A, 1995. 715(1): 67–79.
Pereira, V. , et al ., Simultaneous analysis of free amino acids and biogenic amines in honey and wine samples using in loop orthophthalaldehyde derivatization procedure. Journal of Chromatography A, 2008. 1189(1–2): 435–443.
Glencross, B. , et al ., Assessing the implications of variability in the digestible protein and energy value of lupin kernel meals when fed to rainbow trout, Oncorhynchus mykiss. Aquaculture, 2008. 277(3): 251–262.
Berge, G.E. , H. Sveier , and E. Lied , Nutrition on Atlantic salmon (Salmon salar); the requirements and metabolic effect of lysine. Comparative Biochemistry and Physiology Part A, 1998. 120: 477–485.
Refstie, S. , et al ., Capacity for digestive hydrolysis and amino acid absorption in Atlantic salmon (Salmo salar) fed diets with soybean meal or inulin with or without addition of antibiotics. Aquaculture, 2006. 261: 392–406.
Espe, M. , et al ., Assessment of lysine requirement for maximal protein accretion in Atlantic salmon using plant protein diets. Aquaculture, 2007. 263(1): 168–178.
Conceição, L.E. , H. Grasdalen , and M.T. Dinis , A new method to estimate the relative bioavailability of individual amino acids in fish larvae using 13C-NMR spectroscopy. Comparative Biochemistry and Physiology Part B Biochemistry and Molecular Biology, 2003. 134(1): 103–109.
Cozzolino, D. , I. Murray , and J.R. Scaife , Near infrared reflectance spectroscopy in the prediction of chemical characteristics of minced raw fish. Aquaculture Nutrition, 2002. 8(1): 1–6.
Cheng, J. and D. Sun , Partial least squares regression (PLSR) applied to NIR and HSI spectral data modeling to predict chemical properties of fish muscle. Food Engineering Review, 2017. 9: 36–49.
Benešová, L. , et al ., Application of FT-NIR spectroscopy as a rapid tool for analysis of the fish fillet chemical composition. Czech Journal of Food Sciences, 2022. 40: 359–366.
Chen, Y. , et al ., Recent advances for rapid identification of chemical information of muscle foods by hyperspectral imaging analysis. Food Engineering Review, 2016. 8: 336–350.
Ahmed, I. , et al ., Muscle proximate composition of various food fish species and their nutritional significance: a review. Journal of Animal Physiology and Animal Nutrition (Berl), 2022. 106(3): 690–719.
Kimura, S. , Studies on marine invertebrate collagens. V. The neutral sugar composition and glucosylated hydroxylysine contents of several collagens. Bulletin of the Japanese Society for the Science of Fish, 1972. 38: 1153.
Syakilla, N. , et al ., A review on nutrients, phytochemicals, and health benefits of green seaweed, Caulerpa lentillifera. Foods, 2022. 11(18): 2832.
Premarathna, A.D. , et al ., Comparative analysis of proximate compositions, mineral and functional chemical groups of 15 different seaweed species. Scientific Reports, 2022. 12(1): 19610.
El-Beltagi, H.S. , et al ., Phytochemical and potential properties of seaweeds and their recent applications: a review. Marine Drugs, 2022. 20(6): 342.
Ansell, A.D. , Storage and utilization of reserves in Pectinid bivalves with particular reference to the adductor muscle. Proceedings of the Scallop Workshop. 1978. Brest, France.
Epp, J. , V.M. Bricelj , and R.E. Malouf , Seasonal partitioning and utilization of energy reserves in two age classes of the bay scallop Argopecten irradians irradians (Lamarck). Journal of Experimental Marine Biology and Ecology, 1988. 121(2): 113–136.
de Zwaan, A. and D.I. Zandee , Body distribution and seasonal changes in the glycogen content of the common sea mussel Mytilus edulis. Comparative Biochemistry and Physiology Part A: Physiology, 1972. 43(1): 53–58.

Dare, P.J. and D.B. Edwards , Seasonal changes in flesh weight and biochemical composition of mussels (Mytilus edulis L.) in the Conwy Estuary, North Wales. Journal of Experimental Marine Biology and Ecology, 1975. 18(2): 89–97.
Monro, J. and B. Burlingame , Carbohydrates and related food components: INFOODS tag names, meanings, and uses. Journal of Food Composition and Analysis, 1996. 9: 100–118.
Hagen Rødde, R.S. , et al ., Seasonal and geographical variation in the chemical composition of the red alga Palmaria palmata (L.) Kuntze. Botanica Marina, 2004. 47: 125–133.
Østgaard, K. , Enzymatic microassay for the determination and characterization of alginates. Carbohydrate Polymers, 1992. 19(1): 51–59.
Allen, V.J. , et al ., The effects of tactile stimulants on feeding, growth, behaviour, and meat quality of cultures Blackfoot abalone, Haliotis iris. Aquaculture, 2006. 257: 294–308.
Carroll, N.V. , R.W. Longley , and J.H. Roe , The determination of glycogen in liver and muscle by use of anthrone reagent. The Journal of Biological Chemistry, 1956. 220(2): 583–593.
Templeton, M.C. , Microdetermination of glycogen with anthrone reagent, Northwestern University, Dept. Medical Anatomy, Publn no. 658. The Journal of Histochemistry and Cytochemistry, 1961. 9: 670–672.
Van Handel, E. , Estimation of glycogen in small amounts of tissue. Analytical Biochemistry, 1965. 11(2): 256–265.
Beltran-Lugo, A.I. , et al ., Seasonal variations in chemical, physical, textural, and microstructural properties of adductor muscles of Pacific lions-paw scallop (Nodipecten subnodosus). Aquaculture, 2006. 258: 619–632.
Ferreira, I. , et al ., The chemical composition and lipid profile of the chub mackerel (Scomber colias) show a strong seasonal dependence: contribution to a nutritional evaluation. Biochimie, 2020. 178: 181–189.
Bandarra, N.M. , et al ., Seasonal variation in the chemical composition of horse-mackerel (Trachurus trachurus). European Food Research and Technology, 2001. 212(5): 535–539.
Soriguer, F. , et al ., Lipid, protein, and calorie content of different Atlantic and Mediterranean fish, shellfish, and molluscs commonly eaten in the south of Spain. European Journal of Epidemiology, 1997. 13(4): 451–463.
Miller, D.S. and P.R. Payne , A ballistic bomb calorimeter. British Journal of Nutrition, 1959. 13(4): 501–508.
Craig, J.F. , M.J. Kenley , and J.F. Talling , Comparative estimations of the energy content of fish tissue from bomb calorimetry, wet oxidation and proximate analysis. Freshwater Biology, 1978. 8(6): 585–590.
Henken, A.M. , et al ., A comparison between methods used to determine the energy content of feed, fish and faeces samples. Aquaculture, 1986. 58(3): 195–201.
Charrondiere, U.R. , et al ., Impact of different macronutrient definitions and energy conversion factors on energy supply estimations. Journal of Food Composition and Analysis, 2004. 17(3): 339–360.
FAO, Food energy-methods of analysis and conversion factors. Report of a technical workshop . In FAO Food and Nutritional Paper. 2003, FAO: Rome. pp. 18–56.
Atwater, W.O. and C.D. Woods , The Chemical Composition of American Food Materials. Bulletin 28. 1896, U.S.D.o.A.O.o.E. Stations. Washington DC: Government Printing Office.
Southgate, D.A.T. and J.V.G.A. Durnin , Calorie conversion factors. An experimental reassessment of the factors used in the calculation of the energy value of human diets. British Journal of Nutrition, 1970. 24(2): 517–535.
Merrill, A.L. and B.K. Watt , Energy value of foods, basis and derivation, In Agriculture Handbook, Vol. 73. 1973, U.S. Department of Agriculture: Washington, DC. pp. 8–23.
FAO/WHO, Carbohydrates in human nutrition . Report of a joint FAO/WHO expert consultation, FAO Food and Nutrition Paper, 1998. 66: 1–140: Rome.
Jones, D.B. , Factors for converting percentages of nitrogen in foods and feeds into percentages of proteins. United States Department of Agriculture Circular. 1941: Washington, DC.
Elftman, H. , Bioenergetics and growth. By Samuel Brody. Reinhold Publishing Corp., New York, xii + 1023 pp., 1945 ($8.50). American Journal of Physical Anthropology, 1946. 4(1): 116–117.
Krishnamoorthy, R.V. , et al ., Caloric densities of shellfish meat and meat fats. Journal of Agricultural and Food Chemistry, 1979. 27(5): 1125–1127.
Newell, R.I.E. , An evaluation of the wet oxidation technique for use in determining the energy seston samples. Canadian Journal of Fisheries and Aquatic Sciences, 1982. 39: 1383–1388.
European Commission, Communication from the commission to the European parliament, The council, The European economic and social committee and the committee of the regions. A Farm to Fork Strategy for a Fair, Healthy and Environmentally-Friendly Food system, 2020,COM/2020/381 final, Brussels. 20.5.2020.
Peonides, M. , et al ., Food labeling in the European Union: a review of existing approaches. International Journal of Health Governance, 2022. 27(4): 460–468.
Dréano-Trécant, L. , et al . Performance of the front-of-pack nutrition label Nutri-Score to discriminate the nutritional quality of foods products: a comparative study across 8 European countries. Nutrients, 2020. 12, doi:10.3390/nu12051303.

Essential Amino Acids

Ahmed, J. , Habeebullah, S.F.K. , Alagarsamy, S. , et al . High-pressure treatment of silver pomfret (Pampus argenteus): inactivation of Listeria monocytogenes, impact on amino acid profile, and changes during storage. J. Food Process. Preserv. 45, 15296, 2021.

Albin, D.M. , Wubben, J.E. , Gabert, V.M. Effect of hydrolysis time on the determination of amino acids in samples of soybean products with ion-exchange chromatography or precolumn derivatization with phenyl isothiocyanate. J. Agric. Food Chem. 48, 1684–1691, 2000.

Alegría, A. , Barbera, R. , Farre, R. , et al . HPLC method for cyst(e)ine and methionine in infant formulas. J. Food Sci. 61, 1132–1135, 1170, 1996.

Álvarez-Coque, M.C.G. , Hernández, M.J.M. , Camanas, R.M.V. , et al . Formation and instability of ortho-phthalaldehyde derivatives of amino acids. Anal. Biochem. 178, 1–7, 1989.

Ambler, R.P. Standards and accuracy in amino acid analysis. In: J.M. Rattenbury , ed. Amino Acid Analysis, Chichester, UK: Ellis Horwood, 1981, pp. 119–137.

Antoine, F.R. , Wei, C.I. , Littell, R.C. , et al . HPLC method for analysis of free amino acids in fish using o-phthaldialdehyde precolumn derivatization. J. Agric. Food Chem. 47, 5100–5107, 1999.

Arellano, M. , Simeon, N. , Puig, P. , et al . Several applications of capillary electrophoresis for wines analysis. Quantitation of organic and inorganic acids, inorganic cations, amino acids and biogenic amines. J. Int. Sci. Vigne Vin. 31, 213–218, 1997.

Aristoy, M.C. , Toldrá, F. Deproteinization techniques for HPLC amino acid analysis in fresh pork muscle and dry-cured ham. J. Agric. Food Chem. 39, 1792–1795, 1991.

Aristoy, M.C. , Toldrá, F. Amino acids. In: L.M.L. Nollet , ed., Handbook of Food Analysis, Vol 1, New York: Marcel Dekker, Inc., 2004, pp. 5-83 to 5-123.

Aristoy, M.C. , Toldrá, F. Amino acids in foods, feeds, and nutrition. In: C. Ley , ed., Kirk-Othmer Encyclopedia of Chemical Technology, John Wiley & Sons, Inc., 2021. doi:10.1002/0471238961.koe00058.

Arnold, U. , Ludiwg, E. , Kuhn, R. , et al . Analysis of free amino acids in green coffee beans. I. Determination of amino acids after precolumn derivatisation using 9-fluorenylmethylchloroformate. Z. Lebensm. Unters. Forsch. 199, 22–25, 1994.

Ashworth, R.B. Amino acids analysis for meat protein evaluation. J. Assoc. Off. Anal. Chem. 70, 80–85, 1987a.

Ashworth, R.B. Ion-exchange separation of amino acids with postcolumn orthophthalaldehyde detection. J. Assoc. Off. Anal. Chem. 70, 248–252, 1987b.

Badawy, A.A.-B. , Morgan, C.J. , Turner, J.A. Application of the Phenomenex EZ:faast trade mark amino acid analysis kit for rapid gas-chromatographic determination of concentrations of plasma tryptophan and its brain uptake competitors. Amino Acids 34, 587–596, 2008.

Bëtner, I. , Foldi, P. The FMOC-ADAM approach to amino acid analysis. LC-GC Int. 6, 832–840. 1988.

Bidlingmeyer, B.A. , Cohen, S.A. , Tarvin, T.L. Rapid analysis of amino acids using pre-column derivatization. J. Chromatogr. 336, 93–104, 1984.

Bidlingmeyer, B.A. , Cohen, S.A. , Tarvin, T.L. , et al . New rapid high sensitivity analysis of amino acids in food type samples. J. Assoc. Off. Anal. Chem. 70, 241–247, 1987.

Blanchard, J. Evaluation of the relative efficacy of various techniques for deproteinizing plasma samples prior to high-performance liquid chromatographic analysis. J. Chromatogr. Biomed. Appl. 226, 455–460, 1981.

Boogers, I. , Plugge, W. , Stokkermans, Y.Q. , et al . Ultra-performance liquid chromatographic analysis of amino acids in protein hydrolysates using an automated pre-column derivatisation method. J. Cromatogr. A, 1189, 406–409, 2008.

Bosch, L. , Alegría, A. , Farré, R. Application of the 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate (AQC) reagent to the RP-HPLC determination of amino acids in infant formula. J. Cromatogr. B 831, 176–183, 2006.

Bradbury, A.F. , Smith, D.G. The use of 3-bromopropionic acid for the determination of protein thiol groups. J. Biochem. 131, 637–642, 1973.

Brüeckner, H. , Schieber, A. Determination of free D-amino acids in Mammalia by gas chromatography-mass spectrometry. HRC. 23, 576–582, 2000.

Büetikofer, U. , Ardö, Y. Quantitative determination of free amino acids in cheese. Bull. Int. Dairy Fed. 337, 24–32, 1999.

Burton, C. Fully automated amino acid analysis using precolumn derivatization. Int. Lab. 30, 32–34, 36, 38, 1986.

Burton, D.E. , Sepaniak, M.J. , Maskarinec, M.P. Analysis of B6 vitamers by micellar electrokinetic capillary chromatography with laser-excited fluorescence detection. J. Chromatogr. Sci. 24, 347–351, 1986.

Buser, W. , Erbersdobler, H.F. Determination of amino acids by gas-liquid chromatography and nitrogen selective detection. Z. Lebensm. Unters. Forsch. 186, 509–513, 1988.

Castagnola, D.V. , Rossetti, D.V. , Cassiano, L. , et al . Optimization of phenylthiohydantoin amino acid separation by micellar electrokinetic capillary chromatography. J. Chromatogr. 638, 327–333, 1993.

Cavazza, A. , Corradini, C. , Lauria, A. , et al . Rapid analysis of essential and branched-chain amino acids in nutraceutical products by micellar electrokinetic capillary chromatography. J. Agric. Food Chem. 48, 3324–3329, 2000.

Chang, J.Y. , Knecht, R. , Braun, D.G. Amino acid analysis in the picomole range by precolumn derivatization and high-performance liquid chromatography. Meth. Enzymol. 91, 41–48, 1983.

Chen, N. , Terabe, S. , Nakagawa, T. Effect of organic modifier concentrations in micellar electrokinetic chromatography. Electrophoresis 16, 1457–1462, 1995.

Chen, S. , Liu, J.Q. , Xiao, H. , et al . Simultaneous qualitative assessment and quantitative analysis of metabolites (phenolics, nucleosides and amino acids) from the roots of fresh *Gastrodia elata* using UPLC-ESI-triple quadrupole ion MS and ESI-linear ion trap high-resolution MS. Plos One 11, e0150647, 2016.

Chen, Z.B. , Lin, F.Y. , Ye, X.M. , et al . Simultaneous determination of five essential amino acids in plasma of hyperlipidemic subjects by UPLC-MS/MS. Lipids Health Dis. 19, 52, 2020.

Cobas, N. , Gómez-Limia, L. , Franco, I. , et al . Amino acid profile and protein quality related to canning and storage of swordfish packed in different filling media. J. Food Comp. Anal. 107, 104328, 2022.

Cohen, S.A. , Strydon, J. Amino acid analysis utilizing phenylisothiocyanate derivatives. Anal. Biochem. 174, 1–16, 1988.

Coroneo, V. , Corrias, F. , Brutti, A. , et al . Effect of high-pressure processing on fresh sea urchin gonads in terms of shelf life, chemical composition, and microbiological properties. Foods 11, 260, 2022.

Corradini, C. , Cavazza, A. Application of capillary zone electrophoresis (CZE) and micellar electrokinetic chromatography (MEKC) in food analysis. It. J. Food Sci. 10, 299–316, 1998.

Dôgan, G. , Ertan, O.O. Determination of amino acid and fatty acid composition of goldband goatfish [Upeneus moluccensis (Bleeker, 1855)] fishing from the Gulf of Antalya (Turkey). Int. Aquat. Res. 9, 313–327, 2017.

Duan, Z. , Dong, S. , Elkin, Y.D. , et al . Geographical origin identification of two salmonid species via flavor compound analysis using headspace-gas chromatography-ion mobility spectrometry combined with electronic nose and tongue. Food Res. Int. 145, 110385, 2021.

Euerby, M.R. Effect of differing thiols on the reversed-phase high-performance liquid chromatographic behaviour of o-phthaldialdehyde-thiol-amino acids. J. Chromatogr. 454, 398–405, 1988.

Fiechter, G. , Sieve, G. , and Mayer, H.K. 2013. Application of UHPLC for the simultaneous analysis of free amino acids and biogenic amines in ripened acid-curd cheeses. J. Chromatogr. B 927, 191–200, 2013.

Francioso, A. , Fanelli, S. , Vigli, D. , et al . HPLC determination of bioactive sulfur compounds, amino acids and biogenic amines in biological specimens. In: Lee, DH ., Schaffer, S.W. , Park, E. , Kim, H.W. (eds.) Taurine 10. Advances in Experimental Medicine and Biology, Springer, Dordrecht. 975, 535–549, 2017.

Fullmer, C.S. Identification of cysteine-containing peptides in protein digests by high-performance liquid chromatography. Anal. Biochem. 142, 336–339, 1984.

Fürst, P. , Pollack, L. , Graser, T.A. , et al . HPLC analysis of free amino acids in biological material - an appraisal of four pre-column derivatization methods. J. Liq. Chromatogr. 12, 2733–2760, 1989.

García, S.E. , Baxter, J.H. Determination of tryptophan content in infant formulas and medical nutritionals. J. Assoc. Off. Anal. Chem. Int. 75, 1112–1119, 1992.

Gehrke, C.W. , Rexroad, P.R. , Schisla, R.M. , et al . Quantitative analysis of cystine, methionine, lysine, and nine other amino acids by a single oxidation-4 hours hydrolysis method. J. Assoc. Off. Anal. Chem. 70, 171–174, 1987.

Gehrke, C.W. , Wall, L.L. , Absheer, J.S. , et al . Sample preparation for chromatography of amino acids: acid hydrolysis of proteins. J. Assoc. Off. Anal. Chem. 68, 811–821, 1985.

Godel, H. , Graser, T. , Foldi, P. , et al . Measurement of free amino acids in human biological fluids by high-performance liquid chromatography. J. Chromatogr. 297, 49–61, 1984.

Godel, H. , Seitz, P. , Verhoef, M. Automated amino acid analysis using combined OPA and FMOC-Cl precolumn derivatization. LC-GC Intl. 5, 44–49, 1992.

Grumbach, E.S. , Wagrowski-Diehl, D.M. , Mazzeo, J.R. , et al . Hydrophilic interaction chromatography using silica columns for the retention of polar analytes and enhanced ESI-MS sensitivity. LCGC North America 22, 1010–1023. 2004.

Grunau, J.A. , Swiader, J.M. Chromatography of 99 amino acids and other ninhydrin-reactive compounds in the Pickering lithium gradient system. J. Chromatogr. 594, 165–171, 1992.

Guo, S. , Duan, J. , Qian, D. , et al . Rapid determination of amino acids in fruits of Ziziphus jujube by hydrophilic interaction ultra-high-performance liquid chromatography coupled with triple-quadrupole mass. J. Agric. Food Chem. 61, 2709–2719, 2013.

Gurd, F.R.N. Carboxymethylation. Meth. Enzymol. 25, 424–438. 1972.

Hagen, S.R. , Augustin, J. , Grings, E. , et al . Precolumn phenylisothiocyanate derivatization and liquid chromatography of free amino acids in biological samples. Food Chem. 16, 319–323, 1993.

Hale, J.E. , Beidler, D.E. , Jue, R.A. Quantitation of cysteine residues alkylated with 3-bromopropylamine by amino acid analysis. Anal. Biochem. 216, 61–66, 1994.

Harada, Y. , Ito, S. , Ogawa, N.O. , et al . Compound-specific nitrogen isotope analysis of amino acids in eye lenses as a new tool to reconstruct the geographic and trophic histories of fish. Front. Mar. Sci. 8, 2021, 2022.

Hayashi, T. , Yamaguchi, K. , Konosu, S. Sensory analysis of taste-active components in the extract of boiled snow crab meat. J. Food Sci. 46, 479–483, 1981.
Hirs, C.H.W. Performic acid oxidation. Methods Enzymol. 11, 197–199, 1967.
Hugli, T.E. , Moore, S. Determination of the tryptophan content of proteins by ion-exchange chromatography of alkaline hydrolysates. J. Biol. Chem. 247, 2828–2834, 1972.
Iordache, A. , Horj, E. , Toma, A. , et al . Determination of amino acid composition of two carp species by GC-MS. Asian J. Chem. 23, 4757–4760, 2011.
Issaq, H.J. , Chan, K.C. Separation and detection of amino acids and their enantiomers by capillary electrophoresis: a review. Electrophoresis 16, 467–480, 1995.
Izco, J.M. , Torre, P. , Barcina, Y. Ripening of Ossau-Iraty cheese: determination of free amino acids by RP-HPLC and of total free amino acids by the TNBS method. Food Control 11, 7–11, 2000.
Jandasek, J. , Kracmar, S. , Milerski, M , et al . Comparison of the contents of intramuscular amino acids in different lamb hybrids. Czech J. Animal Sci. 48, 301–306, 2003.
Jansen, E.H.J.M. , Vandenberg, R.H. , Bothmiedema, R. , et al . Advantages and limitations of precolumn derivatization of amino acids with dabsyl chloride. J. Chromatogr. 553, 123–133, 1991.
Jarret, H.W. , Cooksy, K.D. , Ellis, B. , et al . The separation of ortho-phthalaldehyde derivatives of amino acids by reversed-phase chromatography on octyl silica columns. Anal. Biochem. 153, 189–198, 1986.
Jia, S. , Kang, Y.P. , Park, J.H. , et al . Simultaneous determination of 23 amino acids and 7 biogenic amines in fermented food samples by liquid chromatography/quadrupole time-of-flight mass spectrometry. J. Chromatogr. A 1218, 9174–9182, 2011.
Jorgenson, J.W. , Lukacs, K.D. Free-zone electrophoresis in glass capillaries. Clin. Chim. 27, 1551–1553, 1981.
Jorgenson, J.W. , Lukacs, K.D. Capillary zone electrophoresis. Science 222(4621), 266–272, 1983.
Kabelová, I. , Dvořáková, M. , Čížková, H. , et al . Determination of free amino acids in cheeses from the Czech market. Czech J. Food Sci. 27, 143–150, 2009.
Kaspar, H. , Dettner, K. , Gronwald, W. , et al . Automated GC-MS analysis of free amino acids in biological fluids. J. Chromatogr. B 870, 222–232, 2008.
Kataoka, H. , Sakiyama, N. , Makita, M. Distribution and contents of free o-phosphoamino acids in animal-tissues. J. Biochem. 109, 577–580, 1991.
Kwanyuen, P.A. , Burton, J.W. Modified amino acid analysis using PITC derivatization for soybeans with accurate determination of cysteine and half-cystine. J. Am. Oil Chem. Soc. 87, 127–132, 2010.
Lee, J. , Harnly, J.M. Free amino acid and cysteine sulfoxide composition of 11 garlic (Allium sativum L.) cultivars by gas chromatography with flame ionization and mass selective detection. J. Agric. Food Chem. 53, 9100–9104, 2005.
Li, R. , Sun, Z. , Zhao, Y. , et al . Effect of different thermal processing methods on water-soluble taste substances of tilapia fillets. J. Food Comp. Anal. 106, 104298. 2022.
Liaset, B. , Espe, M. Nutritional composition of soluble and insoluble fractions obtained by enzymatic hydrolysis of fish-raw materials. Proc. Biochem. 43, 42, 2008.
Liaset, B. , Julshamn, K. , Espe, M. Chemical composition and theoretical nutritional evaluation of the produced fractions from enzymic hydrolysis of salmon frames with Protamex™. Process Biochem. 38, 1747–1759, 2003.
Limin, L. , Feng, X. , Jing, H. Amino acids composition difference and nutritive evaluation of the muscle of five species of marine fish, Pseudosciaena crocea (large yellow croaker), Lateolabrax japonicus (common sea perch), Pagrosomus major (red seabream), Seriola dumerili (Dumeril's amberjack) and Hapalogenys nitens (black grunt) from Xiamen Bay of China. Aq. Nutr. 12, 53–59, 2006.
Liu, H. , Sanuda-Pena, M.C. , Harvey-White, J.D. , et al . Determination of submicromolar concentrations of neurotransmitter amino acids by fluorescence detection using a modification of the 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate method for amino acid analysis. J. Chromatogr. A 828, 383–395, 1998.
Liu, J. , Cobb, K.A. , Novotny, M. , et al . Separation of pre-column ortho-phthalaldehyde-derivatized amino acids by capillary zone electrophoresis with normal and micellar solutions in the presence of organic modifiers. J. Chromatogr. 468, 55–65, 1989.
Liu, J.K. , Chang, J.Y. Chromophore labelling of amino acids with 4-dimethyl-aminoazobenzene-4′-sulfonyl chloride. Anal. Chem. 47, 1634–1638, 1975.
Lucas, B. , Sotelo, A. Amino acid determination in pure proteins, foods, and feeds using two different acid hydrolysis methods. Anal. Biochem. 123, 349–356, 1982.
Mabuchi, R. , Adachi, M. , Ishimaru, A. , et al . Changes in metabolic profiles of yellowtail (Seriola quinqueradiata) muscle during cold storage as a freshness evaluation tool based on GC-MS metabolomics. Foods 8, 511, 2019.
Martín, P. , Polo, C. , Cabezudo, M.D. , et al . Dansyl amino-acids behavior on a Radial Pak C-18 column. Derivatization of grape wine musts, wines and wine vinegar. J. Liq. Chromatogr. 7, 539–558, 1984.
Matsubara, N. , Terabe, S. Separation of 24 dansyl amino acids by capillary electrophoresis with a non-ionic surfactant. J. Chromatogr. A 680, 311–315, 1994.
Matsubara, N. , Terabe, S. Micellar electrokinetic chromatography. Meth. Enzymol. 270, 319–341, 1996.

Mendes, R. , Goncalves, A. , Nunes, M.L. Changes in free amino acids and biogenic amines during ripening of fresh and frozen sardine. J. Food Biochem. 23, 295–306, 1999.
Michel, M. , Salvador, C. , Wiedemair, V. , et al . Method comparison of HPLC-ninhydrin-photometry and UHPLC-PITC-tandem mass spectrometry for serum amino acid analyses in patients with complex congenital heart disease and controls. Metabolomics 16, 128, 2020.
Mohanty, B. , Mahanty, A. , Ganguly, S. , et al . Amino acid compositions of 27 food fishes and their importance in clinical nutrition. J. Amino Acids 2014: 269797. doi:10.1155/2014/269797.
Molnár-Perl, I. , Khalifa, M. Tryptophan analysis simultaneously with other amino acids in gas phase hydrochloric acid hydrolyzates using the Pico-Tag(tm) work station. Chromatographia 36, 43–46, 1993.
Molnár-Perl, I. , Khalifa, M. Analysis of foodstuff amino acids using vapour-phase hydrolysis. LC-GC Int. 7, 395–398, 1994.
Moore, S. , Stein, W.H. Photometric ninhydrin method for use in the chromatography of amino acids. J. Biol. Chem. 176, 367–388, 1948.
Moore, S. , Stein, W.H. Chromatography of amino acids on sulfonated polystyrene resins. J. Biol.Chem. 192, 663–681, 1951.
Morel, M.H. , Bonicel, J. Determination of the number of cysteine residues in high molecular weight subunits of wheat glutenin. Electrophoresis 17, 493–496, 1996.
Noga, S. , Bocian, S. , Buszewski, B. Hydrophilic interaction liquid chromatography columns classification by effect of solvation and chemometric methods. J. Chromatogr. A 1278, 89–97, 2013.
Novotny, M.V. , Cobb, K.A. , Liu, J. Recent advances in capillary electrophoresis of proteins, peptides and amino acids. Electrophoresis 11, 735–749, 1990.
Oh, C.H. , Kim, J.H. , Kim, K.R. , et al . Simultaneous gas chromatographic analysis of non-protein and protein amino acids as N(O,S)-isobutyloxycarbonyl tert-butyldimethylsilyl derivatives. J. Chromatogr. A 669, 125–137, 1994.
Oh, C.H. , Kim, J.H. , Kim, K.R. , et al . Rapid gas chromatographic screening of edible seeds, nuts and beans for non-protein and protein amino acids. J. Chromatogr. A 708, 131–141, 1995.
Otsuka, K. , Terabe, S. Effect of methanol and urea on optical resolution of phenylthiohydantoin-DL-amino acids by micellar electrokinetic chromatography with sodium N-dodecanoyl-L-valinate. Electrophoresis 11, 982–984, 1990.
Otsuka, K. , Terabe, S. , Ando, T. Electrokinetic chromatography with micellar solutions separation of phenylthiohydantoin-amino acids. J. Chromatogr. 332, 219–226, 1985.
Prieto, J.A. , Collar, C. , Benedito de Barber , C. Reversed-phase high-performance liquid chromatographic determination of biochemical changes in free amino acids during wheat flour mixing and bread baking. J. Chrom. Sci. 28, 572–577, 1990.
Pripis-Nicolau, L. , de Revel, G. , Marchand, S. , et al . Automated HPLC method for the measurement of free amino acids including cysteine in musts and wines; first applications. J. Sci. Food Agric. 81, 731–738, 2001.
Qiu, Y. , Su, M. , Liu, Y. , et al . Application of ethyl chloroformate derivatization for gas chromatography-mass spectrometry based metabonomic profiling. Anal. Chim. Acta 583, 277–283, 2007.
Reddy, B.S. , Chary, V.N. , Pavankumar, P. , et al . Characterization of N-methylated amino acids by GC-MS after ethyl chloroformate derivatization. J. Mass Spectrom. 51, 638–650, 2016.
Rosa, R. , Calado, R. , Andrade, A.M. , et al . Changes in amino acids and lipids during embryogenesis of European lobster, Homarus gammarus (Crustacea: Decapoda). Comp. Biochem. Physiol. B Biochem. Mol. 140, 241–249, 2005.
Rosa, R. , Nunes, M.L. Nutritional quality of red shrimp, Aristeus antennatus (Risso), pink shrimp, Parapenaeus longirostris (Lucas), and Norway lobster, Nephrops norvegicus (Linnaeus). J. Sci. Food Agric. 84, 89–94, 2004.
Ruiz-Capillas, C. , Moral, A. Changes in free amino acids during chilled storage of hake (Merluccius merluccius, L.) in controlled atmospheres and their use as a quality control index. Eur. Food Res. Techn. A 212, 302–307, 2001.
Ruiz-Capillas, C. , Moral, A. Effect of controlled and modified atmospheres on the production of biogenic amines and free amino acids during storage of hake. Eur. Food Res. Technol. A 214, 476–481, 2002.
Ruiz-Capillas, C. , Moral, A. Free amino acids in muscle of Norway lobster (Nephrops norvegicus (L.) in controlled and modified atmospheres during chilled storage. Food Chem. 86, 85–91, 2004.
Sakaguchi, M. , Murata, M. , Kawai, A. Changes in free amino acids and creatine contents in yellowtail (Seriola quinqueradiata) muscle during ice storage. J. Food Sci. 47, 1662–1666, 1982.
Sarwar, G. , Botting, H.G. Rapid analysis of nutritionally important free amino acids in serum and organs (liver, brain, and heart) by liquid chromatography of precolumn phenylisothiocyanate. J. Assoc. Off. Anal. Chem. 73, 470–475, 1990.
Sarwar, G. , Botting, H.G. Evaluation of liquid chromatographic analysis of nutritionally important amino acids in food and physiological samples. J. Chromatogr. 615, l–22, 1993.
Schrijver, R.D. , Eenaeme, C.V. , Fremaut, D. , et al . Hydrolysate preparation and comparative amino acid determination by cation-exchange and gas-liquid chromatography in diet ingredients. Cerevisia Biotech. 16, 26–37, 1991.

Schuster, R. Determination of amino acids in biological, pharmaceutical, plant and food samples by automated precolumn derivatization and high-performance liquid chromatography. J. Chromatogr. 431, 271–284, 1988.
Shibata, K. , Onodera, M. , Aihara, S. High-performance liquid chromatographic measurement of tryptophan in blood, tissues, urine and foodstuffs with electrochemical and fluorometric detections. Agric. Biol. Chem. 55, 1475–1481, 1991.
Simons, S.S. , Johnson, D.F. Reaction of o-phthalaldehyde and thiols with primary amines; formation of 1-alkyl(and aryl)thio-2-alkylisoindoles. J. Org. Chem. 43, 2886–2891, 1978.
Skoĉir, E. , Vindevogel, J. , Sandra, P. Separation of 23 dansylated amino acids by micellar electrokinetic chromatography at low temperature. Chromatographia 39, 7–10, 1994.
Sobolevsky, T.G. , Revelsky, A.I. , Miller, B. , et al . Comparison of silylation and esterification/acylation procedures in GC-MS analysis of amino acids. J. Sep. Sci. 26, 1474–1478, 2003.
Soga, T. , Heiger, D.N. Amino acid analysis by capillary electrophoresis electrospray ionisation mass spectrometry. Anal. Chem. 72, 1236–1241, 2000.
Standara, S. , Drdak, M. , Vesela, M. Amino acid analysis: reduction of ninhydrin by sodium borohydride. Nahrung 43, 410–413, 1999.
Starke, I. , Kleinpeter, E. , Kamm, B. Separation, identification, and quantification of amino acids in L-lysine fermentation potato juices by gas chromatography-mass spectrometry. Fresen. J. Anal. Chem. 371, 380–384, 2001.
Stocchi, V. , Piccoli, G. , Magnani, M. , et al . Reversed-phase high-performance liquid chromatography separation of dimethylaminoazobenzene sulfonyl- and dimethylaminoazobenzene thiohydantoin-amino acid derivatives for amino acid analysis and microsequencing studies at the picomole level. Anal. Biochem. 178, 107–117, 1989.
Sun, S.W. , Lin, Y.C. , Weng, Y.M. , et al . Efficiency improvements on ninhydrin method for amino acid quantification. J. Food Comp. Anal. 19, 112–117, 2006.
Szterk, A. , Roszko, M. Simultaneous determination of free amino acids, l-carnosine, purine, pyrimidine, and nucleosides in meat by liquid chromatography/single quadrupole mass spectrometry. J. Liq. Chromatogr. Relat. Technol. 37(5), 664–680, 2014.
Terabe, S. , Otsuka, K. , Ando, T. Electrokinetic chromatography with micellar solution and open-tubular capillary. Anal. Chem. 57, 834–841, 1985.
Terabe, S. , Otsuka, K. , Ichikawa, K. , et al . Electrokinetic separations with micellar solutions and open-tubular capillaries. Anal. Chem. 56, 111–113, 1984.
Tian, M.M. , Zhang, J.F. , Mohamed, A.C. , et al . Efficient capillary electrophoresis separation and determination of free amino acids in beer samples. Electrophoresis 35, 577–584, 2014.
Toldrá, F. Meat: chemistry and biochemistry. In: Y.H. Hui , J.D. Culbertson , S. Duncan , et al . eds. Handbook of Food Science, Technology and Engineering, Vol 1, Boca Raton, FL: CRC Press, 2006, pp. 28-1 to 28-18.
Tuan, Y.H. , Phillips, R.D. Optimized determination of cystine/cysteine and acid-stable amino acids from a single hydrolysate of casein- and sorghum-based diet and digesta samples. J. Agric. Food Chem. 45, 3535–3540, 1997.
Wang, X. , Wu, H. , Li, N. , et al . Rapid determination of free amino acids, nucleosides, and nucleobases in commercial clam species harvested at different seasons in Jiangsu, China, using UFLC-MS/MS. Food Anal. Methods 9, 1520–1531, 2016.
Wang, Y.-Q. , Ye, D.-Q. , Zhu, B.-Q. , et al . Rapid HPLC analysis of amino acids and biogenic amines in wines during fermentation and evaluation of matrix effect. Food Chem. 163, 6–15, 2014.
Williams, A.P. Determination of amino acids and peptides. In: R. McCrae , ed. HPLC in Food Analysis, New York: Academic Press, 1982, pp. 285–311.
Willis, D.E. Automated pre-column derivatization of amino acids with o-phthalaldehyde by a reagent sandwich technique. J. Chromatogr. 408, 217–225, 1987.
Winspear, M.J. , Oaks, A. Automated pre-column amino acid analyses by reversed-phase high-performance liquid chromatography. J. Chromatogr. 270, 378–382, 1983.
Woodward, C. , Gilman, L.B. , Engelhart, W.G. An evaluation of microwave heating for the vapor phase hydrolysis of proteins. Int. Lab. Sept. 40–45, 1990.
Zhao, X. , Liu, Y. , Li, Y. , et al . Authentication of the sea cucumber (Apostichopus japonicus) using amino acids carbon stable isotope fingerprinting. Food Control 91, 128–137, 2018.

Bioactive Peptides from Seafood Products

Abd Rashid N. Y. , M. Abdul Manan , K. F. Pa'ee , N. Saari & F. W. Faizal Wong (2022). Evaluation of antioxidant and antibacterial activities of fish protein hydrolysate produced from Malaysian fish sausage (*Keropok Lekor*) by-products by indigenous *Lactobacillus casei* fermentation. Journal of Cleaner Production, 347, 131303. doi:10.1016/j.jclepro.2022.131303.

Abdelhedi O. & M. Nasri (2019). Basic and recent advances in marine antihypertensive peptides: Production, structure-activity relationship and bioavailability. Trends in Food Science & Technology, 88, 543–557. doi:10.1016/j.tifs.2019.04.002.
Abdelhedi O. , A. Salem , N. Souissi , R. Nasri , M. Nasri & M. Jridi (2019a). Physicochemical, structural and sensory properties of smooth hound autolysates-sugar conjugates formed using a glycosylation reaction. Food Bioscience, 32, 100481. doi:10.1016/j.fbio.2019.100481.
Abdelhedi O. , M. Jridi , I. Jemil , L. Mora , F. Toldrá , M.-C. Aristoy , A. Boualga , M. Nasri & R. Nasri (2016). Combined biocatalytic conversion of smooth hound viscera: Protein hydrolysates elaboration and assessment of their antioxidant, anti-ACE and antibacterial activities. Food Research International, 86, 9–23. doi:10.1016/j.foodres.2016.05.013.
Abdelhedi O. , M. Jridi , R. Nasri , L. Mora , F. Toldrá & M. Nasri (2019b). Rheological and structural properties of Hemiramphus far skin gelatin: Potential use as an active fish coating agent. Food Hydrocolloids, 87, 331–341. doi:10.1016/j.foodhyd.2018.08.005.
Abdelhedi O. , R. Nasri , L. Mora , M. Jridi , F. Toldrá & M. Nasri (2018). In silico analysis and molecular docking study of angiotensin I-converting enzyme inhibitory peptides from smooth-hound viscera protein hydrolysates fractionated by ultrafiltration. Food Chemistry, 239, 453–463. doi:10.1016/j.foodchem.2017.06.112.
Abdelhedi O. , R. Nasri , M. Jridi , L. Mora , M. E. Oseguera-Toledo , M.-C. Aristoy , I. Ben Amara , F. Toldrá & M. Nasri (2017). In silico analysis and antihypertensive effect of ACE-inhibitory peptides from smooth-hound viscera protein hydrolysate: Enzyme-peptide interaction study using molecular docking simulation. Process Biochemistry, 58, 145–159. doi:10.1016/j.procbio.2017.04.032.
Admassu H. , M. A. A. Gasmalla , R. Yang & W. Zhao (2018). Identification of bioactive peptides with α-amylase inhibitory potential from enzymatic protein hydrolysates of red seaweed (*Porphyra* spp). Journal of Agricultural and Food Chemistry, 66, 4872–4882. doi:10.1021/acs.jafc.8b00960.
Ahmed R. & B. S. Chun (2018). Subcritical water hydrolysis for the production of bioactive peptides from tuna skin collagen. The Journal of Supercritical Fluids, 141, 88–96. doi:10.1016/j.supflu.2018.03.006.
Ahmed T. , X. Sun & C. C. Udenigwe (2022). Role of structural properties of bioactive peptides in their stability during simulated gastrointestinal digestion: A systematic review. Trends in Food Science & Technology, 120, 265–273. doi:10.1016/j.tifs.2022.01.008.
Ahn C. B. & J. Y. Je (2021). Anti-adipogenic peptides from ark shell protein hydrolysate: Purification, identification and anti-adipogenic effect. Process Biochemistry, 109, 143–147. doi:10.1016/j.procbio.2021.07.013.
Alonso-Álvarez S. , E. Pardal , D. Sánchez-Nieto , M. Navarro , M. D. Caballero , M. V. Mateos & A. Martín (2017). Plitidepsin: Design, development, and potential place in therapy. Drug Design, Development and Therapy, 11, 253–264. doi:10.2147/DDDT.S94165.
Asaduzzaman A. K. M. , A. T. Getachew , Y. J. Cho , J. S. Park , M. Haq & B. S. Chun (2020). Characterization of pepsin-solubilised collagen recovered from mackerel (*Scomber japonicus*) bone and skin using subcritical water hydrolysis. International Journal of Biological Macromolecules, 148, 1290–1297. doi:10.1016/j.ijbiomac.2019.10.104.
Aspevik T. , C. Totland , P. Lea & Å. Oterhals (2016). Sensory and surface-active properties of protein hydrolysates based on Atlantic salmon (*Salmo salar*) by-products. Process Biochemistry, 51, 1006–1014. doi:10.1016/j.procbio.2016.04.015.
Aspevik T. , L. Thoresen , S. Steinsholm , M. Carlehög & K. Kousoulaki (2021). Sensory and chemical properties of protein hydrolysates based on mackerel (*Scomber scombrus*) and salmon (*Salmo salar*) side stream materials. Journal of Aquatic Food Product Technology, 30, 176–187. doi:10.1080/10498850.2020.1868644.
Bashir K. M. I. , J. H. Sohn , J. S. Kim & J. S. Choi (2020). Identification and characterization of novel antioxidant peptides from mackerel (*Scomber japonicus*) muscle protein hydrolysates. Food Chemistry, 323, 126809. doi:10.1016/j.foodchem.2020.126809.
Belitz H. D. & H. Wieser (1976). Steric arrangement of sweet and bitter taste of amino acids and peptides. Zeitschrift für Lebensmittel-Untersuchung Und -Forschung, 160, 251–253. doi:10.1007/bf01132288.
Ben Slama-Ben Salem R. , N. Ktari , I. Bkhairia , R. Nasri , L. Mora , R. Kallel , S. Hamdi , K. Jamoussi , T. Boudaouara , A. El-Feki , F. Toldrá & M. Nasri (2018). In vitro and in vivo anti-diabetic and anti-hyperlipidemic effects of protein hydrolysates from *Octopus vulgaris* in alloxanic rats. Food Research International, 106, 952–963. doi:10.1016/j.foodres.2018.01.068.
Brabha J. , N. Akhila , S. Maria Infanshia & S. Vincent (2013). Optimization for autolysis assisted production of fish protein hydrolysate from underutilized fish Pellona ditchela. International Journal of Scientific & Engineering Research, 4, 1863–1869. doi:10.1007/s12291-011-0145-z.
Bui X. D. , C. T. Vo , V. C. Bui , T. M. Pham , T. T. H. Bui , T. D. P. Nguyen-Sy , K. W. Chew , M. D. Mukatova & P. L. Show (2021). Optimization of production parameters of fish protein hydrolysate from Sarda Orientalis black muscle (by-product) using protease enzyme. Clean Technologies and Environmental Policy, 23, 31–40. doi:10.1007/s10098-020-01867-2.
Cai A. , H. Chen , P. Wan , L. Luo , Z. Ye , J. Huang , D. Chen & J. Pan (2022). Isolation and identification of immunomodulatory peptides from the protein hydrolysate of tuna trimmings (*Thunnas albacares*). LWT-Food

Science and Technology, 164, 113614. doi:10.1016/j.lwt.2022.113614.
Chansuwan W. , C. T. Upunqui & P. Chinachoti (2019). Anti-inflammatory and anti-allergic activities of Skipjack tuna (*Katsuwonus pelamis*) dark muscle hydrolysates evaluated in cell culture model. Functional Foods in Health and Disease, 9, 446–465. doi:10.31989/ffhd.v9i7.618.
Chen H. , Z. Xu , F. Fan , P. Shi , M. Tu , Z. Wang & M. Du (2019). Identification and mechanism evaluation of a novel osteogenesis promoting peptide from tubulin alpha-1C chain in Crassostrea gigas. Food Chemistry, 272, 751–757. doi:10.1016/j.foodchem.2018.07.063.
Chen J. , B. Ryu , Y. Zhang , P. Liang , C. Li , C. Zhou , P. Yang , P. Hong & Z. J. Qian (2020). Comparison of an angiotensinIconverting enzyme inhibitory peptide from tilapia (*Oreochromis niloticus*) with captopril: Inhibition kinetics, *in vivo* effect, simulated gastrointestinal digestion and a molecular docking study. Journal of the Science of Food and Agriculture, 100, 315–324. doi:10.1002/jsfa.10041.
Chen J. , W. Bai , D. Cai , Z. Yu & B. Xu (2021). Characterization and identification of novel anti-inflammatory peptides from Baijiao sea bass (*Lateolabrax maculatus*). LWT-Food Science and Technology, 147, 111521. doi:10.1016/j.lwt.2021.111521.
Cheng S. , D. Wu , H. Liu , X. Xu , B. Zhu & M. Du (2022a). A comprehensive method to explore inhibitory kinetics and mechanisms of an anticoagulant peptide derived from Crassostrea gigas. Food Science and Human Wellness, 11, 1491–1499. doi:10.1016/j.fshw.2022.06.006.
Cheng S. , D. Wu , H. Liu , X. Xu , B. Zhu & M. Du (2021c). A novel anticoagulant peptide discovered from *Crassostrea gigas* by combining bioinformatics with the enzymolysis strategy: Inhibitory kinetics and mechanisms. Food & Function, 12, 10136–10146. doi:10.1039/d1fo02148f.
Cheng S. , D. Wu , L. Yuan , H. Liu , H. R. Ei-Seedi & M. Du (2022b). Crassostrea gigas-based bioactive peptide protected thrombin-treated endothelial cells against thrombosis and cell barrier dysfunction. Journal of Agricultural and Food Chemistry, 70, 9664–9673. doi:10.1021/acs.jafc.2c02435.
Cheng S. , M. Tu , H. Liu , Y. An , M. Du & B. Zhu (2021a). A novel heptapeptide derived from Crassostrea gigas shows anticoagulant activity by targeting for thrombin active domain. Food Chemistry, 334, 127507. doi:10.1016/j.foodchem.2020.127507.
Cheng S. , Y. Wang , H. Chen , H. Liu , L. Wang , M. Battino , X. Yao , B. Zhu & M. Du (2021b). Anticoagulant dodecapeptide suppresses thrombosis in vivo by inhibiting the thrombin exosite-I binding site. Journal of Agricultural and Food Chemistry, 69, 10920–10931. doi:10.1021/acs.jafc.1c03414.
Cheung H. S. , F. L. Wang , M. A. Ondetti , E. F. Sabo & D. W. Cushman (1980). Binding of peptide substrates and inhibitors of angiotensin converting enzyme. Importance of the COOH-terminal dipeptide sequence. Journal of Biological Chemistry, 255, 401–407. doi:10.1016/S0021-9258(19)86187-2.
Cheung R. C. F. , T. B. Ng & J. H. Wong (2015). Marine peptides: Bioactivities and applications. Marine Drugs, 13, 4006–4043. doi:10.3390/md13074006.
Cho Y. J. , M. Haq , J. S. Park , H. J. Lee & B. S. Chun (2019). Physicochemical and bio-functional properties of shrimp (*Penaeus japonicus*) hydrolysates obtained from hot-compressed water treatment. The Journal of Supercritical Fluids, 147, 322–328. doi:10.1016/j.supflu.2018.11.021.
Choksawangkarn W. , S. Phiphattananukoon , J. Jaresitthikunchai & S. Roytrakul (2018). Antioxidative peptides from fish sauce by-product: Isolation and characterization. Agriculture and Natural Resources, 52, 460–466. doi:10.1016/j.anres.2018.11.001.
Chotphruethipong L. , T. Binlateh , P. Hutamekalin , W. Sukketsiri , R. E. Aluko & S. Benjakul (2021). In vitro antioxidant and wound-healing activities of hydrolyzed collagen from defatted Asian sea bass skin as influenced by different enzyme types and hydrolysis processes. RSC Advances, 11, 18144–18151. doi:10.1039/D1RA03131G.
Cui M. , J. Li , J. Li , F. Wang , X. Li , J. Yu , Y. Huang & Y. Liu (2023). Screening and characterization of a novel antifreeze peptide from silver carp muscle hydrolysate. Food Chemistry, 403, 134480. doi:10.1016/j.foodchem.2022.134480.
Cunha S. A. & M. E. Pintado (2022). Bioactive peptides derived from marine sources: Biological and functional properties. Trends in Food Science & Technology, 119, 348–370. doi:10.1016/j.tifs.2021.08.017.
Dang M. , R. Wang , Y. Jia , J. Du , P. Wang , Y. Xu & C. Li (2022). The antifreeze and cryoprotective activities of a novel antifreeze peptide from *Ctenopharyngodon idella* scales. Foods, 11, 1830. doi:10.3390/foods11131830.
Daroszewska A. (2012). Prevention and treatment of osteoporosis in women: An update. Obstetrics, Gynaecology & Reproductive Medicine, 22, 162–169. doi:10.1016/j.ogrm.2012.02.007.
David W. (2022). Marine Hydrolyzed Collagen Market Analysis 2022 to 2030 - Top Key Players are Ashland, Croda International Plc, Beyond Biopharma Co. Ltd, Collagen Solutions Plc. - The Knox Reports
Delgado M. C. O. , A. Nardo , M. Pavlovic , H. Rogniaux , M. C. Añón & V. A. Tironi (2016). Identification and characterization of antioxidant peptides obtained by gastrointestinal digestion of amaranth proteins. Food Chemistry, 197, 1160–1167. doi:10.1016/j.foodchem.2015.11.092.
Deng B. , X. Ni , Z. Zhai , T. Tang , C. Tan , Y. Yan , J. Deng & Y. Yin (2017). New quantitative structure-activity relationship model for angiotensin-converting enzyme inhibitory dipeptides based on integrated descriptors. Journal of Agricultural and Food Chemistry, 65, 9774–9781. doi:10.1021/acs.jafc.7b03367.
Devita L. , H. N. Lioe , M. Nurilmala & M. T. Suhartono (2021). The bioactivity prediction of peptides from tuna skin collagen using integrated method combining *in vitro* and *in silico* . Foods, 10, 2739.

doi:10.3390/foods10112739.
Doungapai C. , T. Siriwoharn , Y. Malila , N. Autsavapromporn , S. Makkhun , S. Yarnpakdee , K. Jantanasakulwong , J. M. Regenstein & Wangtueai, S. (2022). UV-B protective and antioxidant activities of protein hydrolysate from sea cucumber (*Holothuria scabra*) using enzymatic hydrolysis. Frontiers in Marine Science, 9, 892255. doi:10.3389/fmars.2022.892255.
Elam E. , J. Feng , Y.-M. Lv , Z.-J. Ni , P. Sun , K. Thakur , J.-G. Zhang , Y.-L. Ma & Z.-J. Wei (2021). Recent advances on bioactive food derived anti-diabetic hydrolysates and peptides from natural resources. Journal of Functional Foods, 86, 104674. doi:10.1016/j.jff.2021.104674.
Elaziz M. A. , A. M. Hemdan , A. Hassanien , D. Oliva & S. Xiong (2017). Analysis of bioactive amino acids from fish hydrolysates with a new bioinformatic intelligent system approach. Scientific Reports, 7, 1–9. doi:10.1038/s41598-017-10890-1.
Ennaas N. , R. Hammami , A. Gomaa , F. Bédard , É. Biron , M. Subirade , L. Beaulieu & I. Fliss (2016). Collagencin, an antibacterial peptide from fish collagen: Activity, structure and interaction dynamics with membrane. Biochemical and Biophysical Research Communications, 473, 642–647. doi: 10.1016/j.bbrc.2016.03.121.
Falanga A. , L. Lombardi , G. Franci , M. Vitiello , M. R. Lovene , G. Morelli , M. Galdiero & S. Galdiero (2016). Marine antimicrobial peptides: Nature provides templates for the design of novel compounds against pathogenic bacteria. International Journal of Molecular Science, 17, 785. doi:10.3390/ijms17050785.
FAO, Food and Agriculture Organization (2020). Aquaculture production (fao.org).
Franca-Oliveira G. , T. Fornari & B. Hernández-Ledesma (2021). A review on the extraction and processing of natural source-derived proteins through eco-innovative approaches. Processes, 9, 1626. doi:10.3390/pr9091626.
Fu Y. , J. Chen , K. H. Bak & R. Lametsch (2019). Valorisation of protein hydrolysates from animal byproducts: Perspectives on bitter taste and debittering methods: A review. International Journal of Food Science & Technology, 54, 978–986. doi:10.1111/ijfs.14037.
Gao J. , Q. Liu , L. Zhao , J. Yu , S. Wang , T. Cao , X. Gao & Y. Wei (2021b). Identification and antihypertension study of novel angiotensin I-converting enzyme inhibitory peptides from the skirt of *Chlamys farreri* fermented with *Bacillus natto* . Journal of Agricultural and Food Chemistry, 69, 146–158. doi:10.1021/acs.jafc.0c04232.
Gao R. , W. Shu , Y. Shen , Q. Sun , W. Jin , D. Li , Y. Li & L. Yuan (2021a). Peptide fraction from sturgeon muscle by pepsin hydrolysis exerts anti-inflammatory effects in LPS-stimulated RAW264.7 macrophages via MAPK and NF-κB pathways. Food Science and Human Wellness, 10, 103–111. doi:10.1016/j.fshw.2020.04.014.
Ghalamara S. , S. Silva , C. Brazinha & M. Pintado (2020). Valorization of fish by-products: Purification of bioactive peptides from codfish blood and sardine cooking wastewaters by membrane processing. Membranes, 10, 44. doi:10.3390/membranes10030044.
Giannetto C. , E. Esposito , M. Lanza , S. Oliva , K. Riolo , S. Di Pietro , J. M. Abbate , G. Briguglio , G. Cassata , L. Cicero & F. Macrì (2020). Protein hydrolysates from anchovy (*Engraulis encrasicolus*) waste: *In vitro* and *in vivo* biological activities. Marine Drugs, 18, 86. doi:10.3390/md18020086.
Golpaigani M. H. , P. Ariaii , M. Ahmadi & R. Safari (2023). Preservation effect of protein hydrolysate of rainbow trout roe with a composite coating on the quality of fresh meat during storage at 4±1°C. Journal of Food Measurement and Characterization, 17, 1–13. doi:10.1007/s11694-022-01783-7.
Green B. D. , N. Irwin , N. A. Duffy , V. A. Gault , F. P. O'Harte & P. R. Flatt (2006). Inhibition of dipeptidyl peptidase-IV activity by metformin enhances the antidiabetic effects of glucagon-like peptide-1. European Journal of Pharmacology, 547, 192–199. doi:10.1016/j.ejphar.2006.07.043.
Gui M. , L. Gao , L. Rao , P. Li , Y. Zhang , J. W. Han & J. Li (2022). Bioactive peptides identified from enzymatic hydrolysates of sturgeon skin. Journal of the Science of Food and Agriculture, 102, 1948–1957. doi:10.1002/jsfa.11532.
Hakimi S. , N. M. Kari , N. Ismail , M. N. Ismail & F. Ahmad (2022). Evaluation of taste active peptides and amino acids from anchovy proteins in fish sauce by in silico approach. Food Science and Biotechnology, 31, 767–785. doi:10.1007/s10068-022-01097-w.
Hanachi A. , A. Bianchi , C. J. Kahn , E. Velot , E. Arab-Tehrany , C. Cakir-Kiefer & M. Linder (2022). Encapsulation of salmon peptides in marine liposomes: Physico-chemical properties, antiradical activities and biocompatibility assays. Marine Drugs, 20, 249. doi:10.3390/md20040249.
Hao G. , W. Cao , T. Li , J. Chen , J. Zhang , W. Weng , K. Osako & H. Ren (2019). Effect of temperature on chemical properties and antioxidant activities of abalone viscera subcritical water extract. The Journal of Supercritical Fluids, 147, 17–23. doi:10.1016/j.supflu.2019.02.007.
Harnedy-Rothwell P. A. , C. M. McLaughlin , M. B. O'Keeffe , A. V. Le Gouic , P. J. Allsopp , E. M. McSorley , S. Sharkey , J. Whooley , B. McGovern , F. P. M. O'Harte & R. J. FitzGerald (2020). Identification and characterisation of peptides from a boarfish (*Capros aper*) protein hydrolysate displaying *in vitro* dipeptidyl peptidase-IV (DPP-IV) inhibitory and insulinotropic activity. Food Research International, 131, 108989. doi:10.1016/j.foodres.2020.108989.
Hartmann R. & H. Meisel (2007). Food-derived peptides with biological activity: From research to food applications. Current Opinion in Biotechnology, 18, 163–169. doi:10.1016/j.copbio.2007.01.013.

He J. , H. Guo , M. Zhang , M. Wang , L. Sun & Y. Zhuang (2022). Purification and characterization of a novel calcium-binding heptapeptide from the hydrolysate of Tilapia bone with its osteogenic activity. Foods, 11, 468. doi:10.3390/foo0ds11030468.
Henriques A. , J. A. Vázquez , J. Valcarcel , R. Mendes , N. M. Bandarra & C. Pires (2021). Characterization of protein hydrolysates from fish discards and by-products from the North-West Spain fishing fleet as potential sources of bioactive peptides. Marine Drugs, 19, 338. doi:10.3390/md19060338.
Heo S. Y. , S. C. Ko , S. Y. Nam , J. Oh , Y. M. Kim , J. I. Kim , N. Kim , M. Yi & W. K. Jung (2018). Fish bone peptide promotes osteogenic differentiation of MC3T3E1 preosteoblasts through upregulation of MAPKs and Smad pathways activated BMP2 receptor. Cell Biochemistry and Function, 36, 137–146. doi:10.1002/cbf.3325.
Hong H. , Y. Zheng , S. Song , Y. Zhang , C. Zhang , J. Liu & Y. Luo (2020). Identification and characterization of DPP-IV inhibitory peptides from silver carp swim bladder hydrolysates. Food Bioscience, 38, 100748. doi:10.1016/j.fbio.2020.100748.
Hosseini S. F. , M. R. Soleimani & M. Nikkhah (2018). Chitosan/sodium tripolyphosphate nanoparticles as efficient vehicles for antioxidant peptidic fraction from common kilka. International Journal of Biological Macromolecules, 111, 730–737. doi:10.1016/j.ijbiomac.2018.01.023.
Hu X. , X. Yang , T. Wang , L. Li , Y. Wu , Y. Zhou & L. You (2020). Purification and identification of antioxidant peptides from round scad (*Decapterus maruadsi*) hydrolysates by consecutive chromatography and electrospray ionization-mass spectrometry. Food and Chemical Toxicology, 135, 110882. doi:10.1016/j.fct.2019.110882.
Hu Y. , N. Xiao , Y. Ye & W. Shi (2022). Fish proteins as potential precursors of tasteactive compounds: An in silico study. Journal of the Science of Food and Agriculture, 102, 6404–6413. doi:10.1002/jsfa.12006.
Jamshidi A. , B. Shabanpour , P. Pourashouri & M. Raeisi (2019). Optimization of encapsulation of fish protein hydrolysate and fish oil in W1/O/W2 double emulsion: Evaluation of sensory quality of fortified yogurt. Journal of Food Processing and Preservation, 43, e14063. doi:10.1111/jfpp.14063.
Janardhan S. & G. Narahari Sastry (2014). Dipeptidyl peptidase IV inhibitors: A new paradigm in type 2 diabetes treatment. Current Drug Targets, 15, 600–621. doi:10.2174/1389450115666140311102638.
Jemil I. , L. Mora , R. Nasri , O. Abdelhedi , M.-C. Aristoy , M. Hajji , M. Nasri & F. Toldrá (2016a). A peptidomic approach for the identification of antioxidant and ACE-inhibitory peptides in sardinelle protein hydrolysates fermented by *Bacillus subtilis* A26 and *Bacillus amyloliquefaciens* An6. Food Research International, 89, 347–358. doi:10.1016/j.foodres.2016.08.020.
Jemil I. , O. Abdelhedi , L. Mora , R. Nasri , M.-C. Aristoy , M. Jridi , M. Hajji , F. Toldrá & M. Nasri (2016b). Peptidomic analysis of bioactive peptides in zebra blenny (*Salaria basilisca*) muscle protein hydrolysate exhibiting antimicrobial activity obtained by fermentation with *Bacillus mojavensis* A21. Process Biochemistry, 51, 2186–2197. doi:10.1016/j.procbio.2016.08.021.
Jemil I. , O. Abdelhedi , R. Nasri , L. Mora , M. Jridi , M.-C. Aristoy , F. Toldrá & M. Nasri . (2017b). Novel bioactive peptides from enzymatic hydrolysate of sardinelle (*Sardinella aurita*) muscle proteins hydrolysed by *Bacillus subtilis* A26 proteases. Food Research International, 100, 121–133. doi:10.1016/j.foodres.2017.06.018.
Jemil I. , O. Abdelhedi , R. Nasri , L. Mora , R. Marrekchi , K. Jamoussi , A. ElFeki , M. Hajji , F. Toldrá & M. Nasri (2017a). Hypolipidemic, antiobesity and cardioprotective effects of sardinelle meat flour and its hydrolysates in high-fat and fructose diet fed Wistar rats. Life Sciences, 176, 54–66. doi:10.1016/j.lfs.2016.07.012.
Jeong Y. R. , J. S. Park , D. Nkurunziza , Y. J. Cho & B. S. Chun (2021). Valorization of blue mussel for the recovery of free amino acids rich products by subcritical water hydrolysis. The Journal of Supercritical Fluids, 169, 105135. doi:10.1016/j.supflu.2020.105135.
Jin R. , X. Teng , J. Shang , D. Wang & N. Liu (2020). Identification of novel DPP-IV inhibitory peptides from Atlantic salmon (*Salmo salar*) skin. Food Research International, 133, 109161. doi:10.1016/j.foodres.2020.109161.
Joshi I. , H. S. Mohideen & R. A. Nazeer (2021). A Meretrix meretrix visceral mass derived peptide inhibits lipopolysaccharide-stimulated responses in RAW264. 7 cells and adult zebrafish model. International Immunopharmacology, 90, 107140. doi:10.1016/j.intimp.2020.107140.
Joshi I. , K. Janagaraj , P. M. K. Noorani & R. A. Nazeer (2020). Isolation and characterization of angiotensin I-converting enzyme (ACE-I) inhibition and antioxidant peptide from by-catch shrimp (*Oratosquilla woodmasoni*) waste. Biocatalysis and Agricultural Biotechnology, 29, 101770. doi:10.1016/j.bcab.2020.101770.
Kang B. , D. I. Skonberg & A. D. Myracle (2020). Anti-hyperglycemic effects of green crab hydrolysates derived by commercially available enzymes. Foods, 9(3), 258. doi:10.3390/foods9030258.
Kantlehner M. , P. Schaffner , D. Finsinger , J. Meyer , A. Jonczyk , B. Diefenbach , B. Nies , G. Hölzemann , S. L. Goodman & H. Kessler (2000). Surface coating with cyclic RGD peptides stimulates osteoblast adhesion and proliferation as well as bone formation. Chembiochem: A European Journal of Chemical Biology, 1, 107–114. doi:10.1002/1439-7633(20000818)1:2<107:AID-CBIC107>3.0.CO;2–4.
Kim H. O. & E. C. Li-Chan (2006). Quantitative structure-activity relationship study of bitter peptides. Journal of Agricultural and Food Chemistry, 54, 10102–10111. doi:10.1021/jf062422j.
Klomklao S. & S. Benjakul (2018). Protein hydrolysates prepared from the viscera of skipjack tuna (*Katsuwonus pelmamis*): Antioxidative activity and functional properties. Turkish Journal of Fisheries and Aquatic Sciences, 18, 69–79. doi:10.4194/1303-2712-v18_1_08.

Ko S. C. , D. S. Lee , W. S. Park , J. S. Yoo , M. J. Yim , Z. J. Qian , C. Lee , J. Oh , W. Jung & I. W. Choi (2016). Anti-allergic effects of a nonameric peptide isolated from the intestine gastrointestinal digests of abalone (*H. discus hannai*) in activated HMC-1 human mast cells. International Journal of Molecular Medicine, 37, 243–250. doi:10.3892/ijmm.2015.2420.
Lajmi K. , J. Gómez-Estaca , M. Hammami & O. Martínez-Alvarez (2019). Upgrading collagenous smooth hound by-products: Effect of hydrolysis conditions, in vitro gastrointestinal digestion and encapsulation on bioactive properties. Food Bioscience, 28, 99–108. doi:10.1016/j.fbio.2019.01.014.
Lang M. , Y. Song , Y. Li , X. Xiang , L. Ni & J. Miao (2021). Purification, identification, and molecular mechanism of DPPIV inhibitory peptides from defatted Antarctic krill powder. Journal of Food Biochemistry, 45, e13872. doi:10.1111/jfbc.13872.
Lee E. J. , J. Hur , S. A. Ham , Y. Jo , S. Lee , M. J. Choi & H. G. Seo (2017). Fish collagen peptide inhibits the adipogenic differentiation of preadipocytes and ameliorates obesity in high fat diet-fed mice. International Journal of Biological Macromolecules, 104, 281–286. doi:10.1016/j.ijbiomac.2017.05.151.
Lee J. E. , S. K. Noh & M. J. Kim (2022). Effects of enzymatic-and ultrasound-assisted extraction on physicochemical and antioxidant properties of collagen hydrolysate fractions from Alaska pollack (*Theragra chalcogramma*) skin. Antioxidants, 11, 2112. doi:10.3390/antiox11112112.
Li W. , S. Ye , Z. Zhang , J. Tang , H. Jin , F. Huang , Z. Yang , Y. Tang , Y. Chen , G. Ding & F. Yu (2019a). Purification and characterization of a novel pentadecapeptide from protein hydrolysates of Cyclina sinensis and its immunomodulatory effects on RAW264. 7 cells. Marine Drugs, 17, 30. doi:10.3390/md17010030.
Li Y. , J. Li , S. J. Lin , Z. S. Yang & H. X. Jin (2019b). Preparation of antioxidant peptide by microwave-assisted hydrolysis of collagen and its protective effect against H2O2-induced damage of RAW264.7 cells. Marine Drugs, 17, 642. doi:10.3390/md17110642.
Li Y. & J. Yu (2015). Research progress in structure-activity relationship of bioactive peptides. Journal of Medicinal Food, 18, 147–156. doi:10.1089/jmf.2014.0028.
Lima K. O. , C. D. C. de Quadros , M. da Rocha , J. T. J. G. de Lacerda , M. A. Juliano , M. Dias , M. A. Mendes & C. Prentice (2019). Bioactivity and bioaccessibility of protein hydrolyzates from industrial byproducts of Stripped weakfish (*Cynoscion guatucupa*). LWT-Food Science and Technology, 111, 408–413. doi:10.1016/j.lwt.2019.05.043.
Lin S. , X. Hu , L. Li , X. Yang , S. Chen , Y. Wu & S. Yang (2021). Preparation, purification and identification of iron-chelating peptides derived from tilapia (*Oreochromis niloticus*) skin collagen and characterization of the peptide-iron complexes. LWT-Food Science and Technology, 149, 111796. doi:10.1016/j.lwt.2021.111796.
Lin Y. H. , C. A. Chen , J. S. Tsai & G. W. Chen (2019). Preparation and identification of novel antihypertensive peptides from the in vitro gastrointestinal digestion of marine cobia skin hydrolysates. Nutrients, 11, 1351. doi:10.3390/nu11061351.
Lu Y. , Y. Wu , X. Hou , Y. Lu , H. Meng , S. Pei , Z. Dai & S. Wu (2022). Separation and identification of ACE inhibitory peptides from lizard fish proteins hydrolysates by metal affinity-immobilized magnetic liposome. Protein Expression and Purification, 191, 106027. doi:10.1016/j.pep.2021.106027.
Ma T. , Q. Fu , Q. Mei , Z. Tu & L. Zhang (2021). Extraction optimization and screening of angiotensin-converting enzyme inhibitory peptides from Channa striatus through bioaffinity ultrafiltration coupled with LC-Orbitrap-MS/MS and molecular docking. Food Chemistry, 354, 129589. doi:10.1016/j.foodchem.2021.129589.
Marasinghe C. K. , W. K. Jung & J. Y. Je (2022). Antiinflammatory action of ark shell (*Scapharca subcrenata*) protein hydrolysate in LPSstimulated RAW264.7 murine macrophages. Journal of Food Biochemistry, 46, e14493. doi:10.1111/jfbc.14493.
McClements D. J. (2018). Encapsulation, protection, and delivery of bioactive proteins and peptides using nanoparticle and microparticle systems: A review. Advances in Colloid and Interface Science, 253, 1–22. doi:10.1016/j.cis.2018.02.002.
Melgosa R. , E. Trigueros , M. T. Sanz , M. Cardeira , L. Rodrigues , N. Fernández , A. A. Matias , M. R. Bronze , M. Marques , A. Paiva & P. Simões (2020). Supercritical CO2 and subcritical water technologies for the production of bioactive extracts from sardine (*Sardina pilchardus*) waste. The Journal of Supercritical Fluids, 164, 104943. doi:10.1016/j.supflu.2020.104943.
Melgosa R. , M. Marques , A. Paiva , A. Bernardo , N. Fernández , I. Sá-Nogueira & P. Simões (2021). Subcritical water extraction and hydrolysis of Cod (*Gadus morhua*) frames to produce bioactive protein extracts. Foods, 10, 1222. doi:10.3390/foods10061222.
Mirzapour-Kouhdasht A. , M. Moosavi-Nasab , Y.-M. Kim & J.-B. Eun (2020). The antioxidant mechanism, antibacterial activity, and functional characterization of peptide fractions obtained from barred mackerel gelatin with a focus on application in carbonated beverages. Food Chemistry, 342, 128339. doi:10.1016/j.foodchem.2020.128339.
Mora L. & F. Toldrá (2023). Advanced enzymatic hydrolysis of food proteins for the production of bioactive peptides. Current Opinion in Food Science, 49, 100973. doi:10.1016/j.cofs.2022.100973.
Najafian L. & A. S. Babji (2018). Fractionation and identification of novel antioxidant peptides from fermented fish (Pekasam). Journal of Food Measurement and Characterization, 12, 2174–2183. doi:10.1007/s11694-018-9833-1.
Nasri M. (2017). Protein hydrolysates and biopeptides: Production, biological activities, and applications in foods and health benefits. A review. Advances in Food and Nutrition Research, 81, 109–159.

doi:10.1016/bs.afnr.2016.10.003.
Nasri R. , M. Hamdi , S. Touir , S. Li , M. Karra-Chaabouni & M. Nasri (2021). Development of delivery system based on marine chitosan: Encapsulation and release kinetic study of antioxidant peptides from chitosan microparticle. International Journal of Biological Macromolecules, 167, 1445–1451. doi:10.1016/j.ijbiomac.2020.11.098.
Nasri R. , O. Abdelhedi , I. Jemil , I. Ben Amor , A. Elfeki , J. Gargouri , A. Boualga , M. Karra-Châabouni & M. Nasri (2018). Preventive effect of goby fish protein hydrolysates on hyperlipidemia and cardiovascular disease in Wistar rats fed a high-fat/fructose diet. RSC Advances, 8, 9383–9393. doi:10.1039/c7ra13102j.
Nasri R. , O. Abdelhedi , M. Nasri & M. Jridi (2022). Fermented protein hydrolysates: Biological activities and applications. Current Opinion in Food Science, 43, 120–127. doi:10.1016/j.cofs.2021.11.006.
Neves A. C. , P. A. Harnedy , M. B. O'Keeffe , M. A. Alashi , R. E. Aluko & R. J. FitzGerald (2017). Peptide identification in a salmon gelatin hydrolysate with antihypertensive, dipeptidyl peptidase IV inhibitory and antioxidant activities. Food Research International, 100, 112–120. doi:10.1016/j.foodres.2017.06.065.
Nikoo M. , S. Benjakul & H. A. Gavlighi (2022). Protein hydrolysates derived from aquaculture and marine byproducts through autolytic hydrolysis. Comprehensive Reviews in Food Science and Food Safety, 21, 4872–4899. doi:10.1111/1541-4337.13060.
Nikoo M. , S. Benjakul , H. A. Gavlighi , X. Xu & J. M. Regenstein (2019). Hydrolysates from rainbow trout (*Oncorhynchus mykiss*) processing by-products: Properties when added to fish mince with different freeze-thaw cycles. Food Bioscience, 30, 100418. doi:10.1016/j.fbio.2019.100418.
Noman A. , J. Qixing , Y. Xu , A. H. Ali , W. Q. Al-Bukhaiti , S. M. Abed & W. Xia (2019). Influence of degree of hydrolysis on chemical composition, functional properties, and antioxidant activities of Chinese sturgeon (*Acipenser sinensis*) hydrolysates obtained by using alcalase 2.4 L. Journal of Aquatic Food Product Technology, 28, 583–597. doi:10.1080/10498850.2019.1626523.
Nongonierma A. B. & R. J. FitzGerald (2019). Features of dipeptidyl peptidase IV (DPPIV) inhibitory peptides from dietary proteins. Journal of Food Biochemistry, 43, e12451. doi:10.1111/jfbc.12451.
Nuñez S. M. , F. Guzmán , P. Valencia , S. Almonacid & C. Cárdenas (2020). Collagen as a source of bioactive peptides: A bioinformatics approach. Electronic Journal of Biotechnology, 48, 101–108. doi:10.1016/j.ejbt.2020.09.009.
Oh J. Y. , E. A. Kim , H. Lee , H. S. Kim , J. S. Lee & Y. J. Jeon (2019a). Antihypertensive effect of surimi prepared from olive flounder (*Paralichthys olivaceus*) by angiotensin-I converting enzyme (ACE) inhibitory activity and characterization of ACE inhibitory peptides. Process Biochemistry, 80, 164–170. doi:10.1016/j.procbio.2019.01.016.
Oh Y. , C. B. Ahn , J. H. Hyung & J. Y. Je (2019b). Two novel peptides from ark shell protein stimulate osteoblast differentiation and rescue ovariectomy-induced bone loss. Toxicology and Applied Pharmacology, 385, 114779. doi:10.1016/j.taap.2019.114779.
Peng Z. , J. Gao , W. Su , W. Cao , G. Zhu , X. Qin , C. Zhang & Y. Qi (2022). Purification and identification of peptides from Oyster (*Crassostrea hongkongensis*) protein enzymatic hydrolysates and their anti-skin photoaging effects on UVB-irradiated HaCaT Cells. Marine Drugs, 20, 749. doi:10.3390/md20120749.
Peredo-Lovillo A. , A. Hernández-Mendoza , B. Vallejo-Cordoba & H. E. Romero-Luna (2021). Conventional and in silico approaches to select promising food-derived bioactive peptides: A review. Food Chemistry: X, 13, 100183. doi:10.1016/j.fochx.2021.100183.
Pezeshk S. , S. M. Ojagh , M. Rezaei & B. Shabanpour (2019). Fractionation of protein hydrolysates of fish waste using membrane ultrafiltration: Investigation of antibacterial and antioxidant activities. Probiotics and Antimicrobial Proteins, 11, 1015–1022. doi:10.1007/s12602-018-9483-y.
Racioppo A. , B. Speranza , D. Campaniello , M. Sinigaglia , M. R. Corbo & A. Bevilacqua (2021). Fish loss/waste and low-value fish challenges: State of art, advances, and perspectives. Foods, 10, 2725. doi:10.3390/foods10112725.
Ramezanzade L. , S. F. Hosseini & M. Nikkhah (2017). Biopolymer-coated nanoliposomes as carriers of rainbow trout skin-derived antioxidant peptides. Food Chemistry, 234, 220–229. doi:10.1016/j.foodchem.2017.04.177.
Rivas-Vela C. I. , S. L. Amaya-Llano , E. Castaño-Tostado & G. A. Castillo-Herrera (2021). Protein hydrolysis by subcritical water: A new perspective on obtaining bioactive peptides. Molecules, 26, 6655. doi:10.3390/molecules26216655.
Rocha Camargo T. , P. Ramos , J. M. Monserrat , C. Prentice , C. J. Fernandes , W. F. Zambuzzi & W. C. Valenti (2021). Biological activities of the protein hydrolysate obtained from two fishes common in the fisheries bycatch. Food Chemistry, 342, 128361. doi:10.1016/j.foodchem.2020.128361.
Rodrigues L. A. , A. A. Matias & A. Paiva (2021). Recovery of antioxidant protein hydrolysates from shellfish waste streams using subcritical water extraction. Food and Bioproducts Processing, 130, 154–163. doi:10.1016/j.fbp.2021.09.011.
Ru S. , K. Q. Zhang & R. B. Wei (2016). In vitro antioxidative activities of squid (*Ommastrephes bartrami*) viscera autolysates and identification of active peptides. Process Biochemistry, 51, 1674–1682. doi:10.1016/j.procbio.2016.06.015.
Saisavoey T. , P. Sangtanoo , O. Reamtong & A. Karnchanatat (2019). Free radical scavenging and anti inflammatory potential of a protein hydrolysate derived from salmon bones on RAW 264.7 macrophage cells.

Journal of the Science of Food and Agriculture, 99, 5112–5121. doi:10.1002/jsfa.9755.
Sasaki C. , S. Tamura , R. Tohse , S. Fujita , M. Kikuchi , C. Asada & Y. Nakamura (2018). Isolation and identification of an angiotensin I-converting enzyme inhibitory peptide from pearl oyster (*Pinctada fucata*) shell protein hydrolysate. Process Biochemistry, 77, 137–142. doi:10.1016/j.procbio.2018.11.017.
Schindler A. , A. Dunkel , F. Stähler , M. Backes , J. Ley , W. Meyerhof & T. Hofmann (2011). Discovery of salt taste enhancing arginyl dipeptides in protein digests and fermented fish sauces by means of a sensomics approach. Journal of Agricultural and Food Chemistry, 59, 12578–12588. doi:10.1021/jf2041593.
Seo J. K. , H. J. Go , C. H. Kim , B. H. Nam & N. G. Park (2016). Antimicrobial peptide, hdMolluscidin, purified from the gill of the abalone, Haliotis discus. Fish & Shellfish Immunology, 52, 289–297. doi:10.1016/j.fsi.2016.03.150.
Sepúlveda C. T. , A. Alemán , J. E. Zapata , M. P. Montero & M. C. Gómez-Guillén (2021). Characterization and storage stability of spray dried soy-rapeseed lecithin/trehalose liposomes loaded with a tilapia viscera hydrolysate. Innovative Food Science & Emerging Technologies, 71, 102708. doi:10.1016/j.ifset.2021.102708.
Sepúlveda C. T. & J. E. Zapata (2020). Effects of enzymatic hydrolysis conditions on the antioxidant activity of red tilapia (*Oreochromis spp.*) viscera hydrolysates. Current Pharmaceutical Biotechnology, 21, 1249–1258. doi:10.2174/1389201021666200506072526.
Shahidi F. (1994). Seafood processing by-products. Seafoods: Chemistry, Processing Technology and Quality, 320–334. doi:10.1007/978-1-4615-2181-5_16.
Sripokar P. , S. Benjakul & S. Klomklao (2019). Antioxidant and functional properties of protein hydrolysates obtained from starry triggerfish muscle using trypsin from albacore tuna liver. Biocatalysis and Agricultural Biotechnology, 17, 447–454. doi:10.1016/j.bcab.2018.12.013.
Steinsholm S. , Å. Oterhals , J. Underhaug , I. Måge , A. Malmendal & T. Aspevik (2020). Sensory assessment of fish and chicken protein hydrolysates. Evaluation of NMR metabolomics profiling as a new prediction tool. Journal of Agricultural and Food Chemistry, 68, 3881–3890. doi:10.1021/acs.jafc.9b07828.
Stubbs M. T. & W. Bode (1995). The clot thickens: Clues provided by thrombin structure. Trends in Biochemical Sciences, 20, 23–28. doi:10.1016/S0968-0004(00)88945-8.
SuárezJiménez G. M. , A. BurgosHernández , W. TorresArreola , C. M. LópezSaiz , C. A. Velázquez Contreras & J. M. Ezquerra-Brauer (2018). Bioactive peptides from collagen hydrolysates from squid (*Dosidicus gigas*) by products fractionated by ultrafiltration. International Journal of Food Science & Technology, 54, 1054–1061. doi:10.1111/ijfs.13984.
Sugiyama K. , M. Egawa , H. Onzuka & K. Ôba (1991). Characteristics of sardine muscle hydrolysates prepared by various enzymatic treatments. Nippon Suisan Gakkaishi, 57, 475–479.
Suwal S. , S. Ketnawa , A. M. Liceaga & J. Y. Huang (2018). Electro-membrane fractionation of antioxidant peptides from protein hydrolysates of rainbow trout (*Oncorhynchus mykiss*) byproducts. Innovative Food Science & Emerging Technologies, 45, 122–131. doi:10.1016/j.ifset.2017.08.016.
Theysgeur S. , B. Cudennec , B. Deracinois , C. Perrin , I. Guiller , A. Lepoudère , C. Flahaut & R. Ravallec (2020). New bioactive peptides identified from a tilapia byproduct hydrolysate exerting effects on DPP-IV activity and intestinal hormones regulation after canine gastrointestinal simulated digestion. Molecules, 26, 136. doi:10.3390/molecules26010136.
Thuanthong M. , C. De Gobba , N. Sirinupong , W. Youravong & J. Otte (2017). Purification and characterization of angiotensin-converting enzyme-inhibitory peptides from Nile tilapia (*Oreochromis niloticus*) skin gelatine produced by an enzymatic membrane reactor. Journal of Functional Foods, 36, 243–254. doi:10.1016/j.jff.2017.07.011.
Tkaczewska J. , M. Bukowski & P. Mak (2018). Identification of antioxidant peptides in enzymatic hydrolysates of carp (*Cyprinus carpio*) skin gelatin. Molecules, 24, 97. doi:10.3390/molecules24010097.
Tyagi V. V. , S. C. Kaushik , S. K. Tyagi & T. Akiyama (2011). Development of phase change materials based microencapsulated technology for buildings: A review. Renewable and Sustainable Energy Reviews, 15, 1373–1391. doi:10.1016/j.rser.2010.10.006.
Vásquez P. , J. E. Zapata , V. C. Chamorro , S. F. G. Fillería & V. A. Tironi (2022). Antioxidant and angiotensin I-converting enzyme (ACE) inhibitory peptides of rainbow trout (*Oncorhynchus mykiss*) viscera hydrolysates subjected to simulated gastrointestinal digestion and intestinal absorption. LWT-Food Science and Technology, 154, 112834. doi:10.1016/j.lwt.2021.112834.
Wang L. , J. Sun , S. Ding & B. Qi (2018). Isolation and identification of novel antioxidant and antimicrobial oligopeptides from enzymatically hydrolyzed anchovy fish meal. Process Biochemistry, 74, 148–155. doi:10.1016/j.procbio.2018.08.021.
WHO, World Health Organization (2021). Hypertension (who.int).
Wiebe N. , P. Stenvinkel & M. Tonelli (2019). Associations of chronic inflammation, insulin resistance, and severe obesity with mortality, myocardial infarction, cancer, and chronic pulmonary disease. JAMA Network Open, 2, e1910456. doi:10.1001/jamanetworkopen.2019.10456.
Wong F. C. , J. Xiao , G. Michelle , L. Ong , M. J. Pang , S. J. Wong , L. K. Teh & T. T. Chai (2019). Identification and characterization of antioxidant peptides from hydrolysate of blue-spotted stingray and their stability against thermal, pH and simulated gastrointestinal digestion treatments. Food Chemistry, 271, 614–622. doi:10.1016/j.foodchem.2018.07.206.

Wu D. , N. Sun , J. Ding , B. Zhu & S. Lin (2019). Evaluation and structure-activity relationship analysis of antioxidant shrimp peptides. Food & Function, 10, 5605–5615. doi:10.1039/C9FO01280J.
Xiang X. , M. Lang , Y. Li , X. Zhao , H. Sun , W. Jiang , L. Ni & Y. Song (2021a). Purification, identification and molecular mechanism of dipeptidyl peptidase IV inhibitory peptides from discarded shrimp (*Penaeus vannamei*) head. Journal of Chromatography B, 1186, 122990. doi:10.1016/j.jchromb.2021.122990.
Xiang X. W. , X. L. Zhou , R. Wang , C. H. Shu , Y. F. Zhou , X. G. Ying & B. Zheng (2021b). Protective effect of tuna bioactive peptide on dextran sulfate sodium-induced colitis in mice. Marine Drugs, 19, 127. doi:10.3390/md19030127.
Xu Z. , H. Chen , F. Fan , P. Shi , M. Tu , S. Cheng , Z. Wang & M. Du (2019). Bone formation activity of an osteogenic dodecapeptide from blue mussels (*Mytilus edulis*). Food & Function, 10, 5616–5625. doi:10.1039/C9FO01201J.
Yamamoto N. , A. Akino & T. Takano (1994). Antihypertensive effect of the peptides derived from casein by an extracellular proteinase from *Lactobacillus helveticus* CP790. Journal of Dairy Science, 77, 917–922. doi:10.3168/jds.S0022-0302(94)77026-0.
Yang Q. , X. Cai , A. Yan , Y. Tian , M. Du & S. Wang (2020). A specific antioxidant peptide: Its properties in controlling oxidation and possible action mechanism. Food Chemistry, 327, 126984. doi:10.1016/j.foodchem.2020.126984.
Yang X. R. , Y. Q. Zhao , Y. T. Qiu , C. F. Chi & B. Wang (2019). Preparation and characterization of gelatin and antioxidant peptides from gelatin hydrolysate of skipjack tuna (*Katsuwonus pelamis*) bone stimulated by *in vitro* gastrointestinal digestion. Marine Drugs, 17, 78. doi:10.3390/md17020078.
Yuan L. , Q. Chu , X. Wu , B. Yang , W. Zhang , W. Jin & R. Gao (2021). Anti-inflammatory and antioxidant activity of peptides from ethanol-soluble hydrolysates of sturgeon (*Acipenser schrenckii*) cartilage. Frontiers in Nutrition, 8, 279. doi:10.3389/fnut.2021.689648.
Zhang A. , S. Gao , C. Zhang , Y. Zhang , H. Liu , H. Hong & Y. Luo (2020a). Evaluating in vitro dipeptidyl peptidase IV inhibition by peptides from common carp (*Cyprinus carpio*) roe in cell culture models. European Food Research and Technology, 246, 179–191. doi:10.1007/s00217-019-03399-6.
Zhang K. , B. Li , Q. Chen , Z. Zhang , X. Zhao & H. Hou (2018). Functional calcium binding peptides from pacific cod (*Gadus macrocephalus*) bone: Calcium bioavailability enhancing activity and anti-osteoporosis effects in the ovariectomy-induced osteoporosis rat model. Nutrients, 10, 1325. doi:10.3390/nu10091325.
Zhang K. , J. Li , H. Hou , H. Zhang & B. Li (2019). Purification and characterization of a novel calcium-biding decapeptide from Pacific cod (*Gadus Macrocephalus*) bone: Molecular properties and calcium chelating modes. Journal of Functional Foods, 52, 670–679. doi:10.1016/j.jff.2018.11.042.
Zhang L. , Y. Shan , H. Hong , Y. Luo , X. Hong & W. Ye (2020b). Prevention of protein and lipid oxidation in freeze-thawed bighead carp (*Hypophthalmichthys nobilis*) fillets using silver carp (*Hypophthalmichthys molitrix*) fin hydrolysates. LWT-Food Science and Technology, 123, 109050. doi:10.1016/j.lwt.2020.109050.
Zhang Y. , R. Chen , X. Chen , Z. Zeng , H. Ma & S. Chen (2016). Dipeptidyl peptidase IV-inhibitory peptides derived from silver carp (*Hypophthalmichthys molitrix* Val.) proteins. Journal of Agricultural and Food Chemistry, 64, 831–839. doi:10.1021/acs.jafc.5b05429.
Zhang Y. , S. He , É. Bonneil & B. K. Simpson (2020c). Generation of antioxidative peptides from Atlantic sea cucumber using alcalase versus trypsin: In vitro activity, *de novo* sequencing, and *in silico* docking for *in vivo* function prediction. Food Chemistry, 306, 125581. doi:10.1016/j.foodchem.2019.125581.
Zhi T. , X. Li , F. A. Sadiq , K. Mao , J. Gao , S. Mi , X. Liu , W. Deng , B. Chitrakar & Y. Sang (2022). Novel antioxidant peptides from protein hydrolysates of scallop (*Argopecten irradians*) mantle using enzymatic and microbial methods: Preparation, purification, identification and characterization. LWT-Food Science and Technology, 164, 113636. doi:10.1016/j.lwt.2022.113636.
Zhu K. , Z. Zheng & Z. Dai (2022). Identification of antifreeze peptides in shrimp byproducts autolysate using peptidomics and bioinformatics. Food Chemistry, 383, 132568. doi:10.1016/j.foodchem.2022.132568.
Zou Y. , E. Tortorella , J. Robbens , M. Heyndrickx , J. Debode , D. De Pascale & K. Raes (2021). Bioactivity screening of hydrolysates from brown crab processing side streams fermented by marine *Pseudoalteromonas* strains. Waste and Biomass Valorization, 12, 2459–2468. doi:10.1007/s12649-020-01195-y.

Antioxidants

Afonso, C. , Bandarra, N.M. , Nunes, L. , Cardoso, C. , 2016. Tocopherols in seafood and aquaculture products. Crit. Rev. Food Sci. Nutr. 56, 128–140. doi:10.1080/10408398.2012.694920.
Dias, M.G. , Sanchez, M.V. , Bartolo, H. , Oliveira, L. , 2003. Vitamin content of fish and fish products consumed in Portugal. Elect. J. Environ. Agric. Chem. Food Chem. 2(4), 510–515, 510–513.
Durazzo, A. , Di Lena, G. , Gabrielli, P. , Santini, A. , Lombardi-Boccia, G. , Lucarini, M. , 2022. Nutrients and bioactive compounds in seafood: quantitative literature research analysis. Fishes 7, 1–14. doi:10.3390/fishes7030132.

Erkan, N. , Bilen, G. , 2010. Effect of essential oils treatment on the frozen storage stability of chub mackerel fillets. J. fur Verbraucherschutz und Leb. 5, 101–110. doi:10.1007/s00003-009-0546-6.
Kalogeropoulos, N. , Chiou, A. , 2010. Antioxidant, in: Nollet, L. , Toldra, F. (Eds.), Handbook of Seafood and Seafood Analysis. Boca Raton: CRC Press. pp. 309–326.
Kulawik, P. , Özogul, F. , Glew, R. , Özogul, Y. , 2013. Significance of antioxidants for seafood safety and human health. J. Agric. Food Chem. 61, 475–491. doi:10.1021/jf304266s.
Laplante, S. , Souchet, N. , Bryl, P. , 2009. Comparison of low-temperature processes for oil and coenzyme Q10 extraction from mackerel and herring. Eur. J. Lipid Sci. Technol. 111, 135–141. doi:10.1002/ejlt.200800133.
Li, Z. , Ren, T. , Han, Y. , Jiang, Z. , Hu, Y. , Bai, Z. , Wang, L. , Ding, J. , 2018. The effects of sub-lethal dietary mercury on growth performance, bioaccumulation, and activities of antioxidant enzymes in sea cucumber, Apostichopus japonicus. Bull. Environ. Contam. Toxicol. 100, 683–689. doi:10.1007/s00128-018-2321-9.
Lopes, P.A. , Pinheiro, T. , Santos, M.C. , Joao, M. , Viegas-Crespo, A.M. , 2001. Response of antioxidant enzymes in freshwater fish populations to inorganic pollutants exposure. Sci. Total Environ. 280, 153–163.
López, M.C. , Satué, M.T. , González, M.L. , Agramont, A. , 1995. A-Tocopherol content in trout oil. Food Chem. 53, 67–70. doi:10.1016/0308-8146(95)95788-8.
López-López, E. , Sedeño-Díaz, J.E. , Soto, C. , Favari, L. , 2011. Responses of antioxidant enzymes, lipid peroxidation, and Na+/K+-ATPase in liver of the fish Goodea atripinnis exposed to Lake Yuriria water. Fish Physiol. Biochem. 37, 511–522. doi:10.1007/s10695-010-9453-0.
Maqsood, S. , Benjakul, S. , Abushelaibi, A. , Alam, A. , 2014. Phenolic compounds and plant phenolic extracts as natural antioxidants in prevention of lipid oxidation in seafood: a detailed review. Compr. Rev. Food Sci. Food Saf. 13, 1125–1140. doi:10.1111/1541-4337.12106.
Mariutti, L.R.B. , Bragagnolo, N. , 2017. Influence of salt on lipid oxidation in meat and seafood products: a review. Food Res. Int. 94, 90–100. doi:10.1016/j.foodres.2017.02.003.
Monge-Rojas, R. , Campos, H. , 2011. Tocopherol and carotenoid content of foods commonly consumed in Costa Rica. J. Food Compos. Anal. 24, 202–216. doi:10.1016/j.jfca.2010.09.015.
Ozogul, Y. , Durmus, M. , BaliKci, E. , Ozogul, F. , Ayas, D. , Yazgan, H. , 2011. The effects of the combination of freezing and the use of natural antioxidant technology on the quality of frozen sardine fillets (Sardinella aurita). Int. J. Food Sci. Technol. 46, 236–242. doi:10.1111/j.1365-2621.2010.02476.x.
Ozogul, Y. , Ozyurt, G. , Boga, E.K. , 2009. Effects of cooking and reheating methods on the fatty acid profile of sea bream treated with rosemary extract. J. Sci. Food Agric. 89, 1481–1489. doi:10.1002/jsfa.3612.
Pezeshk, S. , Ojagh, S.M. , Alishahi, A. , 2015. Effect of plant antioxidant and antimicrobial compounds on the shelf-life of seafood – a review. Czech J. Food Sci. 33, 195–203. doi:10.17221/593/2014-CJFS.
Pyo, Y.H. , Oh, H.J. , 2011. Ubiquinone contents in Korean fermented foods and average daily intakes. J. Food Compos. Anal. 24, 1123–1129. doi:10.1016/j.jfca.2011.03.018.
Ribarova, F. , Zanev, R. , Shishkov, S. , Rizov, N. , 2003. α-Tocopherol, fatty acids and their correlations in Bulgarian foodstuffs. J. Food Compos. Anal. 16, 659–667. doi:10.1016/S0889-1575(03)00079-6.
Shahidi, F. , 1998. Flavor of Meat, Meat Products and Seafoods. Blackie Academic & Professional. doi:10.1016/0742-051X(89)90005-X.
Solé, M. , Porte, C. , Albaigés, J. , 1995. Seasonal variation in the mixedfunction oxygenase system and antioxidant enzymes of the mussel Mytilus galloprovincialis. Environ. Toxicol. Chem. 14, 157–164. doi:10.1002/etc.5620140118.
Suraiya, S. , Ahmmed, M.K. , Haq, M. , 2022. Immunity boosting roles of biofunctional compounds available in aquafoods: a review. Heliyon 8, e09547. doi:10.1016/j.heliyon.2022.e09547.
Sureda, A. , Box, A. , Enseñat, M. , Alou, E. , Tauler, P. , Deudero, S. , Pons, A. , 2006. Enzymatic antioxidant response of a labrid fish (Coris julis) liver to environmental caulerpenyne. Comp. Biochem. Physiol. C Toxicol. Pharmacol. 144, 191–196. doi:10.1016/j.cbpc.2006.08.001.
Undeland, I. , Hall, G. , Lingnert, H. , 1999. Lipid oxidation in fillets of herring (Clupea harengus) during ice storage. J. Agric. Food Chem. 47, 524–532.
Yamamoto, Y. , Fujisawa, A. , Hara, A. , Dunlap, W.C. , 2001. An unusual vitamin E constituent (α-tocomonoenol) provides enhanced antioxidant protection in marine organisms adapted to cold-water environments. Proc. Natl. Acad. Sci. U. S. A. 98, 13144–13148. doi:10.1073/pnas.241024298.

Vitamins

Akram, Muhammad , Naveed Munir , Muhammad Daniyal , Chukwuebuka Egbuna , Mihnea-Alexandru Găman , Peculiar Feenna Onyekere , and Ahmed Olatunde . 2020. “Vitamins and Minerals: Types, Sources and Their Functions.” Functional Foods and Nutraceuticals. 1st Edition, Springer International Publishing: 149–172. doi:10.1007/978-3-030-42319-3_9.
American Heart Association Nutrition Committee ; Lichtenstein , Alice H. , Lawrence J. Appel , Michael Brands , Mercedes Carnethon , Stephen Daniels , Harold A. Franch , Barry Franklin , Penny Kris-Etherton , William S

Harris , Barbara Howard , Njeri Karanja , Michael Lefevre , Lawrence Rudel , Frank Sacks , Linda Van Horn , Mary Winston , Judith Wylie-Rosett . 2006. “Diet and Lifestyle Recommendations Revision 2006: A Scientific Statement from the American Heart Association Nutrition Committee.” Circulation 114 (1): 82–96. doi:10.1161/CIRCULATIONAHA.106.176158. Epub 2006 Jun 19. Erratum in: Circulation. 2006 Dec 5;114(23):e629. Erratum in: Circulation. 2006 Jul 4;114(1):e27. PMID: 16785338.

Ata, F. , A. Bint I Bilal , S. Javed , H. Shabir Chaudhry , R. Sharma , R. Fatima Malik , H. Choudry , A. Bhaskaran Kartha . 2020. Optic neuropathy as a presenting feature of vitamin B-12 deficiency: A systematic review of literature and a case report. Annals of Medicine and Surgery 60, pp. 316–322. doi: 10.1016/J.AMSU.2020.11.010.

Alina, Vlaic Romina , Mureşan Crina Carmen , Muste Sevastita , Mureşan Andruţa , Muresan Vlad , Suharoschi Ramona , Petruţ Georgiana , et al . 2019. “Food Fortification Through Innovative Technologies.” Food Engineering (January). IntechOpen: Chapter 6, 1-25. doi:10.5772/INTECHOPEN.82249.

Bekah, Devesh , Asho D. Thakoor , Avin Ramanjooloo , Itisha Chummun Phul , Sabine Botte , Prerna Roy , Preeti Oogarah , Sarvanen Curpen , Nowsheen Goonoo , John Bolton , Archana Bhaw-Luximon . 2023. “Vitamins, Minerals and Heavy Metals Profiling of Seaweeds from Mauritius and Rodrigues for Food Security.” Journal of Food Composition and Analysis 115 (January). Academic Press: 104909. doi:10.1016/J.JFCA.2022.104909.

Biology Educare . 2022. “Vitamin Requirements of Fish: Sources and Deficiency Symptoms.” https://biologyeducare.com/vitamin-requirements-of-fish/.

Bonto, Aldrin P. , Ken Sammuel I. Camacho , and Drexel H Camacho . 2018. “Increased Vitamin B5 Uptake Capacity of Ultrasonic Treated Milled Rice: A New Method for Rice Fortification.” LWT 95 (September). Academic Press: 32–39. doi:10.1016/J.LWT.2018.04.062.

Bowers, Jane A. , and Jean Craig . 1978. “Components of Vitamin B6 in Turkey Breast Muscle.” Journal of Food Science. 43 (5): p. 1619. doi:10.3/JQUERY-UI.JS.

Bowling, Francis Gerard . 2011. “Pyridoxine Supply in Human Development.” Seminars in Cell & Developmental Biology 22 (6). Academic Press: 611–618. doi:10.1016/J.SEMCDB.2011.05.003.

Boyaci, Bilgi , Jae Yoon Han Berna , M. Tugrul Masatcioglu , Erkan Yalcin , Sueda Celik , Gi Hyung Ryu , and Hamit Koksel . 2012. “Effects of Cold Extrusion Process on Thiamine and Riboflavin Contents of Fortified Corn Extrudates.” Food Chemistry 132 (4). Elsevier: 2165–2170. doi:10.1016/J.FOODCHEM.2011.12.013.

Buehler, Bruce A. 2023. “Vitamin B2: Riboflavin.” Journal of Evidence-Based Complementary & Alternative Medicine 16 (2): 88–90. doi:10.1177/1533210110392943.

Cannell, John J. , and Bruce W. Hollis . 2008. Use of vitamin D in clinical practice. Altern Med Reviews 13(1): 6–20. PMID: 18377099.

Caprioli, Giovanni , Gianni Sagratini , Sauro Vittori, and Elisabetta Torregiani . 2018. “Optimization of an Extraction Procedure for the Simultaneous Quantification of Riboflavin, Nicotinamide and Nicotinic Acid in Anchovies (Engraulis Enrasicolus) by High-Performance Liquid Chromatography-Tandem Mass Spectrometry.” Journal of Food Composition and Analysis 66 (March). Academic Press Inc.: 23–29. doi:10.1016/J.JFCA.2017.11.004.

Carling, Rachel S. , and Charles Turner . 2019. “Methods for Assessment of Biotin (Vitamin B7).” Laboratory Assessment of Vitamin Status 2019 (January). Academic Press: 193–217. doi:10.1016/B978-0-12-813050-6.00010-3.

Carpenter, Kenneth J. 2016. “The History of Scurvy and Vitamin C, Kenneth J. Carpenter. 1986. Cambridge University Press, New York. 336 Pages. ISBN: 0-521-34773-4. 10 (2). Sage Publications: Thousand Oaks, CA: 122–123. doi:10.1177/027046769001000241.

Ceylan, Zafer , Mustafa Yaman , Osman Sağdıç , Ercan Karabulut , and Mustafa Tahsin Yilmaz . 2018. “Effect of Electrospun Thymol-Loaded Nanofiber Coating on Vitamin B Profile of Gilthead Sea Bream Fillets (Sparus Aurata).” LWT 98 (August), Elsevier: 162–169. doi:10.1016/j.lwt.2018.08.027.

Chatterjee, Niladri Sekhar , Rangasamy Anandan , Mary Navitha , Asha Kurukkan Kunnath , Kaparboyna Ashok Kumar , Suseela Mathew , and Ravishankar Chandragiri Nagarajarao . 2016. “Development of Thiamine and Pyridoxine Loaded Ferulic Acid-Grafted Chitosan Microspheres for Dietary Supplementation.” Journal of Food Science and Technology 53 (1). Springer: 551. doi:10.1007/S13197-015-2044-4.

Chatterjee, Niladri Sekhar , Kaparboyna Ashok Kumar , Kizhakkeppurath Kumaran Ajeeshkumar , K R Remya Kumari , Kalladathvalappil Venugopalan Vishnu , Rangasamy Anandan , Suseela Mathew , and Ravishankar Chandragiri Nagarajarao . 2017. “Screening Natural Content of Water-Soluble B Vitamins in Fish: Enzymatic Extraction, HILIC Separation, and Tandem Mass Spectrometric Determination.” Journal of AOAC International 100 (3): 579–585. doi:10.5740/jaoacint.17-0056.

Coburn, S.P. 2015. Vitamin B-6 Metabolism and Interactions with TNAP. Sub-Cellular Biochemistry 76, pp. 207–238. doi: 10.1007/978-94-017-7197-9_11.

Combs, Gerald F. , and James P. McClung . 2017. “The Vitamins: Fundamental Aspects in Nutrition and Health.” The Vitamins: Fundamental Aspects in Nutrition and Health (January). 5th Edition, Elsevier: 1–612. doi:10.1016/B978-0-12-802965-7.01001-7.

Curely, J. , By J. Clifford and. 2019. “Quick Facts What Are Water – Soluble.” Nutrients 9, Colorado State University, USA.

Czarnowska-Kujawska, Marta , Joanna Klepacka , Olga Zielińska , and María de Lourdes Samaniego-Vaesken . 2022. “Characteristics of Dietary Supplements with Folic Acid Available on the Polish Market.” Nutrients, MDPI: 14 (17): 1–11. doi:10.3390/nu14173500.

Dahl L. , A. Duinker , A. Måge , I. Eide Graff . 2014. Næringsstoff I Sild Og Makrell Project 900663. https://www.fhf.no/prosjekter/prosjektbasen/900663/

Dias M Graça , M Sánchez , Helena Bártolo and Luísa Oliveira . “Vitamin content of fish and fish products consumed in Portugal.” Electronic journal of environmental, agricultural and food chemistry 2 (2003): 510–515.

Drouin, Guy , Jean-Remi Godin , and Benoit Page . 2011. “The Genetics of Vitamin C Loss in Vertebrates.” Current Genomics 12 (5). Bentham Science Publishers Ltd.: 371–378. doi:10.2174/138920211796429736.

Ebbing, M. , K. H. Bønaa , E. Arnesen , P. M. Ueland , J. E. Nordrehaug , K. Rasmussen , I. Njølstad , D. W. Nilsen , H. Refsum , A. Tverdal , S. E. Vollset , H. Schirmer , Ø. Bleie , T. Steigen , Ø Midttun , A. Fredriksen , E. R. Pedersen , O. Nygård . 2010. “Combined Analyses and Extended Follow-up of Two Randomized Controlled Homocysteine-Lowering B-Vitamin Trials: Original Article.” Journal of Internal Medicine 268 (4): 367–382. doi:10.1111/J.1365-2796.2010.02259.X. PMID: 20698927.

Eijkman, Christiaan . 1896. “Christiaan Eijkman, Beriberi and Vitamin B1.” https://educationalgames.nobelprize.org/educational/medicine/vitamin_b1/eijkman.php.

Ersoy, Beyza , and Akif Özeren . 2009. “The Effect of Cooking Methods on Mineral and Vitamin Contents of African Catfish.” Food Chemistry 115 (2). Elsevier: 419–422. doi:10.1016/J.FOODCHEM.2008.12.018.

Esteve, Más María José , Farré Rosaura , Frígola Ana M and García-Cantabella José Manuel . 1998. “Determination of Vitamin B6 (Pyridoxamine, Pyridoxal and Pyridoxine) in Pork Meat and Pork Meat Products by Liquid Chromatography.” Journal of Chromatography A 795 (2). Elsevier: 383–387. doi:10.1016/S0021-9673(97)00990-4.

Fischer, Carlos Gonzalez, Tara Garnett, Food and Agriculture Organization of the United Nations, and University of Oxford, Food Climate Research Network. 2016. “Plates, Pyramids, and Planets: Developments in National Healthy and Sustainable Dietary Guidelines: A State of Play Assessment.” FAO, 70.

Galani, Y. J. H. , C. Orfila , and Y. Y. Gong . 2022. “A Review of Micronutrient Deficiencies and Analysis of Maize Contribution to Nutrient Requirements of Women and Children in Eastern and Southern Africa.” Critical Reviews in Food Science and Nutrition 62 (6). Taylor & Francis: 1568–1591. doi:10.1080/10408398.2020.1844636.

Gentili, Alessandra , Fulvia Caretti , Giuseppe D'Ascenzo , Stefano Marchese , Daniela Perret , Daniele Di Corcia , and Lucia Mainero Rocca . 2008. “Simultaneous Determination of Water-Soluble Vitamins in Selected Food Matrices by Liquid Chromatography/Electrospray Ionization Tandem Mass Spectrometry.” Rapid Communications in Mass Spectrometry 22 (13). John Wiley & Sons, Ltd: 2029–2043. doi:10.1002/RCM.3583.

Grande, Fernanda , Eliana Bistriche Giuntini , Franco Maria Lajolo , and Elizabete Wenzel de Menezes . 2016. “How Do Calculation Method and Food Data Source Affect Estimates of Vitamin A Content in Foods and Dietary Intake?” Journal of Food Composition and Analysis 46 (March). Academic Press: 60–69. doi:10.1016/J.JFCA.2015.11.006.

Gregory, Jesse F. 1989. “Chemical and Nutritional Aspects of Folate Research: Analytical Procedures, Methods of Folate Synthesis, Stability, and Bioavailability of Dietary Folates.” Advances in Food and Nutrition Research 33 (C). Academic Press: 1–101. doi:10.1016/S1043-4526(08)60126-6.

Harvard School of Public Health Nutrition Source . 2022. “Vitamin D|The Nutrition Source|Harvard T.H. Chan School of Public Health.” https://www.hsph.harvard.edu/nutritionsource/vitamin-d/.

Hicks, Christina C. , Philippa J. Cohen , Nicholas A. J. Graham , Kirsty L. Nash , Edward H. Allison , Coralie D'Lima , David J. Mills , Matthew Roscher , Shakuntala H Thilsted , Andrew L Thorne-Lyman , and M Aaron MacNeil . 2019. “Harnessing Global Fisheries to Tackle Micronutrient Deficiencies.” Nature 574 (7776): 95–98. doi:10.1038/S41586-019-1592-6.

Hopkins, F. Gowland . 1906. “The Analyst and the Medical Man.” Analyst 31 (369). The Royal Society of Chemistry: 385b–404. doi:10.1039/AN906310385B.

Institute of Medicine (US) Standing Committee on the Scientific Evaluation of Dietary Reference Intakes and its Panel on Folate, Other B Vitamins, and Choline . Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline. 1998. Washington (DC): National Academies Press (US). Available from: https://www.ncbi.nlm.nih.gov/books/NBK114310/ doi: 10.17226/6015.

Kawarazuka, Nozomi , and Christophe Béné . 2011. “The Potential Role of Small Fish Species in Improving Micronutrient Deficiencies in Developing Countries: Building Evidence.” Public Health Nutrition 14 (11). Public Health Nutr: 1927–1938. doi:10.1017/S1368980011000814.

Kennedy, David O. 2016. “B Vitamins and the Brain: Mechanisms, Dose and Efficacy-A Review.” Nutrients 8 (2). Multidisciplinary Digital Publishing Institute (MDPI): 68. doi:10.3390/NU8020068.

Kjerstad, Margareth , Wenche Emblem Larssen , and Lisa Kolden Midtbø . 2020. “Belly Flap from Norwegian Spring-Spawning Herring (Clupea Harengus L.): A Potentially New Product with High Content of Vitamin D, EPA and DHA.” Heliyon 6 (10). Elsevier Ltd: e05239. doi:10.1016/j.heliyon.2020.e05239.

Krist, Alex H. , Karina W. Davidson , Carol M. Mangione , Michael Cabana , Aaron B. Caughey , Esa M. Davis , Katrina E. Donahue , Chyke A. Doubeni , John W. Epling Jr , Martha Kubik , Li Li , Gbenga Ogedegbe , Douglas K Owens , Lori Pbert , Michael Silverstein , James Stevermer , Chien-Wen Tseng , John B Wong . 2021. “US Preventive Services Task Force. Screening for Vitamin D Deficiency in Adults: US Preventive

Services Task Force Recommendation Statement.” JAMA – Journal of the American Medical Association 325 (14). American Medical Association: 1436–1442. doi:10.1001/jama.2021.3069.
Lebiedzińska, Anna , Marcin Leszek Marszałł , Jadwiga Kuta , and Piotr Szefer . 2007. “Reversed-Phase High-Performance Liquid Chromatography Method with Coulometric Electrochemical and Ultraviolet Detection for the Quantification of Vitamins B1 (Thiamine), B6 (Pyridoxamine, Pyridoxal and Pyridoxine) and B12 in Animal and Plant Foods.” Journal of Chromatography A 1173 (1–2). Elsevier: 71–80. doi:10.1016/J.CHROMA.2007.09.072.
Lepkovsky, Samuel , Thomas H. Jukes , and Myrtise E. Krause . 1936. “The Multiple Nature of the Third Factor of the Vitamin B Complex.” Journal of Biological Chemistry 115: 557–566. Elsevier.
Li, Chao , Caihui Feng , Fengdong Qu , Juan Liu , Linghui Zhu , Ying Lin , Ying Wang , et al . 2015. “Electrospun Nanofibers of P-Type NiO/n-Type ZnO Heterojunction with Different NiO Content and Its Influence on Trimethylamine Sensing Properties.” Sensors and Actuators B: Chemical 207 (Part A). Elsevier: 90–96. doi:10.1016/J.SNB.2014.10.035.
Luhila, Õnnela , Tiina Paalme , Kristel Tanilas , and Inga Sarand . 2022. “Omega-3 Fatty Acid and B12 Vitamin Content in Baltic Algae.” Algal Research 67 (September). Elsevier: 102860. doi:10.1016/J.ALGAL.2022.102860.
Maciej Serda , Fernando Gertum Becker , Michelle Cleary , R. M. Team , Helge Holtermann , Disclaimer The, National Agenda, et al . 1977. “Vitaminler ve Enzimler,” edited by G. Balint , B. Antala , C. Carty , J- M. A. Mabieme , I. B. Amar , and A. Kaplanova . Uniwersytet Śląski 7 (1). Ankara Üniversitesi Eczacılık Fakültesi: Ankara: 343–354. doi:10.2/JQUERY.MIN.JS.
Majewski, Michael S. and Anna Lebiedzińska . 2014. “The evaluation of selected shellfish as a source of niacin in nutrition and therapy of modern human.” Polish annals of medicine 21: 14–19.
Marques, Ivone,Goreti Botelho and Raquel Guiné . 2019. "Comparative study on nutritional composition of fish available in Portugal", Nutrition & Food Science 49 (5): pp. 925–941. doi: 10.1108/NFS-11-2018-0311.
Maras, Janice E. , Odilia I. Bermudez , Ning Qiao , Peter J. Bakun , Esther L. Boody-Alter , and Katherine L. Tucker . 2004. “Intake of α-Tocopherol Is Limited among US Adults.” Journal of the American Dietetic Association 104 (4). Elsevier: 567–575. doi:10.1016/J.JADA.2004.01.004.
Martel, Julianna L. , Connor C. Kerndt , Harshit Doshi , and David S. Franklin . 2022. “Vitamin B1 (Thiamine).” Vitamins in the Prevention of Human Diseases (August). StatPearls Publishing: 41–61. doi:10.1515/9783110214499.
Marton, Ledyane Taynara , Ricardo de Alvares Goulart , Antonelly Cassio Alves de Carvalho , and Sandra Maria Barbalho . 2019. “Omega Fatty Acids and Inflammatory Bowel Diseases: An Overview.” International Journal of Molecular Sciences 20 (19): 4851. Multidisciplinary Digital Publishing Institute: 4851. doi:10.3390/IJMS20194851.
Mazur, Anna , David Aebisher , and Dorota Bartusik-Aebisher . 2022. “Vitamin B3.” A Biochemical View of Vitamins (June). StatPearls Publishing: January 21, 429–431. doi:10.3109/9780203492079-196.
MedlinePlus . 2010. “25-Hydroxy Vitamin D Test: MedlinePlus Medical Encyclopedia.” https://medlineplus.gov/ency/article/003569.htm.
Miller, Susan . 2006. “Vitamins and Minerals.” A Sight and Life Publication 69 (10). doi:10.1016/b978-0-8155-1347-6.50026-1.
Mohanty, Bimal P. , T. V. Sankar , Satabdi Ganguly , Arabinda Mahanty , R. Anandan , Kajal Chakraborty , B. N. Paul , et al . 2016. “Micronutrient Composition of 35 Food Fishes from India and Their Significance in Human Nutrition.” Biological Trace Element Research 174 (2). Biological Trace Element Research: 448–458. doi:10.1007/s12011-016-0714-3.
Moore, R. 2012. “Water-Soluble Vitamins: B-Complex and Vitamin C.” Colorado State University Fact Sheet (9): 5.
Moyad, Mark . 2009. “Vitamin D: A Rapid Review – PubMed.” https://pubmed.ncbi.nlm.nih.gov/19283958/.
Moyad, Mark A. 2008. “Vitamin D: A Rapid Review.” Urologic Nursing: Official Journal of the American Urological Association Allied 28(5): 343–349, 384; quiz 350.
Nair, Rathish , and Arun Maseeh . 2012. “Vitamin D: The ‘Sunshine’ Vitamin.” Journal of Pharmacology & Pharmacotherapeutics 3 (2). Wolters Kluwer – Medknow Publications: 118. doi:10.4103/0976-500X.95506.
Ofoedu, Chigozie E. , Jude O. Iwouno , Ebelechukwu O. Ofoedu , Chika C. Ogueke , Victory S. Igwe , Ijeoma M. Agunwah , Arinze F. Ofoedum , James Chacha , Onyinye Muobike , Adedoyin Agunbiade , Njideka Njoku , Adanze Nwakaudu , Euphresia Nkiru Odimegwu , Onyekachi Ndukauba , Chukwuka Ogbonna , Joncer Naibaho , Maciej Korus , Charles Okpala . 2021. “Revisiting Food-Sourced Vitamins for Consumer Diet and Health Needs: A Perspective Review, from Vitamin Classification, Metabolic Functions, Absorption, Utilization, to Balancing Nutritional Requirements.” PeerJ 9 (September). PeerJ: e11940. doi:10.7717/PEERJ.11940.
Olds, S. J. , J. T. Vanderslice , and D. Brochetti . 1993. “Vitamin B6 in Raw and Fried Chicken by HPLC.” Journal of Food Science 58 (3). John Wiley & Sons, Ltd: 505–507. doi:10.1111/J.1365-2621.1993.TB04311.X.
Omoniyi, Adeyemi-Doro , Iyiola Adams Ovie , and Vincenzo Tufarelli . 2018. “Vitamin C: An Important Nutritional Factor in Fish Diets.” Journal of Agriculture and Ecology Research International 16 (2). Sciencedomain International: 1–7. doi:10.9734/JAERI/2018/15528.
Oregon State University, Corvallis, Oregon . 2016. “Micronutrients for Health.” Linus Pauling Institute. https://lpi.oregonstate.edu/sites/lpi.oregonstate.edu/files/pdf/mic/micronutrients_for_health.pdf.

Paiva, Emmanuela Prado de , Marcella Melo Assis Costa , and Clayton Anderson de Azevedo . 2015. “Folate – Analytical Properties, Bioavailability and Stability in Foods.” Scientia Chromatographica. ACS publication: 7 (3): 199–222. doi:10.4322/sc.2016.004.

Pinto, John Thomas , and Richard Saul Rivlin . 2013. “Riboflavin (Vitamin B2),” edited by Janos Zempleni , John W. Suttie , Jesse F. Gregory III , and Patrick J. Stover . Hanbook of Vitamins. CRC Press, London, pp. 192–222. https://www.routledge.com/Handbook-of-Vitamins/Zempleni-Suttie-III-Stover/p/book/9781466515567.

Pique, K. , W. Taber , A. Thompson , C.G. Maitland . 2021. Isolated optic neuropathy due to folate deficiency with associated iron overload. BMJ Case Reports 14 (7). doi: 10.1136/BCR-2021-242399.

Polansky, M. Marilyn and Edward W. Toepfer . 1969. “Vitamin B6 Components in Some Meats, Fish, Dairy Products, and Commercial Infant Formulas.” Journal of Agricultural and Food Chemistry 17 (6): 1394–1397. doi:10.3/JQUERY-UI.JS.

Porter, Kate , and John K. Lodge . 2021. “Determination of Selected Water-Soluble Vitamins (Thiamine, Riboflavin, Nicotinamide and Pyridoxine) from a Food Matrix Using Hydrophilic Interaction Liquid Chromatography Coupled with Mass Spectroscopy.” Journal of Chromatography. B, Analytical Technologies in the Biomedical and Life Sciences 1171 (May), 122541. doi:10.1016/J.JCHROMB.2021.122541.

Powers, Hilary J. 2003. “Riboflavin (Vitamin B-2) and Health.” The American Journal of Clinical Nutrition 77 (6). Am J Clin Nutr: 1352–1360. doi:10.1093/AJCN/77.6.1352.

Puthusseri, Bijesh , Peethambaran Divya , Veeresh Lokesh , and Bhagyalakshmi Neelwarne . 2013. “Salicylic Acid-Induced Elicitation of Folates in Coriander (Coriandrum Sativum L.) Improves Bioaccessibility and Reduces Pro-Oxidant Status.” Food Chemistry 136 (2). Elsevier: 569–575. doi:10.1016/J.FOODCHEM.2012.09.005.

Rockwell, Michelle , Vivica Kraak , Matthew Hulver , and John Epling . 2018. “Clinical Management of Low Vitamin D: A Scoping Review of Physicians’ Practices.” Nutrients 10 (4). MDPI AG. doi:10.3390/NU10040493.

Rosner, Ilana , Everett Rogers , Amanda Maddrey , and David M. Goldberg . 2019. “Clinically Significant Lab Errors Due to Vitamin B7 (Biotin) Supplementation: A Case Report Following a Recent FDA Warning.” Cureus (August). Cureus, Inc.: 11(8): e5470. doi:10.7759/CUREUS.5470.

Sakakeeny, Lydia , Ronenn Roubenoff , Martin Obin , Joao D. Fontes , Emelia J. Benjamin , Yoram Bujanover , Paul F. Jacques , and Jacob Selhub . 2012. “Plasma Pyridoxal-5-Phosphate Is Inversely Associated with Systemic Markers of Inflammation in a Population of U.S. Adults.” The Journal of Nutrition 142 (7). J Nutr: 1280–1285. doi:10.3945/JN.111.153056.

Sandstrom, B. , N. Lyhne , J. I. Pedersen , A. Aro , I. Thorsdottir , and W. Becker . 2012. “Nordic Nutrition: Recommendations 2012.”, Integrating nutrition and physical activity (5th ed.). (2014). doi: 10.6027/Nord2014-002. Scandinavian Journal of Nutrition/Naringsforskning 40. https://altomkost.dk/fileadmin/user_upload/altomkost.dk/Slet_ikke_filliste/Raad_og_anbefalinger/Nordic_Nutrition_Recommendations_2012.pdf.

Sanvictores, Terrence , and Shaylika Chauhan . 2022. “Vitamin B5 (Pantothenic Acid).” Clinical Guide to Nutrition & Dietary Supplements in Disease Management (October). StatPearls Publishing: 699–701. doi:10.1016/B978-0-443-07193-5.50106-0.

Schellack, Gustav , Pamela Harirari , and Natalie Schellack . 2015. “B-Complex Vitamin Deficiency and Supplementation.” South African Pharmaceutical Journal, Medpharm Publications: 82 (4): 28–32. https://www.sapj.co.za/index.php/SAPJ/article/view/2003.

Semba, Richard David . 2012. “The Discovery of the Vitamins.” International Journal for Vitamin and Nutrition Research 82 (5): 310–315. doi:10.1024/0300-9831/a000124.

Spitzer, Volker , and Ulrich Höller . 2004. “Vitamins – Overview.” Encyclopedia of Analytical Science: Second Edition (January). Elsevier Inc.: 147–159. doi:10.1016/B0-12-369397-7/00643-9.

Stark, Ken D. , Mary E. Van Elswyk , M. Roberta Higgins , Charli A. Weatherford , and Norman Salem Jr . 2016. “Global Survey of the Omega-3 Fatty Acids, Docosahexaenoic Acid and Eicosapentaenoic Acid in the Blood Stream of Healthy Adults.” Progress in Lipid Research 63 (July). Prog. Lipid Res.: 132–152. doi:10.1016/J.PLIPRES.2016.05.001.

Strobbe, S. , D. Van Der Straeten . 2018. Toward Eradication of B-Vitamin Deficiencies: Considerations for Crop Biofortification. Frontiers in Plant Science p. 443. doi:10.3389/FPLS.2018.00443

Supplementation, Vitamin D. 2010. “Vitamin D Supplementation: An Update.” https://www.uspharmacist.com/article/vitamin-d-supplementation-an-update.

Supplements, NIH Office of Dietary . 2022. “Vitamin D – Health Professional Fact Sheet.” https://ods.od.nih.gov/factsheets/Vitamind-HealthProfessional/.

Tortolero, Simon Alexis Ramos , Bruno Adam Sagratski Cavero , Janaina Gomes de Brito , Climeia Correa Soares , Joel Lima da Silva Junior , Jose Carlos de Almeida , Gangadhar Barlaya , and Keshavanath Perar . 2016. “Solak, Kaleli & Baytut_2016_Trjfas_The Distribution of Cymbelloid Diatoms in Yalova Runningwaters.” Turkish Journal of Fisheries and Aquatic Sciences, Central Fisheries Research Institute of Türkiye and Japan International Cooperation Agency (JICA), 16 (4): 953–959. doi:10.4194/1303-2712-v16.

Uebanso, T. , A. Yoshimoto , S. Aizawa , M. Nakamura , R. Masuda , T. Shimohata , A. Takahashi . 2020. Glycolate is a Novel Marker of Vitamin B2 Deficiency Involved in Gut Microbe Metabolism in Mice. Nutrients, 12 (3). doi: 10.3390/NU12030736.

Vahteristo, Liisa T. , Velimatti Ollilainen , and Pertti Varo . 1997. “Liquid Chromatographic Determination of Folate Monoglutamates in Fish, Meat, Egg, and Dairy Products Consumed i023n Finland.” Journal of AOAC International 80 (2). AOAC International: 373–378. doi:10.1093/JAOAC/80.2.373.
Vedrina-Dragojević, Irena , and Blaženka Šebečić . 1994. “Effect of Frozen Storage on the Degree of Vitamin B6 Degradation in Different Foods.” Zeitschrift Fur Lebensmittel-Untersuchung Und -Forschung 198 (1). Z Lebensm Unters Forsch: 44–46. doi:10.1007/BF01195282.
Vitamin D council . 2023. “Vitamin D2.” Accessed January 14. https://www.vitamindcouncil.org/vitaminDPharmacology.shtml.
Waagbø, Rune . 2010. “Water-Soluble Vitamins in Fish Ontogeny.” Aquaculture Research 41 (5). John Wiley & Sons, Ltd: 733–744. doi:10.1111/J.1365-2109.2009.02223.X.
WHO . 2021a. “Fact Sheets – Malnutrition.” https://www.who.int/news-room/fact-sheets/detail/malnutrition.
WHO . 2021b. “Micronutrients.” https://www.who.int/health-topics/micronutrients#tab=tab_1.
WHO-UNICEF . 2017. “The Fourth Meeting of the WHO-UNICEF Technical Expert Advisory Group on Nutrition Monitoring (TEAM).” https://cdn.who.int/media/docs/default-source/nutritionlibrary/team---technical-expert-advisory-group-on-nutrition-monitoring/meeting-reports/2017-team-4thmeeting-report.pdf?sfvrsn=268b5d69_4&download=true.
Williams, P.A. , J.M. Harder , N.E. Foxworth , K.E. Cochran , V.M. Philip , V. Porciatti , S.W.M. John . 2017. Vitamin B 3 modulates mitochondrial vulnerability and prevents glaucoma in aged mice. Science: New York (N.Y.): 355 (6326): pp. 756–760.
World Health Organization . 2009. “Global Prevalence of Vitamin A Deficiency in Populations at Risk 1995–2005: WHO Global Database on Vitamin A Deficiency.” https://apps.who.int/iris/handle/10665/44110.
Xie, Zhongjian , Weibo Xia , Zhenlin Zhang , Wen Wu , Chunyan Lu , Shuqing Tao , Lijun Wu , et al . 2019. “Prevalence of Vitamin D Inadequacy among Chinese Postmenopausal Women: A Nationwide, Multicenter, Cross-Sectional Study.” Frontiers in Endocrinology 10 (January). Frontiers Media S.A. doi:10.3389/FENDO.2018.00782/FULL.
Yerlikaya, Pinar , Ali Can Alp , Fahrettin Gokhun Tokay , Tugce Aygun , Adem Kaya , Osman Kadir Topuz , and Hanife Aydan Yatmaz . 2022. “Determination of Fatty Acids and Vitamins A, D and E Intake through Fish Consumption.” International Journal of Food Science and Technology 57 (1). John Wiley and Sons Inc: 653–661. doi:10.1111/IJFS.15435.
Yu, Hai Rui , Meng Jie Guo , Le Yong Yu , Ling Yao Li , Qing He Wang , Fang Hui Li , Yu Zhuo Zhang , et al . 2022. “Effects of Dietary Riboflavin Supplementation on the Growth Performance, Body Composition and Anti-Oxidative Capacity of Coho Salmon (Oncorhynchus Kisutch) Post-Smolts.” Animals 12 (22). doi:10.3390/ani12223218.

Minerals and Trace Elements

Vohra, S.B. , Is human body a microcosm? A critical study. Studies Hist. Med., 5(1), 61–65, 1981. Proceedings of the first International Conference on Elements and Disease, Indian Institute of history of medicine and medical research, New Delhi, India; First ed., 1984, pp. 15–26.
Shahid, M. , Niazi, N.K. , Rinklebe, J. , Bundschuh, J. , Dumat, C. , and Pinelli, E. , Trace elements-induced phytohormesis: A critical review and mechanistic interpretation. Crit. Rev. Environ. Sci. Technol., 50(19), 1984–2015, 2020.
Ranau, R. , Oehlenschläger, J. , and Steinhart, H. , Determination of aluminium in the edible part of fish by GFAAS after sample pretreatment with microwave activated oxygen plasma. Fresen. J. Anal. Chem., 364, 599, 1999.
Ranau, R. , Oehlenschläger, J. , and Steinhart, H. , Aluminium content in edible parts of seafood. Eur. Food Res. Technol., 212, 431, 2001.
Türkmen, A. , Türkmen, M. , Tepe, Y. , and Akyurt, I. , Heavy metals in three commercially valuable fish species from Iskenderun Bay, Northern East Mediterranean Sea, Turkey. Food Chem., 91, 167, 2005.
Shang, D. , Zhao, Y. , Zhai, Y. , Ning, J. , Ding, H. , and Sheng, X. , Development of a new method for analyzing free aluminum ions (Al^{3+}) in seafood using HPLC-ICP-MS. Chin. Sci. Bull., 58(35), 4437–4442, 2013.
Fang, L. , Ma, H. , Li, L. , Yang, X. , Rong, H. , and Zhu, C. , Speciation analysis of aluminum in *Ostrea rivularis* . South China Fish. Sci., 14(4), 94–101, 2018.
Borak, J. and Hosgood, H.D. , Seafood arsenic: Implications for human risk assessment. Reg. Toxicol. Pharmacol., 47, 204, 2007.
Francesconi, K.A. and Edmonds, J.S. , Arsenic species in marine samples. Croat. Chem. Acta, 71, 343, 1998.
Francesconi, K.A. , Arsenic’s not so bad. J. Environ. Monitor., 6, 94N, 2004.
Francesconi, K.A. , Toxic metal species and food regulations-Making a healthy choice. Analyst, 132, 17, 2007.
Luten, J.B. , Riekwel-Booy, G. , and Rauchbaar, A. , Occurrence of arsenic in plaice (*Pleuronectes platessa*), nature of organo-arsenic compound present and its excretion by man. Environ. Health Persp., 45, 165, 1982.

Schoof, R.A. , Yost, L.J. , Eickhoff, J. , Crecelius, E.A. , Cragin, D.W. , Meacher, D.M. , and Menzel, D.B. , A market basket survey of inorganic arsenic in food. Food Chem. Toxicol., 37, 839, 1999.

De Dieter, M. , Leermakers, M. , Van Ryssen, R. , Noyen, J. , Goeyens, L. , and Baeyens, W. , Total and toxic arsenic levels in North Sea fish. Arch. Environ. Contam. Toxicol., 43, 406, 2002.

Larsen, E.H. , Engman, J. , Sloth, J.J. , Hansen, M. , and Jorhem, L. , Determination of inorganic arsenic in white fish using microwave-assisted alkaline alcoholic sample dissolution and HPLC-ICP-MS. Anal. Bioanal. Chem., 381, 339, 2005.

Sloth, J.J. , Larsen, E.H. , and Julshamn, K. , Survey of inorganic arsenic in marine animals and marine certified reference materials by anion exchange high-performance liquid chromatography-inductively coupled plasma mass spectrometry. J. Agric. Food Chem., 53, 6011, 2005.

Li, W. , Wei, C. , Zhang, C. , van Hulle, M. , Cornelis, R. , and Zhang, X. , A survey of arsenic species in Chinese seafood. Food Chem. Toxicol., 41, 1103, 2003.

Hirata, S. and Toshimitsu, H. , Determination of arsenic species and arsenosugars in marine samples by HPLC-ICP-MS. Anal. Bioanal. Chem., 383, 454, 2005.

Robberecht, H. , Cauwenbergh, R.V. , Bosscher, D. , Cornelis, R. , and Deelstra, H. , Daily dietary arsenic intake in Belgium using duplicate portion sampling and elemental content of various foodstuffs. Eur. Food Res. Technol., 214, 27, 2002.

Wolle, M.M. and Conklin, S.D. , Speciation analysis of arsenic in seafood and seaweed: Part I-evaluation and optimization of methods. Anal. Bioanal. chem., 410(22), 5675–5687, 2018a.

Wolle, M.M. and Conklin, S.D. , Speciation analysis of arsenic in seafood and seaweed: Part II-single laboratory validation of method. Anal. Bioanal. Chem., 410(22), 5689–5702, 2018b.

Zmozinski, A.V. , Llorente-Mirandes, T. , Damin, I.C. , López-Sánchez, J.F. , Vale, M.G.R. , Welz, B. , and Silva, M.M. , Direct solid sample analysis with graphite furnace atomic absorption spectrometry-A fast and reliable screening procedure for the determination of inorganic arsenic in fish and seafood. Talanta, 134, 224–231, 2015.

Dufailly, V. , Guérin, T. , Noël, L. , Frémy, J.M. , and Beauchemin, D. , A simple method for the speciation analysis of bio-accessible arsenic in seafood using on-line continuous leaching and ion exchange chromatography coupled to inductively coupled plasma mass spectrometry. J. Anal. Atomic Spectrom., 23(9), 1263–1268, 2008.

Luvonga, C. , Rimmer, C.A. , Lee, L.Y. , and Lee, S.B. , Determination of total arsenic and hydrophilic arsenic species in seafood. J. Food Compos. Anal., 96, 103729, 2021.

Lin, Y. , Sun, Y. , Wang, X. , Chen, S. , Wu, Y. , and Fu, F. , A universal method for the speciation analysis of arsenic in various seafood based on microwave-assisted extraction and ion chromatography-inductively coupled plasma mass spectrometry. Microchem. J., 159, 105592, 2020.

Zmozinski, A.V. , Llorente-Mirandes, T. , López-Sánchez, J.F. , and da Silva, M.M. , Establishment of a method for determination of arsenic species in seafood by LC-ICP-MS. Food Chem., 173, 1073–1082, 2015.

Vos, G. , Hovens, J.P.C. , and Hagel, P. , Chromium, nickel, copper, zinc, arsenic, selenium, cadmium, mercury and lead in Dutch fishery products 1977–1984. Sci. Total Environ., 52, 25, 1986.

Lendinez, E. , Lorenzo, M.L. , Cabrera, C. , and López, M.C. , Chromium in basic foods of the Spanish diet: Seafood, cereals, vegetables, olive oils and dairy products. Sci. Total Environ., 278, 183, 2001.

Bratakos, M.S. , Lazos, E.S. , and Bratakos, S.M. , Chromium content of selected Greek foods. Sci. Total Environ., 290, 47, 2002.

Sepe, A. , Ciaralli, L. , Ciprotti, M. , Giordano, R. , Funari, E. , and Costantini, S. , Determination of cadmium, chromium, lead and vanadium in six fish species from the Adriatic Sea. Food Addit. Contamin., 20, 543, 2003.

Orban, E. , Di Lena, G. , Nevigato, T. , Casini, I. , Caproni, R. , Santaroni, G. , and Giulini, G. , Nutritional and commercial quality of the striped venus clam, *Chamelea gallina*, from the Adriatic Sea. Food Chem., 101, 1063, 2006.

Hamilton, E. M. , Young, S. D. , Bailey, E. H. , and Watts, M. J. , Chromium speciation in foodstuffs: A review. Food chemistry, 250, 105–112, 2018.

Cheung, Y.H. and Wong, M.H. , Trace metal contents of the Pacific oyster *(Crassostrea gigas)* purchased from markets in Hong Kong. Environ. Manage., 16, 753, 1992.

Vyncke, W. , Hillewaert, H. , Guns, M. , and van Hoeyweghen, P. , Trace metals in cut through shell *(Spisula subtruncata)* from Belgian coastal waters. Food Addit. Contam., 16, 1, 1999.

Karl, H. and Münkner, W. , Iod in Fischen und Fischerzeugnissen. Inf. Fischwirtsch., 45, 115, 1998.

Karl, H. and Münkner, W. , Jod in marinen Lebensmitteln . Ernahrungs-Umschau, 46, 288, 1999.

Dahl, L. , Johansson, L. , Julshamn, K. , and Meltzer, H.M. , The iodine content of Norwegian foods and diets. Pub. Health Nutr., 7, 569, 2003.

Haldimann, A. , Alt, A. , Blanc, A. , and Blondeau, K. , Iodine content of food groups. J. Food Comp. Anal., 18, 461, 2005.

Julshamn, K. , Maage, A. , Waagbø, R. , and Lundebye, A.-K. , A preliminary study on tailoring of fillet iodine concentrations in adult Atlantic salmon (*Salmo salar* L.) through dietary supplementation. Aquacult. Nutr., 12, 45, 2006.

Karl, H. , Basak, S. , Ziebell, S. , and Quast, P. , Changes of the iodine content in fish during household preparation and smoking. Deutsche Lebensm. Rundsch., 101, 1, 2005.

Todorov, T.I. , Smith, T. , Abdalla, A. , Mapulanga, S. , Holmes, P. , Hamilton, M. , Lewis, T. , and McDonald, M. , Comparison of ICP-MS and spectrophotometry methods for the analysis of iodine in 2013 US FDA total diet study samples. Food Anal. Methods, 11(11), 3211–3223, 2018.

Todorov, T.I. and Gray, P.J. , Analysis of iodine in food samples by inductively coupled plasma-mass spectrometry. Food Add. Contam. Part A, 33(2), 282–290, 2016.

Wang, S. , Xie, T. , Dong, X. , Hu, J. , Men, L. , and Cao, J. , Determination of iodine species in seafood by ionic liquid-based in-line solid-phase extraction-capillary electrophoresis. Food Anal. Methods, 12(10), 2139–2149, 2019.

Yebra, M.C. and Moreno-Cid, A. , On-line determination of manganese in solid seafood samples by flame atomic absorption spectrometry. Anal. Chim. Acta, 477, 149, 2003.

Da Silva, E.G.P. , Hatje, V. , Dos Santos, W.N.L. , Costa, L.M. , Nogueira, A.R.A. , and Ferreira, S.L.C. , Fast method for the determination of copper, manganese and iron in seafood samples. J. Food Comp. Anal., 21, 259, 2008.

Ogunlade, I. , Olaofe, O. , and Fadare, T. , Chemical composition, amino acids and functional properties of selected seafood. J. Food Agric. Environ., 3, 130, 2005.

Gokoglu, N. , Yerlikaya, P. , and Gokoglu, M. , Trace elements in edible tissues of three shrimp species *(Penaeus semisulcatus, Parapenaeus longirostris* and *Paleomon serratus*). J. Sci. Food Agr., 88, 175, 2008.

Mohapatra, A. , Rautray, T.R. , Vijayan, V. , Mohanty, R.K. , and Dey, S.K. , Trace elemental characterization of some food crustacean tissue samples by EDXRF technique. Aquaculture, 270, 552, 2007.

Astorga Espana, M.S. , Rodriguez, E.M. , and Diaz Romero, C. , Comparison of mineral and trace element concentrations in two molluscs from the Strait of Magellan (Chile). J. Food Comp. Anal., 20, 273, 2007.

Seixas, S. , Bustamante, P. , and Pierce, G.J. , Interannual patterns of variation in concentrations of trace elements in arms of Octopus vulgaris. Chemosphere, 59, 1113, 2005.

Gökoðlu, N. and Yerlikaya, P. , Determination of proximate composition and mineral contents of blue crab *(Callinectes sapidus)* and swim crab *(Portunuspelagicus)* caught off the Gulf of Antalya. Food Chem., 80, 495, 2003.

Gokoglu, N. , Gokoglu, M. , and Yerlikaya, P. , Seasonal variations in proximate and elemental composition of pearl oyster (*Pinctada radiata*, Leach, 1814). J. Sci. Food Agr., 86, 2161, 2006.

Demirezen, D. and Uruc, K. , Comparative study of trace elements in certain fish, meat and meat products. Meat Sci., 74, 255, 2006.

Tahvonen, R. , Aro, T. , Nurmi, J. , and Kallio, H. , Mineral content in Baltic herring and Baltic herring products. J. Food Comp. Anal., 13, 893, 2000.

Chen, Y.-C. and Chen, M.-H. , Heavy metal concentrations in nine species of fishes caught in coastal waters off Ann-Ping, S.W. Taiwan. J. Food Drug Anal., 9, 107, 2001.

El-Faer, M.Z. , Rawdah, T.N. , Attar, K.M. , and Arab, M. , Mineral and proximate composition of some commercially important fish of the Arabian Gulf. Food Chem., 45, 95, 1992.

Sivaperumal, P. , Sankar, T.V. , and Viswanathan Nair, P.G. , Heavy metal concentrations in fish, shellfish and fish products from internal markets of India vis-a-vis international standards. Food Chem., 102, 612, 2007.

Begum, A. , Amin, M.N. , Kaneco, S. , and Ohta, K. , Selected elemental composition of the muscle tissue of three species of fish, *Tilapia nilotica*, *Cirrhina mrigala* and *Clarius batrachus*, from the fresh water Dhanmondi Lake in Bangladesh. Food Chem., 93, 439, 2005.

Ruelas-Inzunza, J. and Paez-Osuna, F. , Essential and toxic metals in nine fish species for human consumption from two coastal lagoons in the Eastern Gulf of California. J. Environ. Sci. Health Part A, 42, 1411, 2007.

Krelowska-Kulas, M. , Content of some metals in mean tissue of salt-water and fresh-water fish and in their products. Nahrung, 39, 166, 1995.

da Silva, E.G. , Hatje, V. , Dos Santos, W.N. , Costa, L.M. , Nogueira, A.R. , and Ferreira, S.L. , Fast method for the determination of copper, manganese and iron in seafood samples. J. Food Composit. Anal., 21(3), 259–263, 2008.

Lemos, V.A. and Vieira, U.S. , Single-drop microextraction for the determination of manganese in seafood and water samples. Microchim. Acta, 180(5), 501–507, 2013.

Nunes, L.S. , das Graças Andrade Korn, M. , and Lemos, V.A. , Direct immersion single-drop microextraction and continuous-flow microextraction for the determination of manganese in tonic drinks and seafood samples. Food Anal. Methods, 13(8), 1681–1689, 2020.

Zaijun, L. , Jiaomai, P. , and Jian, T. , Determination of trace molybdenum in vegetable and food samples by spectrophotometry with *p*-carboxyphenylfluorone. Anal. Bioanal. Chem., 374, 11125, 2002.

Guérin, T. , Chekri, R. , Vastel, C. , Sirot, V. , Volatier, J.L. , Leblanc, J.C. , and Noël, L. , Determination of 20 trace elements in fish and other seafood from the French market. Food Chem., 127(3), 934–942, 2020.

Da Le, N. , Ha Hoang, T.T. , Phung, V.P. , Nguyen, T.L. , Duong, T.T. , Dinh, L.M. , Pham, T.M.H. , Phung, T.X.B. , Nguyen, T.D. , Duong, T.N. , Le, T.M.H. , Le, P.T. , and Quynh Le, T.P. , Trace metal element analysis in some seafood in the coastal zone of the Red River (Ba Lat Estuary, Vietnam) by green sample preparation and inductively coupled plasma-mass spectrometry (ICP-MS). J. Anal. Methods Chem., 2021, 6649362, 2021.

Fox, T.E. , Van den Heuvel, E.G.H.M. , Atherton, C.A. , Dainty, J.R. , Lewis, D.J. , Langford, N.J. , Crews, H.M. , Luten, J.B. , Lorentzen, M. , Sieling, F.W. , van Aken-Schneyder, P. , Hoek, M. , Kotterman, M.J.J. , van Dael, P. , and Fairweather-Tait, S.J. , Bioavailability of selenium from fish, yeast and selenate: A comparative study in humans using stable isotopes. Eur. J. Clin. Nutr., 58, 343, 2004.

Sager, M. , Selenium in agriculture, food, and nutrition. Pure Appl. Chem., 78, 111, 2006.

Satovic, V. , Beker, D. , and Gumhalter-Karolyi, L. , Selenium content in the pilchard of the Adriatic Sea. Eur. Food Res. Technol., 217, 154, 2003.

McNaughton, S.A. and Marks, G.C. , Selenium content in Australian foods: A review of literature values. J. Food Comp. Anal., 15, 169, 2002.

Pappa, E.C. , Pappas, A.C. , and Surai, P.F. , Selenium consent in selected foods from the Greek market and estimation of the daily intake. Sci. Total Environ., 372, 100, 2006.

Ørnsrud, R. and Lorentzen, M. , Bioavailability of selenium from raw or cured selenomethionine-enriched fillets of Atlantic salmon *(Salmo salar)* assessed in selenium-deficient rats. Br. J. Nutr., 87, 13, 2002.

Maher, W. , Baldwin, S. , Deaker, M. , and Lrving, M. , Characteristics of selenium in Australian marine biota. Appl. Organometal. Chem., 6, 103, 1992.

Bourre, J.-M.E. and Paquotte, P.M. , Contributions (in 2005) of marine and fresh water products (finfish and shellfish, seafood, wild and farmed) to the French dietary intakes of vitamin D and B12, selenium, iodine and docosahexaenoic acid: Impact on public health. Int. J. Food Sci. Nutr., 2007, doi:10.1080/09637480701553741.

Burger, J. and Gochfeld, M. , Heavy metals in commercial fish in New Jersey. Environ. Res., 99, 403, 2005.

Sharif, A.K.M. , Alamgir, M. , Mustafa, A.I. , Hossain, M.A. , and Amin, M.N. , Trace element concentrations in ten species of freshwater fish of Bangladesh. Sci. Total Environ., 138, 117, 1993.

Capelo, J.L. , Fernandez, C. , Pedras, B. , Santos, P. , Gonzalez, P. , and Vaz, C. , Trends in selenium determination/speciation by hyphenated techniques based on AAS or AFS. Talanta, 68, 1442, 2006.

Karaś, K. , Zioła-Frankowska, A. , and Frankowski, M. , New method for simultaneous arsenic and selenium speciation analysis in seafood and onion samples. Molecules, 26(20), 6223, 2021.

Bryszewska, M.A. and Måge, A. , Determination of selenium and its compounds in marine organisms. J. Trace Elements Med. Biol., 29, 91–98, 2015.

Xie, X. , Feng, C. , Ye, M. , and Wang, C. , Speciation determination of selenium in seafood by high-performance ion-exchange chromatography-hydride generation-atomic fluorescence spectrometry. Food Anal. Methods, 8(7), 1739–1745, 2015.

Das, A.K. , Chakraborty, R. , Luisa Cervera, M. , and de la Guardia, M. , Determination of thallium in biological samples. Anal. Bioanal. Chem., 385, 665, 2006.

Agusa, T. , Kunito, T. , Tanabe, S. , Pourkazemi, M. , and Aubrey, D.G. , Concentrations of trace elements in muscle of sturgeons in the Caspian Sea. Mar. Pollut. Bull., 49, 789, 2004.

Agusa, T. , Kunito, T. , Sudaryanto, A. , Monirith, I. , Kan-Atireklap, S. , Iwata, H. , Ismail, A. , Sanguansin, J. , Muchtar, M. , Tana, T.S. , and Tanabe, S. , Exposure assessment for trace elements from consumption of marine fish in Southeast Asia. Environ. Pollut., 145, 766, 2007.

Jaafarzadeh Haghighi Fard, N. , Zare Javid, A. , Ravanbakhsh, M. , Ramezani, Z. , Ahmadi, M. , Angali, K.A. , and Ardeshirzadeh, S. , Determination of nickel and thallium concentration in Cynoglossus arel fish in Musa estuary, Persian Gulf, Iran. Environ. Sci. Poll. Res., 24(3), 2936–2945, 2017.

Myron, D.R. , Givand, S.H. , and Nielsen, F.H. , Vanadium content of selected foods as determined by flameless atomic absorption spectroscopy. J. Agric. Food Chem., 25, 297, 1977.

Bu-Olayan, A.H. and Al-Yakoob, S. , Lead, nickel and vanadium in seafood: An expose assessment for Kuwaiti consumers. Sci. Total Environ., 223, 81, 1998.

Lavilla, I. , Vilas, P. , and Bendicho, C. , Fast determination of arsenic, selenium, nickel and vanadium in fish and shellfish by electrothermal atomic absorption spectrometry following ultrasound-assisted extraction. Food Chem., 106, 403, 2008.

Ichihashi, H. , Nakamura, Y. , Kannan, K. , Tsumura, A. , and Yamasaki, S. , Multi-elemental concentrations in tissues of Japanese common squid *(Todarodes pacificus*). Arch. Environ. Contam. Toxicol., 41, 483, 2001.

Santos, A.P. and Lemos, V.A. , Determination of vanadium levels in seafood using dispersive liquid-liquid microextraction and optical sensors. Water Air Soil Poll., 226(3), 1–8, 2015.

Astorga Espana, M.S. , Rodriguez, E.M. , and Diaz Romero, C. , Comparison of mineral and trace element concentrations in two molluscs from the Strait of Magellan (Chile). J. Food Comp. Anal., 20, 273, 2007.

Celik, U. and Oehlenschläger, J. , Zinc and copper content in marine fish samples collected from the eastern Mediterranean Sea. Eur. Food Res. Technol., 220, 37, 2005.

Carvalho, M.L. , Santiago, S. , and Nunes, M.L. , Assessment of the essential element and heavy metal content of edible fish muscle. Anal. Bioanal. Chem., 382, 426, 2005.

Nunes, M.L. , Bandarra, N.M. , Oliveira, L. , Batista, I.G. , and Antónia, M. , Compositional and nutritional value of fishery products consumed in Portugal, in Seafood Research from Fish to Dish, Luten, J.B. , Jacobsen, C. , Bekaert, K. , Sæbø, A. , and Oehlenschläger, J. , Eds., Wageningen Academic Publishers, Wageningen, the Netherlands, 2006, p. 477.

Bustamante, P. , Cherel, Y. , Caurant, F. , and Miramand, P. , Cadmium, copper and zinc in octopuses from Kerguelen Islands, Southern Indian Ocean. Polar Biol., 19, 264, 1998.

Chen, Y.-C. and Chen, M.-H. , Heavy metal concentrations in nine species of fishes caught in coastal waters off Ann-Ping, S.W. Taiwan. J. Food Drug Anal., 9, 107, 2001.
Nabrrzyski, M. and Gajewska, R. , Content of strontium, lithium and calcium in selected milk products and in some marine smoked fish. Nahrung/Food, 46, 204, 2002.
Teeny, F.M. , Gauglitz Jr., E.J. , Hall, A.S. , and Houle, C.R. , Mineral composition of the edible muscle tissue of seven species of fish from the Northeast Pacific. J. Agric. Food Chem., 32, 852, 1984.
Izak-Biran, T. and Guinn, V.P. , Determination of cesium and potassium in marine species by neutron activation analysis. J. Radioanal. Chem., 55, 61, 1980.
Engman, J. and Jorhem, L. , Toxic and essential elements in fish from Nordic waters, with the results seen from the perspective of analytical quality assurance. Food Addit. Contam., 15, 884, 1998.
Tallandini, L. , Giacobini, F. , Turchetto, M. , Galassini, S. , Liu, Q.X. , Shao, H.R. , Moschini, G. , Moro, R. , Gialanella, G. , Ghermandi, G. , Cecchi, R. , Injuk, J. , and Valković, V. , Naturally occurring levels of elements in fishes as determined by PIXE and XRF methods. Nuclear Instr. Meth. Phys. Res., B40/41, 630, 1989.
Gras, N. , Munoz, L. , Thieck, M. , and Hurtado, S. , A study on some trace elements in Chilean seafoods. J. Radioanal. Nucl. Chem., 169, 247, 1993.
Kalay, M. , Ay, Ö., and Canli, M. , Heavy metal concentrations in fish tissues from the Northeast Mediterranean Sea. Bull. Environ. Contam. Toxicol., 63, 673, 1999.
Ichihashi, H. , Kohno, H. , Kannan, K. , Tsumura, A. , and Yamasaki, S.-I. , Multielemental analysis of purpleback flying squid using high resolution inductively coupled plasma-mass spectrometry (HR ICP-MS). Environ. Sci. Technol., 35, 3103, 2001.
Banaoui, A. , Chiffoleau, J.-F. , Moukrim, A. , Burgeot, T. , Kaaya, A. , Auger, D. , and Rozuel, E. , Trace metal distribution in the mussel *Perna* along the Moroccan coast. Mar. Pollut. Bull., 48, 378, 2004.
Kücükgülmez, A. , Çelik, M. , Yanar, Y. , Ersoy, B. , and Çikrikçi, M. , Proximate composition and mineral content of the blue crab *(Callinectes sapidus)* breast meat, claw meat and hepatopancreas. Int. J. Food Sci. Technol., 41, 1023, 2006.
Skonberg, D.I. and Perkins, B.L. , Nutrient composition of green crab *(Carcinus maenus)* leg meat and claw meat. Food Chem., 77, 401, 2002.
Hsieh, Y.-H.P. , Leong, F.-M. , and Barnes, K.W. , Inorganic constituents in fresh and processed cannonball jellyfish (*Stomolophus meleagris*). J. Agric. Food Chem., 44, 3117, 1996.

Fatty Acids

Couturier, L. I. E. et al. State of art and best practices for fatty acid analysis in aquatic sciences. ICES Journal of Marine Science 77, 2375–2395 Preprint at doi:10.1093/icesjms/fsaa121 (2020).
Liu, C. & Ralston, N. V. C. Seafood and health: What you need to know? In: Fidel Toldrà (ed.) Advances in Food and Nutrition Research vol. 97, pp. 275–318 (Academic Press (Elsevier Inc.), Cambridge, MA (US), 2021).
Bentsen, H. Dietary polyunsaturated fatty acids, brain function and mental health. Microbial Ecology in Health and Disease 28, 1281916 (2017).
Román, G. C. , Jackson, R. E. , Gadhia, R. , Román, A. N. & Reis, J. Mediterranean diet: The role of long-chain ω-3 fatty acids in fish; polyphenols in fruits, vegetables, cereals, coffee, tea, cacao and wine; probiotics and vitamins in prevention of stroke, age-related cognitive decline, and Alzheimer disease. Revue Neurologique 175, 724–741 Preprint at doi:10.1016/j.neurol.2019.08.005 (2019).
Gil, A. & Gil, F. Fish, a Mediterranean source of n-3 PUFA: Benefits do not justify limiting consumption. British Journal of Nutrition 113, S58–S67 (2015).
Thomsen, S. T. et al. Human health risk-benefit assessment of fish and other seafood: A scoping review. Critical Reviews in Food Science and Nutrition 62, 7479–7502 Preprint at doi:10.1080/10408398.2021.1915240 (2021).
EFSA Scientific Committee . Statement on the benefits of fish/seafood consumption compared to the risks of methylmercury in fish/seafood. EFSA Journal 13, 3982 (2015).
EFSA Panel on Dietetic Products Nutrition and Allergies (NDA). Scientific opinion on the tolerable upper intake level of eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and docosapentaenoic acid (DPA) . EFSA Journal 10, 2815 (2012).
Piepoli, M. F. et al. European guidelines on cardiovascular disease prevention in clinical practice. European Heart Journal 37, 2315–2381 Preprint at doi:10.1093/eurheartj/ehw106 (2016).
Moss, G. , Smith, P. & Tavernier, D. Glossary of class names of organic compounds and reactive intermediates based on structure. Pure and Applied Chemistry 67, 1307–1375 (1995).
Chiu, H. H. & Kuo, C. H. Gas chromatography-mass spectrometry-based analytical strategies for fatty acid analysis in biological samples. Journal of Food and Drug Analysis 28, 60–73 Preprint at doi:10.1016/j.jfda.2019.10.003 (2020).

Hauff, S. & Vetter, W. Quantification of branched chain fatty acids in polar and neutral lipids of cheese and fish samples. Journal of Agricultural and Food Chemistry 58, 707–712 (2010).
Gunstone, F. D. Fatty acids - Nomenclature, structure, isolation and structure determination, biosynthesis and chemical synthesis. In Fatty Acid and Lipid Chemistry, pp. 1–34, (Springer, New York, NY (US), 1996).
de Carvalho, C. C. C. R. & Caramujo, M. J. The various roles of fatty acids. Molecules 23 Preprint at doi:10.3390/molecules23102583 (2018).
Bernárdez, M. , Pastoriza, L. , Sampedro, G. , Herrera, J. J. R. & Cabo, M. L. Modified method for the analysis of free fatty acids in fish. Journal of Agricultural and Food Chemistry 53, 1903–1906 (2005).
Toldrá, F. & Reig, M. The stability and shelf life of seafood. In: David Kilcast and Persis Subramaniam (eds.), Food and Beverage Stability and Shelf Life pp. 779–792 (Woodhead Publishing (Elsevier), Sawston, United Kingdom, 2011). doi:10.1533/9780857092540.3.779.
Frankel, E. N. Introduction - Classification of lipids. In: Edwin N. Frankel (ed.), Lipid Oxidation pp. 1–6 (The Oily Press, Bridgewater, England, 2005).
Christie, W. W. Lipids: Their structures and occurrence. In Lipid Analysis. Isolation, Separation, Identification and Structural Analysis of Lipids (ed. Christie, W. W.) vol. 15, pp. 1–36 (The Oily Press, Bridgewater, England, 2003).
Dalsgaard, J. , John, M. , Kattner, G. , Muller-Navarra, D. & Hagen, W. Fatty acid trophic markers in pelagic marine environment. Advances in Marine Biology 46, 225–340 (2003).
Zhang, L. Y. et al. Eicosapentaenoic acid in the form of phospholipids exerts superior anti-atherosclerosis effects to its triglyceride form in ApoE-/- mice. Food and Function 10, 4177–4188 (2019).
Ahmmed, M. K. , Ahmmed, F. , Tian, H. , Carne, A. & Bekhit, A. E. D. Marine omega-3 (n-3) phospholipids: A comprehensive review of their properties, sources, bioavailability, and relation to brain health. Comprehensive Reviews in Food Science and Food Safety 19, 64–123 (2019).
Kuschner, C. E. , Yagi, T. & Kim, J. Thinking in polyunsaturated fatty acids, phospholipids, and the brain. In: Ronald Ross Watson and Fabien De Meester (eds.), Omega Fatty Acids in Brain and Neurological Health pp. 21–32 (Academic Press (Elsevier Inc.), Cambridge, MA (US), 2019). doi:10.1016/B978-0-12-815238-6.00002-X.
Fajardo, V. A. , McMeekin, L. & Leblanc, P. J. Influence of phospholipid species on membrane fluidity: A meta-analysis for a novel phospholipid fluidity index. Journal of Membrane Biology 244, 97–103 (2011).
Wen, M. et al. Short-term supplementation of DHA as phospholipids rather than triglycerides improve cognitive deficits induced by maternal omega-3 PUFA deficiency during the late postnatal stage. Food and Function 12, 564–572 (2021).
Lordan, R. , Redfern, S. , Tsoupras, A. & Zabetakis, I. Inflammation and cardiovascular disease: Are marine phospholipids the answer? Food and Function 11, 2861–2885 Preprint at doi:10.1039/c9fo01742a (2020).
Ibarguren, M. , López, D. J. & Escribá, P. V. The effect of natural and synthetic fatty acids on membrane structure, microdomain organization, cellular functions and human health. Biochimica et Biophysica Acta - Biomembranes 1838, 1518–1528 Preprint at doi:10.1016/j.bbamem.2013.12.021 (2014).
Miles, E. A. , Childs, C. E. & Calder, P. C. Long-chain polyunsaturated fatty acids (LCPUFAs) and the developing immune system: A narrative review. Nutrients 13, 1–21 Preprint at doi:10.3390/nu13010247 (2021).
Schönfeld, P. & Wojtczak, L. Short- and medium-chain fatty acids in energy metabolism: The cellular perspective. Journal of Lipid Research 57, 943–954 Preprint at doi:10.1194/jlr.R067629 (2016).
Piccinin, E. et al. Role of oleic acid in the gut-liver axis: From diet to the regulation of its synthesis via Stearoyl-CoA desaturase 1 (SCD1). Nutrients 11, 1–22 (2019).
Calder, P. C. Dietary fatty acids and the immune system. Lipids 34, S137–S140 (1999).
Christie, W. W. & Harwood, J. L. Oxidation of polyunsaturated fatty acids to produce lipid mediators. Essays in Biochemistry 64, 401–421 Preprint at doi:10.1042/EBC20190082 (2020).
Innes, J. K. & Calder, P. C. Marine omega-3 (N-3) fatty acids for cardiovascular health: An update for 2020. International Journal of Molecular Sciences 21 Preprint at doi:10.3390/ijms21041362 (2020).
Bistrian, B. R. Clinical aspects of essential fatty acid metabolism: Jonathan Rhoads lecture. Journal of Parenteral and Enteral Nutrition 27, 168–175 (American Society for Parenteral and Enteral Nutrition, 2003).
Burdge, G. C. & Calder, P. C. Conversion of α-linolenic acid to longer-chain polyunsaturated fatty acids in human adults. Reproduction Nutrition Development 45, 581–597 Preprint at doi:10.1051/rnd:2005047 (2005).
Khan, S. U. et al. Effect of omega-3 fatty acids on cardiovascular outcomes: A systematic review and meta-analysis. EClinicalMedicine 38, 100997 (2021).
Simopoulos, A. P. Omega-6/omega-3 essential fatty acid ratio and chronic diseases. Food Reviews International 20, 77–90 (2004).
Sen Özdemir, N. , Parrish, C. C. , Parzanini, C. , Mercier, A. & Pernet, F. Neutral and polar lipid fatty acids in five families of demersal and pelagic fish from the deep Northwest Atlantic. ICES Journal of Marine Science 76, 1807–1815 (2019).
Lund, E. K. Health benefits of seafood: Is it just the fatty acids? In Food Chemistry 140 (3), pp. 413–420 (2013).
Trushenski, J. T. & Rombenso, A. N. Trophic levels predict the nutritional essentiality of polyunsaturated fatty acids in fish-introduction to a special section and a brief synthesis. North American Journal of Aquaculture 82, 241–250 (2020).

Tocher, D. R. , Agaba, M. , Hastings, N. & Teale, A. J. Biochemical and molecular studies of the polyunsaturated fatty acid desaturation pathway in fish. In The Big Fish Bang. Proceedings of the 26th Annual Larval Fish Conference. 2003 (eds. Browman, H. I. & Skiftesvik, A. B.) pp. 211–227 (Institute of Marine Research, Bergen, Norway, 2003).
Kelly, J. R. & Scheibling, R. E. Fatty acids as dietary tracers in benthic food webs. Marine Ecology Progress Series 446, 1–22 Preprint at doi:10.3354/meps09559 (2012).
Galloway, A. W. E. , Eisenlord, M. E. , Dethier, M. N. , Holtgrieve, G. W. & Brett, M. T. Quantitative estimates of isopod resource utilization using a Bayesian fatty acid mixing model. Marine Ecology Progress Series 507, 219–232 (2014).
Litmanen, J. J. , Perälä, T. A. & Taipale, S. J. Comparison of Bayesian and numerical optimization-based diet estimation on herbivorous zooplankton. Philosophical Transactions of the Royal Society B: Biological Sciences 375, (2020). Identification number: 20190651.
Iverson, S. J. Tracing aquatic food webs using fatty acids: From qualitative indicators to quantitative determination. In: Martin Kainz , Michael T. Brett , Michael T. Arts (eds.), Lipids in Aquatic Ecosystems vol. 9780387893662, pp. 281–308 (Springer, New York, 2009).
Sun, N. , Chen, J. , Wang, D. & Lin, S. Advance in food-derived phospholipids: Sources, molecular species and structure as well as their biological activities. Trends in Food Science and Technology 80, 199–211 Preprint at doi:10.1016/j.tifs.2018.08.010 (2018).
Lopez, A. , Bellagamba, F. & Moretti, V. M. Nutritional quality traits of Mediterranean mussels (Mytilus galloprovincialis): A sustainable aquatic food product available on Italian market all year round. Food Science and Technology International (2022) doi:10.1177/10820132221109582.
Meyer, L. , Pethybridge, H. , Nichols, P. D. , Beckmann, C. & Huveneers, C. Abiotic and biotic drivers of fatty acid tracers in ecology: A global analysis of chondrichthyan profiles. Functionl Ecology 33, 1243–1255 (2019).
Chaguaceda, F. , Eklöv, P. & Scharnweber, K. Regulation of fatty acid composition related to ontogenetic changes and niche differentiation of a common aquatic consumer. Oecologia 193, 325–336 (2020).
Makhutova, O. N. & Stoyanov, K. N. Fatty acid content and composition in tissues of Baikal grayling (Thymallus baicalensis), with a special focus on DHA synthesis. Aquaculture International 29, 2415–2433 (2021).
Góra, A. , Szlinder-Richert, J. & Kornijów, R. Are fatty acids in fish the evidence of trophic links? A case study from the southern Baltic Vistula Lagoon. Oceanologia (2022) doi:10.1016/j.oceano.2022.04.002.
Czesny, S. , Dabrowski, K. , Christensen, J. E. , van Eenennaam, J. & Doroshov, S. Discrimination of wild and domestic origin of sturgeon ova based on lipids and fatty acid analysis. Aquaculture 189, 145–153 (2000).
DePeters, E. J. , Puschner, B. , Taylor, S. J. & Rodzen, J. A. Can fatty acid and mineral compositions of sturgeon eggs distinguish between farm-raised versus wild white (Acipenser transmontanus) sturgeon origins in California? Preliminary report. Forensic Science International 229, 128–132 (2013).
Gessner, J. , Wirth, M. , Kirschbaum, F. & Patriche, N. Processing techniques for caviar and their effect on product composition. International Reviews of Hydrobiology 87, 645–650 (2002).
Gladyshev, M. I. , Sushchik, N. N. , Tolomeev, A. P. & Dgebuadze, Y. Y. Meta-analysis of factors associated with omega-3 fatty acid contents of wild fish. Reviews in Fish Biology and Fisheries 28, 277–299 (2018).
Taşbozan, O. , Gökçe, M. A. & Erbaş, C. The effect of different growing conditions to proximate composition and fatty acid profiles of rainbow trouts (Oncorhynchus mykiss). Journal of Applied Animal Research 44, 442–445 (2016).
Vasconi, M. , Lopez, A. , Galimberti, C. , Moreno Rojas, J. M. , Muñoz Redondo , J. M., Bellagamba, F. & Moretti, V.M. Authentication of farmed and wild European eel (Anguilla anguilla) by fatty acid profile and carbon and nitrogen isotopic analyses. Food Control 102, 112–121 (2019).
Turchini, G. M. , Torstensen, B. E. & Ng, W. K. Fish oil replacement in finfish nutrition. Reviews in Aquaculture 1, 10–57 (2009).
Strobel, C. , Jahreis, G. & Kuhnt, K. Survey of n-3 and n-6 polyunsaturated fatty acids in fish and fish products. Lipids in Health and Disease 11, 1–10 (2012).
Izquierdo, M. S. Essential fatty acid requirements of cultured marine fish larvae. Aquaculture Nutrition 2, 183–191 (1996).
Tocher, D. R. Fatty acid requirements in ontogeny of marine and freshwater fish. Aquaculture Research 41, 717–732 (2010).
Plante, S. , Pernet, F. , Haché, R. , Ritchie, R. , Ji, B. & McIntosh, D. Ontogenetic variations in lipid class and fatty acid composition of haddock larvae Melanogrammus aeglefinus in relation to changes in diet and microbial environment. Aquaculture 263, 107–121 (2007).
Tveiten, H. , Jobling, M. & Andreassen, I. Influence of egg lipids and fatty acids on egg viability, and their utilization during embryonic development of spotted wolf-fish, Anarhichas minor Olafsen. Aquaculture Research 35, 152–161 (2004).
Lopez, A. , Vasconi, M. , Bellagamba, F. , Mentasti, T. & Moretti, V. M. Sturgeon meat and caviar quality from different cultured species. Fishes 5, 9 (2020).
Lee, S. M. Review of the lipid and essential fatty acid requirements of rockfish (Sebastes schlegeli). Aquaculture Research 32, 8–17 (2001).
Yanes-Roca, C. , Rhody, N. , Nystrom, M. & Main, K. L. Effects of fatty acid composition and spawning season patterns on egg quality and larval survival in common snook (Centropomus undecimalis). Aquaculture 287,

335–340 (2009).
Mukhopadhyay, T. & Ghosh, S. Lipid profile and fatty acid composition of two silurid fish eggs. Journal of Oleo Science 56, 399–403 (2007).
Prabhakara Rao, P. G. , Balaswamy, K. , Jyothirmayi, T. , Karuna, M. S. L. & Prasad, R. B. N. Fish Roe Lipids: Composition and Changes During Processing and Storage. Processing and Impact on Active Components in Food (Elsevier Inc., 2015). doi:10.1016/B978-0-12-404699-3.00056-1.
Wirth, M. et al. Chemical and biochemical composition of caviar from different sturgeon species and origins. Nahrung - Food 44, 233–237 (2000).
Rudy, M. D. , Kainz, M. J. , Graeve, M. , Colombo, S. M. & Arts, M. T. Handling and storage procedures have variable effects on fatty acid content in fishes with different lipid quantities. PLoS One 11, e0160497 (2016).
Christie, W. W. Lipid extraction, storage and sample handling. In: Christie, W.W. (ed.), Lipid Analysis. Isolation, Separation, Identification and Structural Analysis of Lipids (ed. Christie, W. W.) vol. 15, pp. 91–102 (The Oily Press, Bridgewater, England, 2003).
Christie, W. W. Preparation of derivatives of fatty acids. In: Christie, W.W. (ed.), Lipid Analysis: Isolation, Separation and Structural Analysis of Lipids pp. 205–225 (The Oily Press, Bridgewater, England, 2003).
Folch, J. , Lees, M. & Sloane Stanley, G. H. A simple method for the isolation and purification of total lipids from animal tissues. Journal of Biological Chemistry 226, 497–509 (1957).
Bligh, E. G. & Dyer, W. J. A rapid method of total lipid extraction and purification. Canadian Journal of Biochemistry and Physiology 37, 8 (1959).
Cequier-Sánchez, E. , Rodríguez, C. , Ravelo, Á. G. & Zárate, R. Dichloromethane as a solvent for lipid extraction and assessment of lipid classes and fatty acids from samples of different natures. Journal of Agriculture and Food Chemistry 56, 4297–4303 (2008).
Matyash, V. , Liebisch, G. , Kurzchalia, T. V. , Shevchenko, A. & Schwudke, D. Lipid extraction by methyl-terf-butyl ether for high-throughput lipidomics. Journal of Lipid Research 49, 1137–1146 (2008).
Sheng, J. , Vannela, R. & Rittmann, B. E. Evaluation of methods to extract and quantify lipids from Synechocystis PCC 6803. Bioresource Technology 102, 1697–1703 (2011).
Ryckebosch, E. , Muylaert, K. & Foubert, I. Optimization of an analytical procedure for extraction of lipids from microalgae. JAOCS, Journal of the American Oil Chemists' Society 89, 189–198 (2012).
Granafei, S. et al. Effect of storage and extraction protocols on the lipid and fatty acid profiles of Dicentrarchus labrax brain. Food Analytical Methods 10, 4003–4012 (2017).
Löfgren, L. et al. The BUME method: A novel automated chloroform-free 96-well total lipid extraction method for blood plasma. Journal of Lipid Research 53, 1690–1700 (2012).
Batista, A. , Vetter, W. & Luckas, B. Use of focused open vessel microwave-assisted extraction asprelude for the determination of the fatty acid profile of fish-a comparison with results obtained after liquid-liquid extractionaccording to Bligh and Dyer. European Food Research and Technology 212, 377–384 (2001).
Costa, D. D. S. V. & Bragagnolo, N. Development and validation of a novel microwave assisted extraction method for fish lipids. European Journal of Lipid Science and Technology 119, 1600108 (2017).
Truzzi, C. , Illuminati, S. , Annibaldi, A. , Antonucci, M. & Scarponi, G. Quantification of fatty acids in the muscle of Antarctic fish Trematomus bernacchii by gas chromatography-mass spectrometry: Optimization of the analytical methodology. Chemosphere 173, 116–123 (2017).
Dodds, E. D. , McCoy, M. R. , Geldenhuys, A. , Rea, L. D. & Kennish, J. M. Microscale recovery of total lipids from fish tissue by accelerated solvent extraction. Journal of the American Oil Chemists' Society 81, 835–840 (2004).
Kaluzny, M. A. , Duncan, L. A. , Merrit, M. V. & Epps, D. E. Rapid separation of lipid classes in high yield and purity using bonded phase columns. Journal of Lipid Research 26, 135–140 (1985).
Dybvik, A. I. , Falch, E. & Rustad, T. Solid phase extraction as a tool to separate lipid classes and study deterioration of marine lipids. Journal of Aquatic Food Product Technology 17, 39–59 (2008).
Ruiz-Gutierrez, V. & Perez-Caminó Caminó , M. Update on solid-phase extraction for the analysis of lipid classes and related compounds. Journal of Chromatography A 885, 321–341 (2000).
Pinkart, H. C. , Devereux, R. & Chapman, P. J. Rapid separation of microbial lipids using solid phase q extraction columns. Journal of Methods Microbiological Journal of Microbiological Methods 34, 9–15 (1998).
Ruiz, J. , Antequera, T. , Andres, A. I. , Petron, M. J. & Muriel, E. Improvement of a solid phase extraction method for analysis of lipid fractions in muscle foods. Analytica Chimica Acta 520, 201–205 (2004).
Christie, W. W. Methods for the separation of simple lipid classes. In Lipid Analysis. Isolation, Separation, Identification and Structural Analysis of Lipids (ed. Christie, W. W.) vol. 15, pp. 105–135 (The Oily Press, Bridgewater, England, 2003).
Fanali, C. , Dugo, L. & Mondello, L. Advances in chromatographic techniques for food authenticity testing. In: Gerard Downey (ed.), Advances in Food Authenticity Testing, pp. 253–284 (Woodhead Publishing (Elsevier), Sawston, United Kingdom, 2016). doi:10.1016/B978-0-08-100220-9.00010-2.
Engewald, W. , Dettmer-Wilde, K. & Rotzche, H. Columns and stationary phases. In Practical Gas Chromatography. A Comprehensive Reference (eds. Dettmer-Wilde, K. & Engewald, W.) (Springer-Verlag, Berlin, Heidelberg, 2014). doi:10.1007/978-3-642-54640-2.

Park, H. , Song, W. Y. , Cha, H. & Kim, T. Y. Development of an optimized sample preparation method for quantification of free fatty acids in food using liquid chromatography-mass spectrometry. Scientific Reports 11, 5947 (2021).
Trbović, D. et al. Determination of the fatty acids in fish tissue and feed - Comparison of different methods and statistical evaluation. Acta Chromatography 30, 175–179 (2018).
Kramer, J. K. G. et al. Evaluating acid and base catalysts in the methylation of milk and rumen fatty acids with special emphasis on conjugated dienes and total trans fatty acids. Lipids 32, 27–29 (1997).
Murrieta, C. M. , Hess, B. W. & Rule, D. C. Comparison of acidic and alkaline catalysts for preparation of fatty acid methyl esters from ovine muscle with emphasis on conjugated linoleic acid. Meat Science 65, 523–529 (2003).
Schlechtriem, C. , Henderson, R. J. & Tocher, D. R. A critical assessment of different transmethylation procedurescommonly employed in the fatty acid analysis of aquatic organisms. Limnology and Oceanography Methods 6, 523–531 (2008).
Kang, J. X. & Wang, J. A simplified method for analysis of polyunsaturated fatty acids. BMC Biochemistry 6, 5 (2005).
Lopez, A. , Bellagamba, F. , Savoini, G. , Moretti, V. M. & Cattaneo, D. Characterization of fat quality in cow milk from alpine farms as influenced by seasonal variations of diets. Animals 12, 515 (2022).
United States Pharmacopeia . https://www.usp.org/resources/chromatographic-columns.
Tolley, H. D. , Tolley, S. E. , Wang, A. & Lee, M. L. Moving thermal gradients in gas chromatography. Journal of Chromatography A 1374, 189–198 (2014).
Andersson, J. T. Detectors. In Practical Gas Chromatography. A Comprehensive Reference (eds. Dettmer-Wilde, K. & Engewald, W.) (Springer-Verlag, Berlin, Heidelberg, 2014). doi:10.1007/978-3-642-54640-2_6.
Maccoll, A. Mass spectrometry, historical perspective. Encyclopedia of Spectroscopy and Spectrometry 742–747 (2016) doi:10.1016/B978-0-12-803224-4.00197-7.
Moeder, M. Gas chromatography-mass spectrometry. In Practical Gas Chromatography. A Comprehensive Reference (eds. Dettmer-Wilde, K. & Engewald, W.) (Springer-Verlag, Berlin, Heidelberg, 2014). doi:10.1007/978-3-642-54640-2.
Vékey, K. Mass spectrometry and mass-selective detection in chromatography. Journal of Chromatography A 921, 227–236 (2001).
Dodds, E. D. , McCoy, M. R. , Rea, L. D. & Kennish, J. M. Gas chromatographic quantification of fatty acid methyl esters: Flame ionization detection vs. electron impact mass spectrometry. Lipids 40, 419–428 (2005).
Thurnhofer, S. & Vetter, W. A gas chromatography/electron ionization-mass spectrometry-selected ion monitoring method for determining the fatty acid pattern in food after formation of fatty acid methyl esters. Journal of Agriculture and Food Chemistry 53, 8896–8903 (2005).
Ackman, R. G. The gas chromatograph in practical analyses of common and uncommon fatty acids for the 21st century. Analytica Chimica Acta 465, 175–192 (2002).
ISO . Animal and vegetable fats and oils-Gas chromatography of fatty acid methyl esters-Part 4: Determination by capillary gas chromatography. www.iso.org (2015).
Quehenberger, O. , Armando, A. M. & Dennis, E. A. High sensitivity quantitative lipidomics analysis of fatty acids in biological samples by gas chromatography-mass spectrometry. Biochimica et Biophysica Acta - Molecular and Cell Biology of Lipids 1811, 648–656 Preprint at doi:10.1016/j.bbalip.2011.07.006 (2011).
Perez-Palacios, T. , Solomando, J. C. , Ruiz-Carrascal, J. & Antequera, T. Improvements in the methodology for fatty acids analysis in meat products: One-stage transmethylation and fast-GC method. Food Chemistry 371, 130995 (2022).
Kenar, A. et al. Electron impact-mass spectrometry fingerprinting and chemometrics for rapid assessment of authenticity of edible oils based on fatty acid profiling. Food Analytical Methods 12, 1369–1381 (2019).
Chin, S. T. , Che Man, Y. B. , Tan, C. P. & Hashim, D. M. Rapid profiling of animal-derived fatty acids using fast GC × GC coupled to time-of-flight mass spectrometry. JAOCS, Journal of the American Oil Chemists' Society 86, 949–958 (2009).
Jover, E. , Adahchour, M. , Bayona, J. M. , Vreuls, R. J. J. & Brinkman, U. A. T. Characterization of lipids in complex samples using comprehensive two-dimensional gas chromatography with time-of-flight mass spectrometry. Journal of Chromatography A 1086, 2–11 (2005).
Zeng, A. X. , Chin, S. T. & Marriott, P. J. Integrated multidimensional and comprehensive 2D GC analysis of fatty acid methyl esters. Journal of Separation Science 36, 878–885 (2013).
Nagumalli, S. K. , Jacob, C. C. & Gamboa da Costa, G. A rapid and highly sensitive UPLC-ESI-MS/MS method for the analysis of the fatty acid profile of edible vegetable oils. Journal of Chromatography B Analytical Technologies in the Biomedical and Life Sciences 1161, 122415 (2020).
Lee-Okada, H. C. , Hama, K. , Yokoyama, K. & Yokomizo, T. Development of a liquid chromatography-electrospray ionization tandem mass spectrometric method for the simultaneous analysis of free fatty acids. The Journal of Biochemistry 170, 389–397 (2021).
Taguchi, R. Advances in lipid analysis/lipidomics - Analyses of phospholipids by recent application of mass spectrometry. In: Abel Lajtha , Naren Banik , Swapan K. Ray (eds.), Handbook of Neurochemistry and Molecular Neurobiology pp. 1–20 (Springer, New York, NY (US), 2009). doi:10.1007/978-0-387-30378-9_1.

Cui, J. et al. Comprehensive evaluation of lipidomics profiles in golden threadfin bream (Nemipterus virgatus) and its by-products using UHPLC-Q-exactive Orbitrap-MS. LWT 165, 114690 (2022).
Li, X. et al. Targeted lipidomics profiling of marine phospholipids from different resources by UPLC-Q-Exactive Orbitrap/MS approach. Journal of Chromatography B Analytical Technologies in the Biomedical and Life Sciences 1096, 107–112 (2018).
He, C. et al. A comprehensive study of lipid profiles of round scad (Decapterus maruadsi) based on lipidomic with UPLC-Q-Exactive Orbitrap-MS. Food Research International 133, 109138 (2020).
Shi, C. et al. Effect of three types of thermal processing methods on the lipidomics profile of tilapia fillets by UPLC-Q-extractive orbitrap mass spectrometry. Food Chemistry 298, 125029 (2019).
Shen, Q. et al. Isolation and lipidomics characterization of fatty acids and phospholipids in shrimp waste through GC/FID and HILIC-QTrap/MS. Journal of Food Composition and Analysis 95, 103668 (2021).
Linderborg, K. M. et al. Bioavailability of docosahexaenoic acid 22:6(n-3) from enantiopure triacylglycerols and their regioisomeric counterpart in rats. Food Chemistry 283, 381–389 (2019).
Michalski, M. C. et al. Multiscale structures of lipids in foods as parameters affecting fatty acid bioavailability and lipid metabolism. Progress in Lipid Research 52, 354–373 Preprint at doi:10.1016/j.plipres.2013.04.004 (2013).

Quality Assessment of Seafood and Seafood Products by Color Measurement

Sato, W. Color's indispensable role in the rapid detection of food. Front. Psychol., 12, 753564, 2021.
MacDougall, D.B. Colour in Food: Improving Quality, Woodhead Publishing, Cambridge, UK, 2002.
Nguyen, C.N. , Vo, V.T. and Ha, N.C. Developing a computer vision system for real-time color measurement - A case study with color characterization of roasted rice. J. Food Eng., 316, 110821, 2022.
Nguyen, C.N. , Vo, V.T. , Nguyen, L.H.N. , Nhan, H.T. and Nguyen, C.N. In situ measurement of fish color based on machine vision: A case study of measuring a clownfish's color. Measurement, 197, 111299, 2022.
Lawless, H.T. and Heymann, H. Sensory Evaluation of Food. Principles and Practices, Chapman & Hall, New York, 1998, p. 379.
Dufossé, L. , Fernández, J. , Galaup, P. and Pérez-Avarez, J.A. Color measurements of muscle-based and dairy foods. In: Handbook of Food Analysis, (L.M.L. Nollet and F. Toldrá , Eds.), 3rd ed., CRC Press, Boca Raton, FL, 2015, pp. 3–19.
Erdag, M. and Ayvaz, Z. The use of color to determine fish freshness: European seabass (Dicentrarchus labrax). J. Aquat. Food Prod. Technol., 30, 847–867, 2021.
Baardseth, P. et al. A comparison of CIE (1976) L*a*b* values obtained from two different instruments on several food commodities. J. Food Sci., 53, 1737, 1988.
Stien, L.H. et al. Instrumental colour analysis of Atlantic salmon (Salmo salar L.) muscle. In: Seafood Research from Fish to Dish. Quality, Safety and Processing of Wild and Farmed Fish, (J.B. Luten et al., Eds.), Wageningen Academic Publishers, Wageningen, the Netherlands, 2006, p. 525.
Fullerton, A. and Keiding, J. A comparison between a tristimulus colorimeter (Minolta Chroma-Meter CR-200) and two spectrophotometers (Minolta Spectrophotometer CM-508i and CM-2002). Quantification of UV-B induced erythema in a hairless guinea pig model. Skin Res. Technol., 3, 237, 1997.
Zheng, C. , Sun, D.W. and Zheng, L. Recent developments and applications of image features for food quality evaluation and inspection-A review. Trends Food Sci. Technol., 17, 642, 2006.
Stien, L.H. et al. Automated image analysis as a tool to quantify the colour and composition of rainbow trout (Oncorhynchus mykiss W.) cutlets. Aquaculture, 261, 695, 2006b.
León, K. et al. Color measurement in L*a*b* units from RGB digital images. Food Res. Int., 39, 1084, 2006.
Yam, K.L. and Papadakis, S.E. A simple digital imaging method for measuring and analyzing color of food surfaces. J. Food Eng., 61, 137, 2004.
Louka, N. et al. A novel colorimetry analysis used to compare different drying fish processes. Food Control, 15, 327, 2004.
Korel, F. , Luzuriaga, D.A. and Balaban, M.Ö. , Objective quality assessment of raw tilapia (Oreochromis niloticus) fillets using electronic nose and machine vision. J. Food Sci., 66, 1018, 2001.
Olafsdottir, G. et al. Multisensor for fish quality determination. Trends Food Sci. Technol., 15, 86, 2004.
Di Natale, C. Data fusion in MUSTEC: Towards the definition of an artificial quality index, In: Quality of Fish from Catch to Consumer: Labelling, Monitoring & Traceability, (J.B. Luten , J. Oehlenschläger and G. Olafsdottir , Eds.), Wageningen Academic Publishers, Wageningen, the Netherlands, 2003, p. 273.
Balaban, M.O. , Kristinsson, H.G. and Otwell, W.S. Evaluation of color parameters in a machine vision analysis of carbon monoxide-treated fish. Part I: Fresh tuna. J. Aquat. Food Prod. Technol., 14, 5, 2005.
Pavlidis, M. , Papandroulakis, N. and Divanach, P. A method for the comparison of chromaticity parameters in fish skin: Preliminary results for coloration pattern of red skin Sparidae. Aquaculture, 258, 211, 2006.
Erikson, U. and Misimi, E. Atlantic salmon skin and fillet color changes effected by perimortem handling stress, rigor mortis, and ice storage. J. Food Sci., 73, C50, 2008.

Alak, G. , Kaynar, O. and Atamanalp, M. The impact of salt concentrations on the physicochemical and microbiological changes of rainbow trout caviar. Food Biosci., 41, 100976, 2021.

Beg, M.M. , Roy, S.M. , Moulick, S. and Mandal, B. Quality evaluation of organically farmed fish fillet of Indian major carps. Aquat. Int., doi:10.1007/s10499-023-01107-6, 2023.

Yesilayer, N. Comparison of flesh colour assessment methods for wild brown trout (Salmo trutta macrostigma), farmed rainbow trout (Oncorhynchus mykiss) and farmed Atlantic salmon (Salmo solar). Pakistan J. Zool., 52, 1007–1014, 2020.

Zotte, A.D. , Concollato, A. , Secci, G. , Culere, M. and Prisi, G. Rainbow trout (Oncorhynchus mykiss) farmed at two different temperatures: Post rigor mortis changes in function of the stunning method. Czech J. Anim. Sci., 65, 354–364, 2020.

Doolan, B.J. et al. Effect of cage colour and light environment on the skin colour of Australian snapper *Pagrus auratus* (Bloch & Schneider, 1801). Aquacult. Res., 38, 1395, 2007.

Osterlie, M. et al. Influence of added astaxanthin level and color on flavor of pastes of rainbow trout. J. Aquat. Food Prod. Technol., 10, 65, 2001.

Jankowska, B. et al. Slaughter value and flesh characteristics of European catfish *(Silurus glanis)* fed natural and formulated feed under different rearing conditions. Eur. Food Res. Technol., 224, 453, 2007.

González, S. et al. Composition of farmed and wild yellow perch (*Perca flavescens*). J. Food Comp. Anal., 19, 720, 2006.

Hatlen, B. , Jobling, M. and Bjerkeng, B. Relationships between carotenoid concentration and colour of fillets of Arctic charr, *Salvelinus alpinus* (L.), fed astaxanthin. Aquacult. Res., 29, 191, 1998.

Bjørnevik, M. et al. Temporal variation in muscle fibre area, gaping, texture, colour and collagen in triploid and diploid Atlantic salmon (*Salmo salar* L). J. Sci. Food Agric., 84, 530, 2004.

Morzel, M. , Sohier, D. and van de Vis, H. Evaluation of slaughtering methods for turbot with respect to animal welfare and flesh quality. J. Sci. Food Agric., 83, 19, 2003.

Ginés, R. et al. Effects of rearing temperature and strain on sensory characteristics, texture, colour and fat of Arctic charr *(Salvelinus alpinus)* . Food Qual. Pref., 15, 177, 2004.

Ginés, R. et al. The effects of long-day photoperiod on growth, body composition and skin colour in immature gilthead sea bream (*Sparus aurata* L.). Aquacult. Res., 35, 1207, 2004.

Roth, B. , Slinde, E. and Arildsen, J. Pre or post mortem muscle activity in Atlantic salmon *(Salmo salar)*. The effect on rigor mortis and the physical properties of flesh. Aquaculture, 257, 504, 2006.

Skjervold, P.O. et al. Properties of salmon flesh from different locations on pre- and post rigor fillets. Aquaculture, 201, 91, 2001.

Jankowska, B. et al. Slaughter yield, proximate composition, and flesh colour of cultivated and wild perch (*Perca fluviatilis* L.). Czech J. Anim. Sci., 52, 260, 2007.

Jankowska, B. et al. A comparison of selected quality features of the tissue and slaughter yield of wild and cultivated pikeperch *Sander lucioperca* (L.). Eur. Food Res. Technol., 217, 401, 2003.

Bjerkeng, B. et al. Quality parameters of the flesh of Atlantic salmon (*Salmo salar*) as affected by dietary fat content and full-fat soybean meal as a partial substitute for fish meal in the diet. Aquaculture, 157, 297, 1997.

Hallier, A. et al. Influence of farming conditions on colour and texture of European catfish (*Silurus glanis*) flesh. J. Sci. Food Agric., 87, 814, 2007.

Park, J.W. Surimi and Surimi Seafood, 2nd ed., Marcel Dekker, New York, 2005.

Segato, S. et al. Effect of triploidy on quality traits of shi drum (*Umbrina cirrosa* L.) until the second rearing year. Aquacult. Res., 38, 59, 2007.

Kristoffersen, S. et al. Effects of pre-rigor filleting on quality aspects of Atlantic cod (*Gadus morhua* L.). Aquacult. Res., 37, 1556, 2006.

Suontama, J. et al. Protein from Northern krill (*Thysanoessa inermis*), Antarctic krill (*Euphausia superba*) and the Arctic amphipod (*Themisto libellula*) can partially replace fish meal in diets to Atlantic salmon (*Salmo salar*) without affecting product quality. Aquacult. Nutr., 13, 50, 2007.

Arredondo-Figueroa, J.L. et al. Color of raw, frozen, and smoked fillets of rainbow trout (*Oncorhynchus mykiss*) fed diets supplemented with astaxanthin and saponified red chilli (*Capsicum annuum*) extracts. J. Aquat. Food Prod. Technol., 16, 35, 2007.

Kalinowski, C.T. et al. Effect of different carotenoid sources and their dietary levels on red porgy (*Pagrus pagrus*) growth and skin colour. Aquaculture, 244, 223, 2005.

Ramírez, J.A. et al. Low-salt restructured products from striped mullet (Mugil cephalus) using microbial transglutaminase or whey protein concentrate as additives. Food Chem., 102, 243, 2007.

Bhattacharya, S. , Choudhury, G.S. and Studebaker, S. Color changes during thermal processing of Pacific chum salmon. J. Aquat. Food Prod. Technol., 3, 39, 1994.

Cruz-Romero, M. et al. Effects of high pressure treatment on physicochemical characteristics of fresh oysters (Crassostrea gigas). Innov. Food Sci. Emerg. Technol., 5, 161, 2004.

Sengor, G.F.U. , Balaban, M.O. , Topaloglu, B. , Ayvaz, Z. , Ceylan, Z. and Dogruyol, H. Color assessment by different techniques of gilthead seabream (Sparus aurata) during cold storage. Food Sci. Technol., 39, 696–703, 2019.

Jaczynski, J. and Park, J.W. Physicochemical properties of surimi seafood as affected by electron beam and heat. J. Food Sci., 68, 1626, 2003.
Himonides, A.T. , Taylor, K.D.A. and Knowles, M.J. The improved whitening of cod and haddock flaps using hydrogen peroxide. J. Sci. Food Agric., 79, 845, 1999.
da Ponte, D.J.B. , Roozen, J.P. and Pilnik, W. Effects of additions on the stability of frozen stored minced fillets of whiting. II. Various anionic and neutral hydrocolloids. J. Food Qual., 8, 183, 1985.
Barrero, M. and Bello, R.E. Characterisation of sardine minced flesh (Sardinella aurita) washed with different solutions. J. Aquat. Food Prod. Technol., 9, 105, 2000.
Suvanich, V. , Marshall, D.L. and Jahncke, M.L. Microbiological and color quality changes of channel catfish frame mince during chilled and frozen storage. J. Food Sci., 65, 151, 2000.
Chen, H.H. Effect of non-muscle protein on the thermogelation of horse mackerel surimi and the resultant cooking tolerance of kamaboko. Fisheries Sci., 66, 783, 2000.
Pérez-Mateos, M. and Montero, P. Contribution of hydrocolloids to gelling properties of blue whiting muscle. Eur. Food Res. Technol., 210, 383, 2000.
Hsu, C.-K. and Chiang, B.-H. Effects of water, oil, starch, calcium carbonate and titanium dioxide on the colour and texture of threadfin and hairtail surimi gels. Int. J. Food Sci. Technol., 37, 387, 2002.
Huda, N. , Abdullah, A. and Babji, A.S. Functional properties of surimi powder from three Malaysian marine fish. Int. J. Food Sci. Technol., 36, 401, 2001.
Karayannakidis, P.D. et al. The effect of initial wash at acidic and alkaline pHs on the properties of protein concentrate (kamaboko) products from sardine (Sardina pilchardus) samples. J. Food Eng., 78, 775, 2007.
Yongsawatdigul, J. , Piyadhammaviboon, P. and Singchan, K. Gel-forming ability of small scale mud carp (Cirrhiana microlepis) unwashed and washed mince as related to endogenous proteinases and transglutaminase activities. Eur. Food Res. Technol., 223, 769, 2006.
Ramírez, J.A. et al. Production of low-salt restructured fish products from Mexican flounder (Cyclopsetta chittendeni) using microbial transglutaminase or whey protein concentrate as binders. Eur. Food Res. Technol., 223, 341, 2006.
Uresti, R.M. et al. Effect of amidated low methoxyl pectin on the mechanical properties and colour attributes of fish mince. Food Technol. Biotechnol., 41, 131, 2003.
Pérez-Mateos, M. et al. Quercetin properties as a functional ingredient in omega-3 enriched fish gels fed to rats. J. Sci. Food Agric., 85, 1651 2005.
Pérez-Mateos, M. and Lanier, T.C. Comparison of Atlantic menhaden gels from surimi processed by acid or alkaline solubilization. Food Chem., 101, 1223, 2007.
Reppond, K.D. and Babbitt, J.K. Gel properties of surimi from various fish species as affected by moisture content. J. Food Sci., 62, 33, 1997.
Kristinsson, H.G. and Liang, Y. Effect of pH-shift processing and surimi processing on Atlantic croaker (Micropogonias undulates) muscle proteins. J. Food Sci., 71, C304, 2006.
Chai, P.P. and Park, J.W. Physical properties of fish proteins cooked with starches or protein additives under ohmic heating. J. Food Qual., 30, 783, 2007.
Chen, Y.-C. and Jaczynski, J. Protein recovery from rainbow trout (Oncorhynchus mykiss) processing byproducts via isoelectric solubilization/precipitation and its gelation properties as affected by functional additives. J. Agric. Food Chem., 55, 9079, 2007.
Park, Y. et al. Incorporation and stabilization of omega-3 fatty acids in surimi made from cod, Gadus morhua. J. Agric. Food Chem., 52, 597, 2004.
Pongviratchai, P. and Park, J.W. Electrical conductivity and physical properties of surimi-potato starch under ohmic heating. J. Food Sci., 72, E503, 2007.
Rawdkuen, S. et al. Effect of cysteine proteinase inhibitor containing fraction from chicken plasma on autolysis and gelation of Pacific whiting surimi. Food Hydrocoll., 21, 1209, 2007.
Sanchez-Alonso, I. et al. Inhibition of hemoglobin-mediated oxidation of regular and lipid-fortified washed cod mince by a white grape dietary fiber. J. Agric. Food Chem., 55, 5299, 2007.
Shie, J.S. and Park, J.W. Physical characteristics of surimi seafood as affected by thermal processing conditions. J. Food Sci., 64, 287, 1999.
Jin, S.-K. et al. Effect of muscle type and washing times on physico-chemical characteristics and qualities of surimi. J. Food Eng., 81, 618, 2007.
Cardoso, C. , Mendes, R. and Nunes, M.L. Effect of transglutaminase and carrageenan on restructured fish products containing dietary fibres. Int. J. Food Sci. Technol., 42, 1257, 2007.
Ramírez, J.A. et al. Low-salt restructured fish products using low-value fish species from the Gulf of Mexico. Int. J. Food Sci. Technol., 42, 1039, 2007.
Sinnhuber, R.O. et al. Radiation sterilization of pre-fried cod and halibut patties. J. Food Technol., 22, 1570, 1984.
Fletcher, G.C. et al. Spoilage of rested harvested King salmon (Oncorhynchus tshawytscha). J. Food Sci., 68, 2810, 2003.
Schubring, R. Determination of fish freshness by instrumental colour measurement. Fleischwirtschaft Int., 2, 26, 1999.

Schubring, R. and Meyer, C. Ice storage of fish, new aspects: Comparison between flake ice and stream ice-Part I: Sardine (Sardinapilchardus). Dtsch. Lebensm.-Rundsch., 102, 405, 2006.
Benjakul, S. et al. Gel-forming properties of surimi produced from bigeye snapper, Priacanthus tayenus and P. macracanthus, stored in ice. J. Sci. Food Agric., 82, 1442, 2002.
Chaijan, M. et al. Changes of pigments and color in sardine (Sardinella gibbosa) and mackerel (Rastrelliger kanagurta) muscle during iced storage. Food Chem., 93, 607, 2005.
Poli, B.M. et al. Sensory, physical, chemical and microbiological changes in European sea bass (Dicentrarchus labrax) fillets packed under modified atmosphere/air or prepared from whole fish stored in ice. Int. J. Food Sci. Technol., 41, 444, 2006.
Torrieri, E. et al. Influence of modified atmosphere packaging on the chilled shelf life of gutted farmed bass (Dicentrarchus labrax). J. Food Eng., 77, 1078, 2006.
Hong, L.C. et al. Quality of Atlantic mackerel (Scomber scombrus L.) fillets during modified atmosphere storage. J. Food Sci., 61, 646, 1996.
Forrester, P.N. et al. Treatment of catfish fillets with citric acid causes reduction of 2-methylisoborneol, but not musty flavour. J. Food Sci., 67, 2615, 2002.
Li, S.J. et al. Color stability and lipid oxidation of rockfish as affected by antioxidant from shrimp shell waste. J. Food Sci., 63, 438, 1998.
Guillerm-Regost, C. et al. Quality characterization of farmed Atlantic halibut during ice storage. J. Food Sci., 71, S83, 2006.
Sohn, J.-H. et al. Lipid oxidations in ordinary and dark muscles of fish: Influences on rancid off-odor development and color darkening of yellowtail flesh during ice storage. J. Food Sci., 70, S490, 2005.
Tejada, M. and De Las Heras, C. Sensory changes in farmed Senegalese sole *(Solea senegalensis)* during ice storage. Food Sci. Technol. Int., 13, 117, 2007.
Nakamura, Y.-N. et al. Effect of fasting on physical/chemical properties of ordinary muscles in full-cycle cultured Pacific bluefin tuna *Thunnus orientalis* during chilled storage. Fisheries Sci., 72, 1079, 2006.
Hiraoka, Y. et al. Preventive method of color deterioration of yellowtail dark muscle during frozen storage and post thawing. Fisheries Sci., 70, 1130, 2004.
Regost, C. , Jakobsen, J.V. and Røra, A.M.B. Flesh quality of raw and smoked fillets of Atlantic salmon as influenced by dietary oil sources and frozen storage. Food Res. Int., 37, 259, 2004.
Hamre, K. , Lie, O. and Sandnes, K. Development of lipid oxidation and flesh colour in frozen stored fillets of Norwegian spring-spawning herring (Clupea harengus L.). Effects of treatment with ascorbic acid. Food Chem., 82, 447, 2003.
Schubring, R. Instrumental colour, texture, water holding and DSC measurements on frozen cod fillets (Gadus morhua) during long term storage at different temperatures. Dtsch. Lebensm.-Rundsch., 100, 247, 2004.
Morkore, T. and Lilleholt, R. Impact of freezing temperature on quality of farmed Atlantic cod. J. Texture Stud., 38, 457, 2007.
Zhu, K. , Yan, W. , Dai, Z.Y. and Zhang, Q.Y. Astaxanthin extract from shrimp (Trachypenaeus curvirostris) by-products improves quality of ready-to-cook shrimp surimi products during frozen storage at -18 degrees C. Foods, 11, 2122, 2022.
No, H.K. and Storebakken, T. Color stability of rainbow trout fillets during frozen storage. J. Food Sci., 56, 969, 1991.
Jittinandana, S. , Kenney, P.B. and Slider, S.D. Cryoprotectants affect physical properties of restructured trout during frozen storage. J. Food Sci., 70, C35, 2005.
Jittinandana, S. , Kenney, P.B. and Slider, S.D. Cryoprotectants preserve quality of restructured trout products following freeze thaw cycling. J. Muscle Foods, 16, 354, 2005.
Rodríguez-Herrera, J.J. et al. Possible role for cryostabilizers in preventing protein and lipid alterations in frozen-stored minced muscle of Atlantic mackerel. J. Agric. Food Chem., 54, 3324, 2006.
Ozbay, G. , Spencer, K. and Gill, T.A. Investigation of protein denaturation and pigment fading in farmed steelhead (Onchorhychus mykiss) fillets during frozen storage. J. Food Process. Preserv., 30, 208, 2006.
Pullela, S.V. et al. Quality comparison of aquacultured pacu (Piaractus mesopotamicus) fillets with other aquacultured fish fillets using subjective and objective sensorial traits. J. Aquat. Food Prod. Technol., 9, 65, 2000.
Bhattacharya, S. , Choudhury, G.S. and Studebaker, S. Color changes during thermal processing of Pacific chum salmon. J. Aquat. Food Prod. Technol., 3, 39, 1994.
Requena, D.D. et al. Detection of discoloration in thermally processed blue crab meat. J. Sci. Food Agric., 79, 786, 1999.
Paredes, M.D.C. and Baker, R.C. Physical, chemical and sensory changes during thermal processing of three species of canned fish. J. Food Process. Preserv., 12, 71, 1988.
Cardinal, M. et al. Sensory characteristics of cold-smoked Atlantic salmon (Salmo salar) from European market and relationships with chemical, physical and microbiological measurements. Food Res. Int., 37, 193, 2004.
Jensen, C. et al. Effect of dietary levels of fat, α-tocopherol and astaxanthin on colour and lipid oxidation during storage of frozen rainbow trout (Oncorhynchus mykiss) and during chill storage of smoked trout. Z. Lebensm. Unters. Forsch. A, 207, 189, 1998.

Quinones, A. , Choubert, G. and Gomez, R. Colour stability of smoked muscle rainbow trout: Packaging effect. Sci. Aliments, 23, 132, 2003.
Birkeland, S. , Haarstad, I. and Bjerkeng, B. Effects of salt-curing procedure and smoking temperature on astaxanthin stability in smoked salmon. J. Food Sci., 69, FEP198, 2004.
Rora, A.M.B. , Monfort, M.C. and Espe, M. Effects of country of origin on consumer preference of smoked salmon collected in a French hypermarket. J. Aquat. Food Prod. Technol., 13, 69, 2004.
Espe, M. et al. Quality of cold smoked salmon collected in one French hypermarket during a period of 1 year. LWT Food Sci. Technol., 37, 627, 2004.
Rora, A.M.B. et al. Quality characteristics of farmed Atlantic salmon (Salmo salar) fed diets high in soybean or fish oil as affected by cold-smoking temperature. LWT Food Sci. Technol., 38, 201, 2005.
Antoine, F.R. et al. Phosphate pretreatment on smoke adsorption of cold smoked mullet (Mugil cephalus). J. Aquat. Food Prod. Technol., 9, 69, 2000.
Fernandez-Segovia, I. et al. Structure and color changes due to thermal treatments in desalted cod. J. Food Process. Preserv., 27, 465, 2003.
Bal'a, M.F.A. , Podalak, R. and Marshall, D.L. Microbial and color quality of fillets obtained from steam-pasteurized deheaded and eviscerated whole catfish. Food Microbiol., 17, 625, 2000.
Fagan, J.D. and Gormley, T.R. Effect of sous vide cooking, with freezing, on selected quality parameters of seven fish species in a range of sauces. Eur. Food Res. Technol., 220, 299, 2005.
Dvorak, P. , Kratochvíl, B. and Grolichová, M. Changes of colour and pH in fish musculature after ionizing radiation exposure. Eur. Food Res. Technol., 220, 309, 2005.
Schubring, R. Comparative study of the DSC pattern, color, texture and water-binding capacity of rainbow trout muscle during heating. J. Food Process. Preserv., 32, 190, 2008.
Kong, F. et al. Kinetics of salmon quality changes during thermal processing. J. Food Eng., 83, 510, 2007.
Ahmed, J. , Sabeena, F.K.H. , Linu, T. , Mehrajfatema, Z.M. , Harsha, J. and Surendraraj, A. Effect of high-pressure treatment and refrigerated storage on the amino acid profile, color, and texture of hammour (*Epinephelus coioides*) fillets. J. Food Proc. Pres., 45, e15977, 2021.
Kristinsson, H.G. , Danyali, N. and Ua-Angkoon, S. , Effect of filtered wood smoke treatment on chemical and microbial changes in mahi mahi fillets, J. Food Sci., 72, C016, 2007.
Schubring, R. et al. Off shore high pressure treatment of freshly caught fish. In: Innovations in Traditional Foods, (P. Fito and F. Toldra , Eds.), Elsevier, London, 2005, p. 1213.
Matser, A.M. et al. Effects of high pressure on colour and texture of fish. High Press. Res., 19, 109, 2000.
Ashie, I.N.A. and Simpson, B.K. , Application of high hydrostatic pressure to control enzyme related fresh seafood texture deterioration, Food Res. Int., 29, 569, 1996.
Chevalier, D. et al. Effect of pressure shift freezing, air-blast freezing and storage on some biochemical and physical properties of turbot (*Scophthalmus maximus*). LWT Food Sci. Technol., 33, 570, 2000.
Schubring, R. et al. Impact of high pressure assisted thawing on the quality of fillets from various fish species. Innov. Food Sci. Emerg. Technol., 4, 257, 2003.
Sequeira-Munoz, A. et al. Physicochemical changes induced in carp (*Cyprinus carpio*) fillets by high pressure processing at low temperature. Innov. Food Sci. Emerg. Technol., 7, 13, 2006.
Chéret, R. et al. Effects of high pressure on texture and microstructure of sea bass (*Dicentrarchus labrax L.*) fillets. J. Food Sci., 70, E477, 2005.
López-Caballero, M.E. et al. A functional chitosan-enriched fish sausage treated by high pressure. J. Food Sci., 70, M166, 2005.
Uresti, R.M. et al. Restructured products from arrowtooth flounder (*Atheresthes stomias*) using high-pressure treatments. Eur. Food Res. Technol., 220, 113, 2005.
Tabilo-Munizaga, G. and Barbosa-Cánovas, G.V. Color and textural parameters of pressurized and heat-treated surimi gels as affected by potato starch and egg white. Food Res. Int., 37, 767, 2004.
Ramirez-Suarez, J.C. and Morrissey, M.T. Effect of high pressure processing (HPP) on shelf life of albacore tuna (*Thunnus alalunga*) minced muscle. Innov. Food Sci. Emerg. Technol., 7, 19, 2006.
Amanatidou, A. et al. Effect of combined application of high pressure treatment and modified atmospheres on the shelf life of fresh Atlantic salmon. Innov. Food Sci. Emerg. Technol., 1, 87, 2000.
Hwang, J.-S. , Lai, K.-M. and Hsu, K.-C. Changes in textural and rheological properties of gels from tilapia muscle proteins induced by high pressure and setting. Food Chem., 104, 746, 2007.
Tironi, V. , LeBail, A. and de Lamballerie, M. Effects of pressure-shift freezing and pressure-assisted thawing on sea bass (*Dicentrarchus labrax*) quality. J. Food Sci., 72, C381, 2007.
Yagiz, Y. et al. Effect of high pressure treatment on the quality of rainbow trout (Oncorhynchus mykiss) and mahi mahi (*Coryphaena hippurus*). J. Food Sci., 72, C509, 2007.
Gómez-Estaca, J. , Gómez-Guillén, M.C. and Montero, P. High pressure effects on the quality and preservation of cold-smoked dolphinfish (*Coryphaena hippurus*) fillets. Food Chem., 102, 1250, 2007.

Instrumental Texture

Alakhrash, F. , Anyanwu, U. , and Tahergorabi, R. Physicochemical properties of Alaska pollock (*Theragra chalcograma*) *surimi* gels with oat bran. LWT - Food Sci. Technol., 66, 41, 2016.

Ando, M. , Toyohara, H. , Shimizu, Y. , and Sakaguchi, M. Validity of a puncture test for evaluating change in muscle firmness of fish during ice storage. Nippon Suisan Gakkai Shi, 57, 2341, 1991.

Arnold, P.C. , and Mohsenin, N.N. Proposed techniques for axial compression tests on intact agricultural products of convex shape. Trans. ASABE, 14, 78, 1971.

Ashton, T.J. , Michie, I. , and Johnston, I.A. Novel tensile test method to assess texture and gaping in salmon fillets. J. Food Sci., 75, S182, 2010.

Azmi, N.S. Basha , R.K., Arifin, N.N.T. , Othman, S.H. , and Mohammed, M.A.P. Functional properties of tilapia's fish scale gelatin film: Effects of different type of plasticizers. Sains Malaysiana, 49, 2221, 2020.

Badfar, N. , Abdollahi, M. , Stubbe, P.R. , and Jafarpour, A. Texture and viscoelastic characteristics of silver carp (*Hypophthalmichthys molitrix*) surimi affected by combination of washing regimes and hydrogen peroxide. J. Texture Stud., 53, 490, 2022.

Bainy, E.M. , Bertan, L.C. , Corazza, M.L. , and Lenzi, M.K. Effect of grilling and baking on physicochemical and textural properties of tilapia (*Oreochromis niloticus*) fish burger. J. Food Sci. Technol., 52, 5111, 2015.

Barnes, H.A. , Hutton, J.F. , and Walters, K. An Introduction to Rheology. Elsevier, Amsterdam, 1993.

Barroso, M. , Careche, M. , Barrios, L. , and Borderias, A.J. Frozen hake fillets quality as related to texture and viscosity by mechanical methods. J. Food Sci., 63, 793, 1998a.

Barroso, M. , Careche, M. , and Borderias, A.J. Evaluation of fish freshness using mechanical methods. In: Methods to Determine the Freshness of Fish in Research and Industry. Olafsdottir, G. , Luten, J.B. , Dalgaard, P. , Careche, M. , Verrez-Bagnis, V. , Martinsdottir, E. , and Heia, K. Eds. International Institute of Refrigeration, Paris, p. 355, 1997.

Barroso, M. , Careche, M. , and Borderias, A.J. Quality control of frozen fish using rheological techniques. Trends Food Sci. Technol., 9, 223, 1998b.

Baydin, T. , Dille, M.J. , Aarstad, O.A. , Hattrem, M.N. , and Draget, K.I. The impact of sugar alcohols and sucrose on the physical properties, long-term storage stability, and processability of fish gelatin gels. J. Food Eng., 341, 111334, 2023.

Bernardo, Y.A. , Rosario, D.K.A. , Monteiro, M.L.G. , Mano, S.B. , Delgado, I.F. , and Conte-Junior, C.A. Texture profile analysis: How parameter settings affect the instrumental texture characteristics of fish fillets stored under refrigeration? Food Anal. Methods, 15, 144, 2022.

Bland, J.M. , and Bett-Garber, K.L. Comparison of sensory and instrumental methods for the analysis of texture of cooked individually quick frozen and fresh-frozen catfish fillets. Food Sci. Nutr., 6, 1692, 2018.

Borderías, A.J. , Lamua, M. , and Tejada, M. Texture analysis of fish fillets and minced fish by both sensory and instrumental methods. J. Food Technol., 18, 85, 1983.

Botta, J.R. Instrument for nondestructive texture measurement of raw Atlantic cod (*Gadus morhua*) fillets. J. Food Sci., 56, 962, 1991.

Botta, J.R. Physical methods of evaluating freshness quality. In: Botta, J. R. (Ed.), Evaluation of Seafood Freshness Quality. VCH Publishers Inc., Weinheim, Germany, pp. 35–63, 1995.

Botta, J.R. , Bonnell, G. , and Squires, B.E. Effect of method of catching and time of season on sensory quality of fresh raw Atlantic cod (*Gadus morhua*). J. Food Sci., 52, 928, 1987.

Bourne, M.C. Texture profile of ripening pears. J. Food Sci., 33, 223, 1968.

Bourne, M.C. Method for obtaining compression and shear coefficients of foods using cylindrical punches. J. Texture Stud., 5, 459, 1975.

Bourne, M.C. Texture profile analysis. Food Technol., 32, 62, 1978.

Bourne, M.C. Food texture and viscosity: Concept and measurement. In: Food Texture and Viscosity: Concept and Measurement. Taylor, S.L. , Ed. Academic Press, London, UK, 2002.

Brandt, M.A. , Skinner, E.Z. , and Coleman, J.A. Texture profile method. J. Food Sci., 28, 404, 1963.

Bratzler, L.J. Determining the tenderness of meat by use of the Warner-Bratzler method. Proceedings of the 2nd Reciprocal Meat Conference, p. 117, 1949.

Breene, W. Application of texture profile analysis to instrumental food texture evaluation. J. Texture Stud., 6, 53, 1975.

Bremner, H.A. , Olley, J. , and Vail, A.M.A. Estimating time-temperature effects by rapid systematic sensory methods. In: Seafood Quality Determination. Kramer, D.E. , and Liston, J. , Eds. Elsevier, Amsterdam, p. 413, 1987.

Brenner, T. , and Nishinari, K. Note on instrumental measures of adhesiveness and their correlation with sensory perception. J. Texture Stud., 45, 74, 2014.

Calzada, J.F. , and Peleg, M. Mechanical interpretation of compressive stress-strain relationships of solid foods. J. Food Sci., 43, 1087, 1978.

Campo, L. , and Tovar, C.A. Influence of the starch content in the viscoelastic properties of surimi gels. J. Food Eng., 84, 140, 2008.
Campo-Deaño, L. , and Tovar, C. The effect of egg albumen on the viscoelasticity of crab sticks made from Alaska Pollock and Pacific Whiting *surimi* . Food Hydrocoll., 23, 1641, 2009.
Campus, M. , Addis, M.F. , Cappuccinelli, R. , Porcu, M.C. , Pretti, L. , Tedde, V. , Secchi, N. , Stara, G. , and Roggio, T. Stress relaxation behaviour and structural changes of muscle tissues from Gilthead Sea Bream (*Sparus aurata* L.) following high pressure treatment. J. Food Eng., 96, 192, 2010.
Carbonell, I. , Duran, L. , Izquierdo, L. , and Costell, E. Texture of cultured gilthead sea bream (*Sparus aurata*): Instrumental and sensory measurement. J. Texture Stud., 34, 203, 2003.
Careche, M. , and Barroso, M. Instrumental texture measurement. In: Fishery Products: Quality, Safety and Authenticity. Rehbein, H. , and Oehlenschläger, J. Eds. Blackwell Publishing Ltd, Oxford, U.K. pp. 214–239, 2009.
Careche, M. , Tryggvadottir, S.V. , Herrero, A. , Lägel, B., Petermann, U. , Schubring, R. , and Nesvadba, P. Instrumental methods for measuring texture of fish. In: Quality of Fish from Catch to Consumer: Labeling, Monitoring and Traceability. Luten, J.B. , Oehlenschager, J. , Olafsdottir, G. Eds. Wageningen Academic Publishers, Wageningen, pp. 189–200, 2003.
Chamberlain, A.I. , Kow, F. , and Balasubramaniam, E. Instrumental method for measuring texture of fish. Food Aust., 45, 439, 1993.
Chen, Y.C. , and Jaczynski, J. Gelation of protein recovered from whole Antarctic krill (*Euphausia superba*) by isoelectric solubilization/precipitation as affected by functional additives. J. Agric. Food Chem., 55, 1814, 2007.
Cheng, J.H. , Sun, D.W. , Han, Z. , and Zeng, X.A. Texture and structure measurements and analyses for evaluation of fish and fillet freshness quality: A review. Compr. Rev. Food Sci. Food Saf., 13, 52, 2014.
Chu, C.F. , and Peleg, M. The compressive behavior of solid food specimens with small height to diameter ratios. J. Texture Stud., 16, 451, 1985.
Chung, S.L. , and Merritt, J.H. Physical measures of sensory texture in thawed sea scallop meat. Int. J. Food Sci. Tech., 26, 207, 1991.
Çırak, S. , Taştan, Y. , and Sönmez, A.Y. Comparison of postmortem mass changes in myosin heavy chain and textural characteristics among *Oncorhynchus mykiss* (Walbaum, 1972), Salmo trutta fario (Linnaeus, 1758) and *Salvelinus fontinalis* (Mitchill, 1814). Aquac. Res., 50, 3259, 2019.
Collignan, A. , and Montet, D. Tenderizing squid mantle by marination at different pH and temperature levels. Lebensm.-Wiss. u-Technol., 31, 673, 1998.
Coppes, Z. , Pavlisko, A , and De Vecchi, S. Texture measurements in fish and fish products. J. Aquat. Food Prod. Technol., 11, 89–105, 2002.
Cuq, B. , Gontard, N. , Cuq, J.L. , and Guilbert, S. Rheological model for the mechanical properties of myofibrillar protein-based films. J. Agric. Food Chem., 44, 1116, 1996.
Debusca, A. , Tahergorabi, R. , Beamer, S.K. , Partington, S. , and Jaczynski, J. Interactions of dietary fibre and omega-3-rich oil with protein in *surimi* gels developed with salt substitute. Food Chem., 141, 201, 2013.
Di Natale, C. Data fusion in MUSTEC: Towards the definition of an artificial quality index. In: Quality of Fish from Catch to Consumer: Labelling, Monitoring and Traceability. Luten, J. B. , Oehlenschager, J. , and Olafsdottir, G. Eds. Wageningen Academic Publishers, Wageningen, pp. 273–282, 2003.
Dincer, M.T. , and Çakli, S. Textural acceptability of prepared fish sausages by controlling textural indicators. Turkish J. Vet. Anim. Sci., 39, 3, 2015.
Dunajski, E. Texture of fish muscle. J. Texture Stud., 10, 301, 1980.
Eddin, A.S. , Adegoke, S. , Issa, A.T. , Wilson, C. , and Tahergorab, R. Physicochemical changes of *surimi* gels with addition of different particle sizes of citrus peel fiber. J. Aquat. Food Prod. Technol., 29, 1029, 2020.
Faergemand, J. , Ronsholdt, B. , Alsted, N. , and Borresen, T. Fillet texture of rainbow-trout as affected by feeding strategy, slaughtering procedure and storage post-mortem. Water Sci. Technol., 31, 225, 1995.
Feinstein, G.R. , and Buck, E.M. Relationship of texture to pH and collagen content of yellowtail flounder and cusk. J. Food Sci., 49, 298, 1984.
Fiszman, S.M. , Pons, M. , and Damasio, M.H. New parameters for instrumental texture profile analysis: Instantaneous and retarded recoverable springiness. J. Texture Stud., 29, 499, 1998.
Friedman, H.H. , Whitney, J.E. , and Szczesniak, A.S. The texturometer-A new instrument for objective texture measurement. J. Food Sci., 28, 390, 1963.
Gunasekaran, S. , and Ak, M.M. Dynamic oscillatory shear testing of foods - Selected applications. Trends Food Sci. Technol., 11, 115, 2000.
Hallier, A. , Chevallier, S. , Serot, T. , and Prost, C. Freezing-thawing effects on the colour and texture of European catfish flesh. Int. J. Food Sci. Technol., 43, 1253, 2008.
Hamann, D.D. , Purkayastha, S. , and Lanier, T.C. Applications of thermal scanning rheology to the study of food gels. In: Thermal Analysis of Foods. Harwalker, V.R. , and Ma, C.Y. Eds. Elsevier, Barking, Essex, England, pp. 306–332, 1990.
Hatae, K. , Nakayama, T. , Matsui, Y. , Shimada, A. , and Matsumoto, J.J. Creep compliance behaviours of raw fish muscles in five species. Bull. Jap. Soc. Sci. Fish., 54, 1595, 1988.

Hatae, K. , Yoshimatsu, F. , and Matsumoto, J.J. Role of muscle-fibers in contributing firmness of cooked fish. J. Food Sci., 55, 693, 1990.
Herrero, A.M. , and Careche, M. Stress relaxation test to evaluate textural quality of frozen stored Cape hake (*M. capensis* and *M. paradoxus*). Food Res. Int., 38, 69, 2005.
Herrero, A.M. , and Careche, M. Prediction of frozen storage time of Cape hake (*Merluccius capensis* and *Merluccius paradoxus*) by instrumental methods. J. Sci. Food Agric., 86, 2128, 2006.
Herrero, A.M. , Heia, K. , and Careche, M. Stress relaxation test for monitoring post mortem textural changes of ice-stored cod (*Gadus morhua*). J. Food Sci., 69, FEP178, 2004.
Howgate, P. Aspects of fish texture. In: Sensory Properties of Food. Birch, G.G. , Brennan, J.G. , and Parker, K.J. Eds. Applied Science Publishers, London, UK, pp. 249–269, 1977.
Hunt, A. , and Park, J.W. Comparative study of sodium bicarbonate on gelling properties of Alaska pollock *surimi* prepared at different freezing rates. J. Food Qual., 37, 349, 2014.
Hyldig, G. , and Nielsen, D. A review of sensory and instrumental methods used to evaluate the texture of fish muscle. J. Texture Stud., 32, 219, 2001.
Iso, N. , Mizuno, H. , Saito, T. , Mochizuki, Y. , Ishii, K. , Okunuki, H. , and Miyata, K. The relationships between the rheological properties and the freshness of fish meat. Bull. Jap. Soc. Sci. Fish., 53, 1231, 1987.
Iso, N. , Mizuno, H. , Saito, T. , Ohzeki, F. , and Wang, Z. Studies on the rheological properties of the heated yellowtail meat. Bull. Jap. Soc. Sci. Fish., 50, 2061, 1984a.
Iso, N. , Mizuno, H. , Saito, T. , Ohzeki, F. , and Yang, L.C. Studies on the rheological properties of heated carp meats. Bull. Jap. Soc. Sci. Fish., 50, 349, 1984b.
Izquierdo-Pulido, M.L. , Hatae, K. , and Haard, N.F. Nucleotide catabolism and changes in texture indices during ice storage of cultured sturgeon, Acipenser transmontanus. J. Food Biochem., 16, 173, 1992.
Johnson, E.A. , Peleg, M. , Sawyer, F.M. , Segars, R.A. , and Cardello, A. Mechanical methods of measuring textural characteristics of fish flesh. Refrigeration Science and Technology, 1981-4, 93–103, 1981.
Johnson, E.A. , Segars, R.A. , Kapsalis, J.G. , Normand, M.D. , and Peleg, M. Evaluation of the compressive deformability modulus of fresh and cooked fish flesh. J. Food Sci., 45, 1318, 1980.
Johnson, M. Overview of texture profile analysis. Available from https://www.texturetechnologies.com/resources/texture-profile-analysis [last accessed March 2023], 2014.
Jridi, M. , Abdelhedi, O. , Salem, A. , Kechaou, H. , Nasri, M. , and Menchari, Y. Physicochemical, antioxidant and antibacterial properties of fish gelatin-based edible films enriched with orange peel pectin: Wrapping application. Food Hydrocoll., 103, 105688, 2020.
Kagawa, M. , Matsumoto, M. , Yoneda, C. , Mitsuhashi, T. , and Hatae, K. Changes in meat texture of three varieties of squid in the early stage of cold storage. Fish. Sci., 68, 783, 2002.
Kim, Y.J. , Park, J.W. , and Yoon, W.B. Rheology and texture properties of surimi gels. In: Surimi and Surimi Seafood. 2nd edition. Park, J.W. Ed. CRC Press, Boca Raton, pp. 491–582, 2005.
Kimura, H. , Saito, T. , Mizuno, H. , Ogawa, H. , Mochizuki, Y. , Suyama, Y. , and Iso, N. The rheological properties of salted jellyfish during cooking and dipping in water. Bull. Jap. Soc. Sci. Fish., 57, 463, 1991.
Kong, J. , Dougherty, M.P. , Perkins, L.B. , and Camire, M.E. Composition and consumer acceptability of a novel extrusion-cooked salmon snack. J. Food Sci., 73, S118, 2008.
Kuo, J.D. , Peleg, M. , and Hultin, H.O. Tensile characteristics of squid mantle. J. Food Sci., 55, 369, 1990.
Kramer, A. , Burkhardt, G.T. , and Rogers, H.P. The shear-press, a device for measuring food quality. Canner, 12, 34, 1951.
Kramer, D.E. , and Peters, M.D. Effect of pH and prefreezing treatment on the texture of yellowtail rockfish (*Sebastes flavidus*) as measured by the Ottawa texture measuring system. J. Food Technol., 16, 493, 1981.
Krivchenia, M. , and Fennema, O. Effect of cryoprotectants on frozen whitefish fillets. J. Food Sci., 53, 999, 1988.
Krueger, D.J. , and Fennema, O.R. Effect of chemical additives on toughening of fillets of frozen Alaska pollack (Theragra chalcogramma). J. Food Sci., 54, 1101, 1989.
Liu, Q. , Bao, H. , Xi, C. , and Miao, H. Rheological characterization of tuna myofibrillar protein in linear and nonlinear viscoelastic regions. J. Food Eng., 121, 58, 2014.
Ma, L. , Grove, A. , and Barbosa-Cánovas, G.V. Viscoelastic characterization of *surimi* gel: Effects of setting and starch. J. Food Sci., 61, 881, 1996.
Macagnano, A. , Careche, M. , Herrero, A. , Paolesse, R. , Martinelli, E. , Pennazza, G. , Carmona, P. , D'Amico, A. , and Di Natale, C. A model to predict fish quality from instrumental features. Sens. Actuators B Chem., 111, 293, 2005.
Martelo-Vidal, M.J. , Mesas, J.M. , and Vázquez, M. Low-salt restructured fish products from Atlantic mackerel (*Scomber scombrus*) with texture resembling turkey breast. Food Sci. Technol. Int., 18, 251, 2012.
McKenna, D.R. , Nanke, K.E. , and Olson, D.G. The effects of irradiation, high hydrostatic pressure, and temperature during pressurization on the characteristics of cooked-reheated salmon and catfish fillets. J. Food Sci., 68, 368, 2003.
Meullenet, J.-F.K. Carpenter , J.A., Lyon, B.G. , and Lyon, C.E. Bi-cyclical instrument for assessing texture profile parameters and its relationship to sensory evaluation of texture. J. Texture Stud., 28, 101, 1997.

Michalczyk, M. , and Surówka, K. Microstructure and instrumentally measured textural changes of rainbow trout (*Oncorhynchus mykiss*) gravads during production and storage. J. Sci. Food Agric., 89, 1942, 2009.
Mochizuki, Y. , Mizuno, H. , Ogawa, H. , Ishimura, K. , Tsuchiya, H. , Fukuzawa, M. , and Iso, N. Rheological properties of cuttlefish and squid raw meat. Fish. Sci., 60, 555, 1994.
Mochizuki, Y. , Mizuno, H. , Ogawa, H. , Ishimura, K. , Tsuchiya, H. , and Iso, H. Changes of rheological properties of cuttlefish and squid meat by heat treatment. Fish. Sci., 61, 680, 1995.
Mohsenin, N.N. Some basic concepts of rheology. In: Physical Properties of Plants and Animals Materials. Vol. 1. Structure, Physical Characteristics and Mechanical Properties. Mohsenin, N.N. , Ed. Gordon & Breach Science Publishers Inc., New York, pp. 88–173, 1970.
Moller, A.J. Analysis of Warner-Bratzler shear pattern with regard to myofibrillar and connective tissue components of tenderness. Meat Sci., 5, 247, 1981.
Montero, P. , and Borderias, J. Influence of age on muscle connective tissue in trout (*Salmo irideus*). J. Sci. Food Agric., 51, 261, 1990a.
Montero, P. , and Borderias, J. Behavior of myofibrillar proteins and collagen in hake (*Merluccius merluccius*) muscle during frozen storage and its effect on texture. Z. Lebensm. Unters. Forsch., 190, 112, 1990b.
Montero, P. , and Borderias, J. Influence of myofibrillar proteins and collagen aggregation on the texture of frozen hake muscle. In: Quality Assurance in the Fish Industry. Huss, H.H. , Jakobsen, M. , and Liston, J. , Eds. Elsevier Science Publishers B.V., Amsterdam, The Netherlands, p. 149, 1992.
Morkore, T. , and Einen, O. Relating sensory and instrumental texture analyses of Atlantic salmon. J. Food Sci., 68, 1492, 2003.
Morzel, M. , Heapes, M.M. , Reville, W.J. , and Arendt, E.K. Textural and ultrastructural changes during processing and storage of lightly preserved salmon (*Salmo salar*) products. J. Sci. Food Agric., 80, 1691, 2000.
Nesvadba, P. Quality control by instrumental texture measurements. In: Seafoods - Quality, Technology and Nutraceutical Applications. Alasavar, C. , and Taylor, T. , Eds. Springer, Berlin, pp. 43–57, 2002.
Nishinari, K. , and Fang, Y. Perception and measurement of food texture: Solid foods. J. Texture Stud., 49, 160, 2018.
Nishinari, K. , Fang, Y. , and Rosenthal, A. Human oral processing and texture profile analysis parameters: Bridging the gap between the sensory evaluation and the instrumental measurements. J. Texture Stud., 50, 369, 2019.
Okazaki, E. , Tsukada, K. , Kanna, K. , and Suzuki, T. Changes of properties of meat-textured fish-protein concentrate during frozen storage. Bull. Jap. Soc. Sci. Fish., 50, 307, 1984.
Olafsdottir, G. , Nesvadba, P. , Di Natale, C. , Careche, M. , Oehlenschager, J. , Tryggvadottir, S.V. , Schubring, R. , Kroeger, M. , Heia, K. , Esaiassen, M. , Macagnano, A. , and Jorgensen, B.A. Multisensor for fish quality determination. Trends Food Sci. Technol., 15, 86, 2004.
Oliveira, A.C.M. , Himelbloom, B.H. , Montazeri, N. , Davenport, M. , Biceroglu, H. , Brenner, K.A. , Thomas, S.R. , and Crapo, C.A. Development and characterization of fish sausages supplemented with salmon oil. J. Food Process. Preserv., 38, 1641, 2014.
Orban, E. , Sinesio, F. , and Paoletti, F. The functional properties of the proteins, texture and the sensory characteristics of frozen sea bream fillets (*Sparus aurata*) from different farming systems. Lebensm.-Wiss. u-Technol., 30, 214, 1997.
Paker, I. , and Matak, K.E. Impact of sarcoplasmic proteins on texture and color of silver carp and Alaska Pollock protein gels. LWT - Food Sci. Technol., 63, 985, 2015.
Paker, I. , and Matak, K.E. Effects of starch concentration on calcium-enhanced black bullhead catfish protein gels. Food Sci. Nutr., 5, 763, 2017.
Park, H.W. , Park, J.W. , and Yoon, W.B. The relationship between penetration, tension, and torsion for the fracture of *surimi* gels: Application of digital image correlation (DIC). Processes, 11, 265, 2023.
Park, J. , and Morrissey, M. The need for developing uniform *surimi* standards. In: Quality Control & Quality Assurance for Seafood. Sylvia, G. , Shriver, A.L. , and Morrissey, M. Eds. Oregon Sea Grant, Corvallis, OR, pp. 64–71, 1993.
Park, J.D. , Park, J.W. , and Yoon, W.B. Semi-empirical relationship between rupture properties of *surimi* pastes and failure shear stress of *surimi* gels at different moisture contents. J. Texture Stud., 44, 247, 2013.
Peleg, M. Texture profile analysis parameters obtained by an Instron universal testing machine. J. Food Sci., 41, 721, 1976.
Peleg, M. Characterization of stress relaxation curves of solid foods. J. Food Sci., 44, 277, 1979.
Peleg, M. The instrumental texture profile analysis revisited. J. Texture Stud., 50, 362, 2019.
Pérez-Won, M. , Barraza, M. , Cortés, F. , Madrid, D. , Cortés, P. , Roco, T. , Osorio, F. , and Tabilo-Munizaga, G. Textural characteristics of frozen blue squat lobster (*Cervimunida johni*) tails as measured by instrumental and sensory methods. J. Food Process Eng., 29, 519, 2006.
Pietrowski, B.N. , Tahergorabi, R , Matak, K.E. , Tou, J.C. , and Jaczynski, J. Chemical properties of *surimi* seafood nutrified with w-3 rich oils. Food Chem., 129, 912, 2011.
Pons, M. , and Fiszman, S.M. Instrumental texture profile analysis with particular reference to gelled systems. J. Texture Stud., 27, 597, 1996.

Rahman, M.S. , Kasapis, S. , Guizani, N. , and Amri, O.S. State diagram of tuna meat: Freezing curve and glass transition. J. Food Eng., 57, 321, 2003.
Ramírez, J.A. , Del Ángel , A., Uresti, R.M. , Velazquez, G. , and Vázquez, M. Low-salt restructured products from striped mullet (*Mugil cephalus*) using microbial transglutaminase or whey protein concentrate as additives. Food Chem., 102, 243, 2007.
Rao, M.A. Phase transitions, food texture and structure. In: Texture in Food, Volume 1: Semi-Solid Foods. McKenna, B.M. Eds. CRC Press, Boca Raton, Boston, New York, Washington, DC, pp. 36–62, 2003.
Rosenthal, A.J. Texture profile analysis - How important are the parameters? J. Texture Stud., 41, 672, 2010.
Sablani, S.S. , Kasapis, S. , Rahman, M.S. , Al Jabri, A. , and Al Habsi, N. Sorption isotherms and the state diagram for evaluating stability criteria of abalone. Food Res. Int., 37, 915, 2004.
Sánchez-Alonso, I. , and Borderías, A.J. Technological effect of red grape antioxidant dietary fibre added to minced fish muscle. Int. J. Food Sci. Technol., 43, 1009, 2008.
Sánchez-Alonso, I. , Hají-Maleki, R. , and Borderías, A.J. Wheat fiber as a functional ingredient in restructured fish products. Food Chem., 100, 1037, 2007a.
Sánchez-Alonso, I. , Solas, M. T. , and Borderías, A.J. Physical study of minced fish muscle with a white-grape by-product added as ingredient. J. Food Sci., 72, E94, 2007b.
Sánchez-González, I. , Carmona, P. , Moreno, P. , Borderías, J. , Sánchez-Alonso, I. , Rodríguez-Casado, A. , and Careche, M. Protein and water structural changes in fish *surimi* during gelation as revealed by isotopic H/D exchange and Raman spectroscopy. Food Chem., 106, 56, 2008.
Sánchez-Valencia, J. , Sánchez-Alonso, I. , Martínez, I. , and Careche, M. Estimation of frozen storage time or temperature by kinetic modeling of the Kramer shear resistance and water holding capacity (WHC) of hake (*Merluccius merluccius*, L.) muscle. J. Food Eng., 120, 37–43, 2014.
Sawyer, F.M. , Cardello, A.V. , Prell, P.A. , Johnson, E.A. , Segars, R.A. , Maller, O. , and Kapsalis, J. Sensory and instrumental evaluation of snapper and rockfish species. J. Food Sci., 49, 727, 1984.
Segars, R.A. , Hamel, R.G. , Kapsalis, J.G. , and Kluter, R.A. A punch and die test cell for determining the textural qualities of meat. J. Texture Stud., 6, 211, 1975.
Shahmohammadi, H.R. , Bakar, J. , Rahman, R.A. , and Adzhan, N.M. Studying the effects of nucleating agents on texture modification of puffed corn-fish snack. J. Food Sci., 79, E178, 2014.
Sherman, P. A texture profile of foodstuffs based upon well-defined rheological properties. J. Food Sci., 34, 458, 1969.
Sigurgisladottir, S. , Hafsteinsson, H. , Jonsson, A. , Lie, O. , Nortvedt, R. , Thomassen, M. , and Torrissen, O. Textural properties of raw salmon fillets as related to sampling method. J. Food Sci., 64, 99, 1999.
Soto-Simental, S. , Valera-Quezada, E. , Hernandez-Chavez, J.F. , Guemes-Vera, N. , and Ayala-Martinez, M. Effect of fat, add water, carragennan and phosphates on carp *(Cyprinus carpio)* meat emulsioned product. Agrociencia, 50, 413, 2016.
Surya, P. , Sundaramanickam, A. , Nithin, A. , and Iswarya, P. Eco-friendly preparation and characterization of bioplastic films made from marine fish-scale wastes. Environ. Sci. Pollut. Res. Int., 30, 34174, 2023.
Szczesniak, A.S. Classification of textural characteristics. J. Food Sci., 28, 385, 1963.
Szczesniak, A.S. General foods texture profile revisited - Ten years perspective. J. Texture Stud., 6, 5, 1975.
Szczesniak, A.S. Sensory texture profiling - Historical and scientific perspectives. Food Technol., 52, 54, 1998.
Szczesniak, A.S. Texture is a sensory property. Food Qual. Prefer., 13, 215, 2002.
Szczesniak, A.S. , Brandt, M.A. , and Friedman, H.H. Development of standard rating scales for mechanical parameters of texture and correlation between the objective and the sensory methods of texture evaluation. J. Food Sci., 28, 397, 1963.
Tabilo-Munizaga, G. , and Barbosa-Canovas, G.V. Color and textural parameters of pressurized and heat-treated *surimi* gels as affected by potato starch and egg white. Food Res. Int., 37, 767, 2004.
Tanaka, M. General foods texturometer application to food texture research in Japan. J. Texture Stud., 6, 101, 1975.
Taylor, R.G. , Fjaera, S.O. , and Skjervold, P.O. Salmon fillet texture is determined by myofiber-myofiber and myofiber-myocommata attachment. J. Food Sci., 67, 2067, 2002.
Techarang, J. , Apichartsrangkoon, A. , Pathomrungsiyounggul, P. , Chaikham, P. , and Dajanta, K. Viscoelastic behavior and physico-chemical characteristics of heated swai-fish (*Pangasius hypophthalmus*) based emulsion containing fermented soybeans. LWT - Food Sci. Technol., 66, 63, 2016.
Timbers, G.E. , Voisey, P.W. , and Kloek, M. Influence of number and thickness of the blades on the performarce of the Kramer-type shear-compression cell. J. Texture Stud., 16, 303, 1985.
Tirloni, E. , Stella, S , and Bernardi, C. An efficient and tasty use of Atlantic salmon trimming: Microbiological and chemical-physical evaluation of salmon frankfurters. Turkish J. Fish. Aquat. Sci., 5, 111, 2015.
van Vliet, T. Rheological classification of foods and instrumental techniques for their study. In: Food Texture: Measurement and Perception. Rosenthal, A.J. , Ed. Aspen Publishers Inc., Gaithersburg, MD, p. 65, 1999.
Veland, J.O. , and Torrissen, O.J. The texture of Atlantic salmon (*Salmo salar*) muscle as measured instrumentally using TPA and Warner-Brazler shear test. J. Sci. Food Agric., 79, 1737, 1999.
Voisey, P.W. , and Kloek, M. Effect of cell-size on the performance of the shear-compression texture test cell. J. Texture Stud., 12, 133, 1981.

Wang, Y. , Song, X. , and Liu, B. Changes in mechanical properties of salmon fillets during the cold storage. Int. J. Food Ferment. Technol., 3, 212, 2016.
Wangtueai, S. , Noomhorm, A. , and Regenstein, J.M. Effect of microbial transglutaminase on gel properties and film characteristics of gelatin from Lizardfish (*Saurida* spp.) scales. J. Food Sci., 75, C731, 2010.
Warner, K.F. Progress report of the mechanical test for tenderness of meat. Ann. Am. Proc. Soc. Animal Prod., 21, 114, 1928.
Wee, M.S.M. , Goh, A.T. , Stiegerb, M. , and Forde, C.G. Correlation of instrumental texture properties from textural profile analysis (TPA) with eating behaviours and macronutrient composition for a wide range of solid foods. Food Funct., 9, 5301, 2018.
Weinberg, Z.G. , and Angel, S. Behavior of a formed fish product under the stress-relaxation text. J. Food Sci., 50, 589, 1985.
Xavier, K.A.M. , Hauzoukima, Kannuchamy , N., Balange, A.K. , Chouksey, M.K. , and Gudipatib, V. Functionality of chitosan in batter formulations for coating of fishsticks: Effect on physicochemical quality. Carbohydr. Polym., 169, 433, 2017.
Xin, G. , Ogawa, H. , Tashiro, Y. , and Iso, N. Rheological properties and structural changes in raw and cooked abalone meat. Fish. Sci., 67, 314, 2001.
Xin, G. , Tashiro, Y. , and Ogawa, H. The correlation between rheological properties and characteristic values of structure for steamed abalone meat. Food Sci. Technol. Res., 8, 304, 2002a.
Xin, G. , Tashiro, Y. , and Ogawa, H. Rheological properties and structural changes in steamed and boiled abalone meat. Fish. Sci., 68, 499, 2002b.
Yang, Y. , Liu, X. , Xue, Y. , Xue, C. , and Zhaoa, Y. The process of heat-induced gelation in *Litopenaeus vannamei* . Food Hydrocol., 98, 105260, 2020.
Yoon, W.B. , Gunasekaran, S. , and Park, J.W. Characterization of thermorheological behavior of Alaska Pollock and Pacific Whiting *surimi* . J. Food Sci., 69, 338, 2004.
Yoshioka, K. , and Yamamoto, T. Changes of ultrastructure and the physical properties of carp muscle by high pressurization. Fish. Sci., 64, 89, 1998.

Aroma

Milo, C. and W. Grosch , Changes in the odorants of boiled salmon and cod as affected by the storage of the raw material. Journal of Agricultural and Food Chemistry, 1996. 44 (8): 2366–2371.
Milo, C. and W. Grosch , Changes in the odorants of boiled trout (*Salmo fario*) as affected by the storage of the raw material. Journal of Agricultural and Food Chemistry, 1993. 41 (11): 2076–2081.
Milo, C. and W. Grosch , Potent Odorants in Boiled Cod as Affected by the Storage of Raw Material, In Flavor and Lipid Chemistry of Seafoods, F. Shahidi and K. R. Cadwallader (eds.), 1997, American Chemical Society: Washington, DC. pp. 110–119.
Baek, H.H. and K.R. Cadwallader , Character-Impact Aroma Compounds of Crustaceans, In Flavor and Lipid Chemistry of Seafoods, F. Shahidi and K. R. Cadwallader (eds.), 1997, American Chemical Society: Washington, DC. pp. 85–94.
Cadwallader, K.R. and H.H. Baek , Aroma-Impact Compounds in Cooked Tail Meat of Freshwater Crayfish (Procambarus clarkii), In Developments in Food Science, E.T. Contis , C.-T. Ho , C.J. Mussinan , T.H. Parliment , Fereidoon Shahidi , A.M. Spanier (eds.), 1998, Elsevier Science B.V.: Amsterdam, The Netherlands. pp. 271–278.
Cadwallader, K.R. , et al ., Evaluation of the aroma of cooked spiny lobster tail meat by aroma extract dilution analysis. Journal of Agricultural and Food Chemistry, 1995. 43(9): 2432–2437.
Chung, H.Y. and K.R. Cadwallader , Aroma extract dilution analysis of blue crab claw meat volatiles. Journal of Agricultural and Food Chemistry, 1994. 42(12): 2867–2870.
Durnford, E. and F. Shahidi , Flavour of Fish Meat, In Flavor of Meat, Meat Products and Seafoods, F. Shahidi , Editor. 1998, Blackie Academic and Professional: Glasgow. pp. 131–152.
Krzymien, M.E. and L. Elias , Feasibility study on the determination of fish freshness by trimethylamine headspace analysis. Journal of Food Science, 1990. 55(5): 1228–1232.
Milo, C. and W. Grosch , Detection of odor defects in boiled cod and trout by gas chromatography-olfactometry of headspace samples. Journal of Agricultural and Food Chemistry, 1995. 43(2): 459–462.
Whitfield, F.B. , Biological origins of off-flavours in fish and crustaceans. Water Science and Technology, 1999. 40(6): 265–272.
Whitfield, F.B. , et al ., Distribution of bromophenols in Australian wild-harvested and cultivated prawns (shrimp). Journal of Agricultural and Food Chemistry, 1997. 45(11): 4398–4405.
Sérot, T. , et al ., Effect of dietary lipid sources on odour-active compounds in muscle of turbot (*Psetta maxima*). Journal of the Science of Food and Agriculture, 2001. 81(14): 1339–1346.
Sérot, T. , C. Regost , and J. Arzel , Identification of odour-active compounds in muscle of brown trout (*Salmo trutta*) as affected by dietary lipid sources. Journal of the Science of Food and Agriculture, 2002. 82(6):

636–643.
Turchini, G.M. , et al ., Effects of dietary lipid sources on flavour volatile compounds of brown trout (*Salmo trutta* L.) fillet. Journal of Applied Ichthyology, 2004. 20(1): 71–75.
Turchini, G.M. , et al ., Effects of dietary lipid source on fillet chemical composition, flavour volatile compounds and sensory characteristics in the freshwater fish tench (Tinca L.). Food Chemistry, 2007. 102(4): 1144–1155.
Runge, G. , et al ., Amounts of volatile sulfur-compounds in the edible part of carp (*Cyprinus carpio* L.) fed different fat and α-tocopheryl acetate dietary supplements. Agribiological Research, 1990. 43(3): 183–190.
Pennarun, A.-L. , et al ., Comparison of two microalgal diets. 2. Influence on odorant composition and organoleptic qualities of raw oysters (*Crassostrea gigas*). Journal of Agricultural and Food Chemistry, 2003. 51(7): 2011–2018.
Kim, J.-S. , W.C.J. Ma , and H.Y. Chung , Enhancement of bromophenol content in cultivated green grouper (*Epinephelus coioides*). Journal of the Fisheries Science and Technology, 2007. 10(3): 113–118.
Hirano, T. , et al ., Studies on the odor of fishes-I. Identification of volatile compounds in ayu fish and its feeds. Nippon Suisan Gakkaishi, 1992. 58(3): 547–557.
Farmer, L.J. , et al ., Flavour and off-flavour in wild and farmed Atlantic salmon from locations around Northern Ireland. Water Science and Technology, 1995. 31(11): 259–264.
Alasalvar, C. , K.D.A. Taylor , and F. Shahidi , Comparison of volatiles of cultured and wild sea bream (*Sparus aurata*) during storage in ice by dynamic headspace analysis/gas chromatography−mass spectrometry. Journal of Agricultural and Food Chemistry, 2005. 53(7): 2616–2622.
Grigorakis, K. , K.D.A. Taylor , and M.N. Alexis , Organoleptic and volatile aroma compounds comparison of wild and cultured gilthead sea bream (*Sparus aurata*): sensory differences and possible chemical basis. Aquaculture, 2003. 225(1–4): 109–119.
Prost, C. , T. Serot , and M. Demaimay , Identification of the most potent odorants in wild and farmed cooked turbot (*Scophtalamus maximus* L.). Journal of Agricultural and Food Chemistry, 1998. 46(8): 3214–3219.
Turchini, M.G. , et al ., Discrimination of origin of farmed trout by means of biometrical parameters, fillet composition and flavor volatile compounds. Italian Journal of Animal Science, 2004. 3(2): 123–140.
Frank, D. , et al ., Investigation of sensory and volatile characteristics of farmed and wild barramundi (*Lates calcarifer*) using gas chromatography-olfactometry mass spectrometry and descriptive sensory analysis. Journal of Agricultural and Food Chemistry, 2009. 57(21): 10302–10312.
Duflos, G. , et al ., Determination of volatile compounds to characterize fish spoilage using headspace/mass spectrometry and solid-phase microextraction/gas chromatography/mass spectrometry. Journal of the Science of Food and Agriculture, 2006. 86(4): 600–611.
Olafsdottir, G. , et al ., Characterization of volatile compounds in chilled cod (*Gadus morhua*) fillets by gas chromatography and detection of quality indicators by an electronic nose. Journal of Agricultural and Food Chemistry, 2005. 53(26): 10140–10147.
Wierda, R.L. , et al ., Analysis of volatile compounds as spoilage indicators in fresh king salmon (*Oncorhynchus tshawytscha*) during storage using SPME−GC−MS. Journal of Agricultural and Food Chemistry, 2006. 54(22): 8480–8490.
Edirisinghe, R.K.B. , A.J. Graffham , and S.J. Taylor , Characterisation of the volatiles of yellowfin tuna (*Thunnus albacares*) during storage by solid phase microextraction and GC-MS and their relationship to fish quality parameters. International Journal of Food Science & Technology, 2007. 42(10): 1139–1147.
David, B.J. , C.L. Robert , and A.S. David , Identification of volatile aroma compounds from oxidized frozen whitefish (*Coregonus clupeaformis*). Canadian Institute of Food Science and Technology Journal, 1984. 17(3): 178–182.
Choi, S.H. and H. Kato , Changes in cooked odor of antarctic krill during frozen storage. Agricultural and Biological Chemistry, 1984. 48(2): 545–547.
Triqui, R. , Sensory and flavor profiles as a means of assessing freshness of hake (*Merluccius merluccius*) during ice storage. European Food Research and Technology, 2005. 222(1–2): 41–47.
Triqui, R. and N. Bouchriti , Freshness assessments of Moroccan sardine (*Sardina pilchardus*): comparison of overall sensory changes to instrumentally determined volatiles. Journal of Agricultural and Food Chemistry, 2003. 51(26): 7540–7546.
Ganeko, N. , et al ., Analysis of volatile flavor compounds of sardine (*Sardinops melanostica*) by solid phase microextraction. Journal of Food Science, 2007. 73(1): S83–S88.
Prost, C. , et al ., Effect of storage time on raw sardine (*Sardina pilchardus*) flavor and aroma quality. Journal of Food Science, 2006. 69(5): S198–S204.
Alasalvar, C. , Quantick, P. C. , & Grigor, J. M. (1997). Aroma compounds of fresh and stored mackerel (*Scomber scombrus*). In F. Shahidi & K. R. Cadwallader (Eds.), Flavor and Lipid Chemistry of Seafoods (pp. 39–54). Washington, DC: American Chemical Society.
Frankel, E.N. , Formation of headspace volatiles by thermal decomposition of oxidized fish oils vs. oxidized vegetable oils. Journal of the American Oil Chemists' Society, 1993. 70(8): 767–772.
Girard, B. and S. Nakai , Static headspace gas chromatographic method for volatiles in canned salmon. Journal of Food Science, 1991. 56(5): 1271–1274.
Girard, B. and S. Nakai , Grade classification of canned pink salmon with static headspace volatile patterns. Journal of Food Science, 1994. 59(3): 507–512.

Girard, B. and T. Durance , Headspace volatiles of sockeye and pink salmon as affected by retort process. Journal of Food Science, 2000. 65(1): 34–39.
Khayat, A. , Hydrogen sulfide production by heating tuna meat. Journal of Food Science, 1977. 42(3): 601–609.
Lerke, P.A. and R.W. Huck , Objective determination of canned tuna quality: identification of ethanol as a potentially useful index. Journal of Food Science, 1977. 42(3): 755–758.
De Quirós, A.R.-B. , et al ., Comparison of volatile components in fresh and canned sea urchin (*Paracentrotus lividus*, Lamarck) gonads by GC-MS using dynamic headspace sampling and microwave desorption. European Food Research and Technology, 2001. 212(6): 643–647.
Oliveira, A.C.M. , et al ., Headspace gas chromatography-mass spectrometry and electronic nose analysis of volatile compounds in canned Alaska pink salmon having various grades of watermarking. Journal of Food Science, 2005. 70(7): s419–s426.
Przybylski, R. , N.A.M. Eskin , and L.J. Malcolmson , Development of a gas chromatographic system for trapping and analyzing volatiles from canned tuna. Canadian Institute of Food Science and Technology Journal, 1991. 24(3–4): 129–135.
Cardinal, M. , et al ., Effects of the smoking process on odour characteristics of smoked herring (*Clupea harengus*) and relationships with phenolic compound content. Food Chemistry, 2006. 96(1): 137–146.
Cardinal, M. , et al ., Effect of various smoking techniques on the nature of volatile compounds and on the sensory characteristics of salmon meat. Sciences des Aliments, 1997. 17(6): 679–696.
Guillén, M.D. and M.C. Errecalde , Volatile components of raw and smoked black bream (*Brama rai*) and rainbow trout (*Oncorhynchus mykiss*) studied by means of solid phase microextraction and gas chromatography/mass spectrometry. Journal of the Science of Food and Agriculture, 2002. 82(9): 945–952.
Guillén, M.D. , et al ., Headspace volatile components of smoked swordfish (*Xiphias gladius*) and cod (*Gadus morhua*) detected by means of solid phase microextraction and gas chromatography-mass spectrometry. Food Chemistry, 2006. 94(1): 151–156.
Ishiguro, K. , H. Wakabayashi , and H. Kawaguchi , Changes in volatile compounds during smoking process and evaluation of major aroma constituents of dried bonito (Katuo-Bushi). Nippon Shokuhin Kagaku Kogaku Kaishi, 2001. 48(8): 570–577.
Sakakibara, H. , et al ., Volatile flavor compounds of some kinds of dried and smoked fish. Agricultural and Biological Chemistry, 1990. 54(1): 9–16.
Sérot, T. , et al ., Effect of smoking processes on the contents of 10 major phenolic compounds in smoked fillets of herring (Cuplea harengus). Food Chemistry, 2004. 85(1): 111–120.
Varlet, V. , et al ., Olfactometric determination of the most potent odor-active compounds in salmon muscle (*Salmo salar*) smoked by using four smoke generation techniques. Journal of Agricultural and Food Chemistry, 2007. 55(11): 4518–4525.
Varlet, V. , C. Prost , and T. Serot , New procedure for the study of odour representativeness of aromatic extracts from smoked salmon. Food Chemistry, 2007. 100(2): 820–829.
Varlet, V. , C. Prost , and T. Serot , Volatile aldehydes in smoked fish: analysis methods, occurence and mechanisms of formation. Food Chemistry, 2007. 105(4): 1536–1556.
Varlet, V. , et al ., Comparison of odor-active volatile compounds of fresh and smoked salmon. Journal of Agricultural and Food Chemistry, 2006. 54(9): 3391–3401.
Chung, H.Y. , et al ., Static headspace analysis-olfactometry (SHA-O) of odor impact components in salted-dried white herring (*Ilisha elongata*). Food Chemistry, 2007. 104(2): 842–851.
Jonsdottir, R. , et al ., Flavor and quality characteristics of salted and desalted cod (*Gadus morhua*) produced by different salting methods. Journal of Agricultural and Food Chemistry, 2011. 59(8): 3893–3904.
Cha, Y.J. and K.R. Cadwallader , Volatile components in salt-fermented fish and shrimp pastes. Journal of Food Science, 1995. 60(1): 19–24.
Cha, Y.J. , G.H. Lee , and K.R. Cadwallader , Aroma-Active Compounds in Salt-Fermented Anchovy, In Flavor and Lipid Chemistry of Seafoods, F. Shahidi & K. R. Cadwallader (eds.), 1997, American Chemical Society: Washington, DC. pp. 131–147.
Choi, S.H. and H. Kato , Odor of fermented small shrimp. Part V. Volatile components of *Sergia lucens* and its fermented product. Agricultural and Biological Chemistry, 1984. 48(6): 1479–1486.
Choi, S.H. and A. Kobayashi , Odor of fermented small shrimp. Part II. Cooked odor of commercial shiokara made from mysid shrimps, *Acetes japonicus* Kishinouye: difference between raw material and fermented product. Journal of Japanese Society of Food Science and Technology, 1983. 30(7): 404–408.
Choi, S.H. , A. Kobayashi , and T. Yamanishi , Odor of fermented small shrimp. Part I. Odor of cooked small shrimp, *Acetes japonicus* Kishinouye: difference between raw material and fermented product. Agricultural and Biological Chemistry, 1983. 47(2): 337–342.
He, C.S. and H. Kato , Odor of fermented small shrimp. Part VI. Flavor of fermented product of Antarctic krill prepared by modified method. Nippon Shokuhin Kogyo Gakkaishi, 1985. 32(4): 274–280.
Nordvi, B. , et al ., Characterization of volatile compounds in a fermented and dried fish product during cold storage. Journal of Food Science, 2007. 72(6): S373–S380.
Anihouvi, V.B. , et al ., Biochemical changes and aroma development during the spontaneous fermentation of cassava fish into Lanhouin and their influence on product acceptability. Journal of Aquatic Food Product Technology, 2009. 18(4): 370–384.

Chung, H.Y. , et al ., Analysis of volatile components in frozen and dried scallops (*Patinopecten yessoensis*) by gas chromatography/mass spectrometry. Food Research International, 2002. 35(1): 43–53.
Josephson, D.B. , R.C. Lindsay , and D.A. Stuiber , Influence of processing on the volatile compounds characterizing the flavor of pickled fish. Journal of Food Science, 1987. 52(1): 10–14.
Sharma, S.K. , S. Basu , and A.S. Gholap , Effect of irradiation on the volatile compounds of shrimp (Solenocera choprii). Journal of Food Science and Technology -Mysore-, 2007. 44(3): 267–271.
Guo, H. , et al ., Effects of electron-beam irradiation on volatile flavor compounds of salmon fillets by the molecular sensory science technique. Journal of Food Science, 2021. 86(1): 184–193.
Lopetcharat, K. , et al ., Fish sauce products and manufacturing: a review. Food Reviews International, 2001. 17(1): 65–88.
Fukami, K. , et al ., Identification of distinctive volatile compounds in fish sauce. Journal of Agricultural and Food Chemistry, 2002. 50(19): 5412–5416.
McIver, R.C. , R.I. Brooks , and G.A. Reineccius , Flavor of fermented fish sauce. Journal of Agricultural and Food Chemistry, 1982. 30(6): 1017–1020.
Peralta, R.R. , M. Shimoda , and Y. Osajima , Further identification of volatile compounds in fish sauce. Journal of Agricultural and Food Chemistry, 1996. 44(11): 3606–3610.
Shimoda, M. , R.R. Peralta , and Y. Osajima , Headspace gas analysis of fish sauce. Journal of Agricultural and Food Chemistry, 1996. 44(11): 3601–3605.
Michihata, T. , T. Yano , and T. Enomoto , Volatile compounds of headspace gas in the Japanese fish sauce ishiru. Bioscience, Biotechnology, and Biochemistry, 2002. 66(10): 2251–2255.
Cha, Y.-J. , H.-H. Baek , and T.C.Y. Hsieh , Volatile components in flavour concentrates from crayfish processing waste. Journal of the Science of Food and Agriculture, 1992. 58(2): 239–248.
Cha, Y.J. , K.R. Cadwallader , and H.H. Baek , Volatile flavor components in snow crab cooker effluent and effluent concentrate. Journal of Food Science, 1993. 58(3): 525–530.
Tanchotikul, U. and T.C.Y. Hsieh , Volatile flavor components in crayfish waste. Journal of Food Science, 1989. 54(6): 1515–1520.
Elmore, J.S. , Aroma, In Handbook of Muscle Foods Analysis, Leo M.L. Nollet , Fidel Toldrà (eds.), 2008., CRC Press: Boca Raton. pp. 241–262.
Elmore, J.S. , Extraction Techniques for Analysis of Aroma Compounds, In Flavour Development, Analysis and Perception in Food and Beverages, J.K. Parker , J.S. Elmore , and L. Methven , Editors. 2015, Woodhead Publishing. Cambridge. pp. 31–46.
Aro, T. , et al ., Determination of semivolatile compounds in Baltic herring (*Clupea harengus membras*) by supercritical fluid extraction−supercritical fluid chromatography−gas chromatography−mass spectrometry. Journal of Agricultural and Food Chemistry, 2002. 50(7): 1970–1975.
Amitsuka, T. , et al ., The contribution of aromatic components in Katsuobushi to preference formation and reinforcement effect. Bioscience, Biotechnology, and Biochemistry, 2017. 81(8): 1561–1568.
Roh, H.-S. , et al ., Isolation of off-flavors and odors from tuna fish oil using supercritical carbon dioxide. Biotechnology and Bioprocess Engineering, 2006. 11(6): 496–502.
Weurman, C. , P.J. Groenen , and L.J. van Gemert , Experiments on “high-vacuum transfer” in food odour research. Food/Nahrung, 1970. 14(7): 607–616.
Kubota, K. , et al ., Odor of antarctic krills. Part I. Cooked odor of Antarctic krills. Nippon Nōgeikagaku Kaishi, 1980. 54(1): 1–5.
Shen, C. , J. Xie , and X. Xu , The components of cuttlefish (*Sepiella maindroni* de Rochebrune) oil. Food Chemistry, 2007. 102(1): 210–214.
Triqui, R. and G.A. Reineccius , Flavor development in the ripening of anchovy (*Engraulis encrasicholus* L.). Journal of Agricultural and Food Chemistry, 1995. 43(2): 453–458.
Triqui, R. and G.A. Reineccius , Changes in flavor profiles with ripening of anchovy (*Engraulis encrasicholus*). Journal of Agricultural and Food Chemistry, 1995. 43(7): 1883–1889.
Pennarun, A.-L. , C. Prost , and M. Demaimay , Identification and origin of the character-impact compounds of raw oyster *Crassostrea gigas* . Journal of the Science of Food and Agriculture, 2002. 82(14): 1652–1660.
Pennarun, A.-L. , C. Prost , and M. Demaimay , Aroma extracts from oyster *Crassostrea gigas*: comparison of two extraction methods. Journal of Agricultural and Food Chemistry, 2002. 50(2): 299–304.
Selli, S. , et al ., Characterization of aroma-active compounds in rainbow trout (*Oncorhynchus mykiss*) eliciting an off-odor. Journal of Agricultural and Food Chemistry, 2006. 54(25): 9496–9502.
Le Guen, S. , C. Prost , and M. Demaimay , Characterization of odorant compounds of mussels (*Mytilus edulis*) according to their origin using gas chromatography-olfactometry and gas chromatography-mass spectrometry. Journal of Chromatography A, 2000. 896(1–2): 361–371.
Le Guen, S. , C. Prost , and M. Demaimay , Evaluation of the representativeness of the odor of cooked mussel extracts and the relationship between sensory descriptors and potent odorants. Journal of Agricultural and Food Chemistry, 2001. 49(3): 1321–1327.
Likens, S.T. and G.B. Nickerson , Detection of certain hop oil constituents in brewing products. Proceedings. Annual Meeting - American Society of Brewing Chemists, 1964. 22(1): 5–13.

Runge, G. and H. Steinhart , Determination of volatile sulfur compounds in the edible part of carp. Agribiological Research, 1990. 43: 155–163.

Kubota, K. , A. Kobayashi , and T. Yamanishi , Some sulfur containing compounds in cooked odor concentrate from boiled Antarctic krills (*Euphausia superba Dana*). Agricultural and Biological Chemistry, 1980. 44(11): 2677–2682.

Kubota, K. , A. Kobayashi , and T. Yamanishi , Cooked odor of Antarctic krills. Part VI. Basic and neutral compounds in the cooked odor from Antarctic krill. Agricultural and Biological Chemistry, 1982. 46(11): 2835–2839.

Tanchotikul, U. and T.C.Y. Hsieh , Analysis of volatile flavor components in steamed rangia clam by dynamic headspace sampling and simultaneous distillation and extraction. Journal of Food Science, 1991. 56(2): 327–331.

Chen, D. and M. Zhang , Analysis of volatile compounds in Chinese mitten crab (Eriocheir sinensis). Journal of Food and Drug Analysis, 2006. 14(3): 297–303.

Zhang, H.-Z. and T.-C. Lee , Gas Chromatography-Mass Spectrometry Analysis of Volatile Flavor Compounds in Mackerel for Assessment of Fish Quality, In Flavor and Lipid Chemistry of Seafoods, F. Shahidi and K. R. Cadwallader (Eds.), 1997, American Chemical Society: Washington, DC. pp. 55–63.

Chung, H.Y. and K.R. Cadwallader , Volatile components in blue crab (*Callinectes sapidus*) meat and processing by-product. Journal of Food Science, 1993. 58(6): 1203–1207.

Chung, H.Y. , Volatile components in crabmeats of *Charybdis feriatus* . Journal of Agricultural and Food Chemistry, 1999. 47(6): 2280–2287.

Chung, H.Y. , I.K. Shing Yung , and J.-S. Kim , Comparison of volatile components in dried scallops (*Chlamys farreri* and *Patinopecten yessoensis*) prepared by boiling and steaming methods. Journal of Agricultural and Food Chemistry, 2001. 49(1): 192–202.

Morita, K. , K. Kubota , and T. Aishima , Comparing sensory and gas chromatographic profiles in aromas of boiled squid, prawn, and scallop using full factorial design. Journal of Food Science, 2002. 67(9): 3456–3462.

Morita, K. , K. Kubota , and T. Aishima , Investigating sensory characteristics and volatile components in boiled scallop aroma using chemometric techniques. Food Chemistry, 2002. 78(1): 39–45.

Le Guen, S. , C. Prost , and M. Demaimay , Critical comparison of three olfactometric methods for the identification of the most potent odorants in cooked mussels (*Mytilus edulis*). Journal of Agricultural and Food Chemistry, 2000. 48(4): 1307–1314.

Cros, S. , et al ., Desalination of mussel cooking juices by electrodialysis: effect on the aroma profile. Journal of Food Engineering, 2005. 69(4): 425–436.

Morita, K. , K. Kubota , and T. Aishima , Sensory characteristics and volatile components in aromas of boiled prawns prepared according to experimental designs. Food Research International, 2001. 34(6): 473–481.

Selli, S. and G.G. Cayhan , Analysis of volatile compounds of wild gilthead sea bream (*Sparus aurata*) by simultaneous distillation-extraction (SDE) and GC-MS. Microchemical Journal, 2009. 93(2): 232–235.

Cayhan, G.G. and S. Selli , Characterization of the key aroma compounds in cooked grey mullet (*Mugil cephalus*) by application of aroma extract dilution analysis. Journal of Agricultural and Food Chemistry, 2011. 59(2): 654–659.

Chang, Y. , H. Hou , and B. Li , Identification of volatile compounds in codfish (Gadus) by a combination of two extraction methods coupled with GC-MS analysis. Journal of Ocean University of China, 2016. 15(3): 509–514.

Huang, X.-H. , et al ., The effects of different extraction methods on the aroma fingerprint, recombination and visualization of clam soup. Food and Function, 2021. 12(4): 1626–1638.

Morita, K. , K. Kubota , and T. Aishima , Comparison of aroma characteristics of 16 fish species by sensory evaluation and gas chromatographic analysis. Journal of the Science of Food and Agriculture, 2003. 83(4): 289–297.

Whitfield, F.B. , et al ., Distribution of bromophenols in species of marine polychaetes and bryozoans from eastern Australia and the role of such animals in the flavor of edible ocean fish and prawns (shrimp). Journal of Agricultural and Food Chemistry, 1999. 47(11): 4756–4762.

Chung, H.Y. , W.C. Joyce Ma , and J.-S. Kim , Seasonal distribution of bromophenols in selected Hong Kong seafood. Journal of Agricultural and Food Chemistry, 2003. 51(23): 6752–6760.

Boyle, J.L. , R.C. Lindsay , and D.A. Stuiber , Bromophenol distribution in salmon and selected seafoods of fresh- and saltwater origin. Journal of Food Science, 1992. 57(4): 918–922.

Ma, W.C.J. , et al ., Enhancement of bromophenol levels in aquacultured silver seabream (*Sparus sarba*). Journal of Agricultural and Food Chemistry, 2005. 53(6): 2133–2139.

da Silva, V. , et al ., Determination of simple bromophenols in marine fishes by reverse-phase high performance liquid chromatography (RP-HPLC). Talanta, 2005. 68(2): 323–328.

Mall, V. and P. Schieberle , Characterization of key aroma compounds in raw and thermally processed prawns and thermally processed lobsters by application of aroma extract dilution analysis. Journal of Agricultural and Food Chemistry, 2016. 64(33): 6433–6442.

Chaintreau, A. , Simultaneous distillation-extraction: from birth to maturity. Review. Flavour and Fragrance Journal, 2001. 16(2): 136–148.

Acree, T.E. , Bioassays for Flavour, In Flavor Science: Sensible Principles and Techniques, T.E. Acree and R. Teranishi , Editors. 1993, American Chemical Society: Washington, DC. pp. 1–6.

Kubota, K. , et al ., Identification and Formation of Characteristic Volatile Compounds from Cooked Shrimp, In Thermal Generation of Aromas, T.H. Parliament , R.J. McGorrin , and C.-T. Ho , Editors. 1989, American Chemical Society: Washington, DC. pp. 376–385.
Elmore, J.S. , D.S. Mottram , and A.T. Dodson , Meat Aroma Analysis: Problems and Solutions, In Handbook of Flavor Characterization: Sensory Analysis, Chemistry, and Physiology. Deibler, K.D. and Delwiche, J. (eds.), 2004, Marcel Dekker, Inc.: New York. pp. 295–311.
Lee, G.H. , O. Suriyaphan , and K.R. Cadwallader , Aroma components of cooked tail meat of American lobster (*Homarus americanus*). Journal of Agricultural and Food Chemistry, 2001. 49(9): 4324–4332.
Cha, Y.J. and K.R. Cadwallader , Aroma-active compounds in skipjack tuna sauce. Journal of Agricultural and Food Chemistry, 1998. 46(3): 1123–1128.
Triqui, R. and H. Guth , Determination of Potent Odorants in Ripened Anchovy (Engraulis encrasicholus L.) by Aroma Extract Dilution Analysis and by Gas Chromatography-Olfactometry of Headspace Samples, In Flavor and Lipid Chemistry of Seafoods, F. Shahidi & K. R. Cadwallader (Eds.), 1997, American Chemical Society, Washington, DC. pp. 31–38.
Triqui, R. and K. Zouine , Sensory and instrumental assessments of the ripening process of anchovy (*Engraulis encrasicholus*). LWT - Food Science and Technology, 1999. 32(4): 203–207.
Schlüter, S. , et al ., Changes in the odorants of boiled carp fillet (*Cyprinus carpio* L.) as affected by increasing methionine levels in feed. Journal of Agricultural and Food Chemistry, 1999. 47(12): 5146–5150.
Engel, W. , W. Bahr , and P. Schieberle , Solvent assisted flavour evaporation - a new and versatile technique for the careful and direct isolation of aroma compounds from complex food matrices. European Food Research and Technology, 1999. 209(3–4): 237–241.
Salum, P. , G. Guclu , and S. Selli , Comparative evaluation of key aroma-active compounds in raw and cooked red mullet (*Mullus barbatus*) by aroma extract dilution analysis. Journal of Agricultural and Food Chemistry, 2017. 65(38): 8402–8408.
Zhang, Y. , et al ., Comparison of different volatile extraction methods for the identification of fishy off-odor in fish by-products. Molecules, 2022. 27(19): 6177.
Girard, B. and S. Nakai , Nonparametric discriminant analysis of static headspace volatiles for grading fresh pacific salmon. Journal of Food Quality, 1994. 17(5): 409–421.
Medina, I. , M.T. Satué-Gracia , and E.N. Frankel , Static headspace gas chromatographic analyses to determine oxidation of fish muscle lipids during thermal processing. Journal of the American Oil Chemists' Society, 1999. 76(2): 231–236.
Joaquin, H.J.F. , et al ., Effect of milk protein concentrate on lipid oxidation and formation of fishy volatiles in herring mince (*Clupea harengus*) during frozen storage. Journal of Agricultural and Food Chemistry, 2008. 56(1): 166–172.
Hollingworth, T.A. , H.R. Throm , and M.M. Wekell , Determination of Ethanol in Canned Salmon, In Seafood Quality Determination, D.E. Kramer and J. Liston , Editors. 1986, Elsevier: Amsterdam. pp. 153–160.
Chantarachoti, J. , et al ., Alaska pink salmon (*Oncorhynchus gorbuscha*) spoilage and ethanol incidence in the canned product. Journal of Agricultural and Food Chemistry, 2007. 55(7): 2517–2525.
McLachlan, D.G. , P.D. Wheeler , and G.G. Sims , Automated gas chromatographic method for the determination of ethanol in canned salmon. Journal of Agricultural and Food Chemistry, 1998. 47(1): 217–220.
Lindsay, R.C. , D.B. Josephson , and G. Olafsdottir , Chemical and Biochemical Indices for Assessing the Quality of Fish Packaged in Controlled Atmospheres, In Seafood Quality Determination, D.E. Kramer and J. Liston , Editors. 1987, Elsevier: Amsterdam. p. 221.
Yasuhara, A. and T. Shibamoto , Quantitative analysis of volatile aldehydes formed from various kinds of fish flesh during heat treatment. Journal of Agricultural and Food Chemistry, 1995. 43(1): 94–97.
Kolb, B. and L.S. Ettre , Static Headspace-Gas Chromatography: Theory and Practice. 2nd ed. 2006. Wiley, John Wiley & Sons: Hoboken, NJ.
Wang, Y. , et al ., Microbial volatile organic compounds and their application in microorganism identification in foodstuff. Trends in Analytical Chemistry, 2016, 78(1), 1–16.
Matiella, J.E. and T.C.Y. Hsieh , Analysis of crabmeat volatile compounds. Journal of Food Science, 1990. 55(4): 962–966.
Zhang, C.-H. , et al ., Studies on the odor of fishes. III. Volatile compounds and their generation in smelt. Nippon Suisan Gakkaishi, 1992. 58(4): 773–779.
Kawai, T. , et al ., Flavor components of dried squid. Journal of Agricultural and Food Chemistry, 1991. 39(4): 770–777.
Josephson, D.B. , R.C. Lindsay , and D.A. Stuiber , Identification of compounds characterizing the aroma of fresh whitefish (*Coregonus clupeaformis*). Journal of Agricultural and Food Chemistry, 1983. 31(2): 326–330.
Josephson, D.B. , R.C. Lindsay , and D.A. Stuiber , Variations in the occurrences of enzymically derived volatile aroma compounds in salt- and freshwater fish. Journal of Agricultural and Food Chemistry, 1984. 32(6): 1344–1347.
Josephson, D.B. , R.C. Lindsay , and D.A. Stuiber , Influence of maturity on the volatile aroma compounds from fresh Pacific and Great Lakes salmon. Journal of Food Science, 1991. 56(6): 1576–1576.
Josephson, D.B. , R.C. Lindsay , and D.A. Stuiber , Volatile compounds characterizing the aroma of fresh Atlantic and Pacific oysters. Journal of Food Science, 1985. 50(1): 5–9.

Ishizaki, S. , et al ., Evaluation of odour-active compounds in roasted shrimp (*Sergia lucens* Hansen) by aroma extract dilution analysis. Flavour and Fragrance Journal, 2005. 20(6): 562–566.
Hallier, A. , C. Prost , and T. Serot , Influence of rearing conditions on the volatile compounds of cooked fillets of *Silurus glanis* (European Catfish). Journal of Agricultural and Food Chemistry, 2005. 53(18): 7204–7211.
Hallier, A. , T. Serot , and C. Prost , Odour of cooked silurus (*Silurus glanis*) flesh: evaluation by sensory analysis and comparison of collection methods to assess the odour representativeness of extracts obtained by dynamic headspace. Journal of the Science of Food and Agriculture, 2004. 84(15): 2113–2122.
Hallier, A. , et al ., New gas chromatography-olfactometric investigative method, and its application to cooked *Silurus glanis* (European catfish) odor characterization. Journal of Chromatography A, 2004. 1056(1–2): 201–208.
Aro, T. , et al ., Volatile compounds of Baltic herring analysed by dynamic headspace sampling-gas chromatography-mass spectrometry. European Food Research and Technology, 2003. 216(6): 483–488.
Piveteau, F. , et al ., Aroma of fresh oysters *Crassostrea gigas*: composition and aroma notes. Journal of Agricultural and Food Chemistry, 2000. 48(10): 4851–4857.
Hsieh, T.C.Y. , et al ., Volatile Flavor Components in Thermally Processed Louisiana Red Swamp Crayfish and Blue Crab, In Thermal Generation of Aromas, T.H. Parliment , R.J. McGorrin , and C.-T. Ho , Editors. 1989, American Chemical Society: Washington, D.C. pp. 386–395.
Vejaphan, W. , T.C.Y. Hsieh , and S.S. Williams , Volatile flavor components from boiled crayfish (Procambarus clarkii) tail meat. Journal of Food Science, 1988. 53(6): 1666–1670.
Wichaphon, J. , et al ., Volatile aroma components of Thai fish sauce in relation to product categorization. Flavour and Fragrance Journal, 2012. 27(2): 149–156.
Jørgensen, L.V. , H.H. Huss , and P. Dalgaard , Significance of volatile compounds produced by spoilage bacteria in vacuum-packed cold-smoked salmon (*Salmo salar*) analyzed by GC-MS and multivariate regression. Journal of Agricultural and Food Chemistry, 2001. 49(5): 2376–2381.
Refsgaard, H.H.F. , A.-M. Haahr , and B. Jensen , Isolation and quantification of volatiles in fish by dynamic headspace sampling and mass spectrometry. Journal of Agricultural and Food Chemistry, 1999. 47(3): 1114–1118.
Methven, L. , et al ., Influence of sulfur amino acids on the volatile and nonvolatile components of cooked salmon (*Salmo salar*). Journal of Agricultural and Food Chemistry, 2007. 55(4): 1427–1436.
Jonsdottir, R. , et al ., Volatile compounds suitable for rapid detection as quality indicators of cold smoked salmon (*Salmo salar*). Food Chemistry, 2008. 109(1): 184–195.
Jonsdottir, R. , et al ., Flavor characterization of ripened cod roe by gas chromatography, sensory analysis, and electronic nose. Journal of Agricultural and Food Chemistry, 2004. 52(20): 6250–6256.
Giri, A. , et al ., Headspace volatiles along with other instrumental and sensory analyses as indices of maturation of horse mackerel miso. Journal of Food Science, 2010. 75(8): S406.
Andersen, E. , M.L. Andersen , and C.P. Baron , Characterization of oxidative changes in salted herring (*Clupea harengus*) during ripening. Journal of Agricultural and Food Chemistry, 2007. 55(23): 9545–9553.
Aidos, I. , et al ., Volatile oxidation products formed in crude herring oil under accelerated oxidative conditions. European Journal of Lipid Science and Technology, 2002. 104(12): 808–818.
Zhang, Z. and J. Pawliszyn , Headspace solid-phase microextraction. Analytical Chemistry, 1993. 65(14): 1843–1852.
Kataoka, H. , Recent advances in solid-phase microextraction and related techniques for pharmaceutical and biomedical analysis. Current Pharmaceutical Analysis, 2005. 1(1): 65–84.
Pawliszyn, J. , Handbook of Solid Phase Microextraction. 2009. Chemical Industry Press, Beijing.
Linder, M. and R.G. Ackman , Volatile compounds recovered by solid-phase microextraction from fresh adductor muscle and total lipids of sea scallop (*Placopecten magellanicus*) from Georges Bank (Nova Scotia). Journal of Food Science, 2002. 67(6): 2032–2037.
Song, X. , et al ., Volatile Compounds in the Hepatic and Muscular Tissues of Common Carp, Japanese Flounder, Spanish Mackerel and Skipjack, In Developments in Food Science, M. Sakaguchi , Editor. 2004, Elsevier B.V., Amsterdam pp. 209–222.
Wei, H. , et al ., Comparison of potent odorants in raw and cooked mildly salted large yellow croaker using odor-active value calculation and omission test: understanding the role of cooking method. Food Chemistry, 2023. 402: 134015.
Li, D. , et al ., Influence of heat processing on the volatile organic compounds and microbial diversity of salted and vacuum-packaged silver carp (*Hypophthalmichthys molitrix*) fillets during storage. Food Microbiology, 2018. 72: 73–81.
Hu, M. , et al ., Flavor profile of dried shrimp at different processing stages. LWT-Food Science & Technology, 2021. 146: 111403.
Chen, Q. , et al ., Characterization of the effect of different sugar on volatile flavor compounds of dried fish floss using e-nose combined with HS-SPME/GC-MS. Journal of Food Processing and Preservation, 2022. 46(5): e16567.
Wang, Y. , et al ., Novel insight into the formation mechanism of volatile flavor in Chinese fish sauce (Yu-lu) based on molecular sensory and metagenomics analyses. Food Chemistry, 2020. 323: 126839.

Gao, R. , et al ., Optimization of removal of off-odor in mullet (*Channa Argus*) head soup by yeast using response surface methodology and variations of volatile components during fermentation. Journal of Food Processing and Preservation, 2021. 45(11): e15920.
Zhou, Y. , et al ., Effect of lactic acid bacteria on mackerel (*Pneumatophorus japonicus*) seasoning quality and flavor during fermentation. Food Bioscience, 2021. 41: 100971.
Gao, P. , et al ., Aroma profiles of commercial Chinese traditional fermented fish (Suan yu) in Western Hunan: GC-MS, odor activity value and sensory evaluation by partial least squares regression. International Journal of Food Properties, 2020. 23(1): 213–226.
Gao, P. , et al ., Effects of three carp species on texture, color, and aroma properties of Suan yu, a Chinese traditional fermented fish. Journal of Food Processing and Preservation, 2020. 44(4): e14403.
Zang, J. , et al ., Correlations between microbiota succession and flavor formation during fermentation of Chinese low-salt fermented common carp (Cyprinus carpio L.) inoculated with mixed starter cultures. Food Microbiology, 2020. 90: 103487.
Yu, D. , et al ., The effects of edible chitosan-based coatings on flavor quality of raw grass carp (Ctenopharyngodon idellus) fillets during refrigerated storage. Food Chemistry, 2018. 242: 412–420.
Zhang, J.-J. , X.-C. Wang , and W.-Z. Shi , Odor characteristics of white croaker and small yellow croaker fish during refrigerated storage. Journal of Food Biochemistry, 2019. 43(10): e12852.
Cao, J.-X. , et al ., The effect of oxidation on the structure of G-actin and its binding ability with aroma compounds in carp grass skeletal muscle. Food Chemistry, 2018. 240: 346–353.
Zhang, M. , M. Chen , and S. Xing , Characterization of the key odorants of crucian carp soup and flavour improvement by modulated temperature mode in electrical stewpot. Flavour and Fragrance Journal, 2021. 36(6): 637–651.
Tanimoto, S. , et al ., Qualitative changes in each part of yellowtail *Seriola quinqueradiata* flesh during cold storage. Fisheries Science (Tokyo, Japan), 2018. 84(1): 135–148.
Kitabayashi, K. , et al ., Effect of nitrogen gas packaging on odor development in yellowtail *Seriola quinqueradiata* muscle during ice storage. Fisheries Science (Tokyo, Japan), 2019. 85(1): 247–257.
Wu, N. , et al ., Effects of dietary replacement of fish oil by vegetable oil on proximate composition and odor profile of hepatopancreas and gonad of Chinese mitten crab (*Eriocheir sinensis*). Journal of Food Biochemistry, 2019. 43(10): e12646.
Mansur, M.A. , et al ., Volatile flavor compounds of some sea fish and prawn species. Fisheries Science, 2003. 69(4): 864–866.
Mentana, A. , et al ., Investigating the effects of mild preservation technology on perishable foods by volatolomics: the case study of ready-to-cook tuna-burgers. LWT-Food Science and Technology, 2019. 115: 108425.
Maqsood, S. and S. Benjakul , Effect of bleeding on lipid oxidation and quality changes of Asian seabass (Lates calcarifer) muscle during iced storage. Food Chemistry, 2010. 124(2): 459–467.
Pham, A.J. , et al ., Characterization of fish sauce aroma-impact compounds using GC-MS, SPME-Osme-GCO, and Stevens' Power Law exponents. Journal of Food Science, 2008. 73(4): C268.
Russo, G.L. , et al ., Volatile compounds, physicochemical and sensory characteristics of Colatura di Alici, a traditional Italian fish sauce. Journal of the Science of Food and Agriculture, 2020. 100(9): 3755–3764.
Belleggia, L. , et al ., Discovering microbiota and volatile compounds of surstromming, the traditional Swedish sour herring. Food Microbiology, 2020. 91: 103503.
Liu, H.-J. and M. Fang , Characterization of aroma active volatile components in roasted mullet roe. Food Chemistry, 2022. 385: 132736.
Yang, J. , et al ., Characterization of flavor active volatile and non-volatile compounds in the Chinese dry-cured red drum (Sciaenops ocellatus). Journal of Aquatic Food Product Technology, 2022. 31(2): 200–213.
Ding, A. , et al ., Effect of fatty acids on the flavor formation of fish sauce. LWT-Food Science and Technology, 2020. 134: 110259.
Yang, Z. , et al ., Microbial succession and the changes of flavor and aroma in Chouguiyu, a traditional Chinese fermented fish. Food Bioscience, 2020. 37: 100725.
Chen, Z. , et al ., A comparative study of volatile flavor components in four types of zaoyu using comprehensive two-dimensional gas chromatography in combination with time-of-flight mass spectrometry. Journal of Food Processing and Preservation, 2021. 45(3): e15230.
Wang, Q. , J. O'Reilly , and J. Pawliszyn , Determination of low-molecular mass aldehydes by automated headspace solid-phase microextraction with in-fibre derivatisation. Journal of Chromatography A, 2005. 1071(1–2): 147–154.
Bianchi, F. , et al ., Fish and food safety: determination of formaldehyde in 12 fish species by SPME extraction and GC-MS analysis. Food Chemistry, 2007. 100(3): 1049–1053.
Baltussen, E. , et al ., Stir bar sorptive extraction (SBSE), a novel extraction technique for aqueous samples: theory and principles. Journal of Microcolumn Separations, 1999. 11(10): 737–747.
Bicchi, C. , et al ., Stir bar sorptive extraction (SBSE) and headspace sorptive extraction (HSSE): an overview. LCGC North America, 2009. 27(5): 376–390.

Zhou, X. , et al ., Determination of the effects of different washing processes on aroma characteristics in silver carp mince by MMSE-GC-MS, e-nose and sensory evaluation. Food Chemistry, 2016. 207: 205–213.
Wu, N. and X.-C. Wang , Comparison of gender differences in nutritional value and key odor profile of hepatopancreas of Chinese mitten crab (*Eriocheir Sinensis*). Journal of Food Science, 2017. 82(2): 536–544.
Lu, Q. , F. Liu , and J. Bao , Volatile components of American silver carp analyzed by electronic nose and MMSE-GC-MS-O. Journal of Food Biochemistry, 2019. 43(11): e13006.
Wang, H. , et al ., Volatile components present in different parts of grass carp. Journal of Food Biochemistry, 2018. 42(6): 12668.
Yimdee, T. and X.-C. Wang , Comparison of odor and taste of commercial brand fish sauces from east and southeast Asian countries. International Journal of Food Properties, 2016. 19(4): 873–896.
Bai, J. , et al ., Aroma profile characterization of mahi-mahi and tuna for determining spoilage using purge and trap gas chromatography-mass spectrometry. Journal of Food Science, 2019. 84(3): 481–489.
Chan, S.T. , et al ., Evaluation of chemical indicators for monitoring freshness of food and determination of volatile amines in fish by headspace solid-phase microextraction and gas chromatography-mass spectrometry. European Food Research and Technology, 2006. 224(1): 67–74.
Li, X. , et al ., Novel fiber coated with amide bridged-calix[4]arene used for solid-phase microextraction of aliphatic amines. Journal of Chromatography A, 2004. 1041(1–2): 1–9.
Howgate, P. , Tainting of farmed fish by geosmin and 2-methyl-iso-borneol: a review of sensory aspects and of uptake/depuration. Aquaculture, 2004. 234(1–4): 155–181.
Heil, T. and R. Lindsay , A method for quantitative analysis of flavor-tainting alkylphenols and aromatic thiols in fish. Journal of Environmental Science and Health, Part B, 1988. 23(5): 475–488.
Robin, J. , et al ., Off flavor characterization and origin in French trout farming. Aquaculture, 2006. 260(1–4): 128–138.
Schrader, K.K. , et al ., Geosmin and 2methylisoborneol cause offflavors in cultured largemouth bass and white sturgeon reared in recirculatingwater systems. North American Journal of Aquaculture, 2005. 67(3): 177–180.
Petersen, M.A. , et al ., Chemical and sensory quantification of geosmin and 2-methylisoborneol in rainbow trout (*Oncorhynchus mykiss*) from recirculated aquacultures in relation to concentrations in basin water. Journal of Agricultural and Food Chemistry, 2011. 59(23): 12561–12568.
Deng, X. , et al ., Microwave-assisted purge-and-trap extraction device coupled with gas chromatography and mass spectrometry for the determination of five predominant odors in sediment, fish tissues, and algal cells. Journal of Chromatography A, 2012. 1219: 75–82.
Grimm, C.C. , et al ., Using microwave distillation-solid-phase microextraction--gas chromatography--mass spectrometry for analyzing fish tissue. Journal of Chromatographic Science, 2000. 38(7): 289–296.
Conte, E.D. , et al ., Determination of geosmin and methylisoborneol in catfish tissue (*Ictalurus punctatus*) by microwave-assisted distillation−solid phase adsorbent trapping. Journal of Agricultural and Food Chemistry, 1996. 44(3): 829–835.
Johnsen, P.B. and S.W. Lloyd , Influence of fat content on uptake and depuration of the off-flavor 2-methylisoborneol by channel catfish (*Ictalurus punctatus*). Canadian Journal of Fisheries and Aquatic Sciences, 1992. 49(11): 2406–2411.
Lloyd, S.W. and C.C. Grimm , Analysis of 2-methylisoborneol and geosmin in catfish by microwave distillation−solid-phase microextraction. Journal of Agricultural and Food Chemistry, 1999. 47(1): 164–169.
Kondjoyan, N. and J.-L. Berdagué , A Compilation of Relative Retention Indices for the Analysis of Aromatic Compounds. 1996. France: Laboratoire Flaveur, Saint Genes Champanelle, INRA de Theix.
Mukhopadhyay, R. , Product review: old reliable benchtop GC/MS. Analytical Chemistry, 2004. 76(11): 213 A–216 A.
Adahchour, M. , J. Beens , and U.A.T. Brinkman , Recent developments in the application of comprehensive two-dimensional gas chromatography. Journal of Chromatography A, 2008. 1186(1–2): 67–108.
Čajka, T. and J. Hajšlová , Gas Chromatography-Time-of-Flight Mass Spectrometry in Food Analysis. 2007, LC-GC Europe. pp. 25–31.
Milo, C. and I. Blank , Quantification of Impact Odorants in Food by Isotope Dilution Assay: Strength and Limitations, In Flavor Analysis: Developments in Isolation and Characterization, C.J. Mussinan and M.J. Morello , Editors. 1998, American Chemical Society: Washington, DC. pp. 250–259.
Ellison, S.L.R. and M. Thompson , Standard additions: myth and reality. Analyst, 2008. 133(8): 992–997.
d'Acampora Zellner, B. , et al ., Gas chromatography-olfactometry in food flavour analysis. Journal of Chromatography A, 2008. 1186(1–2): 123–143.
Mahmoud, M.A.A. and A. Buettner , Characterisation of aroma-active and off-odour compounds in German rainbow trout (Oncorhynchus mykiss). Part II: Case of fish meat and skin from earthen-ponds farming. Food Chemistry, 2017. 232: 841–849.
Mahmoud, M.A.A. , et al ., Odorants in fish feeds: a potential source of malodors in aquaculture. Frontiers in Chemistry (Lausanne, Switzerland), 2018. 6: 241/1.
Lapsongphon, N. , J. Yongsawatdigul , and K.R. Cadwallader , Identification and characterization of the aroma-impact components of Thai fish sauce. Journal of Agricultural and Food Chemistry, 2015. 63(10): 2628–2638.

An, Y. , et al ., Characterization of warmed-over flavor compounds in surimi gel made from silver carp (*Hypophthalmichthys molitrix*) by gas chromatography-ion mobility spectrometry, aroma extract dilution analysis, aroma recombination, and omission studies. Journal of Agricultural and Food Chemistry, 2022. 70(30): 9451–9462.

An, Y. , et al ., Comparative characterization of aroma compounds in silver carp (*Hypophthalmichthys molitrix*), Pacific whiting (*Merluccius productus*), and Alaska pollock (*Theragra chalcogramma*) surimi by aroma extract dilution analysis, odor activity value, and aroma recombination studies. Journal of Agricultural and Food Chemistry, 2020. 68(38): 10403–10413.

Sengeremonnot, P. , et al ., Odour active aroma compounds of sea fig (*Microcosmus sulcatus*). Food Chemistry, 2006. 97(3): 465–471.

Tian, X.-Y. , Q. Cai , and Y.-M. Zhang , Rapid classification of hairtail fish and pork freshness using an electronic nose based on the PCA method. Sensors, 2012. 12: 260–277.

Du, W.-X. , et al ., Microbiological, sensory, and electronic nose evaluation of yellowfin tuna under various storage conditions. Journal of Food Protection, 2001. 64(12): 2027–2036.

Li, C. , et al ., Identification of the aroma compounds in stinky mandarin fish (*Siniperca chuatsi*) and comparison of volatiles during fermentation and storage. International Journal of Food Science and Technology, 2013. 48(11): 2429–2437.

Wang, Y. , et al ., Analysis of volatile compounds in sea bass (*Lateolabrax japonicus*) resulting from different slaughter methods using electronic-nose (e-nose) and gas chromatography-ion mobility spectrometry. Molecules, 2021. 26(19): 5889.

Wan, W. , et al ., Determination of cooking state of a Chinese traditional fish dish (Suantangyu) and flavor characterization by modeling, sensory evaluation, and instrumental analysis. Journal of Food Processing and Preservation, 2022. 46(11): e16953.

Zhao, T. , et al ., Gas-phase ion migration spectrum analysis of the volatile flavors of large yellow croaker oil after different storage periods. Current Research in Food Science, 2022. 5: 813–822.

Volpe, M.G. , et al ., Gonad quality of sea urchin *Paracentrotus lividus* cultured in an offshore pilot-scale trial on the south-east Italian coast. Aquaculture Nutrition, 2018. 24(5): 1444–1455.

de Diego, S.M. , et al ., Study along Storage of Volatile Compounds of Two Fish Oils Extracted by Supercritical Carbon Dioxide, In Recent Advances in Food and Flavor Chemistry: Food Flavors and Encapsulation, Health Benefits, Analytical Methods, and Molecular Biology of Functional Foods, C.T. Ho , et al ., Editors. 2010, The Royal Society of Chemistry: Cambridge, UK. pp. 164–169.

Miyasaki, T. , M. Hamaguchi , and S. Yokoyama , Change of volatile compounds in fresh fish meat during ice storage. Journal of Food Science, 2011. 76(9): C1319.

Chen, Y.P. , et al ., Application of gas chromatography-ion mobility spectrometry (GC-IMS) and ultrafast gas chromatography electronic-nose (uf-GC E-nose) to distinguish four Chinese freshwater fishes at both raw and cooked status. Journal of Food Biochemistry, 2022. 46(6): e13840.

Pérez Pavón, J.L. , et al ., Strategies for qualitative and quantitative analyses with mass spectrometry-based electronic noses. TrAC Trends in Analytical Chemistry, 2006. 25(3): 257–266.

Ratel, J. , et al ., Mass spectrometry based sensor strategies for the authentication of oysters according to geographical origin. Journal of Agricultural and Food Chemistry, 2008. 56(2): 321–327.

Gabelica, V. , Ion Mobility-Mass Spectrometry: An Overview, In Ion Mobility-Mass Spectrometry: Fundamentals and Applications, A.E. Ashcroft and F. Sobott , Editors. 2022, The Royal Society of Chemistry: Cambridge, UK. pp. 1–25.

Snyder, A.P. , et al ., Portable hand-held gas chromatography/ion mobility spectrometry device. Analytical Chemistry, 1993. 65(3): 299–306.

Dworzanski, J.P. , et al ., Performance advances in ion mobility spectrometry through combination with high speed vapor sampling, preconcentration and separation techniques. Analytica Chimica Acta, 1994. 293(3): 219–235.

Leonhardt, J.W. , A new ppb-gas analyzer by means of GC-ion mobility spectrometry (GC-IMS). Journal of Radioanalytical and Nuclear Chemistry, 2003. 257(1): 133–139.

Szymańska, E. , A.N. Davies , and L.M.C. Buydens , Chemometrics for ion mobility spectrometry data: recent advances and future prospects. Analyst, 2016. 141(20): 5689–5708.

Snyder, A.P. , et al ., Hand-Portable Gas Chromatography-Ion Mobility Spectrometer for the Determination of the Freshness of Fish, In Third International Workshop on Ion Mobility Spectrometry, J.H. Cross , Editor. 1995, KRUG Life Sciences Inc.: Houston. pp. 146–166.

te Brinke, E. , A. Arrizabalaga-Larrañaga , and M.H. Blokland , Insights of ion mobility spectrometry and its application on food safety and authenticity: a review. Analytica Chimica Acta, 2022. 1222: 340039.

Parchami, R. , M. Kamalabadi , and N. Alizadeh , Determination of biogenic amines in canned fish samples using head-space solid phase microextraction based on nanostructured polypyrrole fiber coupled to modified ionization region ion mobility spectrometry. Journal of Chromatography A, 2017. 1481: 37–43.

Espalha, C. , et al . Fast and Direct Detection of Biogenic Amines in Fish by GC-IMS Technology. In 2019 IEEE 6th Portuguese Meeting on Bioengineering (ENBENG), Curran Associates, Inc.,: Red Hook, NY. 2019. pp. 383–387. https://www.proceedings.com/48316.html

Barnard, G. , et al ., Clearance of biogenic amines from saliva following the consumption of tuna in water and in oil. International Journal for Ion Mobility Spectrometry, 2011. 14(4): 207–211.
Menéndez, M. , et al ., Direct determination of volatile analytes from solid samples by UV-ion mobility spectrometry. Journal of Chromatography A, 2008. 1215(1): 8–14.
Duan, Z. , et al ., Geographical origin identification of two salmonid species via flavor compound analysis using headspace-gas chromatography-ion mobility spectrometry combined with electronic nose and tongue. Food Research International, 2021. 145: 110385.
Bai, J. , et al ., Characteristic flavor of Antarctic krill (*Euphausia superba*) and white shrimp (Penaeus vannamei) induced by thermal treatment. Food Chemistry, 2022. 378: 132074.
Taylor, A. , Atmospheric pressure chemical ionisation mass spectrometry for in vivo analysis of volatile flavour release. Food Chemistry, 2000. 71(3): 327–338.
Blake, R.S. , et al ., Demonstration of proton-transfer reaction time-of-flight mass spectrometry for real-time analysis of trace volatile organic compounds. Analytical Chemistry, 2004. 76(13): 3841–3845.
Phillips, K. , et al ., Sensory and volatile analysis of sea urchin roe from different geographical regions in New Zealand. LWT--Food Science and Technology, 2009. 43(2): 202–213.
An, Y. , et al ., In vivo and in vitro aroma release in surimi gel with different cross-linking degrees by proton transfer reaction-mass spectrometry. Food Chemistry, 2022. 373(Part_B): 131502.
Smith, D. and P. Španěl , Selected ion flow tube mass spectrometry (SIFT-MS) for on-line trace gas analysis. Mass Spectrometry Reviews, 2005. 24(5): 661–700.
Noseda, B. , et al ., Effect of food matrix and pH on the volatilization of bases (TVB) in packed north Atlantic gray shrimp (*Crangon crangon*): volatile bases in MAP fishery products. Journal of Agricultural and Food Chemistry, 2010. 58(22): 11864–11869.
Noseda, B. , et al ., Validation of selective ion flow tube mass spectrometry for fast quantification of volatile bases produced on Atlantic cod (*Gadus morhua*). Journal of Agricultural and Food Chemistry, 2010. 58(9): 5213–5219.
Kuuliala, L. , et al ., Multivariate statistical analysis for the identification of potential seafood spoilage indicators. Food Control, 2018. 84: 49–60.
Kuuliala, L. , et al ., Microbiological, chemical and sensory spoilage analysis of raw Atlantic cod (*Gadus morhua*) stored under modified atmospheres. Food Microbiology, 2018. 70: 232–244.
Dalsvaag, H. , et al ., Mass spectrometric quantification of volatile compounds released by fresh Atlantic salmon stored at 4°C under modified atmosphere packaging and vacuum packaging for up to 16 days. ACS Food Science and Technology, 2022. 2(3): 400–414.
Rochat, S. , J.-Y.D.S. Laumer , and A. Chaintreau , Analysis of sulfur compounds from the in-oven roast beef aroma by comprehensive two-dimensional gas chromatography. Journal of Chromatography A, 2007. 1147(1): 85–94.
Santa, T. , Derivatization reagents in liquid chromatography/electrospray ionization tandem mass spectrometry. Biomedical Chromatography, 2011. 25(1–2): 1–10.
Hofstetter, C.K. , A. Dunkel , and T. Hofmann , Unified flavor quantitation: toward high-throughput analysis of key food odorants and tastants by means of ultra-high-performance liquid chromatography tandem mass spectrometry. Journal of Agricultural and Food Chemistry, 2019. 67(31): 8599–8608.
Peters, V.C.T. , et al ., A high throughput toolbox for comprehensive flavor compound mapping in mint. Food Chemistry, 2021. 365: 130522.
Yan, Y. , et al ., Quantitation of pyrazines in Baijiu and during production process by a rapid and sensitive direct injection UPLC-MS/MS approach. LWT, 2020. 128: 109371.
Yan, Y. , et al ., Quantitative analysis of pyrazines and their perceptual interactions in soy sauce aroma type baijiu. Foods, 2021. 10(2): 441.
Bösl, M. , A. Dunkel , and T.F. Hofmann , Rapid, high-throughput quantitation of odor-active 2-acetyl azaheterocycles in food products by UHPLC-MS/MS. Journal of Agricultural and Food Chemistry, 2021. 69(4): 1405–1412.
Aszyk, J. , et al ., Comprehensive determination of flavouring additives and nicotine in e-cigarette refill solutions. Part I: liquid chromatography-tandem mass spectrometry analysis. Journal of Chromatography A, 2017. 1519: 45–54.

Quality Index Methods

Bremner A. A convenient easy-to-use system for estimating the quality of chilled seafood. Fish Process. Bull., 7, 59–70, 1985.
Larsen EP , Hyldig G , and Frederiksen M. Fersk fisk-Kvalitet i detailhandlen. DFU Rapport udgivet af Danmarks Fiskeriundersøgelser, Afdeling for Fiskeindustriel Forskning, Lyngby, Denmark, 1998–1999.
Bonilla AC , Sveinsdottir K , and Martinsdottir E. Development of quality index method (QIM) scheme for fresh cod *(Gadus morhua)* fillets and application in shelf life study. Food Control, 18, 352–358, 2007.

Hyldig G and Nielsen J. A rapid sensory method for quality management. In Ólafsdóttir G and others (eds.). Action, C. Methods to Determine the Freshness of Fish in Research and Industry; Proceedings of the Final Meeting of the Concerted Action "Evaluation of Fish Freshness" AIR3CT942283, Nantes Conference, Nov. 12–14, International Institute of Refrigeration, Paris, France, p. 297, 1997.
Warm K , Bøknæs N , and Nielsen J. Development of quality index methods for evaluation of frozen cod *(Gadus morhua)* and cod fillets. J. Aquat. Food Prod. Technol., 7, 45–59, 1998.
Herrero AM , Huidobro A , and Careche M. Development of quality index method for frozen hake (*M. capensis* and *M. paradoxus*). J. Food Sci., 68, 1086–1092, 2003.
Warm K. Sensory Quality Criteria for New and Traditional Fish Species of Relevance to Consumer Needs. Danish Institute for Fisheries Research, Lyngby, The Royal Veterinary and Agricultural University, Copenhagen, Denmark, p. 1, 2000.
Larsen E , Hyldig G , Dalgaard P , Bech AC , and Østerberg C. Consumers and experts responses to fresh cod fillets. In Luten JB , Oehlenschlager J , and Ólafsdóttir G (eds.). Quality of Fish from Catch to Consumer: Labelling, Monitoring and Traceability. Wageningen Academic Publ., Wageningen, the Netherlands, p. 345, 2003.
Nielsen J , Hyldig G , and Larsen E. Eating quality of fish-A review. J. Aquat. Food Prod. Technol., 11, 125–141, 2002.
Larsen EP , Heldbo J , Jespersen CM , and Nielsen J. Development of a standard for quality assessment on fish for human consumption. In Huss HH , Jacobsen M , and Liston J (eds.). Quality Assurance in the Fish Industry. Elsevier, Amsterdam, the Netherlands, p. 351, 1992.
Huidobro A , Pastor A , and Tejada M. Quality index method developed for raw gilthead seabream *(Sparus aurata)* . J. Food Sci., 65, 1202–1205, 2000.
Sveinsdóttir K , Martinsdóttir E , Hyldig G , Jørgensen B , and Kristbergsson K. Application of quality index method (QIM) scheme in shelf life study of farmed Atlantic Salmon *(Salmo salar)* . J. Food Sci., 67(4), 1570–1579, 2002.
Sveinsdóttir K , Hyldig G , Martinsdóttir E , Jorgensen B , and Kristbergsson K. Development of quality index method (QIM) scheme for farmed Atlantic Salmon *(Salmo salar)* . Food Qual. Prefer., 14, 237–245, 2003.
Nielsen D , Green D , Bolton G , Hodson R , and Nielsen J. Hybrid Striped Bass-A QIM Scheme for a Major U.S. Aquaculture Species; Poster at First Joint Trans Atlantic Fisheries Technology Conference.
Hyldig G and Nielsen J. QIM-A tool for determination of fish freshness. In Shahidi F and Simpson BK (eds.). Seafood Quality and Safety. Advances in the New Millennium. ScienceTech Publishing Company, St. John's, NL, p. 81, 2004.
Hyldig G and Green-Petersen DMB . Quality index method-An objective tool for determination of sensory quality. J. Aquat. Food Prod. Technol., 13(4), 71–80, 2005.
Bremner HA , Olley J , and Vail AMA . Estimating time-temperature effects by a rapid systematic sensory method. In: Donald E. Kramer , John Liston (eds.), Advances in Food Research: Seafood Quality Determination. Elsevier Press, Amsterdam, the Netherlands, p. 413, 1987.
. Council regulation (EC) No. 2406/96 of November 26, 1996, laying down common marketing standards for certain fishery products. Off. J. Eur. Commun., L334, 1–14, 1996.
https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A31996R2406.
Martinsdóttir E , Sveinsdóttir K , Luten J , Schelvis-Smit R , and Hyldig G. Sensory Evaluation of Fish Freshness. A Reference Manual for the Fish Industry. QIM-Eurofish, the Netherlands, 2001, 2004. https://dl-manual.com/doc/qim-manual-english-version-mnop66r14jzq.
Boulter M , Poole S , and Bremner A. Australian Quality Index Manual. Fisheries Research and Development Corporation, Canberra, ACT, 2006.
https://www.sydneyfishmarket.com.au/Seafood-Trading/Quality/Australian-Seafood-Quality-Index.
Portela CDG . Tecnologia pós-despesca dos camarões de água doce *Macrobrachium rosenbergii* e *Macrobrachium amazonicum* [Doc Thesis]. Jaboticabal, Brazil: Universidade Estadual Paulista; 2009.
Cyprian OO , Sveinsdóttir K , Magnússon H , and Martinsdóttir E. Application of quality index method (QIM) scheme and effects of short-time temperature abuse in shelf life study of fresh water artic char (*Salvelinus alpinus*). J. Food Prod. Technol., 17, 303–321, 2008.
Guillerm-Regost C , Haugen T , Nortvedt R , Carlehög M , Lunestad BT , Kiessling A , and Rørár AMB . Quality characterization of farmed Atlantic halibut during ice storage. J. Food Sci., 71(2), 83–90, 2006.
Musgrove R , Carragher J , Mathews, and Slattery S. Value adding Australian sardines: Factors affecting rates of deterioration in sardine (*Sardinops sagax*) quality during post-harvest handling. Food Control, 18, 1372–1382, 2007.
Silva SC . Validade comercial de sardinhas inteiras e refrigeradas avaliadas por análises físico-químicas, bacteriológicas e sensorial. Niterói, Brazil: Universidade Federal Fluminense; 2010.
Nunes ML , Batista I , and Cardoso C. Aplicação do índice de qualidade (QIM) na avaliação da frescura do pescado. Lisboa: Publicações Avulsas do IPIMAR; 2007.
Sant'ana LS , Soares SM , and Vaz-Pires P. Development of a quality index method (QIM) sensory scheme and study of shelf-life of ice-stored blackspot seabream (*Pagellus bogaraveo*). LWT/Food Sci. Tech., 44, 2253–2259, 2011.

Bogdanovic T , Simat V , Frka-Roic A , and Markovic K. Development and application of quality index method scheme in a shelf life study of wild and fish farm affected bogue (*Boops boops*, L.). J. Food Sci., 77, S99–S106, 2012.
Song Y , Liu L , Shen H , You J , and Luo Y. Effect of sodium alginate-based edible coating containing different anti-oxidants on quality and shelf life of refrigerated bream (*Megalobrama amblycephala*). Food Control, 22, 608–615, 2011.
Martinsdóttir E , Sveinsdottir K , Luten JB , Schelvis-Smit R , and Hyldig G. Reference manual for the fish sector: Sensory evaluation of fish freshness. Ijmuiden: QIM Eurofish; 2001.
Vaz-Pires P and Seixas P. Development of new quality index method (QIM) schemes for cuttlefish (*Sepia officinalis*) and broadtail shortfin squid (*Illex coindetii*). Food Control, 17(12), 942–949, 2006.
Barbosa A and Vaz-Pires P. Quality index method (QIM): Development of a sensorial scheme for commo octopus (*Octopus vulgaris*). Food Control, 15, 161–168, 2004.
Sykes AV , Oliveira AR , Domingues PM , Cardoso CM , Andrade JP , and Nunes ML . Assessment of European cuttlefish (*Sepia officinalis, L.*) nutritional value and freshness under ice storage using a developed quality index method (QIM) and biochemical methods. LWT/Food Sci. Tech., 42, 424–432, 2009.
Özogul Y , Özyurt G , Özogul F , Kuley E , and Polat A. Freshness assessment of European eel (*Anguilla anguilla*) by sensory, chemical and microbiological methods. Food Chem., 92, 745–751, 2005.
Massa AE , Palacios DL , Paredi ME , and Crupkin M. Postmortem changes in quality indices of ice-stored flounder (*Paralichtys patagonicus*). J. Food Biochem., 29, 570–590, 2005.
Alasalvar C , Taylor KDA , Öksüz A , Garthwaite T , Alexis, MN , and Grigorakis K. Freshness assessment of cultured sea bream (*Sparus aurata*) by chemical, physical and sensory methods. Food Chem., 72, 33–40, 2001.
Campus M , Bonaglini E , Cappuccinelli R , Porcu MC , Tonelli R , and Roggio T. Effect of modified atmosphere packaging on quality index method (QIM) scores o farmed gilthead seabream (*Sparus aurata* L.) at low and abused temperatures. J. Food Sci., 76(3), 185–191, 2011.
Özyurt G , Kuley E , Özkütük S , and Özogul F. Sensory, microbiological and chemical assessment of the freshness of red mullet (*Mullus barbatus*) and goldband goatfish (*Upeneus moluccensis*) during storage in ice. Food Chem., 114, 505–510, 2009.
Silva KB . Avaliação do frescor e vida útil da lagosta (*Panulirus argus*), pré- cozida e armazenada sobrefrigeração [Msc Thesis]. Recife, Brazil: Universidade Federal Rural do Semi-Árido; 2009.
Lyhs U and Schelvis-Smit R. Development of a quality index method (QIM) for maatjes herring stored in air and under modified atmosphere. J. Aquat. Food Prod. Technol., 14, 63–76, 2005.
Triqui R and Bouchriti N. Freshness assessment of Moroccan Sardine *(Scardina pilchardus):* Comparison of overall sensory changes to instrumentally determined volatiles. J. Agric. Food Chem., 51, 7540, 2003.
Noojuy N and Boonprab K. Quality index method (QIM) and its related indexes for meder's mangrove crab (*Neoepisesarma Mederi*, H. Milne Edwards 1853) stored in ice. Kmitl Sci. J., 8(2), 52–59, 2008.
Pons-Sánchez-Cascado S , Vidal-Carou MC , Nunes ML , and Veciana-Nogués MT . Sensory analysis to assess the freshness of mediterranean anchovies (*Engraulis encrasicholus*) stored in ice. Food Control, 17, 564–569, 2006.
Baixas-Nogueras S , Bover-Cid S , Veciana-Nogués T , Nunes ML , and Vidal-Carou MC . Development of a quality index method to evaluate freshness in mediterranean hake (*Merluccius merluccius*). J. Food Sci., 68(3), 1067–1071, 2003.
Wünnenburg A and Oehlenschläger J. Untersuchungen zur saisonalen Abhängigkeit der Haltbarkeit von Zuchtforellen (*Onchorhynchus mykiss*) während der Eislagerung mittels der Qualitäts-Index-Method (QIM) an Ganzfisch und Sensorik gegarter Filetproben. Archiv für Lebensmittelhyg, 59, 221–226, 2008.
Alasalvar C , Taylor KDA , Öksüz A , Shahidi F , and Alexis M. Comparison of freshness quality of cultured and wild sea bass (*Dicentrarchus labrax*). J. Food Sci., 67, 3220–3226, 2002.
Gonçalves AC . Qualidade e valorização em aquacultura: Propriedades sensoriais e período de conservação útil de peixe e bivalves [Doc Thesis]. Lisboa, Portugal: Universidade de Lisboa; 2010.
Oliveira VM , Freitas MQ , Clemente SCS , and Mársico ET . Método do Índice de Qualidade (MIQ) desenvolvido para camarão (*Litopeneaus vannamei*) cultivado. Rev. Univ. Rur. Série Ciências da Vida., 29, 60–71, 2009.
Rodrigues TP . Estudo de critérios para avaliação da qualidade da tilápia do Nilo (Oreochromis niloticus) cultivada; eviscerada e estocada em gelo [Msc Thesis]. Niterói, Brazil: Universidade Federal Fluminense; 2008.
Bekaert K. Development of quality index method scheme to evaluate freshness of tub gurnard (*Chelidonichthys lucernus*). In Luten JB , Jacobsen C , Bekaert K , Sæbo A , and Oehlenschlager J (eds.). Seafood Research from Fish to Dish. Wageningen Academic Publishers, Wageningen, pp. 289–296, 2006.
Teixeira MS , Borges A , Franco RM , Clemente SCS , and Freitas MQ . Método de Índice de Quaidade (MIQ): protocolo sensorial para corvina (*Micropogonias furnieri*). Rev. Bras. Ciênc Vet., 16, 83–88, 2009.
Ritter DO , Lanzarin M , Novaes SF , Monteiro MLG , Almeida Filho ES , Mársico ET , Franco RM , Conte-Junior CA , and Freitas MQ . Quality index method (QIM) for gutted ice-stored hybrid tambatinga (Colossoma macropomum×Piaractus brachypomum) and study of shelf life. LWT Food Sci. Technol., 67, 55–61, 2016.
Lanzarin M. , Ritter DO , Novaes SF , Monteiro MLG , Almeida Filho ES , Mársico ET , Franco RM , Conte CA , and Freitas MQ . Quality index method (QIM) for ice stored gutted Amazonian Pintado (Pseudoplatystoma

fasciatum × Leiarius marmoratus) and estimation of shelf life. LWT Food Sci. Technol., 65, 363–370, 2016,
Agüeria D , Sanzano P , Vaz-Pires P , Rodríguez E , and Yeannes MI . Development of quality index method scheme for common carp (Cyprinus carpio) stored in ice: shelf-life assessment by physicochemical, microbiological, and sensory quality indices. J. Aquat. Food Prod. Technol., 25(5), 708–723, 2016.
Gutiérrez GN , Amorocho CC , Sandoval AA , and Ruíz OY . Quality index method developed for gutted and ungutted red tilapia (Oreochromis ssp). Revista MVZ Córdoba, 20(1), 4461–4471, 2015.
López-García MM , Ramil-Novo LA , Vázquez-Odériz ML , and Romero-Rodríguez MA . Development of a quality index method for freshness assessment of thawed Greenland halibut (Reinhardtius hippoglossoides) stored at chilling temperature. Food Bioproc. Technol., 7(6), 1847–1852, 2014.
Cyprian OO , Sveinsdóttir K , Magnússon H , Arason S , Jóhannsson R , and Martinsdóttir E. Development of quality index method (QIM) scheme for farmed tilapia fillets and its application in shelf life study. J. Aquat. Food Prod. Technol., 23(3), 278–290, 2014.
Borges A , Conte-Junior CA , Franco RM , Mársico ET , and Freitas MQ . Quality index method (QIM) for the hybrid tambacu (Colossoma macropomum × Piaractus mesopotamicus) and the correlation among its quality parameters. LWT Food Sci. Technol., 56(2), 432–439, 2014.
Massa AE , Manca E , and Yeannes MI . Development of quality index method for anchovy (Engraulis anchoita) stored in ice: Assessment of its shelf-life by chemical and sensory methods. Food Sci. Technol. Int., 18(4), 339–351, 2012.
Bogdanović T , Šimat V , FrkaRoić A , and Marković K. Development and application of quality index method scheme in a shelflife study of wild and fish farm affected bogue (Boops boops, L.). J. Food Sci., 77(2), S99–S106, 2012.
Roiha IS , Jonsson A , Backi CJ , Lunestad BT , and Karlsdottir MG . A comparative study of quality and safety of Atlantic cod (*Gadusmorhua*) fillets during cold storage, as affected by different thawing methods of pre-rigor frozen headed and gutted fish: Quality and safety of chilled cod fillets as affected by thawing methods. J. Sci. Food Agric., 98(1), 400–409, 2018.
Le NT , Doan NK , Nguyen Ba T , and Tran TVT . Towards improved quality benchmarking and shelf life evaluation of black tiger shrimp (*Penaeus monodon*). Food Chem., 235, 220–226, 2017.
Goncalves AA and Soares KMDP . Quality index method scheme for whole fresh carapeba (Eucinostomus gula, Quoy & Gaimard, 1824) stored in ice. Brazilian J. Food Technol., 20, 66–72, 2017.
Fogaca FHDS , Gonzaga Junior MA , Vieira SGA , Araujo TDS , Farias EA , Ferreira-Bravo IA , Alves Silva TF , Calvet RM , Moura P , Alitiene L , and Prentice-Hernandez C. Appraising the shelf life of farmed cobia, *Rachycentron canadum*, by application of a quality index method: Shelf life of farmed cobia. J. World Aquac. Soc., 48(1), 70–82, 2017.
Araujo WSC , De Lima CLS , Peixoto Joele MRS , and Lourenco LDFH . Development and application of the quality index method (QIM) for farmed tambaqui (*Colossoma macropomum*) stored under refrigeration: Application of the quality index method to establish fish shelf life. J. Food Saf., 37(1), e12288, 2017.
Li X , Chen Y , Cai L , Xu Y , Yi S , Zhu W , Lin H. Freshness assessment of turbot (*Scophthalmus maximus*) by quality index method (QIM), biochemical, and proteomic methods. LWT Food Sci. Technol., 78, 172–180, 2017.
Ahmadi Shalhe M , Khodanazary A , and Hosseini SM . Development of a quality index method (QIM) scheme for whole goldlined seabream *Rhabdosargus sarba* stored in ice. Int. J. Food Prop., 21(1), 2539–2549, 2018.
Diler A , and Genc İY . Apractical quality index method (QIM) developed for aquacultured rainbow trout (*Oncorhynchus mykiss*). Int. J. Food Prop., 21(1), 858–867, 2018.
Freitas J , Vaz-Pires P , and Camara JS . Freshness assessment and shelf-life prediction for seriola dumerili from aquaculture based on the quality index method. Molecules, 24(19), 3530, 2019.
Ghani Kuvei F, Khodanazary A , and Zamani I. Quality index method (QIM) sensory scheme for gutted greenback grey mullet *Chelon subviridis* and its shelf life determination. Int. J. Food Prop., 22(1), 618–629, 2019.
Khodanazary A. Freshness assessment of shrimp *Metapenaeus affinis* by quality index method and estimation of its shelf life. Int. J. Food Prop., 22(1), 309–319, 2019.
Vazquez-Sanchez D , Garcia EES , Galvao JA , and Oetterer M. Quality index method (QIM) scheme developed for whole Nile tilapias (Oreochromis niloticus) ice stored under refrigeration and correlation with physicochemical and microbiological quality parameters. J. Aquat. Food Prod. Technol., 29(3), 1–13, 2020.
Bernardi DC , Mársico ET , and Freitas MQD . Quality index method (QIM) to assess the freshness and shelf life of fish. Brazilian Arch. Biol. Technol., 56, 587–598, 2013.
Ndraha N. Fish quality evaluation using quality index method (QIM), correlating with physical, chemical and bacteriological changes during the ice-storage period: A review. In Isnansetyo A and Nuringtyas TR (eds.). Proceeding of the 1st International Conference on Tropical Agriculture. Springer International Publishing, NewYork City. pp. 185–196, 2017.
Bernardo YA , Rosario DK , Delgado IF , and ConteJunior CA . Fish quality index method: Principles, weaknesses, validation, and alternatives-A review. Comp. Rev. Food Sci. Food Saf., 19(5), 2657–2676, 2020.
ISO 8589 . Sensory Analysis-General Guidance for the Design of Test Rooms, 1st edn., International Standard, Geneva, Switzerland, 1988.
NMKL procedure No. 12 . Guiding on Sampling. Nordic Committee on Food Analysis, Copenhagen, Denmark, 2002. Available at https://www.nmkl.org.

Codex: Recommended International code of Practice for Fresh Fish CAC/RCP 9-1976Codex standards for methods of analysis and sampling , “Sampling Plans for Prepackaged Foods (AQL 6.5),” XOT 13-1969, Rome, FAO/WHO Codex. Alimentarius. Codex XOT 13-1969, 1976.
Nielsen D and Hyldig G. Influence of handling procedures and biological factors on the QIM evaluation of whole herring (Clupea harengus L.). Food Res. Int., 37(10), 975, 2004.
Huidobro A , Pastor A , Lopez-Caballero ME , and Tejada M. Washing effect on the quality index method (QIM) developed for raw gilthead seabream (Sparus auratus). Eur. Food Res. Technol., 212, 408, 2001.
Howgate P. Approaches to the Definition and Measurement of Storage Life of Chilled and Frozen Fish. Torry Research Station, Aberdeen, UK, 1985.
Martinsdóttir E and Blomsterberg F. Sjálfvirk ferskleikameling með RT-geðaflokkara 12. RIT Icelandic Fisheries Laboratories, 1987.
Magnússon H , Martinsdóttir E , and Steinpórsson P. Áhrif frystingar og frystigeymslu porsks eftir píðingu. 26. Icelandic Fisheries Laboratories REPORT no. 26, 1990.
Rehbein H , Martinsdóttir E , Blomsterberg F , Valdimarsson G , and Öehlenschlager J. Shelf life of ice-stored redfish, Sebastes marinus and S. mentella. Int. J. Food Sci. Technol., 29, 303, 1994.
Martinsdóttir E , Sveinsdóttir K , and Olafsdóttir G. Development and implementation of a computerised sensory system (QIM) for fish freshness. Icelandic Fisheries Laboratories Project Report 11, 2000.
Bremner HA , Statham JA , and Sykes SJ . Tropical species from the North-West Shelf of Australia. Sensory assessment and acceptability of fish stored on ice. Proceedings of the Sixth Session IPFC Working Party on Fish Technology and Marketing, Melbourne 1984 FAO. Fish Rep., 317(Suppl.), 41, 1984.

Sensory Descriptors

Arvidson, K. 1979. Location and variation in number of taste buds in human fungiform papillae. Scandinavian Journal of Dental Research, 87: 435–442.
Barroso, M. , Careche, M. and Borderías, AJ . 1998. Quality control of frozen fish using rheological techniques. Trends in Food Science and Technology, 9: 223–229.
Bartoshuk, L.M. , Duffy, V.B. and Miller, I.J. 1994. PTC/PROP tasting: Anatomy, psychophysics and sex effects. Physiology and Behavior, 56: 1165–1171.
Borderias, A.J. , Lamua, M. and Tejada, M. 1983. Texture analysis of fish fillets and minced fish by both sensory and instrumental methods. Journal of Food Technology, 18: 85–95.
Bourne, M.C. 1978. Texture profile analysis. Food Technology, 22: 62–66, 72.
Brandt, M.A. , Skinner, E.Z. and Coleman, J.A. 1963. Texture profile method. Journal of Food Science, 28: 404–409.
Breene, W.M. 1975. Application of texture profile analysis to instrumental food texture evaluation. Journal of Texture Studies, 6: 53–82.
Cardello, A.V. , Sawyer, F.M. , Maller, O. and Digman, L. 1982. Sensory evaluation of the texture and appearance of 17 species of North Atlantic fish. Journal of Food Science, 47: 1818–1823.
Cardinal, M. , Gunnlaugsdottir, H. , Bjoernevik, M. , Ouisse, A. , Vallet, J.L. and Leroi, F. 2004. Sensory characteristic of cold-smoked Atlantic salmon (Salmo salar) from European market and relationships with chemical, physical and microbiological measurements. Food Research International, 37: 181–193.
Correa, M. , Hutchinson, I. , Laing, D.G. and Jinks, A.L. 2013. Changes in fungiform papillae density during development in humans. Chemical Senses, 38: 519–527.
Einen, O. and Skrede, G. 1998. Quality characteristics in raw and smoked fillets of Atlantic salmon, Salmo salar, fed high-energy diets. Aquaculture Nutrition, 4: 99–108.
Einen, O. and Thomassen, M.S. 1998. Starvation prior to slaughter in Atlantic salmon (Salmo salar). II. Muscle composition and evaluation of freshness, texture and colour characteristics in raw and cooked fillets. Aquaculture, 169: 37–53.
Erickson, M.C. , Bulgarelli, M.A. , Resurreccion, A.V.A. , Vendetti, R.A. and Gates, K.A. 2007. Sensory differentiation of shrimp using a trained descriptive analysis panel. LWT 40: 1774–1783.
Fan, Y. , Odabasi, A. , Sims, C.A. , Schneider, K.R. , Gao, Z. and Sarnoski, P.J. 2021. Determination of aquacultured whiteleg shrimp (Litopanaeus vannemei) quality using a sensory method with chemical standard references. Journal of the Science of Food and Agriculture, 101: 5236–5244.
Farmer, L.J. , McConnell, J.M. and Kilpatrick, D.J. 2000. Sensory characteristic of farmed and wild Atlantic salmon. Aquaculture, 187: 105–125.
Friedman, H.H. , Whitney, J.E. and Szczesniak, A.S. 1963. The texturometer - A new instrument for objective texture measurement. Journal of Food Science, 28: 390–396.
Fu, X. , Xu, S. and Wanga, Z. 2009. Kinetics of lipid oxidation and off-odor formation in silver carp mince: The effect of lipoxygenase and hemoglobin. Food Research International, 42: 85–90.
Ginés, R. , Valdimarsdottir, T. , Sveinsdottir, K. and Thorarensen, H. 2004. Effect of rearing temperature and strain on sensory characteristics, texture, colour and fat of Arctic charr (Salvelinus alpinus). Food Quality and

Preferences, 15: 177–185.
Green-Petersen, D.M.B. , Nielsen, J. and Hyldig, G. 2006. Sensory profiling of the most common salmon products on the Danish market. Journal of Sensory Studies, 21: 415–427.
Gundavarapu, S. , Hung, Y.-C. and Reynolds, A.E. 1998. Consumer acceptance and quality of microwave-cooked shrimp. Journal of Food Quality, 21: 71–84.
Hamann, D.D. and Webb, N.B. 1979. Sensory and instrumental evaluation of material properties of fish gels. Journal of Texture Studies, 10: 117–130.
Hemre, G.-I. , Karlsen, Ø. , Eckhoff, K. , Tveit, K. , Mangor-Jensen, A. and Rosenlund, G. 2004. Effect of season, light and diet on muscle composition and selected quality parameters in farmed Atlantic cod, Gadus morhua L. Aquaculture Research, 35: 683–697.
Hong, L.C. , Leblanc, E.L. , Hawrysh, Z.J. and Hardin, R.T. 1996. Quality of Atlantic mackerel (Scomber scombrus L.) fillets during modified atmosphere storage. Journal of Food Science, 61: 646–651.
Hurling, R. , Rodell, J.B. and Hunt, H.D. 1996. Research note: Fiber diameter and fish texture. Journal of Texture Studies, 27: 679–685.
Iseya, Z. , Sugiura, S. and Sarki, H. 1996. Procedure for mechanical assessment of texture change in dried fish meat. Fisheries Science, 62: 772–775.
ISO 11035 . 1994. Sensory Analysis - Identification and Selection of Descriptors for Establishing a Sensory Profile by a Multidimensional Approach. International Organization for Standardization. Switzerland.
ISO 13299 . 2016. Sensory Analysis - Methodology - Guidance for Establishing a Sensory Profile. International Organization for Standardization, Geneva, Switzerland.
ISO 3972 . 2011. Sensory Analysis - Methodology - Method of Investigating Sensitivity of Taste. Reference number ISO 3972: 2011. International Organization for Standardization, Geneva, Switzerland.
ISO 5492 . 2008. Sensory Analysis - Vocabulary. International Organization for Standardization, Geneva, Switzerland.
ISO 8586 . 2012. Sensory Analysis - General Guidance for the Selection, Training and Monitoring of Assessors. International Organization for Standardization, Geneva, Switzerland.
Jack, F.R. , Paterson, A. and Piggott, J.R. 1995. Percieved texture: Direct and indirect methods for use in product development. International Journal of Food Science and Technology, 30: 1–12.
Jaffrès, E. , Lalanne, V. , Macé, S. , Cornet, J. , Cardinal, M. , Sérot, T. , Dousset, X. and Joffraud, J.-J. 2011. Sensory characteristics of spoilage and volatile compounds associated with bacteria isolated from cooked and peeled tropical shrimps using SPME-GC-MS analysis. International Journal of Food Microbiology, 147: 195–202.
Johansson, L , Kiessling, A , Kiessling, K.-H. and Berglund, L. 2000. Effects of altered ration levels on sensory characteristics, lipid content and fatty acid composition of rainbow trout (oncorhynchus mykiss). Food Quality and Preference, 11: 247–254.
Johnson, E.A. , Peleg, M. , Sawyer, F.M. , Segars, R.A. and Cardello, A. 1981. Mechanical methods of measuring textural characteristics of fish flesh. Refrigeration Science and Technology, 4: 93–103.
Kang, M.-W. , Chung, S.-J. , Lee, H.-S. , Kim, Y. and Kim, K.-O. 2007. The sensory interactions of organic acids and various flavors in Ramen soup systems. Journal of Food Science, 72(9): 639–647.
Larsen, E. , Hyldig, G. , Dalgaard, P. , Bech, A.C. and Østerberg, C. 2003. Consumers and experts responses to fresh cod fillets. In Luten, J.B. , Oehlenschlager, J. and Ólafsdóttir, G. (eds.) Quality of Fish from Catch to Consumer: Labelling, Monitoring and Traceability. pp. 345–360. Wageningen Academic Publ., Wageningen, The Netherlands.
Leblanc, R.J. and Leblanc, E.L. 1990. Effect of retort process time on the physical and sensory quality of canned lobster (Homarus americanus) meat. Journal of Food Processing and Preservation, 14: 345–368.
Mall, V. and Schieberle, P. 2017. Evaluation of key aroma compounds in processed prawns (whiteleg shrimp) by quantitation and aroma recombination experiments. Journal of Agricultural Food Chemistry, 65: 2776−2783.
Meilgaard, M. , Civille, G.V. and Carr, B.T. 2006. Sensory Evaluation Techniques, 4th edition. CRC Press Ltd., London.
Merbs, S.L. and Nathans, J. 1992. Absorbtion spectra of human cone pigments. Nature, 356: 433–435.
Merbs, S.L. and Nathans, J. 1993. Role of hydroxyl-bearing amino acids in differently tuning the absorpion spectra of the human red and green cone pigments. Photochemistry and Photobiology, 58: 706–710.
Miller, I.J. and Bartoshuk, L.M. 1991. Taste perseption, taste bud distribution and spatial relationships. In Getchell, T.V. , Doty, R.L. , Bartoshuk, L.M. and Snow, J.B. (eds.) Smell and Taste in Health and Disease. pp. 205–255. Raven, New York.
Morita, K. , Kubota, K. and Aishima, T. 2001. Sensory characteristics and volatile components in aroma of boiled prawns prepared according to experimental designs. Food Research International, 34: 473–481.
Morita, K. , Kubota, K. and Aishima, T. 2003. Comparison of aroma characteristics of 16 fish species by sensory evaluation and gas chromatographic analysis. Journal of the Science of Food and Agriculture, 83: 289–297.
Nielsen, D. , Hyldig, G. , Nielsen, H.H. and Nielsen, J. 2004. Sensory properties of marinated herring (Clupea harengus) - Influence of fishing ground and season. Journal of Aquatic Food Product Technology, 13: 3–24.

Nielsen, D. , Hyldig, G. , Nielsen, J. and Nielsen, H.H. 2005. Sensory properties of marinated herring (Clupea harengus) processed from raw material from commercial landings. Journal of the Science of Food and Agriculture, 85(1): 127–134.
Rørå, A.M.B. , Kvåle, A. , Mørkøre, T. , Rørvik, K.A. , Stein, S.S. and Thomassen, M.S. 1998. Process yield, colour and sensory quality of smoked Atlantic salmon (Salmo salar) in relation to raw material characteristics. Food Research International, 31: 601–609.
Sánchez, M.T. 1996. Food texture: Concept and measurement. Alimentaria, 272: 29–34.
Schubring, R. and Oehlenschläger, J. 1997. Comparison of the ripening process in salted Baltic and North Sea herring as measured by instrumental and sensory methods. Zeitschrift für Lebensmittel Untersuchung und Forschung A, 205: 89–92.
Sivertsvik, M. , Rosnes, J.T. , Vorre, A. , Randell, K. , Ahvenainen, R. and Bergslien, H. 1999. Quality of whole gutted salmon in various bulk packages. Journal of Food Quality, 22: 387–402.
Stohr, V. , Joffraud, J.J. , Cardinal, M. and Leroi, F. 2001. Spoilage potential and sensory profile associated with bacteria isolated from cold-smoked salmon. Food Research International, 34: 797–806.
Szczesniak, A.S. 1963. Classification of textural characteristics. Journal of Food Science, 28: 385–389.
Thybo, A.K. and Martens, M. 2000. Analysis of sensory assessors in texture profiling of potatoes by multivariate modelling. Food Quality and Preference, 11: 283–288.
Tomic, O. , Luciano, G. , Nielsen, A. , Hyldig, G. , Lorensen, K. and Næs, T. 2010. Analysing sensory panel performance in a proficiency test using the PanelCheck software. European Food Research Technology, 230(3): 497–511.
Turchini, G.M. , Moretti, V.M. , Mentasi, T. , Orban, E. and Valfré, F. 2007. Effects of dietary lipid source on fillet chemical composition, flavour volatile compounds and sensory characteristics in the freshwater fish tench (Tinca tinca L.). Food Chemistry, 102: 1144–1155.
Vogel, B.F. , Ng, Y.Y. , Hyldig, G. , Mohr, M. and Gram, L. 2006. Potassium lactate combined with sodium diacetate can inhibit growth of Listeria monocytogenes in vacuum-packed cold-smoked salmon and has no adverse sensory effects. Journal of Food Protection, 69: 2134–2142.
Warm, K. , Nielsen, J. and Hyldig, G. 2000. Sensory quality criteria for five fish species. Journal of Food Quality, 23: 583–601.

Sensory Aspects of Heat Treated Seafood

Ando S and Hatano M. 1986. Biochemical characteristics of chum salmon muscle during spawning migration. Bulletin of the Japanese Society of Fisheries 52: 1229–1235.
Ando S , Hatano M and Zama K. 1985. Deterioration of chum salmon (Oncorhynchus keta) muscle during spawning migration - 1. Changes in proximate composition of chum salmon muscle during spawning migration. Comparative Physiology and Biochemistry 80B: 303–307.
Bak LS , Andersen AB , Andersen EM and Bertelsen G. 1999. Effect of modified atmosphere packeaging on oxidative changes in frozen stored cold water shrimp (Pandalus borealis). Food Chemistry 64: 169–175.
Baron CP , Hyldig G and Jacobsen C. 2009. Does feed composition affect oxidation of rainbow trout (Oncorhynchus mykiss) during frozen storage? Journal of Agricultural and Food Chemistry 57: 4185–4194.
Bett KL , Ingram DA , Grimm CC , Vinyard BT , Boyette KDC and Dionigi CP . 2000. Alteration of the sensory perception of the muddy/earthy odorant 2-methylisoborneol in channel catfish Ictalurus punctatus fillet tissues by addition of seasonings. Journal of Sensory Studies 15: 459–472.
Bjerkeng B , Refstie, Fjalestad KT , Storebakken T , Røbotten M and Roem AJ . 1997. Quality parameters of the flesh of Atlantic salmon (Salmo salar) as affected by dietary fat content and full-fat soybean meal as a partial substitute for fish meal in the diet. Aquaculture 157: 297–309.
Bøkness N , Jensen KN , Guldager HS , Østerberg C , Nielsen J and Dalgaard P. 2002. Thawed chilled Barents Sea cod fillets in modified atmosphere packaging-appæication of multivariate data analysis to select key parameters in good manufacturing practice. Lebensmittel-Wissenschaft & Technologie 35: 436–443.
Borresen T. 1992. Quality aspects of wild and reared fish. In Huss HH , Jacobsen M and Liston J (eds.) Quality Assurance in the Fish Industry. Proceedings of an International Conference, Copenhagen, Denmark August 1991. Elsevier, Amsterdam: pp. 1–17.
Buttkus HJ . 1963. Red and white muscle of fish in relation to rigor mortis. Journal of the Fisheries Board of Canada 20: 45–58.
Cardello AV , Sawyer MF , Prell P , Maller O and Kapsalis J. 1983. Sensory methodology for the classification of fish according to “edibility characteristics”. Lebensmittel-Wissenschaft & Technologie 16: 190–194.
Cardinal M , Gunnlaugsdottir H , Bjoernevik M , Ouisse A , Vallet JL and Leroi F. 2004. Sensory characteristic of cold-smoked Atlantic salmon (Salmo salar) from European market and relationships with chemical, physical and microbiological measurements. Food Research International 37: 181–193.
Edmunds WJ and Lillard DA . 1979. Sensory characteristics of oysters, clams and cultured and wild shrimp. Journal of Food Science 44: 368–373.

Einen O and Skrede G. 1998. Quality characteristics in raw and smoked fillets of Atlantic salmon, Salmo salar, fed high-energy diets. Aquaculture Nutrition 4: 99–108.
Einen O and Thomassen M.S. 1998. Starvation prior to slaughter in Atlantic salmon (Salmo salar) II. White muscle composition and evaluation of freshness, texture and colour characteristics in raw and cooked fillets. Aquaculture 169: 37–53.
Erikson, MC , Bulgarelli, MA , Resurreccion, AVA , Vendetti, RA and Gates KA , 2007. Sensory differentiation of shrimp using a trained descriptive analysis panel. Food Science and Technology 40: 1774–1783.
Farmer LJ , McConnell JM and Kilpatrick, DJ . 2000. Sensory characteristic of farmed and wild Atlantic salmon. Aquaculture 187: 105–125.
Ginés R , Valdimarsdottir T , Sveinsdottir K and Thorarensen H. 2004. Effect of rearing temperature and strain on sensory characteristics, texture, colour and fat of Arctic charr (Salvelinus alpinus). Food Quality and Preferences 15: 177–185.
Green-Petersen DMB and Hyldig G. 2010. Variation in sensory profile between individual rainbow trout (Oncorhynchus mykiss) from the same production batch. Journal of Food Science 75(9): S499–S505.
Green-Petersen D , Hyldig G , Jacobsen C , Baron CP , Lund L , Nielsen HH and Jokumsen A. 2014. Influence of dietary lipid and protein sources on the sensory quality of organic rainbow trout (Oncorhynchus mykiss) after ice storage. Journal of Aquatic Food Product Technology, 23(4): 333–346.
Green-Petersen DMB , Nielsen J and Hyldig G. 2006. Sensory profiling of the most common salmon products on the Danish market. Journal of Sensory Studies 21: 415–427.
Hemre G-I , Karlsen Ø , Eckhoff K , Tveit K , Mangor-Jensen A and Rosenlund G. 2004. Effect of season, light and diet on muscle composition and selected quality parameters in farmed Atlantic cod, Gadus morhua L. Aquaculture Research 35: 683–697.
Hong LC , Leblanc EL , Hawrysh ZJ and Hardin RT . 1996. Quality of Atlantic Mackerel (Scomber scombrus L.) fillets during modified atmosphere storage. Journal of Food Science 61: 646–651.
Hyldig G , Jørgensen BM , Undeland I , Olsen RE , Jónsson Á and Nielsen HH . 2012. Sensory properties of frozen herring (Clupea harengus) from different catch seasons and locations. Journal of Food Science 77(9): S288–S293.
ISO 8586 . 2012. Sensory Analysis - General Guidance for the Selection, Training and Monitoring of Assessors - Part 1: Selected Assessors. International Organization for Standardization, Switzerland.
ISO 8589 . 2007. Sensory Analysis - General Guidance for the Design of Test Rooms. Reference number ISO 8589:2007. International Organization for Standardization, Switzerland.
ISO 11035 . 1994. Sensory Analysis - Identification and Selection of Descriptors for Establishing a Sensory Profile by a Multidimensional Approach. International Organization for Standardization, Switzerland.
Johansson L , Kiessling A , Kiessling K-H and Berglund . 2000. Effects of altered ration levels on sensory characteristics, lipid content and fatty acid composition of rainbow trout (oncorhynchus mykiss). Food Quality and preference 11: 247–254.
Meilgaard M , Civille GV and Carr BT . 2006. Sensory Evaluation Techniques. 4th Ed., CRC Press.
Morita K , Kubota K and Aishima T. 2001. Sensory characteristics and volatile components in aroma of boiled prawns prepared according to experimental designs. Food Research International 34: 473–481.
Morita K , Kubota, K and Aishima T. 2003. Comparison of aroma characteristics of 16 fish species by sensory evaluation and gas chromatographic analysis. Journal of the Science of Food and Agriculture 83: 289–297.
Nielsen D , Hyldig G , Nielsen HH and Nielsen J. 2004. Sensory properties of marinated herring (Clupea harengus) - Influence of fishing ground and season. Journal of Aquatic Food Product Technology 13: 3–24.
Nielsen D , Hyldig G , Nielsen HH and Nielsen J. 2005b. Lipid content in herring (Clupea harengus L) - Influence of biological factors and comparison of different methods of analyses: Solvent extraction, fatmeter, NIR and NMR. Lebensmittel-Wissenschaft & Technologie 38: 537–548.
Nielsen D , Hyldig G , Nielsen J and Nielsen HH . 2005a. Sensory properties of marinated herring (Clupea harengus) processed from raw material from commercial landings. Journal of the Science of Food and Agriculture 85(1): 127–134.
Nielsen D , Hyldig G and Sørensen R. 2005c. An effective way to minimize drifting and monitor the performance of a sensory panel during long-term projects - A case study from a project on herring quality. Journal of Sensory Studies 20: 35–47.
NMKL Procedure NR. 6 . 2022. General guidelines for quality assuring sensory laboratories. Nordisk Metodikkomité for Levnedsmidler. https://www.nmkl.org.
NMKL Procedure NR. 21 . 2022. Guide for sensory analysis of fish and shelfish. Nordisk Metodikkomité for Levnedsmidler. https://www.nmkl.org.
Nortvedt R and Tuene S. 1998. Body composition and sensory assessment of three weight groups of Atlantic halibut (Hippoglossus hippoglossus) fed three pellet sizes and three dietary fat levels. Aquaculture 161: 295–313.
Papadopoulos LS and Finne G. 1986. Effect of enviromental salinity on sensory characteristics of Penaeid shrimp. Journal of Food Science 51: 812–814.
Petersen MA , Hyldig G , Strobel BW , Henriksen NH and Jørgensen NOG . 2011. Chemical and sensory quantification of geosmin and 2-methylisoborneol in rainbow trout (Oncorhynchus mykiss) from recirculated aquacultures in relation to concentrations in basin water. Journal of Agricultural and Food Chemistry 59(23):

12561–12568.
Rasmussen RS , Ostenfeld TH , Rønsholdt B and McLean E. 2000. Manipulation of end-product quality of rainbow trout with finishing diets. Aquaculture Nutrition 6: 17–23.
Reinitz GL , Orme LE and Hitzel FN . 1979. Variations of body composition and growth among strains of rainbow trout (Slamo gairdneri). Transactions of the American Fisheries Society 108: 204–207.
Richards M and Hultin HO . 2001. Rancidity development in a fish model system as affected by phospholipids. Journal of Food Lipids 8: 215–230.
Rørå AMB , Kvåle A , Mørkøre T , Rørvik KA , Stein SS and Thomassen M.S. 1998. Process yield, colour and sensory quality of smoked Atlantic salmon (Salmo salar) in relation to raw material characteristics. Food Research International 31: 601–609.
Schubring R and Oehlenschläger J. 1997. Comparison of the ripening process in salted Baltic and North Sea herring as measured by instrumental and sensory methods. Zeitschrift für Lebensmitteluntersuchung und -Forschung A 205: 89–92.
Sérot T , Regot C , Prost C , Robin J and Arzel J. 2001. Effect of dietary lipid sources on odour-active compounds in muscle of turbot (Psetta maxima). Journal of the Science of Food and Agriculture 81: 1339–1346.
Sivertsvik M , Rosnes JT , Vorre A , Randell K , Ahvenainen R and Bergslien H. 1999. Quality of whole gutted salmon in various bulk packages. Journal of Food Quality 22: 387–402.
Stohr V , Joffraud JJ , Cardinal M and Leroi F. 2001. Spoilage potential and sensory profile associated with bacteria isolated from cold-smoked salmon. Food Research International 34: 797–806.
Sveinsdóttir K , Hyldig G , Martinsdóttir E , Jørgensen B and Kristbergsson K. 2003. Development of quality index method (QIM) scheme for farmed Atlantic salmon (Salmo salar). Food Quality and Preferences 14: 237–245.
Sveinsdóttir K , Martinsdóttir E , Green-Petersen D , Hyldig G , Schelvis R and Delahunty C. 2009. Sensory characteristics of different cod products and consumer preferences. Food Quality and Preference 10: 120–132.
Sveinsdóttir K , Martinsdóttir E , Hyldig G and Sigurgísladóttir S. 2010. Sensory characteristics of different cod products. Journal of Sensory Studies 25(2): 294–314.
Toshiki N and Geert W. 2020. Properties of carotenoids in fish fitness: A review. Marine Drugs 18(11): 0568.
Warm K , Nielsen J and Hyldig G. 2000. Sensory quality criteria for five fish species. Journal of Food Quality 23: 583–601.
Whitfield FB , Helidoniotis F , Shaw KJ and Svoronos D. 1997. Distribution of bromophenols in Australian wild-harvested and cultivated prawns (shrimp). Journal of Agriculture and Food Chemistry 45: 4398–4405.
Whitfield FB , Helidoniotis F and Smith D. 2002. Role of feed ingredients in the bromophenol content of cultured prawns. Food Chemistry 79: 355–365.

Methodologies in Sensory and Consumer Sciences for the Evaluation of Seafood Products

Albert, A. , Salvador, A. , Schlich, P. , & Fiszman, S. (2012). Comparison between temporal dominance of sensations (TDS) and key-attribute sensory profiling for evaluating solid food with contrasting textural layers: Fish sticks. Food Quality and Preference, 24(1), 111–118. doi:10.1016/j.foodqual.2011.10.003.
Albert, A. , Varela, P. , Salvador, A. , Hough, G. , & Fiszman, S. (2011). Overcoming the issues in the sensory description of hot served food with a complex texture. Application of QDA(r), flash profiling and projective mapping using panels with different degrees of training. Food Quality and Preference, 22(5), 463–473. doi:10.1016/j.foodqual.2011.02.010.
Alexi, N. , Byrne, D. V. , Nanou, E. , & Grigorakis, K. (2018). Investigation of sensory profiles and hedonic drivers of emerging aquaculture fish species. Journal of the Science of Food and Agriculture, 98(3), 1179–1187. doi:10.1002/jsfa.8571.
Ares, G. , Barreiro, C. , Deliza, R. , Giménez, A. , & Gámbaro, A. (2010). Application of a check-all-that-apply question to the development of chocolate milk desserts. Journal of Sensory Studies, 25, 67–86. doi:10.1111/j.1745-459X.2010.00290.x.
Ares, G. , Bruzzone, F. , Vidal, L. , Cadena, R. S. , Giménez, A. , Pineau, B. , Hunter, D. C. , Paisley, A. G. , & Jaeger, S. R. (2014). Evaluation of a rating-based variant of check-all-that-apply questions: Rate-all-that-apply (RATA). Food Quality and Preference, 36, 87–95. doi:10.1016/j.foodqual.2014.03.006.
Ares, G. , & Jaeger, S. R. (2013). Check-all-that-apply questions: Influence of attribute order on sensory product characterization. Food Quality and Preference, 28(1), 141–153. doi:10.1016/j.foodqual.2012.08.016.
Ares, G. , & Jaeger, S. R. (2017). A comparison of five methodological variants of emoji questionnaires for measuring product elicited emotional associations: An application with seafood among Chinese consumers. Food Research International, 99, 216–228. doi:10.1016/j.foodres.2017.04.028.
Ares, G. , Picallo, A. , Coste, B. , Antúnez, L. , Vidal, L. , Giménez, A. , & Jaeger, S. R. (2018). A comparison of RATA questions with descriptive analysis: Insights from three studies with complex/similar products. Journal of

Sensory Studies, 33(5), e12458. doi:10.1111/joss.12458.
Ares, G. , & Varela, P. (2017). Trained vs. consumer panels for analytical testing: Fueling a long lasting debate in the field. Food Quality and Preference, 61, 79–86. doi:10.1016/j.foodqual.2016.10.006.
ASTM . (2009). MNL63-EB Just-about-Right (JAR) Scales: Design, Usage, Benefits, and Risks. West Conshohocken, PA: ASTM International.
ASTM . (2016). E2164-16, Standard Test Method for Directional Difference Test. West Conschohocken, PA: ASTM International.
ASTM . (2018a). E2610-18, Standard Test Method for Sensory Analysis - Duo-trio test. West Conschohocken, PA: ASTM International.
ASTM . (2018b). E1885-18, Standard Test Method for Sensory Analysis - Triangle Test. West Conschohocken, PA: ASTM International.
ASTM . (2018c). E2139-05, Standard Test Method for Same-Different Test. West Conschohocken, PA: ASTM International.
ASTM . (2018d). E3009-15e1, Standard Test Method for Sensory Analysis - Tetrad Test. West Conschohocken, PA: ASTM International.
Berik, N. , & Çankırılıgil, E. (2018). Sensorial evaluation of fish croquettes produced from different seafood. Aquatic Sciences and Engineering, 33(3), 96–101. doi:10.26650/ASE201818.
Brandt, M. A. , Skinner, E. Z. , and Coleman, J. A. (1963). Texture profile method. Journal of Food Science 28:404–409.
Budhathoki, M. , Zolner, A. , Nielsen, T. , & Reinbach, H. C. (2021). The role of production method information on sensory perception of smoked salmon: A mixed-method study from Denmark. Food Quality and Preference, 94, 104325. doi:10.1016/j.foodqual.2021.104325.
Cairncross, S. E. and Sjostrom, L. B. (1950). Flavor Profiles - A new approach to flavor problems. Food Technology 4:308–311.
Cardello, A. V. (2020). Human experience of eating and drinking: Perspectives on 50 years of measurement progress. H.L. Meiselman (Ed.), In H.L. Meiselman (Ed.), Handbook of Eating and Drinking: Interdisciplinary Perspectives, Springer International Publishing (pp. 1599–1625).
Castura, J. C. , Antúnez, L. , Giménez, A. , & Ares, G. (2016). Temporal check-all-that-apply (TCATA): A novel dynamic method for characterizing products. Food Quality and Preference, 47, 79–90. doi:10.1016/j.foodqual.2015.06.017.
Chen, Z. , Gurdian, C. , Sharma, C. , Prinyawiwatkul, W. , & Torrico, D. D. (2021). Exploring text mining for recent consumer and sensory studies about alternative proteins. Foods, 10(2537), 14. doi:10.3390/foods10112537.
Claret, A. , Guerrero, L. , Gartzia, I. , Garcia-Quiroga, M. , & Ginés, R. (2016). Does information affect consumer liking of farmed and wild fish? Aquaculture, 454, 157–162. doi:10.1016/j.aquaculture.2015.12.024.
Claret, A. , Guerrero, L. , Ginés, R. , Grau, A. , Hernández, M. D. , Aguirre, E. , Peleteiro, J. B. , Fernández-Pato, C. , & Rodríguez-Rodríguez, C. (2014). Consumer beliefs regarding farmed versus wild fish. Appetite, 79, 25–31. doi:10.1016/j.appet.2014.03.031.
Cliff, M. , & Heymann, H. (1993). Development and use of time-intensity methodology for sensory evaluation: A review. Food Research International, 26(5), 375–385. doi:10.1016/0963-9969(93)90081-S.
Collier, E. S. , Normann, A. , Harris, K. L. , Oberrauter, L. M. , & Bergman, P. (2022). Making more sustainable food choices one meal at a time: Psychological and practical aspects of meat reduction and substitution. Foods, 11(9), 1182. doi:10.3390/foods11091182.
Dairou, V. , & Sieffermann, J.-M. (2002). A comparison of 14 jams characterized by conventional profile and a quick original method, the flash profile. Journal of Food Science, 67(2), 826–834. doi:10.1111/j.1365-2621.2002.tb10685.x.
Dondokova, A. , Aich, S. , Kim, H.-C. , & Huh, G. H. (2019). A text mining approach to study individuals' food choices and eating behavior using twitter feeds. In J. C. Hung , N. Y. Yen , & L. Hui (Eds.), Frontier Computing (pp. 520–527). Springer. doi:10.1007/978-981-13-3648-5_60.
Fabinyi, M. , & Liu, N. (2016). The social context of the Chinese food system: An ethnographic study of the Beijing seafood market. Sustainability, 8(3), 244. doi:10.3390/su8030244.
Furey, A. E. , Hoeche, U. , & Noci, F. (2020). Adding value to under-utilised Irish fish roe: A physico-chemical and sensory comparison of cured Irish pollock (Pollachius pollachius) roe with commercial mullet (Mugil cephalus) and cod (Gadus morhua) products. Irish Journal of Agricultural and Food Research, 59(1). doi:10.15212/ijafr-2020-0114.
Gökoglu, N. (2002). A descriptive method for sensory evaluation of mussels. LWT - Food Science and Technology, 35(7), 563–567. doi:10.1006/fstl.2001.0868.
Goulas, A. E. , & Kontominas, M. G. (2007). Effect of modified atmosphere packaging and vacuum packaging on the shelf-life of refrigerated chub mackerel (Scomber japonicus): Biochemical and sensory attributes. European Food Research and Technology, 224(5), 545–553. doi:10.1007/s00217-006-0316-y.
Grisolía, J. M. , López, F. , & Ortúzar, J. de D. (2012). Sea urchin: From plague to market opportunity. Food Quality and Preference, 25(1), 46–56. doi:10.1016/j.foodqual.2012.01.004.
Hackett, P. M. W. , Schwarzenbach, J. B. , & Jürgens, U. M. (2016). Consumer Psychology: A Study Guide to Qualitative Research Methods. Berlin: Verlag Barbara Budrich. doi:10.3224/84740772.

Hyldig, G. , Larsen, E. , & Green-Petersen, D. (2007). Fish and sensory analysis in the fish chain. In Nollet, L.M.L. , Boylston, T. , Chen, F. , Coggins, P.C. , Gloria, M.B. , Hyldig, G. , Kerth, C.R. , Mckee, L.H. and Hui, Y.H. (Eds.), Handbook of Meat, Poultry and Seafood Quality, Wiley-Blackwell, Oxford (pp. 499–510). doi:10.1002/9780470277829.ch39.

ISO . (2005). Standard 5495: Sensory Analysis - Methodology - Paired Comparison Test. Geneva, Switzerland: ISO.

ISO . (2006). Standard 8587: Sensory Analysis - Methodology - Ranking. Geneva, Switzerland: ISO.

ISO . (2017). Standard 8588: Sensory Analysis - Methodology - “A” - “Not A” Test. Geneva, Switzerland: ISO.

Jack, F. R. , Piggott, J. R. , & Paterson, A. (1994). Analysis of textural changes in hard cheese during mastication by progressive profiling. Journal of Food Science, 59(3), 539–543. doi:10.1111/j.1365-2621.1994.tb05557.x.

Jaeger, S. R. , Beresford, M. K. , Paisley, A. G. , Antúnez, L. , Vidal, L. , Cadena, R. S. , Giménez, A. , & Ares, G. (2015). Check-all-that-apply (CATA) questions for sensory product characterization by consumers: Investigations into the number of terms used in CATA questions. Food Quality and Preference, 42, 154–164. doi:10.1016/j.foodqual.2015.02.003.

Jaeger, S. R. , & Cardello, A. V. (2022). Factors affecting data quality of online questionnaires: Issues and metrics for sensory and consumer research. Food Quality and Preference, 102, 104676. doi:10.1016/j.foodqual.2022.104676.

Jaeger, S. R. , Lee, P.-Y. , & Ares, G. (2018). Product involvement and consumer food-elicited emotional associations: Insights from emoji questionnaires. Food Research International, 106, 999–1011. doi:10.1016/j.foodres.2018.01.024.

Jaeger, S. R. , Vidal, L. , & Ares, G. (2021). Should emoji replace emotion words in questionnaire-based food-related consumer research? Food Quality and Preference, 92, 104121. doi:10.1016/j.foodqual.2020.104121.

Jager, G. , Schlich, P. , Tijssen, I. , Yao, J. , Visalli, M. , de Graaf, C. , & Stieger, M. (2014). Temporal dominance of emotions: Measuring dynamics of food-related emotions during consumption. Food Quality and Preference, 37, 87–99. doi:10.1016/j.foodqual.2014.04.010.

Kang, W. , Niimi, J. , Muhlack, R. A. , Smith, P. A. , & Bastian, S. E. P. (2019). Dynamic characterization of wine astringency profiles using modified progressive profiling. Food Research International, 120, 244–254. doi:10.1016/j.foodres.2019.02.041.

Kemp, S. E. , Hollowood, T. , & Hort, J. (2009). Sensory Evaluation: A Practical Handbook. Hoboken, NJ: John Wiley & Sons Ltd.

Lagast, S. , Gellynck, X. , Schouteten, J. J. , De Herdt, V. , & De Steur, H. (2017). Consumers’ emotions elicited by food: A systematic review of explicit and implicit methods. Trends in Food Science & Technology, 69, 172–189. doi:10.1016/j.tifs.2017.09.006.

Lazo, O. , Claret, A. , & Guerrero, L. (2016). A comparison of two methods for generating descriptive attributes with trained assessors: Check-All-That-Apply (CATA) vs. Free Choice Profiling (FCP). Journal of Sensory Studies, 31(2), 163–176. doi:10.1111/joss.12202.

Lawless, H. T. , Sheng, N. , and Knoops, S. S. C. P. (1995). Multidimensional scaling of sorting data applied to cheese perception. Food Quality and Preference 6:91–98.

Lawless, H. T. , & Heymann, H. (2010). Sensory Evaluation of Food: Principles and Practices (2nd ed.). New York: Springer.

Li, X. E. , Jervis, S. M. , & Drake, M. A. (2015). Examining extrinsic factors that influence product acceptance: A review. Journal of Food Science, 80(5), R901–R909. doi:10.1111/1750-3841.12852.

Lichters, M. , Möslein, R. , Sarstedt, M. , & Scharf, A. (2021). Segmenting consumers based on sensory acceptance tests in sensory labs, immersive environments, and natural consumption settings. Food Quality and Preference, 89, 104138. doi:10.1016/j.foodqual.2020.104138.

Lockshin, L. , Jarvis, W. , d'Hauteville, F. , & Perrouty, J.-P. (2006). Using simulations from discrete choice experiments to measure consumer sensitivity to brand, region, price, and awards in wine choice. Food Quality and Preference, 17(3–4), 166–178. doi:10.1016/j.foodqual.2005.03.009.

Meilgaard, M. C. , Civille, G. V. , & Carr, B. T. (2016). Sensory Evaluation Techniques (5th ed.). CRC Press, Taylor & Francis Group, Boca Raton.

Meiselman, H. L. (2021). Emotion Measurement (2nd ed.). Woodhead Publishing, Cambridge, UK

Mueller Loose, S. , Peschel, A. , & Grebitus, C. (2013). Quantifying effects of convenience and product packaging on consumer preferences and market share of seafood products: The case of oysters. Food Quality and Preference, 28(2), 492–504. doi:10.1016/j.foodqual.2012.11.004.

Niimi, J. , Collier, E. S. , Oberrauter, L.-M. , Sörensen, V. , Norman, C. , Normann, A. , Bendtsen, M. , & Bergman, P. (2022). Sample discrimination through profiling with rate all that apply (RATA) using consumers is similar between home use test (HUT) and central location test (CLT). Food Quality and Preference, 95, 104377. doi:10.1016/j.foodqual.2021.104377.

Oliveira, A. R. , Sykes, A. V. , Hachero-Cruzado, I. , Azeiteiro, U. M. , & Esteves, E. (2015). A sensory and nutritional comparison of mussels (Mytilus sp.) produced in NW Iberia and in the armona offshore production area (Algarve, Portugal). Food Chemistry, 168, 520–528. doi:10.1016/j.foodchem.2014.07.082.

Pagès, J. (2005). Collection and analysis of perceived product inter-distances using multiple factor analysis: Application to the study of 10 white wines from the Loire Valley. Food Quality and Preference, 16(7), 642–649.

Woodhead Publishing, Cambridge, UK. Enhanced Reader. doi:10.1016/j.foodqual.2005.01.006.
Payne, C. R. , & Wansink, B. (2010). Doing consumer research in the field. In Jaeger SR , MacFie H. (Eds.), Consumer-Driven Innovation in Food and Personal Care Products (pp. 358–385). Woodhead Publishing, Cambridge, UK. doi:10.1533/9781845699970.3.358.
Phillips, K. , Bremer, P. , Silcock, P. , Hamid, N. , Delahunty, C. , Barker, M. , & Kissick, J. (2009). Effect of gender, diet and storage time on the physical properties and sensory quality of sea urchin (Evechinus chloroticus) gonads. Aquaculture, 288(3–4), 205–215. doi:10.1016/j.aquaculture.2008.11.026.
Phillips, K. , Niimi, J. , Hamid, N. , Silcock, P. , Delahunty, C. , Barker, M. , Sewell, M. , & Bremer, P. (2010). Sensory and volatile analysis of sea urchin roe from different geographical regions in New Zealand. LWT - Food Science and Technology, 43(2), 202–213. doi:10.1016/j.lwt.2009.08.008.
Pineau, N. , Schlich, P. , Cordelle, S. , Mathonnière, C. , Issanchou, S. , Imbert, A. , Rogeaux, M. , Etiévant, P. , & Köster, E. (2009). Temporal dominance of sensations: Construction of the TDS curves and comparison with time-intensity. Food Quality and Preference, 20(6), 450–455. doi:10.1016/j.foodqual.2009.04.005.
Poelman, M. P. , and Steenhuis, I. H. (2019). Food choices in context. In H. L. Meiselman (Ed.), Context: The Effects of Environment on Product Design and Evaluation (pp. 143–168). United Kingdom: Woodhead Publishing.
Porcherot, C. , Delplanque, S. , Gaudreau, N. , Ischer, M. , Marles, A. , & Cayeux, I. (2018). Immersive Techniques and Virtual Reality. Volume 2: Alternative Approaches and Special Applications (pp. 69–83). Elsevier, Duxford, United Kingdom. doi:10.1016/B978-0-08-101743-2.00003-0.
Ramírez Rivera, E. D. J. , Guadalupe Ramón Canul, L. , Huante González, Y. , Shaín Mercado, A. J. , Rafael Bravo Delgado, H. , & Martínez Liébana, C. (2009). Caracterización sensorial del camarón ahumado (Litopenaeus vannamei) mediante la técnica perfil flash. Ciencia y Mar 2009, XIII(38), 27–34.
Sarnoski, P. J. , O'Keefe, S. F. , Jahncke, M. L. , Mallikarjunan, P. , & Flick, G. J. (2010). Analysis of crab meat volatiles as possible spoilage indicators for blue crab (Callinectes sapidus) meat by gas chromatography-mass spectrometry. Food Chemistry, 122(3), 930–935. doi:10.1016/j.foodchem.2010.03.069.
Schouteten, J. J. (2021). Are questionnaires the best way to measure emotions for food products and beverages? Food Quality and Preference, 92, 104122. doi:10.1016/j.foodqual.2020.104122.
Sieffermann, J. M. , Lopetcharat, K. , & Pipatsattayanuwong, S. (2005). Application of sensory science to surimi seafood. In J. W. Park (Ed.), Surimi and Surimi Seafood (pp. 803–845). Boca Raton: CRC.
Silva, F. , Duarte, A. M. , Mendes, S. , Pinto, F. R. , Barroso, S. , Ganhão, R. , & Gil, M. M. (2020). CATA vs. FCP for a rapid descriptive analysis in sensory characterization of fish. Journal of Sensory Studies, 35(6), e12605. doi:10.1111/joss.12605.
Sveinsdóttir, K. , Martinsdóttir, E. , Thórsdóttir, F. , Schelvis, R. , Kole, A. , & Thórsdóttir, I. (2010). Evaluation of farmed cod products by a trained sensory panel and consumers in different test settings. Journal of Sensory Studies, 25(2), 280–293. doi:10.1111/j.1745-459X.2009.00257.x.
Teillet, E. , Schlich, P. , Urbano, C. , Cordelle, S. , & Guichard, E. (2010). Sensory methodologies and the taste of water. Food Quality and Preference, 21(8), 967–976. doi:10.1016/j.foodqual.2010.04.012.
Thomson, D. M. H. , Crocker, C. , & Marketo, C. G. (2010). Linking sensory characteristics to emotions: An example using dark chocolate. Food Quality and Preference, 21(8), 1117–1125. doi:10.1016/j.foodqual.2010.04.011.
Thuillier, B. , Valentin, D. , Marchal, R. , & Dacremont, C. (2015). Pivot(c) profile: A new descriptive method based on free description. Food Quality and Preference, 42, 66–77. doi:10.1016/j.foodqual.2015.01.012.
Varela, P. , & Ares, G. (2012). Sensory profiling, the blurred line between sensory and consumer science. A review of novel methods for product characterization. Food Research International, 48(2), 893–908. doi:10.1016/j.foodres.2012.06.037.
Waldenstrøm, L. , Wahlgren, M. B. , Strand, Å. , Lerfall, J. , & Gaarder, M. Ø. (2022). Norwegian consumers' skepticism towards smoke-flavoring of salmon-is it for real? Foods, 11(14), 2170. doi:10.3390/foods11142170.
Worch, T. , Lê, S. , Punter, P. , & Pagès, J. (2013). Ideal profile method (IPM): The ins and outs. Food Quality and Preference, 28(1), 45–59. doi:10.1016/j.foodqual.2012.08.001.

Detection of Seafood Spoilage Microorganisms

Adzitey, F. , Huda, N. , & Ali, G. R. R. (2013). Molecular techniques for detecting and typing of bacteria, advantages and application to foodborne pathogens isolated from ducks. 3 Biotech, 3(2), 97–107. doi:10.1007/s13205-012-0074-4
Antunes-Rohling, A. , Calero, S. , Halaihel, N. , Marquina, P. , Raso, J. , Calanche, J. , Beltrán, J. A. , Álvarez, I. , & Cebrián, G. (2019a). Characterization of the spoilage microbiota of hake fillets packaged under a modified atmosphere (MAP) rich in CO2 (50% CO2/50% N2) and stored at different temperatures. Foods, 8(10), 489. doi:10.3390/foods8100489
Antunes-Rohling, A. , Calero, S. , Halaihel, N. , Marquina, P. , Raso, J. , Calanche, J. , Beltr, A. , Ignacio, Á. , & Cebri, G. (2019b). Characterization of the spoilage microbiota of hake different temperatures. Foods, 8(489),

1–14.
Bekaert, K. , Devriese, L. , Maes, S. , & Robbens, J. (2015). Characterization of the dominant bacterial communities during storage of Norway lobster and Norway lobster tails (Nephrops norvegicus) based on 16S rDNA analysis by PCR-DGGE. Food Microbiology, 46, 132–138. doi:10.1016/j.fm.2014.06.022
Böhme, K. , Fernández-No, I. C. , Barros-Velázquez, J. , Gallardo, J. M. , Calo-Mata, P. , & Cañas, B. (2010). Species differentiation of seafood spoilage and pathogenic gram-negative bacteria by MALDI-TOF mass fingerprinting. Journal of Proteome Research, 9(6), 3169–3183. doi:10.1021/pr100047q
Broekaert, K. , Heyndrickx, M. , Herman, L. , Devlieghere, F. , & Vlaemynck, G. (2013). Molecular identification of the microbiota of peeled and unpeeled brown shrimp (Crangon crangon) during storage on ice and at 7.5°C. Food Microbiology, 36(2), 123–134. doi:10.1016/j.fm.2013.04.009
Calliauw, F. , De Mulder, T. , Broekaert, K. , Vlaemynck, G. , Michiels, C. , & Heyndrickx, M. (2016). Assessment throughout a whole fishing year of the dominant microbiota of peeled brown shrimp (Crangon crangon) stored for 7 days under modified atmosphere packaging at 4°C without preservatives. Food Microbiology, 54, 60–71. doi:10.1016/j.fm.2015.10.016
Cao, J. , Wang, Q. , Ma, T. , Bao, K. , Yu, X. , Duan, Z. , Shen, X. , & Li, C. (2020a). Effect of EGCG-gelatin biofilm on the quality and microbial composition of tilapia fillets during chilled storage. Food Chemistry, 305(August 2019), 125454. doi:10.1016/j.foodchem.2019.125454
Cao, R. , Lin, R. , Sun, H. , & Liu, Q. (2020b). Microbiota and shelf life of whole and gutted Pacific saury (Cololabis saira) during refrigerated storage. Journal of Ocean University of China, 19(2), 473–478. doi:10.1007/s11802-020-4165-2
Castell, C. Y. , & Anderson, G. W. (1981). Bacteria associated with spoilage of cod fillets. Journal of Food Science, 46(2), 468–470. doi:10.1111/j.1365-2621.1981.tb04887.x
Chen, H. , Wang, M. , Yang, C. , Wan, X. , Ding, H. H. , Shi, Y. , & Zhao, C. (2019a). Bacterial spoilage profiles in the gills of Pacific oysters (Crassostrea gigas) and Eastern oysters (C. virginica) during refrigerated storage. Food Microbiology, 82(February), 209–217. doi:10.1016/j.fm.2019.02.008
Chen, X. , Li, P. , Shen, Y. , Zou, Y. , Yuan, G. , & Hu, H. (2019b). Rhamnolipid-involved antibiotics combinations improve the eradication of Helicobacter pylori biofilm in vitro: A comparison with conventional triple therapy. Microbial Pathogenesis, 131, 112–119.
Dalgaard, P. , Vancanneyt, M. , Euras Vilalta, N. , Swings, J. , Fruekilde, P. , & Leisner, J. J. (2003). Identification of lactic acid bacteria from spoilage associations of cooked and brined shrimps stored under modified atmosphere between 0°C and 25°C. Journal of Applied Microbiology, 94(1), 80–89. doi:10.1046/j.1365-2672.2003.01806.x
De Araujo, L. V. , Abreu, F. , Lins, U. , Santa Anna, L. M. D. M. , Nitschke, M. , & Freire, D. M. G. (2011). Rhamnolipid and surfactin inhibit Listeria monocytogenes adhesion. Food Research International, 44(1), 481–488.
de Lira, A. D. , de Castro, I. M. S. , Mann, M. B. , Mallmann, L. P. , Kothe, C. I. , Varela, A. P. M. , Frazzon, A. P. G. , & Frazzon, J. (2020). Evaluating Sardinella brasiliensis quality indicators through the quantification of histamine and bacterial communities. Heliyon, 6(8), e04461. doi:10.1016/j.heliyon.2020.e04461
Dewi, F. R. , Powell, S. M. , & Stanley, R. A. (2021). The effects of pre-processing sanitation and modified atmosphere packaging on microbial growth in bulk packs of Atlantic salmon (Salmo salar) fillets. IOP Conference Series: Earth and Environmental Science, 733(1), 012081. doi:10.1088/1755- 1315/733/1/012081
Diaz, M. , Ladero, V. , Redruello, B. , Sanchez-Llana, E. , del Rio, B. , Fernandez, M. , Martin, M. C. , & Alvarez, M. A. (2016). A PCR-DGGE method for the identification of histamine-producing bacteria in cheese. Food Control, 63, 216–223. doi:10.1016/j.foodcont.2015.11.035
Dolan, E. B. , Verbruggen, S. W. , & Rolfe, R. A. (2018). Techniques for studying mechanobiology. In: Stefaan W. Verbruggen (Ed.) Mechanobiology in Health and Disease (pp. 1–53). Elsevier. doi:10.1016/B978-0-12-812952-4.00001-5
Ekonomou, S. I. , Parlapani, F. F. , Kyritsi, M. , Hadjichristodoulou, C. , & Boziaris, I. S. (2022). Preservation status and microbial communities of vacuum-packed hot smoked rainbow trout fillets. Food Microbiology, 103(November 2021), 103959. doi:10.1016/j.fm.2021.103959
Ercolini, D. (2004). PCR-DGGE fingerprinting: Novel strategies for detection of microbes in food. Journal of Microbiological Methods, 56(3), 297–314. doi:10.1016/j.mimet.2003.11.006
Fernández-No, I. C. , Böhme, K. , Calo-Mata, P. , Cañas, B. , Gallardo, J. M. , & Barros-Velázquez, J. (2012). Isolation and characterization of Streptococcus parauberis from vacuum-packaging refrigerated seafood products. Food Microbiology, 30(1), 91–97. doi:10.1016/j.fm.2011.10.012
Ferone, M. , Gowen, A. , Fanning, S. , & Scannell, A. G. M. (2020). Microbial detection and identification methods: Bench top assays to omics approaches. Comprehensive Reviews in Food Science and Food Safety, 19(6), 3106–3129. doi:10.1111/1541-4337.12618
Fletcher, B. , Mullane, K. , Platts, P. , Todd, E. , Power, A. , Roberts, J. , Chapman, J. , Cozzolino, D. , & Chandra, S. (2018). Advances in meat spoilage detection: A short focus on rapid methods and technologies. CyTA - Journal of Food, 16(1), 1037–1044. doi:10.1080/19476337.2018.1525432
Franco-Duarte, R. , Černáková, L. , Kadam, S. , Kaushik, K. S. , Salehi, B. , Bevilacqua, A. , Corbo, M. R. , Antolak, H. , Dybka-Stępień, K. , Leszczewicz, M. , Relison Tintino, S. , Alexandrino de Souza, V. C. , Sharifi-Rad, J. , Melo Coutinho, H. D. , Martins, N. , & Rodrigues, C. F. (2019). Advances in chemical and biological

methods to identify microorganisms-From past to present. Microorganisms, 7(5), 130. doi:10.3390/microorganisms7050130
Gram, L. , & Dalgaard, P. (2002). Fish spoilage bacteria - Problems and solutions. Current Opinion in Biotechnology, 13(3), 262–266. doi:10.1016/S0958-1669(02)00309-9
Hovda, M. B. , Lunestad, B. T. , Sivertsvik, M. , & Rosnes, J. T. (2007a). Characterisation of the bacterial flora of modified atmosphere packaged farmed Atlantic cod (Gadus morhua) by PCR-DGGE of conserved 16S rRNA gene regions. International Journal of Food Microbiology, 117(1), 68–75. doi:10.1016/j.ijfoodmicro.2007.02.022
Hovda, M. B. , Sivertsvik, M. , Lunestad, B. T. , & Rosnes, J. T. (2007b). Microflora assessments using PCR-denaturing gradient gel electrophoresis of ozone-treated and modified-atmosphere-packaged farmed cod fillets. Journal of Food Protection, 70(11), 2460–2465. doi:10.4315/0362-028X-70.11.2460
Huang, W. , & Xie, J. (2020). Characterization of the volatiles and quality of hybrid grouper and their relationship to changes of microbial community during storage at 4°C. Molecules, 25(4), 1–16. doi:10.3390/molecules25040818
Huang, Z. , Liu, X. , Jia, S. , Zhang, L. , & Luo, Y. (2018). The effect of essential oils on microbial composition and quality of grass carp (Ctenopharyngodon idellus) fillets during chilled storage. International Journal of Food Microbiology, 266(July 2017), 52–59. doi:10.1016/j.ijfoodmicro.2017.11.003
Jääskeläinen, E. , Jakobsen, L. M. A. , Hultman, J. , Eggers, N. , Bertram, H. C. , & Björkroth, J. (2019). Metabolomics and bacterial diversity of packaged yellowfin tuna (Thunnus albacares) and salmon (Salmo salar) show fish species-specific spoilage development during chilled storage. International Journal of Food Microbiology, 293(August 2018), 44–52. doi:10.1016/j.ijfoodmicro.2018.12.021
Jaffrès, E. , Prévost, H. , Rossero, A. , Joffraud, J.-J. , & Dousset, X. (2010). Vagococcus penaei sp. Nov., isolated from spoilage microbiota of cooked shrimp (Penaeus vannamei). International Journal of Systematic and Evolutionary Microbiology, 60(9), 2159–2164. doi:10.1099/ijs.0.012872-0
Jagadeesan, B. , Gerner-Smidt, P. , Allard, M. W. , Leuillet, S. , Winkler, A. , Xiao, Y. , Chaffron, S. , Van Der Vossen, J. , Tang, S. , Katase, M. , McClure, P. , Kimura, B. , Ching Chai, L. , Chapman, J. , & Grant, K. (2019). The use of next generation sequencing for improving food safety: Translation into practice. Food Microbiology, 79, 96–115. doi:10.1016/j.fm.2018.11.005
Jérôme, M. , Macé, S. , Dousset, X. , Pot, B. , & Joffraud, J.-J. (2016). Genetic diversity analysis of isolates belonging to the Photobacterium phosphoreum species group collected from salmon products using AFLP fingerprinting. International Journal of Food Microbiology, 217, 101–109. doi:10.1016/j.ijfoodmicro.2015.10.018
Jia, S. , Liu, Y. , Zhuang, S. , Sun, X. , Li, Y. , Hong, H. , Lv, Y. , & Luo, Y. (2019). Effect of ε-polylysine and ice storage on microbiota composition and quality of Pacific white shrimp (Litopenaeus vannamei) stored at 0°C. Food Microbiology, 83(April), 27–35. doi:10.1016/j.fm.2019.04.007
Johansson, P. , Jääskeläinen, E. , Nieminen, T. , Hultman, J. , Auvinen, P. , & Björkroth, K. J. (2020). Microbiomes in the context of refrigerated raw meat spoilage. Meat and Muscle Biology, 4(2), 10369.
Kaur, A. , Soni, S. K. , Vij, S. , & Rishi, P. (2021). Cocktail of carbohydrases from Aspergillus niger: An economical and eco-friendly option for biofilm clearance from biopolymer surfaces. AMB Express, 11(1), 22. doi:10.1186/s13568-021-01183-y
Kuuliala, L. , Al Hage, Y. , Ioannidis, A. G. , Sader, M. , Kerckhof, F. M. , Vanderroost, M. , Boon, N. , De Baets, B. , De Meulenaer, B. , Ragaert, P. , & Devlieghere, F. (2018). Microbiological, chemical and sensory spoilage analysis of raw Atlantic cod (Gadus morhua) stored under modified atmospheres. Food Microbiology, 70, 232–244. doi:10.1016/j.fm.2017.10.011
Lan, W. , Sun, Y. , Liu, S. , Guan, Y. , Zhu, S. , & Xie, J. (2022). Effects of ultrasound-assisted chitosan grafted caffeic acid coating on the quality and microbial composition of pompano during ice storage. Ultrasonics Sonochemistry, 86(April), 106032. doi:10.1016/j.ultsonch.2022.106032
Lan, W. , Sun, Y. , Zhang, N. , & Xie, J. (2021). Effects of ε-polylysine and rosemary extract on quality attributes and microbial communities in vacuum-packaged large yellow croaker (Pseudosciaena crocea) during ice storage. Food Science and Biotechnology, 30(3), 465–474. doi:10.1007/s10068-021-00880-5
Lee, J. L. , & Levin, R. (2007). Rapid quantification of total bacteria on cod fillets by using real-time PCR. Journal of Fisheries Sciences.Com, 1(2), 58–67. doi:10.3153/jfscom.2007008
Lee, J.-L. , & Levin, R. (2006a). Direct application of the polymerase chain reaction for quantification of total bacteria on fish fillets. Food Biotechnology, 20(3), 287–298. doi:10.1080/08905430600904500
Lee, J.-L. , & Levin, R. (2006b). Selection of universal primers for PCR quantification of total bacteria associated with fish fillets. Food Biotechnology, 20(3), 275–285. doi:10.1080/08905430600904492
Leroi, F. , Cornet, J. , Chevalier, F. , Cardinal, M. , Coeuret, G. , Chaillou, S. , & Joffraud, J.-J. (2015). Selection of bioprotective cultures for preventing cold-smoked salmon spoilage. International Journal of Food Microbiology, 213, 79–87. doi:10.1016/j.ijfoodmicro.2015.05.005
Li, M. , Shi, J.-N. , You, G. , Ma, Y. , & Zaho, Q. (2022). Characterization of bacterial communities in Coregonus peled fillets during chilled storage and interactions between selected bacterial strains. Journal of Applied Microbiology, 132(6), 4359–4370.
Li, Q. , Zhang, L. , & Luo, Y. (2018). Changes in microbial communities and quality attributes of white muscle and dark muscle from common carp (Cyprinus carpio) during chilled and freeze-chilled storage. Food Microbiology, 73, 237–244. doi:10.1016/j.fm.2018.01.011

Li, Y. , Lei, Y. , Tan, Y. , Zhang, J. , Hong, H. , & Luo, Y. (2022). Efficacy of freeze-chilled storage combined with tea polyphenol for controlling melanosis, quality deterioration, and spoilage bacterial growth of Pacific white shrimp (Litopenaeus vannamei). Food Chemistry, 370(August 2021), 130924. doi:10.1016/j.foodchem.2021.130924
Lim, E. S. , Nam, S. J. , Koo, O. K. , & Kim, J.-S. (2023). Protective role of Acinetobacter and Bacillus for Escherichia coli O157:H7 in biofilms against sodium hypochlorite and extracellular matrix-degrading enzymes. Food Microbiology, 109, 104125. doi:10.1016/j.fm.2022.104125
Liu, J. , Wang, Y. , Zhu, F. , Yang, J. , Ma, X. , Lou, Y. , & Li, Y. (2022a). The effects of freezing under a high-voltage electrostatic field on ice crystals formation, physicochemical indices, and bacterial communities of shrimp (Solenocera melantho). Food Control, 142(July), 109238. doi:10.1016/j.foodcont.2022.109238
Liu, X. , Li, D. , Li, K. , & Luo, Y. (2018). Monitoring bacterial communities in ε-polylysine-treated bighead carp (Aristichthys nobilis) fillets using culture-dependent and culture-independent techniques. Food Microbiology, 76(October 2017), 257–266. doi:10.1016/j.fm.2018.06.001
Liu, Y. , Yan, Y. , Dong, P. , Ni, L. , Luo, X. , Zhang, Y. , & Zhu, L. (2022b). Inhibitory effects of clove and oregano essential oils on biofilm formation of Salmonella Derby isolated from beef processing plant. LWT, 162, 113486. doi:10.1016/j.lwt.2022.113486
Machado, I. , Silva, L. R. , Giaouris, E. D. , Melo, L. F. , & Simões, M. (2020). Quorum sensing in food spoilage and natural-based strategies for its inhibition. Food Research International, 127, 108754. doi:10.1016/j.foodres.2019.108754
McCombie, W. R. , McPherson, J. D. , & Mardis, E. R. (2019). Next-generation sequencing technologies. Cold Spring Harbor Perspectives in Medicine, 9(11), a036798. doi:10.1101/cshperspect.a036798
Meays, C. L. , Broersma, K. , Nordin, R. , & Mazumder, A. (2004). Source tracking fecal bacteria in water: A critical review of current methods. Journal of Environmental Management, 73(1), 71–79. doi:10.1016/j.jenvman.2004.06.001
Mizan, M. F. R. , Jahid, I. K. , & Ha, S.-D. (2015). Microbial biofilms in seafood: A food-hygiene challenge. Food Microbiology, 49, 41–55. doi:10.1016/j.fm.2015.01.009
Odeyemi, O. A. , Burke, C. M. , Bolch, C. C. J. , & Stanley, R. (2018a). Seafood spoilage microbiota and associated volatile organic compounds at different storage temperatures and packaging conditions. International Journal of Food Microbiology, 280, 87–99. doi:10.1016/j.ijfoodmicro.2017.12.029
Odeyemi, O. A. , Burke, C. M. , Bolch, C. J. , & Stanley, R. (2018b). Evaluation of spoilage potential and volatile metabolites production by Shewanella baltica isolated from modified atmosphere packaged live mussels. Food Research International, 103, 415–425.
Odeyemi, O. A. , Burke, C. M. , Bolch, C. C. J. , & Stanley, R. (2019). Spoilage microbial community profiling by 16S rRNA amplicon sequencing of modified atmosphere packaged live mussels stored at 4°C. Food Research International, 121(June 2018), 568–576. doi:10.1016/j.foodres.2018.12.017
Ohshima, C. , Takahashi, H. , Insang, S. , Phraephaisarn, C. , Techaruvichit, P. , Khumthong, R. , Haraguchi, H. , Lopetcharat, K. , & Keeratipibul, S. (2019). Next-generation sequencing reveals predominant bacterial communities during fermentation of Thai fish sauce in large manufacturing plants. LWT, 114, 108375. doi:10.1016/j.lwt.2019.108375
Oliveira, H. L. D. C. D. D. , Fleming, M. E. C. K. , Silva, P. V. , Paula, G. R. D. , Futuro, D. O. , Velarde, G. C. , Esper, L. M. R. , & Teixeira, L. A. (2014). Influence of papain in biofilm formed by methicillin-resistant Staphylococcus epidermidis and methicillin-resistant Staphylococcus haemolyticus isolates. Brazilian Journal of Pharmaceutical Sciences, 50, 261–267.
Parlapani, F. F. , Boziaris, I. S. , Meziti, A. , Michailidou, S. , Haroutounian, S. A. , Argiriou, A. , & Karapanagiotidis, I. T. (2019a). Microbiological status based on 454-pyrosequencing and volatilome analysis of gilthead seabream (Sparus aurata) fed on diets with hydrolyzed feather meal and poultry by-product meal as fishmeal replacers. European Food Research and Technology, 245(7), 1409–1420. doi:10.1007/s00217-019-03270-8
Parlapani, F. F. , Ferrocino, I. , Michailidou, S. , Argiriou, A. , Haroutounian, S. A. , Kokokiris, L. , Rantsiou, K. , & Boziaris, I. S. (2020a). Microbiota and volatilome profile of fresh and chill-stored deepwater rose shrimp (Parapenaeus longirostris). Food Research International, 132, 109057. doi:10.1016/j.foodres.2020.109057
Parlapani, F. F. , Meziti, A. , Kormas, K. A. , & Boziaris, I. S. (2013). Indigenous and spoilage microbiota of farmed sea bream stored in ice identified by phenotypic and 16S rRNA gene analysis. Food Microbiology, 33(1), 85–89. doi:10.1016/j.fm.2012.09.001
Parlapani, F. F. , Michailidou, S. , Anagnostopoulos, D. A. , Koromilas, S. , Kios, K. , Pasentsis, K. , Psomopoulos, F. , Argiriou, A. , Haroutounian, S. A. , & Boziaris, I. S. (2019b). Bacterial communities and potential spoilage markers of whole blue crab (Callinectes sapidus) stored under commercial simulated conditions. Food Microbiology, 82(March), 325–333. doi:10.1016/j.fm.2019.03.011
Parlapani, F. F. , Michailidou, S. , Anagnostopoulos, D. A. , Sakellariou, A. K. , Pasentsis, K. , Psomopoulos, F. , Argiriou, A. , Haroutounian, S. A. , & Boziaris, I. S. (2018). Microbial spoilage investigation of thawed common cuttlefish (Sepia officinalis) stored at 2°C using next generation sequencing and volatilome analysis. Food Microbiology, 76(March), 518–525. doi:10.1016/j.fm.2018.08.004
Parlapani, F. F. , Syropoulou, F. , Tsiartsafis, A. , Ekonomou, S. , Madesis, P. , Exadactylos, A. , & Boziaris, I. S. (2020b). HRM analysis as a tool to facilitate identification of bacteria from mussels during storage at 4°C.

Food Microbiology, 85, 103304. doi:10.1016/j.fm.2019.103304
Qian, Y. F. , Zhang, J. J. , Liu, C. C. , Ertbjerg, P. , & Yang, S. P. (2022). Effects of gaseous ozone treatment on the quality and microbial community of salmon (Salmo salar) during cold storage. Food Control, 142(June), 109217. doi:10.1016/j.foodcont.2022.109217
Ramachandran, P. , Reed, E. , & Ottesen, A. (2018). Exploring the microbiome of Callinectes sapidus (Maryland Blue Crab). Genome Announcement, 6(22), e00466–18. doi:10.1128/genomeA.00466-18
Rodríguez-Sánchez, B. , Cercenado, E. , Coste, A. T. , & Greub, G. (2019). Review of the impact of MALDI-TOF MS in public health and hospital hygiene, 2018. Eurosurveillance, 24(4), 1800193. doi:10.2807/1560-7917.ES.2019.24.4.1800193
Sanger, F. , Nicklen, S. , & Coulson, A. R. (1977). DNA sequencing with chain-terminating inhibitors. Proceedings of the National Academy of Sciences, 74(12), 5463–5467. doi:10.1073/pnas.74.12.5463
Sankar Ganesh, P. , & Rai Vittal, R. (2015). In vitro antibiofilm activity of Murraya koenigii essential oil extracted using supercritical fluid CO2 method against Pseudomonas aeruginosa PAO1. Natural Product Research, 29(24), 2295–2298. doi:10.1080/14786419.2015.1004673
Santos, I. C. , Hildenbrand, Z. L. , & Schug, K. A. (2016). Applications of MALDI-TOF MS in environmental microbiology. The Analyst, 141(10), 2827–2837. doi:10.1039/C6AN00131A
Silbande, A. , Adenet, S. , Chopin, C. , Cornet, J. , Smith-Ravin, J. , Rochefort, K. , & Leroi, F. (2018). Effect of vacuum and modified atmosphere packaging on the microbiological, chemical and sensory properties of tropical red drum (Sciaenops ocellatus) fillets stored at 4°C. International Journal of Food Microbiology, 266(May 2017), 31–41. doi:10.1016/j.ijfoodmicro.2017.10.015
Sørensen, J. S. , Bøknæs, N. , Mejlholm, O. , & Dalgaard, P. (2020). Superchilling in combination with modified atmosphere packaging resulted in long shelf-life and limited microbial growth in Atlantic cod (Gadus morhua L.) from capture-based-aquaculture in Greenland. Food Microbiology, 88(December 2019), 103405. doi:10.1016/j.fm.2019.103405
Syropoulou, F. , Anagnostopoulos, D. A. , Parlapani, F. F. , Karamani, E. , Stamatiou, A. , Tzokas, K. , Nychas, G.-J. E. , & Boziaris, I. S. (2022). Microbiota succession of whole and filleted European Sea Bass (Dicentrarchus labrax) during storage under aerobic and MAP conditions via 16S rRNA gene high-throughput sequencing approach. Microorganisms, 10(9), 1870. doi:10.3390/microorganisms10091870
Syropoulou, F. , Parlapani, F. F. , Bosmali, I. , Madesis, P. , & Boziaris, I. S. (2020). HRM and 16S rRNA gene sequencing reveal the cultivable microbiota of the European sea bass during ice storage. International Journal of Food Microbiology, 327(February), 108658. doi:10.1016/j.ijfoodmicro.2020.108658
Tan, T. , Wu, J. , Wang, Y. , & Teng, J. (2017). Spoilage profiles of green-lipped mussel Perna viridis: Autolysis of mussel. Journal of Food Processing and Preservation, 41(5), e13106. doi:10.1111/jfpp.13106
Tryfinopoulou, P. , Tsakalidou, E. , & Nychas, G.-J. E. (2002). Characterization of Pseudomonas spp. associated with spoilage of gilt-head sea bream stored under various conditions. Applied and Environmental Microbiology, 68(1), 65–72. doi:10.1128/AEM.68.1.65-72.2002
Tsironi, T. , Lougovois, V. , Simou, V. N. , Mexi, A. , Koussissis, S. , Tsakali, E. , Papatheodorou, S. A. , Stefanou, V. , Impe, J. V. , & Houhoula, D. (2019). Next generation sequencing (NGS) for the determination of fish flesh microbiota. Journal of Food Research, 8(4), 101. doi:10.5539/jfr.v8n4p101
Vázquez-Sánchez, D. , Galvão, J. A. , Ambrosio, C. M. S. , Gloria, E. M. , & Oetterer, M. (2018). Single and binary applications of essential oils effectively control Listeria monocytogenes biofilms. Industrial Crops and Products, 121, 452–460. doi:10.1016/j.indcrop.2018.05.045
Waters, C. M. , Lu, W. , Rabinowitz, J. D. , & Bassler, B. L. (2008). Quorum sensing controls biofilm formation in Vibrio cholerae through modulation of cyclic di-GMP levels and repression of vpsT. Journal of Bacteriology, 190(7), 2527–2536.
Wickramasinghe, N. N. , Ravensdale, J. , Coorey, R. , Dykes, G. A. , & Chandry, P. S. (2021). Transcriptional profiling of biofilms formed on chilled beef by psychrotrophic meat spoilage bacterium, Pseudomonas fragi 1793. Biofilm, 3, 100045. doi:10.1016/j.bioflm.2021.100045
Yavuzer, E. , & Köse, M. (2022). Prediction of fish quality level with machine learning. International Journal of Food Science & Technology, 57(8), 5250–5255. doi:10.1111/ijfs.15853
Yi, Z. , Yan, J. , Ding, Z. , & Xie, J. (2022). The HD-GYP domain protein of Shewanella putrefaciens YZ08 regulates biofilm formation and spoilage activities. Food Research International, 157, 111466. doi:10.1016/j.foodres.2022.111466
Yin, L. , Zhang, Y. , Azi, F. , Zhou, J. , Liu, X. , Dai, Y. , Wang, Z. , Dong, M. , & Xia, X. (2022). Inhibition of biofilm formation and quorum sensing by soy isoflavones in Pseudomonas aeruginosa. Food Control, 133, 108629. doi:10.1016/j.foodcont.2021.108629
Zhang, J. , Li, Y. , Liu, X. , Lei, Y. , Regenstein, J. M. , & Luo, Y. (2019). Characterization of the microbial composition and quality of lightly salted grass carp (Ctenopharyngodon idellus) fillets with vacuum or modified atmosphere packaging. International Journal of Food Microbiology, 293(December 2018), 87–93. doi:10.1016/j.ijfoodmicro.2018.12.022
Zhao, X. , Chen, L. , Wongmaneepratip, W. , He, Y. , Zhao, L. , & Yang, H. (2021). Effect of vacuum impregnated fish gelatin and grape seed extract on moisture state, microbiota composition, and quality of chilled seabass fillets. Food Chemistry, 354(November 2020), 129581. doi:10.1016/j.foodchem.2021.129581

Zhu, T. , Yang, C. , Bao, X. , Chen, F. , & Guo, X. (2022). Strategies for controlling biofilm formation in food industry. Grain & Oil Science and Technology, 5(4), 179–186. doi:10.1016/j.gaost.2022.06.003
Zhuang, S. , Li, Y. , Hong, H. , Liu, Y. , Shu, R. , & Luo, Y. (2020). Effects of ethyl lauroyl arginate hydrochloride on microbiota, quality and biochemical changes of container-cultured largemouth bass (Micropterus salmonides) fillets during storage at 4°C. Food Chemistry, 324(April), 126886. doi:10.1016/j.foodchem.2020.126886
Zotta, T. , Parente, E. , Ianniello, R. G. , De Filippis, F. , & Ricciardi, A. (2019). Dynamics of bacterial communities and interaction networks in thawed fish fillets during chilled storage in air. International Journal of Food Microbiology, 293(January), 102–113. doi:10.1016/j.ijfoodmicro.2019.01.008

Detection of Fish Spoilage

Hernández Palacios, M.R. 2001. Study of the Quality Management System and Product Traceability in a Fish Processing Company. The United Nations University, Fisheries Training Programme, Iceland.
Connell, J.J. 1995. Control of Fish Quality, 4th edn. Fishing News Books, Oxford, U.K.
Gill, T.A. 1992. Biochemical and chemical indices of seafood quality. In Quality Assurance in the Fish Industry. H.H. Huss , M. Jakobsen , and J. Liston (eds.), pp. 377–398, Elsevier, Amsterdam, London, New York, and Tokyo.
Drosinos, E.H. and Nychas, G.-J.E. 1996. Brochothrix thermosphacta, a dominant microorganism in Mediterranean fresh fish (Sparus aurata) stored under modified atmosphere. Italian Journal of Food Science 4: 323.
Herbert, R.A. , Hendrie, M.S. , Gibson, D.M. , and Shewan, J.M. 1971. Bacteria active in the spoilage of certain sea foods. Journal of Applied Bacteriology 34: 41.
Hozbor, M.C. , Saiz, A.I. , Yeannes, M.I. , and Fritz, R. 2006. Microbiological changes and its correlation with quality indices during aerobic iced storage of sea salmon (Pseudopercis semifasciata). LWT - Food Science and Technology 39(2): 99–104.
Koutsoumanis, K. and Nychas, G.-J.E. 1999. Chemical and sensory changes associated with microbial flora of Mediterranean boque (Boops boops) stored aerobically at 0, 3, 7 and 10°C. Applied and Environmental Microbiology 65: 698.
Koutsoumanis, K. and Nychas, G.-J.E. 2000. Application of a systematic experimental procedure in order to develop a microbial model for rapid fish shelf life predictions. International Journal of Food Microbiology 60: 171.
Nychas, G.-J.E. , Marshall, D. , and Sofos, J. 2007. Meat poultry and seafood. In Food Microbiology Fundamentals and Frontiers, 3rd edn. M.P. Doyle , L.R. Beuchat , and T.J. Montville (eds.), pp. 105–140, ASM Press, Washington, DC.
Huss, H.H. 1995. Quality and Quality Changes in Fresh Fish. FAO Fisheries Technical Paper, No 348. FAO, Rome, Italy.
Olafsdóttir, G. , Martinsdottir, E. , Oehlenschlager, J. , Dalgaard, P. , Jensen, B. , Undeland, I. , Mackie, I.M. , Henehan, G. , Nielsen, J. , and Nielsen, H. 1997. Methods to evaluate fish freshness in research and industry. Trends in Food Science and Technology 8: 258.
Gram, L. and Dalgaard, P. 2002. Fish spoilage bacteria - Problems and solutions. Current Opinion in Biotechnology 13: 262.
Gram, L. and Huss, H.H. 2000. Fresh and processed fish and shellfish. In The Microbiological Safety and Quality of Food. B.M. Lund , T.C. Baird-Parker , and G.W. Gould (eds.), pp. 472–502, Aspen Publishers, Gaithersburg, MD.
Olafsdóttir, G. , Lauzon, H.L. , Martinsdottir, E. , and Kristbergsson, K. 2006. Influence of storage temperature on microbial spoilage characteristics of haddock fillets (Melanogrammus aeglefinus) evaluated by multivariate quality prediction. International Journal of Food Microbiology 111: 112.
Luten, J.B. , Oehlenschlager, J. , and Olafsdóttir, G. 2003. Quality of Fish from Catch to Consumer; Labelling, Monitoring and Traceability. Wageningen Academic Publishers, Wageningen, the Netherlands.
Gram, L. and Huss, H.H. 1996. Microbiological spoilage of fish and fish products. International Journal of Food Microbiology 33: 121–137.
Parlapani, F.F. 2021. Microbial diversity of seafood. Current Opinion in Food Science 37: 45–51.
Parlapani, F.F. , Boziaris, I.S. , and DeWitt, C.M. 2022. Pathogens and their sources in freshwater fish, sea finfish, shellfish and algae. In Present Knowledge in Food Safety: A Risk-Based Approach Through the Food Chain, 1st edn. M. Knowles , L. Anelich , A. Boobis , and B. Popping (eds.), Elsevier, UK, pp. 471–492.
Boziaris, I.S. and Parlapani, F.F. 2014. Microbiological examination of seafood. In Seafood Processing. Technology, Quality and Safety. I.S. Boziaris (ed.), Wiley-Blackwell, IFST Advances in Food Science Series, pp. 387–418.
Tryfinopoulou, P. , Tsakalidou, E. , and Nychas, G.-J.E. 2002. Characterization of Pseudomonas spp. associated with spoilage of gilt-head sea bream stored under various conditions. Applied and Environmental

Microbiology 68: 65–72.
Gram, L. , Wedell-Neergaard, C. , and Huss, H.H. 1990. The bacteriology of fresh and spoiling Lake Victorian Nile perch (Lates niloticus). International Journal of Food Microbiology 10: 303–316.
Alfaro, B. and Hernandez, I. 2013. Evolution of the indigenous microbiota in modified atmosphere packaged Atlantic horse mackerel (Trachurus trachurus) identified by conventional and molecular methods. International Journal of Food Microbiology 167: 117–123.
Broekaert, K. , Heyndrickx, M. , Herman, L. , Devlieghere, F. , and Vlaemynck, G. 2013. Molecular identification of the microbiota of peeled and unpeeled brown shrimp (Crangon crangon) during storage on ice and at 7.5°C. Food Microbiology 36(2): 123–134. doi:10.1016/j.fm.2013.04.009.
Rudi, K. , Maugesten, T. , Hannevik, S.E. , and Nissen, H. 2004. Explorative multivariate analyses of 16S rRNA gene data from microbial communities in modified-atmosphere-packed salmon and coalfish. Applied and Environmental Microbiology 70: 5010–5018.
Svanevik, C.S. and Lunestad, B.T. 2011. Characterisation of the microbiota of Atlantic mackerel (Scomber scombrus). International Journal of Food Microbiology 151(2): 164–170. doi:10.1016/j.ijfoodmicro.2011.08.016.
Parlapani, F.F. , Kormas, K.A. , and Boziaris, I.S. 2015. Microbiological changes, shelf life and identification of initial and spoilage microbiota of sea bream fillets stored under various conditions using 16S rRNA gene analysis. Journal of the Science of Food and Agriculture 95: 2386–2394.
Syropoulou, F. , Parlapani, F.F. , Bosmali, I. , Madesis, P. , and Boziaris, I.S. 2020. HRM and 16S rRNA gene sequencing reveal the cultivable microbiota of the European sea bass during ice storage. International Journal of Food Microbiology 327: 108658.
Parlapani, F.F. , Michailidou, S. , Pasentsis, K. , Argiriou, A. , Krey, G. , and Boziaris, I.S. 2018. A meta-barcoding approach to assess and compare the storage temperature-dependent bacterial diversity of gilt-head sea bream (Sparus aurata) originating from fish farms from two geographically distinct areas of Greece. International Journal of Food Microbiology 278: 36–43.
Anagnostopoulos, D.A. , Parlapani, F.F. , and Boziaris, I.S. 2022. The evolution of knowledge on seafood spoilage microbiota from the 20st to the 21st century: Have we finished or just begun? Trends in Food Science and Technology 120: 236–247.
Zotta, T. , Parente, E. , Ianniello, R.G. , De Filippis, F. , and Ricciardi, A. 2019. Dynamics of bacterial communities and interaction networks in thawed fish fillets during chilled storage in air. International Journal of Food Microbiology 293: 102–113.
Nychas, G.E. , Skandamis, P.N. , Tassou, C.C. , and Koutsoumanis, K.P. 2008. Meat spoilage during distribution. Meat Science 78: 77–89.
Syropoulou, F. , Parlapani, F.F. , Kakasis, S. , Nychas, G.-J.E. , and Boziaris, I.S. 2021. Primary processing and storage affect the dominant microbiota of fresh and chill-stored sea bass products. Foods 10: 671
Pantazi, D. , Papavergou, A. , Pournis, N. , Kontominas, M.G. , and Savvaidis, I.N. 2008. Shelf-life of chilled fresh Mediterranean swordfish (Xiphias gladius) stored under various packaging conditions: Microbiological, biochemical and sensory attributes. Food Microbiology 25(1): 136–143.
Dalgaard, P. 2000. Fresh and lightly preserved seafood. In Shelf-Life Evaluation of Foods. C.M.D. Man and A.A. Jones (eds.), pp. 110–139, Aspen Publishers, London.
Dalgaard, P. , Gram, L. , and Huss, H.H. 1993. Spoilage and shelf life of cod fillets packed in vacuum or modified atmospheres. International Journal of Food Microbiology 19: 283–294.
Emborg, J. , Laursen, B.G. , Rathjen, T. , and Dalgaard, P. 2002. Microbial spoilage and formation of biogenic amines in fresh and thawed modified atmosphere-packed salmon (Salmo salar) at 2°C. Journal of Applied Microbiology 92: 790–799.
Gennari, M. , Tomaselli, S. , and Cotrona, V. 1999. The microflora of fresh and spoiled sardines (Sardina pilchardus) caught in Adriatic (Mediterranean) Sea and stored in ice. Food Microbiology 16: 15–28.
Gram, L. and Huss, H.H. 2000. Fresh and processed fish and shellfish. In The Microbiological Safety and Quality of Food. B.M. Lund , T. C. Baird-Parker and G. W. Gould (eds.), pp. 472–506, Aspen Publishers, Gaithersburg, MD.
Gram, L. and Dalgaard, P. 2005. Fish spoilage bacteria--Problems and solutions. Current Opinion in Biotechnology 13: 262–262; Vogel, B.F. Venkateswaran, K. , Satomi, M. , Gram, L. 2005. Applied and Environmental Microbiology 71: 6689.
Ekonomou, S.I. , Parlapani, F.F. , Kyritsi, M. , Hadjichristodoulou, C. , and Boziaris, I.S. 2022. Preservation status and microbial communities of vacuum-packed hot smoked rainbow trout fillets. Food Microbiology 103: 103959. doi:10.1016/j.fm.2021.103959.
Boziaris, I.S. and Parlapani, F.F. 2017. Specific spoilage organisms (SSO) in fish. In Microbiological Quality of Food: Foodborne Spoilers. A. Bevilacqua , M.R. Corbo , M. Sinigaglia , and R. Sykes (eds.), pp. 60–98, Elsevier, Woodhead Publishing, UK.
Huss, H.H. 1995. Assurance of Seafood Quality, FAO Fisheries Technical Paper, No. 334. United Nations Food and Agriculture Organization, Rome, Italy.
Leroi, F. 2010. Occurrence and role of lactic acid bacteria in seafood products. Food Microbiology 27(6): 698–709. doi:10.1016/j.fm.2010.05.016.
Parlapani, F.F. and Boziaris, I.S. 2016. Monitoring of spoilage status and determination of microbial communities based on 16S rRNA gene sequence analysis of whole sea bream stored at various temperatures.

LWT - Food Science and Technology 66: 553–559.
Parlapani, F.F. , Verdos, G.I. , Haroutounian, S.A. , and Boziaris, I.S. 2015. The dynamics of pseudomonas and volatilome during the spoilage of gutted sea bream stored at 2°C. Food Control 55: 257–265.
Syropoulou, F. , Parlapani, F.F. , Anagnostopoulos, D.A. , Stamatiou, A. , Mallouchos, A. , and Boziaris, I.S. 2021. Spoilage investigation of chill stored meagre (Argyrosomus regius) using modern microbiological and analytical techniques. Foods 10: 3109.
Duan, S. , Zhou, X. , Xiao, H. , Miao, J. , and Zhao, L. 2019. Characterization of bacterial microbiota in tilapia fillets under different storage temperatures. Journal of Food Science 84: 1487–1493.
Paarup, T. , Sanchez, J.A. , Moral, A. , Christensen, H. , Bisgaard, M. , and Gram, L. 2002. Sensory, chemical and bacteriological changes during storage of iced squid (Todaropsis eblanae). Journal of Applied Microbiology 92: 941–950.
Tryfinopoulou, P. , Tsakalidou, E. , Vancanneyt, M. , Hoste, B. , Swings, J. , and Nychas, G.-J.E. 2007. Diversity of Shewanella population in fish Sparus aurata harvested in the Aegean Sea. Journal of Applied Microbiology 103: 711–721.
Parlapani, F.F. , Syropoulou, F. , Tsiartsafis, A. , Ekonomou, S. , Madesis, P. , Exadactylos, A. , and Boziaris, I.S. 2020. HRM analysis as a tool to facilitate identification of bacteria from mussels during storage at 4°C. Food Microbiology 85: 103304.
Parlapani, F.F. , Ferrocino, I. , Michailidou, S. , Argiriou, A. , Haroutounian, S.A. , Kokokiris, L. , Rantsiou, K. , and Boziaris, I.S. 2020. Microbiota and volatilome profile of fresh and chill-stored deepwater rose shrimp (Parapenaeus longirostris). Food Research International 132: 109057.
Parlapani, F.F. , Michailidou, S. , Anagnostopoulos, D.A. , Sakellariou, A.K. , Pasentsis, K. , Psomopoulos, F. , Argiriou, A. , Haroutounian, S.A. , and Boziaris, I.S. 2018. Microbial spoilage investigation of thawed common cuttlefish (Sepia officinalis) stored at 2°C using next generation sequencing and volatilome analysis. Food Microbiology 76: 518–525.
Chen, H. , Wang, M. , Yang, C. , Wan, X. , Ding, H.H. , Shi, Y. , and Zhao, C. 2019. Bacterial spoilage profiles in the gills of Pacific oysters (Crassostrea gigas) and Eastern oysters (C. virginica) during refrigerated storage. Food Microbiology 82: 209–217.
Broekaert, K. , Noseda, B. , Heyndrickx, M. , Vlaemynck, G. , and Devlieghere, F. 2013. Volatile compounds associated with Psychrobacter spp. and Pseudoalteromonas spp., the dominant microbiota of brown shrimp (Crangon crangon) during aerobic storage. International Journal of Food Microbiology 166: 487–493.
Bekaert, K. , Devriese, L. , Maes, S. , and Robbens, J. 2015. Characterization of the dominant bacterial communities during storage of Norway lobster and Norway lobster tails (Nephrops norvegicus) based on 16S rDNA analysis by PCR-DGGE. Food Microbiology 46: 132–138.
Lambert, A.D. , Smith, J.P. , and Dodds, K.L. 1991. Shelf life extension and microbiological safety of fresh meat - A review. Food Microbiology 8: 267–297.
Jay, J.M. 2000. Modern Food Microbiology. Aspen Publishers, Gaithersburg, MD.
Olafsdóttir, G. , Jonsdottir, R. , Lauzon, H.L. , Luten, J. , and Kristbergsson, K. 2005. Characterization of volatile compounds in chilled cod (Cadus morhua) fillets by gas chromatography and detection of quality indicators by an electronic nose. Journal of Agricultural and Food Chemistry 53: 10140.
Dalgaard, P. 1995. Qualitative and quantitative characterization of spoilage bacteria from packed fish. International Journal of Food Microbiology 26: 319–333.
Dalgaard, P. , Mejlholm, O. , and Huss, H.H. 1996. Conductance method for quantitative determination of photobacterium phosphoreum in fish products. Journal of Applied Bacteriology 81: 57–64.
Chinivasagam, H.N. , Bremner, H.A. , Wood, A.F. , and Nottingham, S.M. 1998. Volatile components associated with bacterial spoilage of tropical prawns. International Journal of Food Microbiology 42: 45–55.
Joffraud, J.J. , Leroi, F. , Roy, C. , and Berdague, J.L. 2001. Characterisation of volatile compounds produced by bacteria isolated from the spoilage flora of cold-smoked salmon. International Journal of Food Microbiology 66: 175–181.
Laursen, B.G. , Leisner, J.J. , and Dalgaard, P. 2006. Carnobacterium species: Effect of metabolic activity and interaction with Brochothrix thermosphacta on sensory characteristics of modified atmosphere packed shrimp. Journal of Agricultural and Food Chemistry 54, 3604–3611.
Miller, III, A. , Scanlan, R.A. , Lee, J.S. , and Libbey, L.M. 1973. Identification of the volatile compounds produced in sterile fish muscle (Sebastes melanops) by Pseudomonas fragi. Applied Microbiology 25: 952–955.
Miller, III, A. , Scanlan, R.A. , Lee, J.S. , and Libbey, L.M. 1973. Volatile compounds produced in sterile fish muscle (Sebastes melanops) by Pseudomonas putrefaciens, Pseudomonas fluorescens, and an Achromobacter species. Applied Microbiology 26: 18–21.
Parlapani, F.F. , Malouchos, A. , Haroutounian, S.A. , and Boziaris, I.S. 2017. Microbial and non-microbial origin volatile organic compounds produced on model fish substrate inoculated or not with gilt-head sea bream spoilage bacteria. LWT - Food Science and Technology 78: 54–62.
Anagnostopoulos, D.A. , Parlapani, F.F. , Mallouchos, A. , Angelidou, A. , Syropoulou, F. , Minos, G. , and Boziaris, I.S. 2022. Volatile organic compounds and 16S metabarcoding in ice-stored red seabream Pagrus major. Foods 11: 666.
Jonsdottir, R. , Olafsdottir, G. , Chanie, E. , and Haugen, J.E. 2008. Volatile compounds suitable for rapid detection as quality indicators of cold smoked salmon (Salmo salar). Food Chemistry 109: 184–195.

Jørgensen, B.R. and Huss, H.H. 1989. Growth and activity of Shewanella putrefaciens isolated from spoiling fish. International Journal of Food Microbiology 9: 51–62.
Parlapani, F.F. , Malouchos, A. , Haroutounian, S.A. , and Boziaris, I.S. 2014. Microbiological spoilage and investigation of volatile profile during storage of sea bream fillets under various conditions. International Journal of Food Microbiology 189: 153–163.
Parlapani, F.F. , Haroutounian, S.A. , Nychas, G.-J.E. , and Boziaris, I.S. 2015. Microbiological spoilage and volatiles production of gutted European sea bass stored under air and commercial modified atmosphere package at 2°C. Food Microbiology 50: 44–53.
Parlapani, F.F. , Anagnostopoulos, D.A. , Koromilas, S. , Kios, K. , Michailidou, S. , Pasentsis, K. , Psomopoulos, F. , Argiriou, A. , Haroutounian, S.A. , and Boziaris, I.S. 2019. Bacterial communities and potential spoilage markers of whole Blue Crab (Callinectes sapidus) stored under commercial simulated conditions. Food Microbiology 82: 325–333.
Kuuliala, L. , Al Hage, Y. , Ioannidis, A.-G. , Sader, M. , Kerckhof, F.-M. , Vanderroost, M. , Boon, N. , De Baets, B. , De Meulenaer, B. , Ragaert, P. and Devlieghere, F. 2018. Microbiological, chemical and sensory spoilage analysis of raw Atlantic cod (Gadus morhua) stored under modified atmospheres. Food Microbiology 70: 232–244.
Bover-Cid, S. , Hernández-Jover, T. , Miguélez-Arrizado, M.J. , and Carmen Vidal-Carou, M. 2003. Contribution of contaminant enterobacteria and lactic acid bacteria to biogenic amine accumulation in spontaneous fermentation of pork sausages. European Food Research and Technology 216: 477–482. doi:10.1007/s00217-003-0691-6.
Chaouqy, N.E. , El Marrakchi , A., and Zekhnini, A. 2005. Bacteria active in the spoilage of anchovy (engraulis encrasicholus) stored in ice and at ambient temperature. [Bactéries actives dans l'altération de l'anchois (Engraulis encrasicholus) entreposé sous glace et à température ambiante]. Sciences Des Aliments 25(2): 129–146. doi:10.3166/sda.25.129-146.
Edwards, R. , Dainty, R. , Hibbard, C. , and Ramantanis, S. 1987. Amines in fresh beef of normal pH and the role of bacteria in changes in concentration observed during storage in vacuum packs at chill temperatures. Journal of Applied Bacteriology 63: 427–434. doi:10.1111/j.1365-2672.1987.tb04864.x.
Emborg, J. , Laursen, B.G. , and Dalgaard, P. 2005. Significant histamine formation in tuna (Thunnus albacares) at 2°C--Effect of vacuum- and modified atmosphere-packaging on psychrotolerant bacteria. International Journal of Food Microbiology 101(3): 263–279. doi:10.1016/j.ijfoodmicro.2004.12.001. PMID: 15925710.
Karpas, Z. , Tilman, B. , Gdalevsky, R. , and Lorber, A. 2002. Determination of volatile biogenic amines in muscle food products by ion mobility spectrometry. Analytica Chimica Acta 463(2): 155–163. doi:10.1016/S0003-2670(02)00378-1.
López-Caballero, M.E. , Álvarez Torres, M.D. , Sánchez-Fernández, J.A. , and Moral, A. (2002). Photobacterium phosphoreum isolated as a luminescent colony from spoiled fish, cultured in model system under controlled atmospheres. European Food Research and Technology 215(5): 390–395. doi:10.1007/s00217-002-0575-1.
Luten, J.B. , Bouquet, W. , Seuren, L.A.J. , Burggraaf, M.M. , Riekwel-Booy, G. , Durand, P. , Etienne, M. , Gouyou, J.P. , Landrein, A. , Ritchie, A. , Leclerq, M. and Guinet, R. 1992. Biogenic amines in fishery products: standardization methods within E.C. In: Quality Assurance in the Fish Industry, H.H. Huss , M. Jakobsen and J. Liston (eds.). Elsevier Science Publishers B.V., Amsterdam, pp. 427–439
Veciana-Nogués, M.T. , Mariné-Font, A. , and Vidal-Carou, M.C. 1997. Biogenic amines as hygienic quality indicators of tuna. Relationships with microbial counts, ATP-related compounds, volatile amines, and organoleptic changes. Journal of Agricultural and Food Chemistry 45: 2036.
Hernández-Jover, T. , Izquierdo-Pulido, M. , Veciana-Nogués, M.T. , Mariné-Font, A. , and Vidal-Carou, M.C. 1997. Biogenic amine and polyamine contents in meat and meat products. Journal of Agricultural and Food Chemistry 45: 2780–2784.
Basavakumar, K. , Karunasagar, I. , and Karunasagar, I. 1992. Ability of fish associated bacteria to produce amines suspected to be involved in scombroid poisoning. Indian Journal of Microbiology 32: 75–79.
Moinard, C. , Cynober, L. , and Bandt, J.P. 2005. Polyamines: Metabolism and implications in human diseases. Clinical Nutrition 24: 184–197.
Prester, L. 2011. Biogenic amines in fish, fish products and shellfish: A review. Food Additives and Contaminants: Part A 28(11): 1547–1560.
Larqué, E , Sabater-Molina, M. , and Zamora, S. 2007. Biological significance of dietary polyamines. Nutrition 23: 87–95.
Biji, K.B. , Ravishankar, C.N. , Venkateswarlu, R. , Mohan, C.O. , and Srinivasa Gopal, T.K. 2016. Biogenic amines in seafood: A review. Journal of Food Science and Technology 53: 2210–2218.
Doeun, D. , Davaatseren, M. , and Chung, M.S. 2017. Biogenic amines in foods. Food Science and Biotechnology 26: 1463–1474.
Xu, Y. , Zang, J. , Regenstein, J.M. , and Xia, W. 2020. Technological roles of microorganisms in fish fermentation: A review. Critical Reviews in Food Science and Nutrition 61: 1–13.
Wunderlichová, L. , Buňková, L. , Koutný, M. , Jančová, P. , and Buňka, F. 2014. Formation, degradation, and detoxification of putrescine by foodborne bacteria: A review. Comprehensive Reviews in Food Science and

Food Safety 13: 1012–1030.
Wang, H. , Luo, Y. , Huang, H. , and Xu, Q. 2014. Microbial succession of grass carp (Ctenopharyngodon idellus) filets during storage at 4 C and its contribution to biogenic amines’ formation. International Journal of Food Microbiology 190: 66–71.
Marcobal, A. , De Las Rivas, B. , Landete, J.M. , Tabera, L. , and Muñoz, R. 2012. Tyramine and phenylethylamine biosynthesis by food bacteria. Critical Reviews in Food Science and Nutrition 52: 448–467.
Paleologos, E.K. , Savvaidis, I.N. , and Kontominas, M.G. 2004. Biogenic amines formation and its relation to microbiological and sensory attributes in ice-stored whole, gutted and filleted Mediterranean Sea bass (Dicentrarchus labrax). Food Microbiology 21: 549–557.
Kuley, E. , Durmus, M. , Balikci, E. , Ucar, Y. , Regenstein, J.M. , and Özogul, F. 2017. Fish spoilage bacterial growth and their biogenic amine accumulation: Inhibitory effect of olive by-products. Intrenational Journal of Food Properties 20: 1029–1043.
Iglesias, J. and Medina, I. 2008. Solid-phase microextraction method for the determination of volatile compounds associated to oxidation of fish muscle. Journal of Chromatography A 1192: 9–16.
Kunyaboon, S. , Thumanu, K. , Park, J.W. , Khongla, C. , and Yongsawatdigul, J. 2021. Evaluation of lipid oxidation, volatile compounds and vibrational spectroscopy of silver carp (Hypophthalmichthys molitrix) during ice storage as related to the quality of its washed mince. Foods 10: 495. doi:10.3390/foods10030495.
Belitz HD , Grosch W , Schieberle P. Lipids. In: Belitz HD , Grosch W , Schieberle P , (eds.). Food Chemistry. Berlin: Springer; 2009. pp. 158–247.
Rathod, N.B. , Ranveer, R.C. , Benjakul, S. , Kim, S.K. , Pagarkar, A.U. , Patange, S. , and Ozogul, F. 2021. Recent developments of natural antimicrobials and antioxidants on fish and fishery food products. Comprehensive Reviews in Food Science and Food Safety 20(4): 4182–4210.
Ghaly, A.E. , Dave, D. , Budge, S. , and Brooks, M.S. 2010. Fish spoilage mechanisms and preservation techniques. American Journal of Applied Sciences 7(7): 859.
Nie, X. , Zhang, R. , Cheng, L. , Zhu, W. , Li, S. , and Chen, X. 2022. Mechanisms underlying the deterioration of fish quality after harvest and methods of preservation. Food Control 135: 108805.
Ashie, I.N.A. , Smith, J.P. , and Simpson, B.K. 1996. Spoilage and shelf-life extension of fresh fish and shellfish. Critical Reviews in Food Science and Nutrition 36: 87–121.
Boziaris, I.S. , Kordila, A. , and Neofitou, C. 2011. Microbial spoilage analysis and its effect on chemical changes and shelf-life of Norway lobster (Nephrops norvegicus) stored in air at various temperatures. International Journal of Food Science and Technology 46: 887–895.
Martinez-Alvarez, O. , Lopez-Caballero, M.E. , Montero, P. , and Gomez-Guillen, M.C. 2007. Spraying of 4-hexylresorcinol based formulations to prevent enzymatic browning in Norway lobsters (Nephrops norvegicus) during chilled storage. Food Chemistry 100: 147–155.
Oehlenschläger, J. and Sörensen, N.-K. 1997. Criteria of seafish freshness and quality aspects in methods to determine the freshness of fish in research and industry. Proceedings of the Final Meeting of the Concerted Action “Evaluation of Fish Freshness”. International Institute of Refrigeration, 1997/11/12 Paris, France.
Haugen, J.E. , Chanie, E. , Westad, F. , Jonsdottir, R. , Bazzo, S. , Labreche, S. , Marcq, P. , Lundby, F. , and Olafsdóttir, G. 2006. Rapid control of smoked Atlantic salmon (Salmo salar) quality by electronic nose: Correlation with classical evaluation methods. Sensors and Actuators B 116: 72.
Dainty, R.H. 1996. Chemical biochemical detection of spoilage. International Journal of Food Microbiology 33: 19.
Howgate, P. , Johnston, A. , and Whittle, K.J. 1992. Multilingual Guide to EC Freshness Grades for Fishery Products. Marine Laboratory, Scottish Office of Agriculture, Environment and Fisheries Department, Aberdeen.
Olafsdóttir, G. , Nesvadba, P. , Di Natale, C. , Careche, M. , Oehlenschlager, J. , Tryggvadóttir, S.V. , Schubring, R. , Kroeger, M. , Heia, H. , Esaiassen, M. , Macagnano, A. , and Jørgensen, B.M. 2004. Multisensor for fish quality determination. Trends in Food Science and Technology 15: 86.
Bernardo, Y.A.A. , Rosario, D.K.A. , Delgado, I.F. , and Conte-Junior, C.A. 2020. Fish quality index method: Principles, weaknesses, validation, and alternatives-A review. Comprehensive Reviews in Food Science and Food Safety 19(5): 2657–2676. doi:10.1111/1541-4337.12600.
Gram, L. , Trolle, G. , and Huss, H.H. 1987. Detection of specific spoilage bacteria from fish stored at low (0°C) and high (20°C) temperatures. International Journal of Food Microbiology 4: 65.
Van Spreekens, K.J.A. 1974. The suitability of a modification of Long and Hammer’s medium for the enumeration of more fastidious bacteria from fresh fishery products. Archiv für Lebensmittelhygiene 25: 213–219.
ISO 2003 . ISO 4833. Microbiology of Food and Animal Feeding Stuffs. Horizontal Method for the Enumeration of Microorganisms - Colony-Count Technique at 30°C. International Organization for Standardization, Geneva, Switzerland.
Kakasis, S. , Parlapani, F.F. , and Boziaris, I.S. 2011. Performance and selectivity of media used for the enumeration of bacterial populations on seafood. 33rd Scientific Conference of Hellenic Association for Biological Sciences, Edessa, 19–21 May.
Gram, L. 1992. Evaluation of the bacteriological quality of seafood. International Journal of Food Microbiology 16: 25–39.

Lopez-Caballero, M.E. , Martinez-Alvarez, O. , Gomez-Guillen, M.C. , and Montero, P. 2006. Effect of natural compounds alternative to commercial antimelanosisc on polyphenol oxidase activity and microbial growth in cultured prawns (Marsupenaeous tiger) during chill storage. European Food Research Technology 223: 7–15.
Khan, M.A. , Parrish, C.C. , and Shahidi, F. 2005. Enumeration of total heterotrophic and psychrotrophic bacteria using different types of agar to evaluate the microbial quality of blue mussels (Mytilus edulis) and sea scallops (Placopecten magellanicus). Research International 38: 751–758.
Broekaert, K. , Heyndrickx, M. , Herman, L. , Devlieghere, F. , and Vlaemynck, G. 2011. Seafood quality analysis: Molecular identification of dominant microbiota after ice storage on several general growth media. Food Microbiology 28: 1162–1169.
Lee, J.-L. and Levin, R.E. 2007. Quantification of total viable bacteria on fish fillets by using ethidium bromide monoazide real-time polymerase chain reaction. International Journal of Food Microbiology 118: 312–317.
Anagnostopoulos, D. , Syropoulou, F. , Kokioumi, D. , Parlapani, F. , and Boziaris, I. 2022. The use of qPCR for the rapid assessment of seafood freshness. Food Micro 2022, 27th International ICFMH Conference, Athens, Greece, 28–31 August, p. 216.
Reynisson, E. , Lauzon, H.L. , Magnusson, H. , Hreggvidsson, G.O. , and Marteinsson, V.T. 2008. Rapid quantitative monitoring method for the fish spoilage bacteria Pseudomonas. Journal of Environmental Monitoring 10: 1357–1362.
Duflos, G. , Theraulaz, L. , Giordano, G. , Mejean, V. , and Malle, P. 2010. Quantitative PCR method for evaluating freshness of whiting (Merlangius merlangus) and plaice (Pleuronectes platessa). Journal of Food Protection 73: 1344–1347.
Macé, S. , Mamlouk, K. , Chipchakova, S. , Prévost, H. , Joffraud, J.-J. , Dalgaard, P. , Pilet, M.-F. , and Dousset, X. 2013b. Development of a rapid real-time PCR method as a tool to quantify viable photobacterium phosphoreum bacteria in salmon (Salmo salar) steaks. Applied and Environmental Microbiology 79: 2612–2619.
Gill, C.O. and Newton, K.G. 1977. The development of aerobic spoilage flora on meat stored at chill temperatures. Journal of Applied Microbiology 43: 189–195.
Castro, P. , Padron, J.C.P. , Cansino, M.J.C. , Velazquez, E.S. , and De Larriva, R.M. 2006. Total volatile base nitrogen and its use to assess freshness in European sea bass stored in ice. Food Control 17: 245–248.
Oehlenschläger, J. 2014. Seafood quality assessment. In Seafood Processing, IFST Advances in Food Science Series. Technology, Quality and Safety. I.S. Boziaris (ed.), pp. 361–386, Wiley-Blackwell, West Sussex, UK.
Kritikos, A. , Aska, I. , Economou, S. , Mallouchos, A. , Parlapani, F.F. , Haroutounian, S.A. , and Boziaris, I.S. 2020. Volatilome of chill-stored European seabass and Atlantic salmon products under modified atmosphere packaging. Molecules 25: 1981.
Jia, S. , Li, Y. , Zhuang, S. , Sun, X. , Zhang, L. , Shi, J. , Hong, H. , and Luo, Y. 2019. Biochemical changes induced by dominant bacteria in chill-stored silver carp (Hypophthalmichthys molitrix) and GC-IMS identification of volatile organic compounds. Food Microbiology 84: 103248. doi:10.1016/j.fm.2019.103248.
Connell, J.J. and Shewan, J.M. 1980. Sensory and non-sensory assessment of fish. In Advances in Fish Science and Technology. J. Connell (ed.), p. 55556, Fishing News Books, Farnham.
Huss, H.H. 1988. Fresh Fish - Quality and Quality Changes. FAO, Danish International Development Agency, Rome, Sagraf.
Jørgensen, B.R. , Gibson, D.M. , and Huss, H.H. 1988. Microbiological quality and shelf life prediction of chilled fish. International Journal of Food Microbiology 6: 295–307.
Mendes, R. , Huidobro, A. , and Lopez-Caballero, M.E. 2002. Indole levels in deepwater pink shrimp (Parapenaeus longirostris) from the Portuguese coast. Effects of temperature abuse. European Food Research and Technology 214: 125–130.
Huang, Y.-R. , Guevara Zelaya, M.F. , and Shiau, C.-Y. 2016. Changes in biochemical compositions and quality of white shrimp (Litopenaeus vannamei) during storage. Journal of Qquatic Food Product Technology 25: 35–45.
Dabadé, D.S. , den Besten, H.M.W. , Azokpota, P. , Nout, M.J.R. , Hounhouigan, D.J. , and Zwietering, M.H. 2015. Spoilage evaluation, shelf-life prediction, and potential spoilage organisms of tropical brackish water shrimp (Penaeus notialis) at different storage temperatures. Food Microbiology 48: 8–16.
Losada, V. , Rodriguez, O. , Miranda, J.M. , Barros-Velazquez, J. , and Aubourg, S.P. 2006. Development of different damage pathways in Norway lobster (Nephrops norvegicus) stored under different chilling systems. Journal of the Science of Food and Agriculture 86: 1552–1558.
Erkan, N. and Özden, Ö. 2006. Gutted and un-gutted sea bass (Dicentrarchus labrax) stored in ice: Influence on fish quality and shelf-life. International Journal of Food Properties 9: 331–345.
Erkan, N. and Özden, Ö. 2008. Quality assessment of whole and gutted sardines (Sardina pilchardus) stored in ice. International Journal of Food Science and Technology 43: 1549–1559.
Drosinos, E.H. , Lambropoulou, K. , Mitre, E. , and Nychas, G.-J.E. 1997. Attributes of fresh gilt seabream (Sparus aurata) fillets treated with potassium sorbate, sodium gluconate and stored under a modified atmosphere at 0±1°C. Journal of Applied Microbiology 83: 569–575.
Reddy, N.R. , Schreiber, C.L. , Buzard, K.S. , Skinner, G.E. , and Armstrong, D.J. 1994. Shelf life of fresh tilapia fillets packaged in high barrier film with modified atmospheres. Journal of Food Science 59: 260–264.

Gonçalves, A.C. , Antas, S.E. , and Nunes, M.L. 2007. Freshness and quality criteria of iced farmed Senegalese sole (Solea senegalensis). Journal of Agriculture and Food Chemistry 55: 345–346.
Tejada, M. , Heras, C.D. , and Kent, M. 2007. Changes in the quality indices during ice storage of farmed Senegalese sole (Solea senegalensis). European Food Research and Technology 225: 225–232.
Antonacopoulos, N ., and Vyncke, W. 1989 Determination of volatile basic nitrogen in fish: A third collaborative study by the West European Fish Technologists' Association (WEFTA). Zeitschrift für Lebensmittel-Untersuchung und -Forschung, 189(4), pp. 309–316
Vyncke, W. , Luten, J. , Brünner, K. , and Moermans, R. 1987. Determination of total volatile bases in fish: A collaborative study by the West European Fish Technologists' Association (WEFTA). Zeitschrift für Lebensmittel-Untersuchung und Forschung 184: 110–114.
Conway, E.J. and O'Malley, E. 1942. Microdiffusion methods. Ammonia and urea using buffered absorbents (revised methods for ranges greater than 10 μg. N). Biochemical Journal 36(7–9): 655–661. doi:10.1042/bj0360655.
Dyer, W.J. 1945. Amines in fish muscle. I. Calorimetric determination of trimethylamine as the picrate salt. Journal of the Fisheries Board of Canada 8: 314.
Olafsdottir, G. , Steinke, J.A. , and Lindsay, R.C. 1985. Quantitative performance of a simple tenax-GC adsorption method for use in the analysis of aroma volatiles. Journal of Food Science 50: 1431–1436. doi:10.1111/j.1365-2621.1985.tb10493.x.
Soncin, S. , Chiesa, L.M. , Panseri, S. , Biondi, P. , and Cantoni, C. 2009. Determination of volatile compounds of precooked prawn (Penaeus vannamei) and cultured gilthead sea bream (Sparus aurata) stored in ice as possible spoilage markers using solid phase microextraction and gas chromatography/mass spectrometry. Journal of the Science of Food and Agriculture 89: 436–442. doi:10.1002/jsfa.3466.
Duflos, G. , Coin, V.M. , Cornu, M. , Antinelli, J.F. , and Malle, P. 2006. Determination of volatile compounds to characterize fish spoilage using headspace/mass spectrometry and solid-phase microextraction/gas chromatography/mass spectrometry. Journal of the Science of Food and Agriculture 86: 600–611.
Edirisinghe, R.K.B. , Graham, A.J. , and Taylor, S.J. 2007. Characterisation of the volatiles of yellowfin tuna (Thunnus albacares) during storage by solid phase microextraction and GC-MS and their relationship to fish quality parameters. International Journal of Food Science and Technology 42: 1139–1147.
Fratini, G. , Lois, S. , Pazos, M. , Parisi, G. , and Medina, I. 2012. Volatile profile of Atlantic shellfish species by HS-SPME GC/MS. Food Research International 48: 856–865.
Miks-Krajnik, M. , Yoon, Y.-J. , Ukuku, D.O. , and Yuk, H.-G. 2016. Volatile chemical spoilage indexes of raw Atlantic salmon (Salmo salar) stored under aerobic condition in relation to microbiological and sensory shelf lives. Food Microbiology 53: 182–191.
Tuckey, N.P.L. , Day, J.R. , and Miller, M.R. 2013. Determination of volatile compounds in New Zealand Greenshell(tm) mussels (Perna canaliculus) during chilled storage using solid phase microextraction gas chromatography-mass spectrometry. Food Chemistry 136: 218–223.
Ropodi, A. , Panagou, E.Z. , and Nychas, G.-J.E. 2016. Data mining derived from food analyses using non-invasive/non-destructive analytical techniques: Determination of food authenticity, quality and safety in tandem with computer science disciplines. Trends in Food Science and Technology 50: 11–25.
Soni, A. , Dixit, Y. , Reis, M.M. , and Brightwell, G. 2022. Hyperspectral imaging and machine learning in food microbiology: Developments and challenges in detection of bacterial, fungal, and viral contaminants. Comprehensive Reviews in Food Science and Food Safety 21: 3717–3745. doi:10.1111/1541-4337.12983.
Sathya, R. and Abraham, A. 2013. Comparison of supervised and unsupervised learning algorithms for pattern classification. International Journal of Advanced Research in Artificial Intelligence 2(2): 34–38.
Ghannam, R.B. and Techtmann, S.M. 2021. Machine learning applications in microbial ecology, human microbiome studies, and environmental monitoring. Computational and Structural Biotechnology Journal 19: 1092–1107. doi:10.1016/j.csbj.2021.01.028.
Çetin, N. , Karaman, K. , Kavuncuoğlu, E. , Yıldırım, B. , and Jahanbakhshi, A. 2022. Using hyperspectral imaging technology and machine learning algorithms for assessing internal quality parameters of apple fruits. Chemometrics and Intelligent Laboratory Systems 230: 104650. doi:10.1016/j.chemolab.2022.104650.
Manthou, E. , Lago, S.L. , Darges, E. , Lianou, A. , Tsakanikas, P. , Panagou, E.Z. , Anastasiadi, M. , Mohareb, F. , and Nychas, G.-J.E. 2020. Application of spectroscopic and multispectral imaging technologies on the assessment of ready-to-eat pineapple quality: A performance evaluation study of machine learning models generated from two commercial data analytics tools. Computers and Electronics in Agriculture 175: 105529.
Manthou, E. , Karnavas, A. , Fengou, L.C. , Bakali, A. , Lianou, A. , Tsakanikas, P. , and Nychas, G.-J.E. 2022. Spectroscopy and imaging technologies coupled with machine learning for the assessment of the microbiological spoilage associated to ready-to-eat leafy vegetables. International Journal of Food Microbiology 361: 109458.
Lytou, A.E. , Tsakanikas, P. , Lymperi, D. , and Nychas, G.-J.E. 2022. Rapid assessment of microbial quality in edible seaweeds using sensor techniques based on spectroscopy, imaging analysis and sensors mimicking human senses. Sensors 22(18): 7018. doi:10.3390/s22187018.
Fengou, L.C. , Spyrelli, E. , Lianou, A. , Tsakanikas, P. , Panagou, E.Z. , and Nychas, G.E. 2019. Estimation of minced pork microbiological spoilage through Fourier transform infrared and visible spectroscopy and multispectral vision technology. Foods 8(7): 238.

Estelles-Lopez, L. , Ropodi, A. , Pavlidis, D. , Fotopoulou, J. , Gkousari, C. , Peyrodie, A. , Panagou, E. , Nychas, G.J. , and Mohareb, F. 2017. An automated ranking platform for machine learning regression models for meat spoilage prediction using multi-spectral imaging and metabolic profiling. Food Research International 99(Pt 1): 206–215. doi:10.1016/j.foodres.2017.05.013. PMID: 28784477.
Govari, M. , Tryfinopoulou, P. , Parlapani, F.F. , Boziaris, I.S. , Panagou, E.Z. , and Nychas, G.E. 2021. Quest of intelligent research tools for rapid evaluation of fish quality: FTIR spectroscopy and multispectral imaging versus microbiological analysis. Foods 10(2): 264. doi:10.3390/foods10020264.
Govari, M. , Tryfinopoulou, P. , Panagou, E.Z. , and Nychas, G.-J.E. 2022. Application of Fourier transform infrared (FT-IR) spectroscopy, multispectral imaging (MSI) and electronic nose (E-nose) for the rapid evaluation of the microbiological quality of gilthead sea bream fillets. Foods 11: 2356. doi:10.3390/foods11152356.
Yu, X. , Tang, L. , Wu, X. , Lu, H. 2018. Nondestructive freshness discriminating of shrimp using visible/near-infrared hyperspectral imaging technique and deep learning algorithm. Food Analytical Methods 11: 768–780. doi:10.1007/s12161-017-1050-8.
Tsakanikas, P. , Fengou, L.-C. , Manthou, E. , Lianou, A. , Panagou, E.Z. , and Nychas, G.-J.E. 2018. A unified spectra analysis workflow for the assessment of microbial contamination of ready-to-eat green salads: Comparative study and application of non-invasive sensors. Computers and Electronics in Agriculture 155: 212–219.
Taoukis, P.S. and Labuza, T.P. 2003. Time-temperature indicators (TTIs). In Novel Food Packaging Techniques, pp. 103–126, Elsevier Ltd. doi:10.1016/B978-1-85573-675-7.50010-9.
Wang, S. , Liu, X. , Yang, M. , Zhang, Y. , Xiang, K. , and Tang, R. 2015. Review of time temperature indicators as quality monitors in food packaging. Packaging Technology and Science 28(10): 839–867. doi:10.1002/pts.2148.
Mercier, S. , Villeneuve, S. , Mondor, M. , and Uysal, I. 2017. Time-temperature management along the food cold chain: A review of recent developments. Comprehensive Reviews in Food Science and Food Safety 16(4): 647–667. doi:10.1111/1541-4337.12269.
Pacquit, A. , Crowley, K. and Diamond, D. (2008). Smart Packaging Technologies for Fish and Seafood Products. In: J. Kerry and P. Butler (eds.). Smart Packaging Technologies for Fast Moving Consumer Goods, J. Kerry and P. Butler (eds.). John Wiley and Sons, Inc., USA, pp. 75–98. https://doi.org/10.1002/9780470753699.ch5
Pacquit, A. , Frisby, J. , Diamond, D. , Lau, K.T. , Farrell, A. , Quilty, B. , and Diamond, D. 2007. Development of a smart packaging for the monitoring of fish spoilage. Food Chemistry 102: 466.
Pacquit, A. , Lau, K.T. , and Diamond, D. 2004. Development of a colorimetric sensor for monitoring of fish spoilage amines in packaging headspace. Sensors 1: 365.
Pacquit, A. , Lau, K.T. , McLaughlin, H. , Frisby, J. , Quilty, B. , and Diamond, D. 2006. Development of a volatile amine sensor for the monitoring of fish spoilage. Talanta 69(2 SPEC. ISS.): 515–520. doi:10.1016/j.talanta.2005.10.046.
Morsy, M.K. , Zór, K. , Kostesha, N. , Alstrøm, T.S. , Heiskanen, A. , El-Tanahi, H. , Sharoba, A. , Papkovsky, D. , Larsen, J. , Khalaf, H. , Jakobsen, M.H. , and Emnéus, J. 2016. Development and validation of a colorimetric sensor array for fish spoilage monitoring. Food Control 60: 346–352. doi:10.1016/j.foodcont.2015.07.038.
Wells, N. , Yusufu, D. , and Mills, A. 2019. Colourimetric plastic film indicator for the detection of the volatile basic nitrogen compounds associated with fish spoilage. Talanta 194: 830–836. doi:10.1016/j.talanta.2018.11.020.
Ma, Q. , Lu, X. , Wang, W. , Hubbe, M.A. , Liu, Y. , Mu, J. , Wang, J. , Sun, J. , and Rojas, O.J. 2021. Recent developments in colorimetric and optical indicators stimulated by volatile base nitrogen to monitor seafood freshness. Food Packaging and Shelf Life 28: 100634. doi:10.1016/j.fpsl.2021.100634.
Tavakoli, S. , Mubango, E. , Tian, L. , Bohoussou ŃDri, Y. , Tan, Y. , Hong, H. , and Luo, Y. 2023. Novel intelligent films containing anthocyanin and phycocyanin for nondestructively tracing fish spoilage. Food Chemistry 402: 134203. doi:10.1016/j.foodchem.2022.134203.
Bovill, R.A. , Bew, J. , and Baranyi, J. 2001. Measurements and predictions of growth for Listeria monocytogenes and Salmonella during fluctuating temperature II. Rapidly changing temperatures. International Journal of Food Microbiology 67: 131–137.
Devlieghere, F. , Geeraerd, A.H. , Versyck, K.J. , Vandewaetere, B. , Van Impe, J. , and Debevere, J. 2001. Growth of Listeria monocytogenes in modified atmosphere packed cooked meat products: A predictive model. Food Microbiology 18: 53–66.
Duffy, L.L. , Vanderlinde, P.B. , and Grau, F.H. 1994. Growth of Listeria monocytogenes on vacuum-packed cooked meats: Effect of pH, aw, nitrite and ascorbate. InternationalJournal of Food Microbiology 23: 377–390.
Farber, J.M. , Cai, Y. , and Ross, W.H. 1996. Predictive modeling of the growth of Listeria monocytogenes in CO2 environments. International Journal of Food Microbiology 32: 133–144.
Fernandez, P.S. , George, S.M. , Sills, C.S. , and Peck, M.W. 1997. Predictive model of the effect of CO2, pH, temperature, and NaCl on the growth and survival of foodborne pathogenic bacteria. International Journal of Food Microbiology 37: 37–45.
Koutsoumanis, K.P. and Taoukis, P. 2005. Meat safety, refrigerated storage and transport: Modeling and management. In Improving the Safety of Fresh Meat. J.N. Sofos (ed.), pp. 503–561, Woodhead/Publishing,

Ltd., CRC Press, Cambridge, U.K.
McClure, P.J. , Blackburn, C. , Cole, M.B. , Curtis, P.S. , Jones, J.E. , Legan, J.D. , Ogden, I.D. , Peck, M.W. , Roberts, T.A. , Sutherland, J.P. , and Walker, S.J. 1994. Modeling the growth, survival and death of microorganisms in foods: The UK food micromodel approach. International Journal of Food Microbiology 34: 265–275.
McMeekin, T.A. , Olley, J.N. , Ross, T. , and Ratkowsky, D.R. 1993. Predictive Microbiology - Theory and Application. Research Studies Press Ltd., Taunton, U.K., p. 339.
Ross, T. 1996. Indices for performance evaluation of predictive models in food microbiology. Journal of Applied Bacteriology 81: 501–508.
Taoukis, P.S. , Koutsoumanis, K. , and Nychas, G.-J.E. 1999. Use of time-temperature intergrator and predictive modelling for shelf life control of chilled fish under dynamic storage conditions. International Journal of Food Microbiology 53: 21.
Giannakourou, M. , Koutsoumanis, K. , Nychas, G.-J.E. , and Taoukis, P.S. 2001. Development and assessment of an intelligent shelf life desicion system (SLDS) for quality optimization of the food chill chain. Journal of Food Protection 64: 1051.
Koutsoumanis, K.P. 2001. Predictive modeling of the shelf life of fish under non isothermal conditions. Applied and Environmental Microbiology 76: 1821–1825.
Koutsoumanis, K. , Giannakourou, M. , Taoukis, P.S. , and Nychas, G.-J.E. 2002. Application of SLDs (shelf life decision system) to marine cultured fish quality. International Journal of Food Microbiology 73: 375.
Rasmussen, S.K.J. , Ross, T. , and McMeekin, T. 2002. A process risk model for the shelf life of Atlantic salmon fillets. International Journal of Food Microbiology 73: 47–60.
Taoukis, P.S. , Koutsoumanis, K. , and Nychas, G.-J.E. 1999. Use of time-temperature intergrator and predictive modelling for shelf life control of chilled fish under dynamic storage conditions. International Journal of Food Microbiology 53: 21.
Van Impe, J.F.M. and Bernaerts, K. 2000. Predictive Modelling in Foods - Conference Proceedings. KULeuven/BioTec, Belgium.
Vanderzant, C. , Savell, J.W. , Hanna, M.O. , and Potluri, V. 1986. A comparison of growth of individual meat bacteria on the lean and fatty tissue of beef, pork and lamb. Journal of Food Science 51: 5–8, 11.
Dalgaard, P. , Buch, P. , and Silberg, S. 2002. Seafood spoilage predictor - Development and distribution of a product specific application software. International Journal of Food Microbiology 73: 343–349.
Koutsoumanis, K. , Stamatiou, A. , Skandamis, P. , and Nychas, G.-J.E. 2006. Development of a microbial model for the combined effect of temperature and pH on spoilage of ground meat and validation of the model under dynamic temperature conditions. Applied and Environmental Microbiology 72: 124–134.
FAO 2022. Tools on chemical and microbiological hazards. https://www.fao.org/food-safety/resources/tools/en/.
Fraser, O. and Sumar, S. 1998. Compositional changes and spoilage in fish. Nutrition and Food Science 98: 275.
Palleroni, N.J. (1992). Introduction to the family Pseudomonadaceae. In: The Prokaryotes, Balows, A. , Truper, H.G. , Dworkin, M. , Harder, W. and Schleifer K-H. (eds.). Springer-Verlag, New York, USA, pp. 3071–3085.
Sutherland, J. 2003. Modelling food spoilage. In Food Preservations Techniques. P. Zeuthen and L. Bogh-Sorensen (eds.), pp. 451–474, CRC Woodhead Publishing Limited, Cambridge, U.K.

Predictive Modeling of Seafood Spoilage

Bernardi, D. C. , Mársico, E. T. , and Freitas, M. Q. D. (2013). Quality index method (QIM) to assess the freshness and shelf life of fish. Brazilian Archives of Biology and Technology, 56, 587–598.
Dabadé, D. S. , Azokpota, P. , Nout, M. R. , Hounhouigan, D. J. , Zwietering, M. H. , and den Besten, H. M. (2015). Prediction of spoilage of tropical shrimp (Penaeus notialis) under dynamic temperature regimes. International Journal of Food Microbiology, 210, 121–130.
Dalgaard, P. (1995). Modelling of microbial activity and prediction of shelf life for packed fresh fish. International Journal of Food Microbiology, 26(3), 305–317. doi:10.1016/0168-1605(94)00136-T.
Dalgaard, P. (2014). Food Spoilage and Safety Predictor (FSSP) Software. In Annual Report on Zoonoses in Denmark 2013 (pp. 31–31). DTU Food. Annual Report on Zoonoses in Denmark https://backend.orbit.dtu.dk/ws/portalfiles/portal/96685008/Dalgaard_2014_FSSP_Annual_Report_2_.pdf, accessed 7/01/2023 .
Dalgaard, P. , Buch, P. , and Silberg, S. (2002). Seafood spoilage predictor-development and distribution of a product specific application software. International Journal of Food Microbiology, 73(2–3), 343–349. doi:10.1016/S0168-1605(01)00670-5.
Dalgaard, P. , Mejlholm, O. , and Huss, H. H. (1997). Application of an iterative approach for development of a microbial model predicting the shelf-life of packed fish. International Journal of Food Microbiology, 38(2–3), 169–179.

Fadiji, T. , Ashtiani, S. H. M. , Onwude, D. I. , Li, Z. , and Opara, U. L. (2021). Finite element method for freezing and thawing industrial food processes. Foods, 10(4), 869. doi: 10.3390/foods10040869.
Giarratana, F. , Panebianco, F. , Nalbone, L. , Ziino, G. , Valenti, D. , and Giuffrida, A. (2022). Development of a predictive model for the shelf-life of Atlantic mackerel. Italian Journal of Food Safety, 11(1), 10019.
Koutsoumanis, K. (2001). Predictive modeling of the shelf life of fish under nonisothermal conditions. Applied and Environmental Microbiology, 67(4), 1821–1829. doi:10.1128/AEM.67.4.1821-1829.2001.
Macé, S. , Cardinal, M. , Jaffrès, E. , Cornet, J. , Lalanne, V. , Chevalier, F. , Sérot, T. , Pilet, M.-F. , Dousset, X. , and Joffraud, J. J. (2014). Evaluation of the spoilage potential of bacteria isolated from spoiled cooked whole tropical shrimp (Penaeus vannamei) stored under modified atmosphere packaging. Food Microbiology, 40, 9–17.
Membré, J. M. , and Lambert, R. J. (2008). Application of predictive modelling techniques in industry: from food design up to risk assessment. International Journal of Food Microbiology, 128(1), 10–15. doi: 10.1016/j.ijfoodmicro.2008.07.006.
Neumeyer, K. , Ross, T. , and McMeekin, T. A. (1997). Development of a predictive model to describe the effects of temperature and water activity on the growth of spoilage pseudomonads. International journal of food microbiology, 38(1), 45–54. doi: 10.1016/S0168-1605(97)00089-5.
Ratkowsky, D. A. , Olley, J. , McMeekin, T. A. , and Ball, A. (1982). Relationship between temperature and growth rate of bacterial cultures. Journal of Bacteriology, 149(1), 1–5. doi:10.1128/jb.149.1.1-5.1982.
Stavropoulou, E. , and Bezirtzoglou, E. (2019). Predictive modeling of microbial behavior in food. Foods, 8(12), 654. doi: 10.3390/foods8120654.
Yi, Z. , and Xie, J. (2021). Prediction in the dynamics and spoilage of Shewanella putrefaciens in bigeye tuna (Thunnus obesus) by gas sensors stored at different refrigeration temperatures. Foods, 10(9), 2132. doi:10.3390/foods10092132.

Detection of the Principal Foodborne Pathogens in Seafood and Seafood-Related Environments

Mead, P.S. , Slutsker, L. , Griffin, P.M. , and Tauxe, R.V. Food-related illness and death in the United States. Emerging Infect. Dis., 5: 607–625, 1999.
Crutchfield, S. , and Roberts, T. Food safety efforts accelerate in 1990’s. USDA Economic Res. Service Food Rev., 23: 44–49, 2000.
Adak, G.K. , Long, S.M. , and O'Brien, S.J. Trends in indigenous foodborne disease and deaths, England and Wales: 1992–2000. Gut, 51: 832–841, 2002.
Käferstein, F.K. , Motarjemi, Y. , and Bettcher, D.W. Foodborne disease control: A transnational challenge. Emerging Infect. Dis., 3: 503–510, 1997.
Kaper, J.B. , Morris, J.G. , and Levine, M.M. Cholera. Clin. Microbiol. Rev., 8: 48–86, 1995.
McLaughlin, J.C. Vibrio. In Manual of Clinical Microbiology, 6th ed., Murray, P.R. , Baron, E.J. , Pfaller, M.A. , Tenover, F.C. , and Yolken, R.H. , Eds., ASM Press, Washington DC, 1995, pp. 465–474.
Rippey, S.R. Infectious diseases associated with molluscan shellfish consumption. Clin. Microbiol. Rev., 7: 419–425, 1994.
Kaysner, C.A. , and DePaola, A. , Vibrio. In Compendium of Methods for the Microbiological Examination of Foods, 4th ed., Downes, F.P. , and Ito, K. , Eds., American Public Health Association, Washington, DC, 2001, pp. 405–420.
Fujino, T. et al. On the bacteriological examination of Shirasu food poisoning. Med. J. Osaka Univ., 4: 299–304, 1953.
Alam, M.J. , Tomochika, K.I. , Miyoshi, S.I. , and Shinoda, S. Environmental investigation of potentially pathogenic Vibrio parahaemolyticus in the Seto-Inland Sea, Japan. FEMS Microbiol. Lett., 208: 83–87, 2002.
Deepanjali, A. , Sanath Kumar, H. , Karunasagar, I. , and Karunasagar, I. Seasonal variation in abundance of total and pathogenic Vibrio parahaemolyticus bacteria in oysters along the southwest coast of India. Appl. Environ. Microbiol., 71: 3575–3580, 2005.
Wong, H.C. et al. Characterization of Vibrio parahaemolyticus isolates obtained from foodborne illness outbreaks during 1992 through 1995 in Taiwan. J. Food Prot., 63: 900–906, 2000.
Su, Y.G. , and Liu, C. Vibrio parahaemolyticus: A concern of seafood safety. Food Microbiol., 24: 549–558, 2007.
Daniels, N.A. et al. Vibrio parahaemolyticus infections in the United States, 1973–1998, J. Infect. Dis., 181: 1661–1666, 2000.
Joseph, S.W. , Colwell, R.R. , and Kaper, J.B. Vibrio parahaemolyticus and related halophilic Vibrios. Crit. Rev. Microbiol., 10: 77–124, 1982.
Nair, G.B. et al. Global dissemination of Vibrio parahaemolyticus serotype O3:K6 and its serovariants. Clin. Microbiol. Rev., 20: 39–48, 2007.

Kaysner, C.A. , and DePaola, A. Outbreaks of Vibrio parahaemolyticus gastroenteritis from raw oyster consumption: Assessing the risk of consumption and genetic methods for detection of pathogenic strains. J. Shellfish Res., 19: 657, 2000.
DePaola, A. , Kaysner, C.A. , Bowers, J. , and Cook, D.W. Environmental investigations of Vibrio parahaemolyticus in oysters after outbreaks in Washington, Texas, and New York (1997 and 1998). Appl. Environ. Microbiol., 66: 4649–4654, 2000.
Velazquez-Roman, J. , Leon-Sicairos, N. , de Jesus Hernandez-Diaz, L. , and Canizalez-Roman, A. Pandemic Vibrio parahaemolyticus O3:K6 on the American continent. Front. Cell. Infect. Microbiol., 3: 110, 2014.
Hara-Kudo, Y. et al. Characteristics of a sharp decrease in Vibrio parahaemolyticus infections and seafood contamination in Japan. Int. J. Food Microbiol., 157: 95–101, 2012.
Fuenzalida, L. et al. Vibrio parahaemolyticus strains isolated during investigation of the summer 2006 seafood related diarrhea outbreaks in two regions of Chile. Int. J. Food Microbiol., 117: 270–275, 2007.
McLaughlin, J.B. et al. Outbreak of Vibrio parahaemolyticus gastroenteritis associated with Alaskan oysters. N. Engl. J. Med., 353: 1463–1470, 2005.
Newton, A.E. et al. Notes from the field: Increase in Vibrio parahaemolyticus infections associated with consumption of Atlantic coast shellfish-2013. MMWR Morb. Mortal. Wkly. Rep., 63: 335–336, 2014.
Martinez-Urtaza, J. et al. Epidemiological investigation of a foodborne outbreak in Spain associated with U.S. West Coast genotypes of Vibrio parahaemolyticus. SpringerPlus, 5: 87, 2016.
Li, B. et al. Vibrio parahaemolyticus O4:K8 forms a potential predominant clone in southern China as detected by whole-genome sequence analysis. Int. J. Food Microbiol., 244: 90–95, 2017.
MMWR . Vibrio vulnificus infections associated with raw A review, J. Microbiol. Meth., 59, 301–316, 2004.
Blake, P.A. , et al . Disease caused by a marine Vibrio. Clinical characteristics and epidemiology. N. Engl. J. Med., 300, 1–5, 1979.
Strom, M.S. , and Paranjpye, R.N. , Epidemiology and pathogenesis of Vibrio vulnificus, Microbes Infect., 2, 177–188, 2000.
Wright, A.C. , et al ., Distribution of Vibrio vulnificus in the Chesapeake Bay. Appl. Environ. Microbiol., 62, 717–724, 1996.
Harwood, V.J. , Gandhi, J.P. , and Wright A.C. Methods for isolation and confirmation of Vibrio vulnificus from oysters and environmental sources: a review, J. Microbiol. Meth., 59, 301– 316, 2004.
Inoue, Y. et al. Epidemiological survey of Vibrio vulnificus infection in Japan between 1999 and 2003. J. Dermatol., 35: 129–139, 2008.
Nagao, Y. et al. Knowledge of Vibrio vulnificus infection among Japanese patients with liver diseases: A prospective multicenter study. Med. Sci. Monit., 15: PH115–PH120, 2009.
Matsumoto, K. et al. Clinical features of Vibrio vulnificus infections in the coastal areas of the Ariake Sea, Japan. J. Infect. Chemother., 16: 272–279, 2010.
Matsuoka, Y. et al. Accurate diagnosis and treatment of Vibrio vulnificus infection: A retrospective study of 12 cases. Braz. J. Infect. Dis., 17: 7–12, 2013.
Cook, D.W. et al. Vibrio vulnificus and Vibrio parahaemolyticus in U.S. retail shell oysters: A national survey from June 1998 to July 1999. J. Food Prot., 65: 79–87, 2002.
Hlady, W.G. , and Klontz, K.C. The epidemiology of Vibrio infections in Florida, 1981–1993. J. Infect. Dis., 173: 1176–1183, 1996.
Klontz, K.C. , Williams, L. , Baldy, L.M. , and Campos, M. Raw oyster-associated Vibrio infections: Linking epidemiologic data with laboratory testing of oysters obtained from a retail outlet. J. Food Prot., 56: 977–979, 1994.
Motes, M.L. et al. Influence of water temperature and salinity on Vibrio vulnificus in Northern Gulf and Atlantic Coast oysters (Crassostrea virginica). Appl. Environ. Microbiol., 64: 1459–1465, 1998.
Daniels, N.A. Vibrio vulnificus oysters: Pearls and perils. Clin. Infect. Dis., 52: 788–792, 2011.
Horseman, M.A. , and Surani, S. A comprehensive review of Vibrio vulnificus: An important cause of severe sepsis and skin and soft-tissue infection. Int. J. Infect. Dis., 15: e157–e166, 2011.
Cazorla, C. et al. Fatal Vibrio vulnificus infection associated with eating raw oysters, New Caledonia. Emerging Infect. Dis., 17: 136–137, 2011.
Jung, S.I. et al. Vibrio vulnificus endophthalmitis occurring after ingestion of raw seafood. J. Infect., 51: e281–e283, 2005.
Shapiro, R. et al. The role of Gulf Coast oysters harvested in warmer months in Vibrio vulnificus infections in the United States, 1988–1996. J. Infect. Dis., 178: 752–759, 1998.
World Health Organization . Weekly epidemiological record. Cholera, 91: 433–440, 2016.
Dobosh, D. , Gomez-Zavaglia, A. , and Kuljich, A. The role of food in cholera transmission. Medicina, 55: 28–32, 1995.
Faruque, S.M. , Albert, M.J. , and Mekalanos, J.J. Epidemiology, genetics, and ecology of toxigenic Vibrio cholerae. Microbiol. Molec. Biol. Rev., 62: 1301–1314, 1998.
Mintz, E.D. , Popovic, T. , and Blake, P.A. Transmission of Vibrio cholerae O1. In Vibrio Cholerae and Cholera: Molecular to Global Perspectives, Wachsmuth, I.K. , Blake, P.A. , and Olsvik, O. , Eds., ASM Press, Washington, DC, 1994: 345–356.

Albert, M.J. Vibrio cholerae O139 Bengal. J. Clin. Microbiol., 32: 2345–2349, 1994.
Hill, V.R. et al. Toxigenic Vibrio cholerae O1 in water and seafood, Haiti. Emerging Infect. Dis., 17: 2147, 2011.
Baron, S. et al. No evidence of significant levels of toxigenic V. cholerae O1 in the Haitian aquatic environment during the 2012 rainy season. PLoS Curr., 5, 2013.
doi:10.1371/currents.outbreaks.7735b392bdcb749baf5812d2096d331e.
Jiménez, M.L. et al. Multinational cholera outbreak after wedding in the Dominican Republic. Emerging Infect. Dis., 17: 2172, 2011.
Madden, J.M. et al. Virulence of three clinical isolates of Vibrio cholerae non O-1 serogroup in experimental enteric infections in rabbits. Infect. Immun., 33: 616–619, 1981.
Sharma, C. et al. Molecular analysis of non-O1 non-O139 Vibrio cholerae associated with an unusual upsurge in the incidence of cholera-like disease in Calcutta, India. J. Clin. Microbiol., 36: 756–763, 1998.
Restrepo, D. , Huprikar, S.S. , VanHorn, K. , and Bottone, E.J. O1 and non-O1 Vibrio cholerae bacteremia produced by hemolytic strains. Diagn. Microbiol. Infect. Dis., 54: 145–148, 2006.
Albuquerque, A. , Cardoso, H. , Pinheiro, D. , and Macedo, G. Vibrio cholerae non-O1 and non-O139 bacteremia in a non-traveler Portuguese cirrhotic patient: First case report. Gastroenterol. Hepatol., 36: 309–310, 2013.
Lu, B. et al. The first case of bacteraemia due to non-O1/non-O139 Vibrio cholerae in a type 2 diabetes mellitus patient in mainland China. Int. J. Infect. Dis., 25: 116–118, 2014.
Arias, C.R. , Garay, E. , and Aznar, R. Nested PCR method for rapid and sensitive detection of Vibrio vulnificus in fish, sediments, and water. Appl. Environ. Microbiol., 61: 3476–3478, 1995.
Colwell, R.R. et al. Occurrence of Vibrio cholerae O1 in Maryland and Louisiana estuaries. Appl. Environ. Microbiol., 41: 555–558, 1981.
Wachsmuth, K. et al. Molecular epidemiology of cholera. In Vibrio cholerae and Cholera: Molecular to Global Perspectives, Wachsmuth, I.K. , Blake, P.A. , and Olsvik, O. , Eds., ASM Press, Washington, DC, 1994, pp. 357–370.
Rocourt, J. , Jacquet, C. , and Reilly, A. Epidemiology of human listeriosis and seafoods. Int. J. Food Microbiol., 62: 197–209, 2000.
Cao, J. et al. Concentrations and tracking of Listeria monocytogenes strains in a seafood-processing environment using a most-probable-number enrichment procedure and randomly amplified polymorphic DNA analysis. J. Food Prot., 69: 489–494, 2006.
Farber, J.M. Present situation in Canada regarding Listeria monocytogenes and ready-to-eat seafood products. Int. J. Food Microbiol., 62: 247–251, 2000.
Van Coillie, E. et al. Prevalence and typing of Listeria monocytogenes in ready-to-eat food products on the Belgian market. J. Food Prot., 67: 2480–2487, 2004.
Midelet-Bourdin, G. , Leleu, G. , and Malle, P. Evaluation of the international reference methods NF EN ISO 11290-1 and 11290-2 and an in-house method for the isolation of Listeria monocytogenes from retail seafood products in France. J. Food Prot., 70: 891–900, 2007.
Jeyasekaran, G. , Karunasagar, I. , and Karunasagar, I. Incidence of Listeria spp. in tropical fish. Int. J. Food Microbiol., 31: 333–340, 1996.
Nakamura, H. et al. Listeria monocytogenes isolated from cold-smoked fish products in Osaka City, Japan. Int. J. Food Microbiol., 94: 323–328, 2004.
Nakamura, H. et al. Molecular typing to trace Listeria monocytogenes isolated from cold-smoked fish to a contamination source in a processing plant. J. Food Prot., 69: 835–841, 2006.
Vongkamjan, K. , Benjakul, S. , Vu, H.T.K. , and Vuddhakul, V. Longitudinal monitoring of Listeria monocytogenes and Listeria phages in seafood processing environments in Thailand. Food Microbiol., 66: 1–19, 2017.
González, D. , Vitas, A.I. , Díez-Leturia, M. , and García-Jalón, I. Listeria monocytogenes and ready-to-eat seafood in Spain: Study of prevalence and temperatures at retail. Food Microbiol., 36: 374–378, 2013.
Humphrey, T. Public-health aspects of Salmonella infection. In Salmonella in Domestic Animals, Way, C. , and Way, A. , Eds., CABI Publishing, Oxon, UK, 2000, pp. 245–263.
CAST Report . Foodborne Pathogens: Risks and Consequences. Task Force Report No. 122, Council for Agricultural Science and Technology, Washington, DC, 1994.
Tirado, C. , and Schmidt, K. WHO surveillance programme for control of foodborne infections and intoxications: Preliminary results and trends across greater Europe. World Health Organization. J. Infect., 43: 80–84, 2001.
Wallace, D.J. et al. Incidence of foodborne illnesses reported by the foodborne diseases active surveillance network (FoodNet)-1997. J. Food Prot., 63: 807–809, 2000.
Schmidt, K. , and Tirado, C. WHO Surveillance Programme for Control of Foodborne Infections and Intoxications in Europe, 7th Report 1993–1998. Federal Institute for Health Protection of Consumers and Veterinary Medicine (BgVV), Berlin, Germany, 2001.
EC (European Commission) . Trends and Sources of Zoonotic Agents in Animals, Feedstuffs, Food and Man in the European Union and Norway to the European Commission in Accordance with Article 5 of the Directive 92/117/EEC. Working document SANCO/927/2002, Part 1, Community Reference Laboratory on the Epidemiology of Zoonoses, Berlin, 2002, pp. 45–122.

Ferrari, R.G. et al. Worldwide epidemiology of salmonella serovars in animal-based foods: A meta-analysis. Appl. Environ. Microbiol., 85: e00591–e00619, 2019.
Kumar, H.S. et al. Detection of Salmonella spp. in tropical seafood by polymerase chain reaction. Int. J. Food Microbiol., 88: 91–95, 2003.
Shabarinath, S. et al. Detection and characterization of Salmonella associated with tropical seafood. Int. J. Food Microbiol., 114: 227–233, 2007.
International Organization for Standardization (ISO) . ISO 8914 General Guidance for the Detection of Vibrio parahaemolyticus. ISO, Geneva, Switzerland, 1990.
Kaysner, C.A. , and DePaola, A. Vibrio cholerae, V. parahaemolyticus, V. vulnificus, and other Vibrio spp. In US Food and Drug Administration Bacteriological Analytical Manual, 8th ed., Revision A , 2004.
International Organization for Standardization (ISO) . ISO/TS 21872-1:2007 Microbiology of Food and Animal Feeding Stuffs. Horizontal Method for the Detection of Potentially Enteropathogenic Vibrio spp. -- Part 1: Detection of Vibrio parahaemolyticus and Vibrio cholerae. ISO, Geneva, Switzerland, 2007a.
Lee, C.Y. , Pan, S.F. , and Chen, C.H. Sequence of a cloned pR72H fragment and its use for detection of Vibrio parahaemolyticus in shellfish with the PCR. Appl. Environ. Microbiol., 61: 1311–1317, 1995.
Karunasagar, I. , Sugumar, G. , Karunasagar, I. , and Reilly, P.J. Rapid polymerase chain reaction method for detection of Kanagawa positive Vibrio parahaemolyticus in seafoods. Int. J. Food Microbiol., 31: 317–323, 1996.
Venkateswaran, K. , Dohmoto, N. , and Harayama, S. Cloning and nucleotide sequence of the gyrB gene of Vibrio parahaemolyticus and its application in detection of this pathogen in shrimp. Appl. Environ. Microbiol., 64: 681–687, 1998.
Kim, Y.B. et al. Identification of Vibrio parahaemolyticus strains at the species level by PCR targeted to the toxR gene. J. Clin.Microbiol., 37: 1173–1177, 1999.
Hara-Kudo, Y. et al. Increased sensitivity in PCR detection of tdh-positive Vibrio parahaemolyticus in seafood with purified template DNA. J. Food Prot., 66: 1675–1680, 2003.
Myers, M.L. , Panicker, G. , and Bej, A.K. PCR detection of a newly emerged pandemic Vibrio parahaemolyticus O3:K6 pathogen in pure cultures and seeded waters from the Gulf of Mexico. Appl. Environ. Microbiol., 69: 2194–2200, 2003.
Luan, X. et al. Comparison of different primers for rapid detection of Vibrio parahaemolyticus using the polymerase chain reaction. Lett. Appl. Microbiol., 44: 242–247, 2007.
Espineira, M. , Atanassova, M. , Vieites, J.M. , and Santaclara, F.J. Validation of a method for the detection of five species, serogroups, biotypes and virulence factors of Vibrio by multiplex PCR in fish and seafood. Food Microbiol., 27: 122–131, 2010.
No, A.R. , Okada, K. , Kogure, K. , and Park, K.S. Rapid detection of Vibrio parahaemolyticus by PCR targeted to the histone like nucleoid structure (H-NS) gene and its genetic characterization. Lett. Appl. Microbiol., 53: 127–133, 2011.
Hossain, M.T. , Kim, Y.O. , and Kong, I.S. Multiplex PCR for the detection and differentiation of Vibrio parahaemolyticus strains using the groEL, tdh and trh genes. Mol. Cell. Probes, 27: 171–175, 2013.
Yu, S. et al. Species-specific PCR detection of the food-borne pathogen Vibrio parahaemolyticus using the irgB gene identified by comparative genomic analysis. FEMS Microbiol. Lett., 307: 65–71, 2010.
Taminiau, B. et al. Validation of real-time PCR for detection of six major pathogens in seafood products. Food Control, 44: 130–137, 2014.
Tada, J. et al. Detection of the thermostable direct hemolysin gene (tdh) and the thermostable direct hemolysin-related hemolysin gene (trh) of Vibrio parahaemolyticus by polymerase chain reaction. Mol. Cell. Probes, 6: 477–487, 1992.
Bej, A.K. et al. Detection of total and hemolysin-producing Vibrio parahaemolyticus in shellfish using multiplex PCR amplification of tl, tdh and trh. J. Microbiol. Meth., 36: 215–225, 1999.
Luan, X. et al. Rapid quantitative detection of Vibrio parahaemolyticus in seafood by MPN-PCR. Curr. Microbiol., 57: 218–221, 2008.
Blackstone, G.M. et al. Detection of pathogenic Vibrio parahaemolyticus in oyster enrichments by real time PCR. J. Microbiol. Meth., 53: 149–155, 2003.
Messelhausser, U. et al. Detection and differentiation of Vibrio spp. in seafood and fish samples with cultural and molecular methods. Int. J. Food Microbiol., 142: 360–364, 2010.
Garrido-Maeztu, A. et al. Development of a multiplex real-time PCR method for pathogenic Vibrio parahaemolyticus detection (tdhC and trhC). Food Control, 24: 128–135, 2012.
Rizvi, A.V. , and Bej, A.K. Multiplexed real-time PCR amplification of tlh, tdh and trh genes in Vibrio parahaemolyticus and its rapid detection in shellfish and Gulf of Mexico water. Antonie Van Leeuwenhoek, 98: 279–290, 2010.
Robert-Pillot, A. et al. Total and pathogenic Vibrio parahaemolyticus in shrimp: Fast and reliable quantification by real-time PCR. Int. J. Food Microbiol., 143: 190–197, 2010.
Robert-Pillot, A. et al. Occurrence of the three major Vibrio species pathogenic for human in seafood products consumed in France using real-time PCR. Int. J. Food Microbiol., 189: 75–81, 2014.

Zhu, R.G. , Li, T.P. , Jia, Y.F. , and Song, L.F. Quantitative study of viable Vibrio parahaemolyticus cells in raw seafood using propidium monoazide in combination with quantitative PCR. J. Microbiol. Methods, 90: 262–266, 2012.
Wang, S. , and Levin, R.E. Rapid quantification of Vibrio vulnificus in clams (Protochaca staminea) using real-time PCR. Food Microbiol., 23: 757–761, 2006.
Kaufman, G.E. et al. Real-time PCR quantification of Vibrio parahaemolyticus in oysters using an alternative matrix. J. Food Prot., 67: 2424–2429, 2004.
Garrido-Maeztu, A. et al. In-house validation of novel multiplex real-time PCR gene combination for the simultaneous detection of the main human pathogenic vibrios (Vibrio cholerae, Vibrio parahaemolyticus, and Vibrio vulnificus). Food Control, 37: 371–379, 2014.
Kim, J.Y. , and Lee, J.L. Multipurpose assessment for the quantification of Vibrio spp. and total bacteria in fish and seawater using multiplex real time polymerase chain reaction. J. Sci. Food Agric., 94: 2807–2817, 2014.
Kim, H.-J. , Lee, H.-J. , Lee, K.-H. , and Cho, J.-C. Simultaneous detection of pathogenic Vibrio species using multiplex real-time PCR. Food Control, 23: 491–498, 2012.
Takahashi, H. , Iwade, Y. , Konuma, H. , and Hara-Kudo, Y. Development of a quantitative real-time PCR method for estimation of the total number of Vibrio parahaemolyticus in contaminated shellfish and seawater. J. Food Prot., 68: 1083–1088, 2005.
Cai, T. , Jiang, L. , Yang, C. , and Huang, K. Application of real-time PCR for quantitative detection of Vibrio parahaemolyticus from seafood in eastern China. FEMS Immunol. Med. Microbiol., 46: 180–186, 2006.
Davis, C.R. et al. Real-time PCR detection of the thermostable direct hemolysin and thermolabile hemolysin genes in a Vibrio parahaemolyticus cultured from mussels and mussel homogenate associated with a foodborne outbreak. J. Food Prot., 67: 1005–1008, 2004.
Rizvi, A.V. , Panicker, G. , Myers, M.L. , and Bej, A.K. Detection of pandemic Vibrio parahaemolyticus O3:K6 serovar in Gulf of Mexico water and shellfish using real-time PCR withTaqman fluorescent probes. FEMS Microbiol. Lett., 262: 185–192, 2006.
Ward, L.N. , and Bej, A.K. Detection of Vibrio parahaemolyticus in shellfish by use of multiplexed real-time PCR with TaqMan fluorescent probes. Appl. Environ. Microbiol., 72: 2031–2042, 2006.
Nordstrom, J.L. et al. Development of a multiplex real-time PCR assay with an internal amplification control for the detection of total and pathogenic Vibrio parahaemolyticus bacteria in oysters. Appl. Environ. Microbiol., 73: 5840–5847, 2007.
Hill, W.E. et al. Polymerase chain reaction identification of Vibrio vulnificus in artificially contaminated oysters. Appl. Environ. Microbiol., 57: 707–711, 1991.
Brauns, L.A. , Hudson, M.C. , and Oliver, J.D. Use of the polymerase chain reaction in detection of culturable and non-culturable Vibrio vulnificus cells. Appl. Environ. Microbiol., 57: 2651–2655, 1991.
Kumar, H.S. , Parvathi, A. , Karunasagar, I. , and Karunasagar, I. A gyrB-based PCR for the detection of Vibrio vulnificus and its application for direct detection of this pathogen in oyster enrichment broths. Int. J. Food Microbiol., 111: 216–220, 2006.
Wang, R.F. , Cao, W.W. , and Cerniglia, C.E. A universal protocol for PCR detection of 13 species of foodborne pathogens in foods. J. Appl. Microbiol., 83: 727–736, 1997.
Brasher, C.W. , DePaola, A. , Jones, D.D. , and Bej, A.K. Detection of microbial pathogens in shellfish with multiplex PCR. Cur. Microbiol., 37: 101–107, 1998.
Lee, C.Y. , Panicker, G. , and Bej, A.K. Detection of pathogenic bacteria in shellfish using multiplex PCR followed by CovaLink NH microwell plate sandwich hybridization. J. Microbiol. Meth., 53: 199–209, 2003.
Canigral, I. et al. Detection of Vibrio vulnificus in seafood, seawater and wastewater samples from a Mediterranean coastal area. Microbiol. Res., 165: 657–664, 2010.
Campbell, M.S. , and Wright, A.C. Real-time PCR analysis of Vibrio vulnificus in oysters. Appl. Environ. Microbiol., 69: 7137–7144, 2003.
Fukushima, H. , Tsunomori, Y. , and Seki, R. Duplex real-time SYBR green PCR assays for detection of 17 species of food- or waterborne pathogens in stools. J. Clin. Microbiol., 41: 5134–5146, 2003.
Panicker, G. , Myers, M.L. , and Bej, A.K. Rapid detection of Vibrio vulnificus in shellfish and Gulf of Mexico water by real-time PCR. Appl. Environ. Microbiol., 70: 498–507, 2004.
Vickery, M.C.L. et al. A real-time PCR assay for the rapid determination of 16S rRNA genotype in Vibrio vulnificus. J. Microbiol. Meth., 68: 376–384, 2007.
Gordon, K.V. et al. Real-time PCR assays for quantification and differentiation of Vibrio vulnificus strains in oysters and water. Appl. Environ. Microbiol., 74: 1704–1709, 2008.
Baker-Austin, C. et al. pilF polymorphism based real-time PCR to distinguish Vibrio vulnificus strains of human health relevance. Food Microbiol., 30: 17–23, 2012.
Baker-Austin, C. et al. Rapid in situ detection of virulent Vibrio vulnificus strains in raw oyster matrices using real-time PCR. Environ. Microbiol. Rep., 2: 76–80, 2010.
Koch, W.H. , Payne, W.L. , Wentz, B.A. , and Cebula, T.A. Rapid polymerase chain reaction method for detection of Vibrio cholerae in foods. Appl. Environ. Microbiol., 59: 556–560, 1993.
DePaola, A. , and Hwang, G.C. Effect of dilution, incubation time, and temperature of enrichment on cultural and PCR detection of Vibrio cholerae obtained from the oyster Crassostrea virginica. Mol. Cell. Probes, 9:

75–81, 1995.
Jeyasekaran, G. et al. Multiplex polymerase chain reaction-based assay for the specific detection of toxin-producing Vibrio cholerae in fish and fishery products. Appl. Microbiol. Biotechnol., 90: 1111–1118, 2011.
Blackstone, G.M. et al. Use of a real time PCR assay for detection of the ctxA gene of Vibrio cholerae in an environmental survey of Mobile Bay. J. Microbiol. Meth., 68: 254–259, 2007.
Chapela, M.-J. et al. Comparison between a TaqMan polymerase chain reaction assay and a culture method for ctx-positive Vibrio cholerae detection. J. Agric. Food Chem., 58: 4051–4055, 2010.
Garrido-Maeztu, A. , Chapela, M.J. , Vieites, J.M. , and Cabado, A.G. lolB gene, a valid alternative for qPCR detection of Vibrio cholerae in food and environmental samples. Food Microbiol., 46: 535–540, 2015.
Bonnin-Jusserand, M. et al. Vibrio species involved in seafood-borne outbreaks (Vibrio cholerae, V. parahaemolyticus and V. vulnificus): Reviewof microbiological versus recent molecular detection methods in seafood products. Crit. Rev. Food Sci. Nutr., 59(4): 597–610, 2019.
Wang, S. , and Levin, R.E. Quantitative determination of Vibrio parahaemolyticus by polymerase chain reaction. Food Biotechnol., 18: 279–287, 2004.
Gannon, V.P. , King, R.K. , Kim, J.Y. , and Thomas, E.J. Rapid and sensitive method for detection of shiga-like toxin-producing Escherichia coli in ground beef using the polymerase chain reaction reaction. Appl. Environ. Microbiol., 58: 3809–3815, 1992.
Rodríguez-Lázaro, D. et al. Trends in analytical methodology in food safety and quality: Monitoring microorganisms and genetically modified organisms. Trends Food Sci. Tech., 18: 306–319, 2007.
Hoorfar, J. et al. Practical considerations in design of internal amplification controls for diagnostic PCR assays. J. Clin. Microbiol., 42: 1863–1868, 2004.
International Organization for Standardization (ISO) . ISO/TS 21872-2:2007 Microbiology of Food and Animal Feeding Stuffs. Horizontal Method for the Detection of Potentially Enteropathogenic Vibrio spp. -- Part 2: Detection of Species Other than Vibrio parahaemolyticus and Vibrio cholerae. ISO, Geneva, Switzerland, 2007b.
Kobayashi, T. , Enomoto, S. , Sakazaki, R. , and Kuwahara, S. A new selective isolation medium for vibrio group on a modified Nakanishi’s medium (TCBS agar medium). Jpn. J. Bacteriol., 18: 387–392, 1963.
Brayton, P.R. , West, P.A. , Russek, E. , and Colwell, R.R. New selective plating medium for isolation of Vibrio vulnificus biogroup 1. J. Clin. Microbiol., 17: 1039–1044, 1983.
Kitaura, T. et al. Halo production by sulfatase activity in V. vulnificus and V. cholerae O1 on a new selective sodium dodecyl sulfate containing agar medium: A screening marker in environmental surveillance. FEMS Microbiol. Lett., 17: 205–209, 1983.
Massad, G. , and Oliver, J.D. New selective and differential medium for Vibrio cholerae and Vibrio vulnificus. Appl. Environ. Microbiol., 53: 2262–2264, 1987.
Tamplin, M.L. et al. Enzyme immuno assay for identification of Vibrio vulnificus in seawater, sediment, and oysters. Appl. Environ. Microbiol., 57: 1235–1240, 1991.
Miceli, G.A. , Watkins, W.D. , and Rippey, S.R. Direct plating procedure for enumerating Vibrio vulnificus in oysters (Crassostrea virginica). Appl. Environ. Microbiol., 59: 3519–3524, 1993.
Høi, L. , Dalsgaard, I. , and Dalsgaard, A. Improved isolation of Vibrio vulnificus from seawater and sediment with cellobiosecolistin agar. Appl. Environ. Microbiol., 64: 1721–2174, 1998.
Cerda-Cuellar, M. , Jofre, J. , and Blanch, A.R. A selective medium and a specific probe for detection of Vibrio vulnificus. Appl. Environ. Microbiol., 66: 855–859, 2000.
Cerda-Cuellar, M. , Permin, L. , Larsen, J.L. , and Blanch, A.R. Comparison of selective media for the detection of Vibrio vulnificus in environmental samples. J. Appl. Microbiol., 91: 322–327, 2001.
Panicker, G. , and Bej, A.K. Real-time PCR detection of Vibrio vulnificus in oysters: Comparison of oligonucleotide primers and probes targeting vvhA. Appl. Environ. Microbiol., 71: 5702–5709, 2005.
International Organization for Standardization (ISO) . ISO 1190-1 Microbiology of food and Animal Feeding Stuffs - Horizontal Method for the Detection and Enumeration of Listeria monocytogenes. Part 1: Detection Method. ISO, Geneva, Switzerland, 1996.
International Organization for Standardization (ISO) . ISO 1190-2 Microbiology of Food and Animal Feeding Stuffs - Horizontal Method for the Detection and Enumeration of Listeria monocytogenes. Part 2: Enumeration Method. ISO, Geneva, Switzerland, 2000.
International Organization for Standardization (ISO) . ISO 1190-1 Microbiology of Food and Animal Feeding Stuffs - Horizontal Method for the Detection and Enumeration of Listeria monocytogenes Part 1: Detection Method. AMENDMENT 1: Modification of the Isolation Media and the Haemolysis Test, and Inclusion of Precision Data. ISO, Geneva, Switzerland, 2004.
International Organization for Standardization (ISO) . ISO 1190-2 Microbiology of Food and Animal Feeding Stuffs - Horizontal Method for the Detection and Enumeration of Listeria monocytogenes. Part 2: Enumeration Method, AMENDMENT 1: Modification of the Enumeration Medium. ISO, Geneva, Switzerland, 2005.
Hitchins, A.D. Detection and enumeration of Listeria monocytogenes. In Foods, US Food and Drug Administration Bacteriological Analytical Manual, 8th ed., 2003.
Gombas, D.E. , Chen, Y. , Clavero, R.S. , and Scott, V.N. Survey of Listeria monocytogenes in ready-to-eat foods. J. Food Prot., 66: 559–569, 2003.

Ryser, E.T. , Arimi, S.M. , Bunduki, M.M. , and Donnelly, C.W. Recovery of different Listeria ribotypes from naturally contaminated, raw refrigerated meat and poultry products with two primary enrichment media. Appl. Environ. Microbiol., 62: 1781–1787, 1996.

Johansson, T. Enhanced detection and enumeration of Listeria monocytogenes from foodstuffs and food-processing environments. Int. J. Food Microbiol., 40: 77–85, 1998.

Herman, L.M.F. , de Ridder, H.F.M. , and Vlaemynck, G.M.M. A multiplex PCR method for the identification of Listeria spp. and Listeria monocytogenes in dairy samples. J. Food Prot., 58: 867–872, 1995.

Bansal, N.S. et al. Multiplex PCR assay for the routine detection of Listeria in food. Int. J. Food Microbiol., 33: 293–300, 1996.

Paziak-Domanska, B. et al. Evaluation of the API test, phosphatidyl-inositol specific phospholipase C activity and PCR method in identification of Listeria monocytogenes in meat foods. FEMS Microbiol. Lett., 171: 209–214, 1999.

Agersborg, A. , Dahl, R. , and Martinez, I. Sample preparation and DNA extraction procedures for polymerase chain reaction identification of Listeria monocytogenes in seafoods. Int. J. Food Microbiol., 35: 275–280, 1997.

Furrer, B. , Candrian, U. , Hoefelein, C. , and Luethy, J. Detection and identification of Listeria monocytogenes in cooked sausage products and in milk by in vitro amplification of haemolysin gene fragments. J. Appl. Bacteriol., 70: 372–379, 1991.

Golsteyn-Thomas, E.J. , King, R.K. , Burchak, J. , and Gannon, V.P. Sensitive and specific detection of Listeria monocytogenes in milk and ground beef with the polymerase chain reaction. Appl. Environ. Microbiol., 57: 2576–2580, 1991.

Jaton, K. , Sahli, R. , and Bille, J. Development of polymerase chain reaction assays for detection of Listeria monocytogenes in clinical cerebrospinal fluid samples. J. Clin. Microbiol., 30: 1931–1936, 1992.

Isonhood, J. , Drake, M.A. , and Jaykus, L.A. Upstream sample processing facilitates PCR detection of Listeria monocytogenes in mayonnaise-based ready-to-eat (RTE) salads. Food Microbiol., 23: 584–590, 2006.

Somer, L. , and Kashi, Y. A PCR method based on 16S rRNA sequence for simultaneous detection of the genus Listeria and the species Listeria monocytogenes in food products. J. Food Prot., 66: 1658–1665, 2003.

Destro, M.T. , Leitao, M.F.F. , and Farber, J.M. Use of molecular typing methods to trace the dissemination of Listeria monocytogenes in a shrimp processing plant. Appl. Environ. Microbiol., 62: 705–711, 1996.

International Organization for Standardization (ISO) . ISO 6579 Microbiology of Food and Animal Feeding Stuffs - Horizontal Method for the Detection of Salmonella spp. ISO, Geneva, Switzerland, 2002.

International Organization for Standardization (ISO) . ISO 6579Microbiology of Food and Animal Feeding Stuffs - Horizontal Method for the Detection of Salmonella spp. Technical Corrigendum 1. ISO, Geneva, Switzerland, 2004.

Andrews, W.H. , and Hammack, T. Salmonella. In US Food and Drug Administration Bacteriological Analytical Manual, 8th ed., 2007.

Vantarakis, A. , Komninou, G. , Venieri, D. , and Papapetropoulou, M. Development of a multiplex PCR detection of Salmonella spp. and Shigella spp. in mussels. Lett. Appl. Microbiol., 31: 105–109, 2000.

Villalobo, E. , and Torres, A. PCR for detection of Shigella spp. in mayonnaise. Appl. Environ. Microbiol., 64: 1242–1245, 1998.

Rahn, K.J. , De Grandis, S.A. , and Clarke, R.C. Amplification of an invA gene sequence of Salmonella typhimurium by polymerase chain reaction as a specific method of detection of Salmonella spp. Mol. Cell. Probes, 6: 271–279, 1992.

Wang, S.J. , and Yeh, D.B. Designing of polymerase chain reaction primers for the detection of Salmonella enteritidis in foods and faecal samples. Lett. Appl. Microbiol., 34: 422–427, 2002.

Seafood Parasites

Abollo, E. , Gestal, C. , and Pascual, S. Anisakis in marine fish and cephalopods from Galician waters: An updated perspective. Parasitol. Res., 87, 492, 2001. doi:10.1007/s004360100389.

Adams, A.M. , Ton, M.N. , Weckell, M.M. , MacKenzie, A.P. and Dong, F.M. Survival of Anisakis simplex in arrowtooth flounder (Atheresthes stomia) during frozen storage. J. Food Prot. 68, 1441–1446, 2005. doi: 10.4315/0362-028X-68.7.1441.

Adams, A.M. Foodborne trematodes, in Foodborne Parasites. Ortega, Y.R. , Ed., Springer, New York, 2006, Chapter 7. doi:10.1007/0-387-31197-1_7.

Adroher, F.J. et al. Larval anisakids (Nematoda:Ascaridoidea) in horse mackerel (Trachurus trachurus) from the fish market in Granada (Spain). Parasitol. Res., 82, 253, 1996. doi:10.1007/s004360050105.

Adroher-Auroux, F.J. , and Benítez-Rodríguez, R. Anisakiasis and Anisakis: An underdiagnosed emerging disease and its main etiological agents. Res. Vet. Sci., 132, 535, 2020. doi:10.1016/j.rvsc.2020.08.003.

Aibinu, I.E. , Smooker, P.M. , and Lopata, A.L. Anisakis nematodes in fish and shellfish-from infection to allergies. Int. J. Parasitol. Parasites Wildl., 9, 384, 2019. doi:10.1016/j.ijppaw.2019.04.007.

Alarcos, A.J. , and Suby, J.A. Potential parasitic infections transmitted by seafood in ancient populations from Patagonia. Quat. Int., 568, 43, 2020. doi:10.1016/j.quaint.2020.06.037.
Alonso-Gómez, A. et al. Anisakis simplex only provokes allergic symptoms when the worm parasitizes the gastrointestinal tract. J. Parasitol. Res., 93, 378, 2004. doi:10.1007/s00436-004-1085-9.
Ando Y. , Ono, Y. , and Ono, S. Diphyllobothriasis from eating Sushi. Am. J. Trop. Med. Hyg., 104, 1953, 2021. doi:10.4269/ajtmh.21-0105.
APROMAR . Evaluación de la presencia de nematodos del género Anisakis en los pescados de acuicultura marina españoles. Ministerio de Agricultura, Alimentación y Medio Ambiente, 2012. https://www.mapa.gob.es/es/pesca/temas/fondos-europeos/APROMAR%20-%20Informe%20ANISAKIS%202012_tcm30-73680.pdf.
Araújo, A. , Reinhard, K. , and Ferreira, L.F. Palaeoparasitology - Human parasites in ancient material. Adv. Parasitol., 90, 349, 2015. doi:10.1016/bs.apar.2015.03.003.
Arlian, L.G. et al. Characterization of allergens of Anisakis simplex. Allergy, 58, 1299, 2003. doi: 10.1046/j.1398-9995.2003.00344.x.
Audicana, M.T. et al. Anisakis simplex: Dangerous-dead and alive? Trends Parasitol., 18, 20, 2002. doi:10.1016/s1471-4922(01)02152-3.
Audicana, M.T. , and Kennedy, M.W. Anisakis simplex: From obscure infectious worm to inducer of immune hypersensitivity. Clin. Microbiol. Rev., 21, 360, 2008. doi:10.1128/CMR.00012-07.
Baeza, M.L. et al. Characterization of allergens secreted by Anisakis simplex parasite: Clinical relevance in comparison with somatic allergens. Clin. Exp. Allergy, 34, 296, 2004. doi:10.1111/j.1365-2222.2004.01883.x.
Bao, M. et al. Assessing the risk of an emerging zoonosis of worldwide concern: Anisakiasis. Sci. Rep., 7, 2017. doi:10.1038/srep43699.
Bao, M. , Pierce, G.J. , Strachan, N.J.C. , Pascual, S. , González-Muñoz, M. and Levsen, A. Human health, legislative and socioeconomic issues caused by the fish-borne zoonotic parasite Anisakis: Challenges in risk assessment. Trends Food Sci. Technol., 86, 298–310, 2019. doi: 10.1016/j.tifs.2019.02.013.
Bathurst, R.R. Archaeological evidence of intestinal parasites from coastal shell middens. J. Archaeol. Sci., 32, 115, 2005. doi:10.1016/j.jas.2004.08.001.
Besprozvannykh, V.V. , Yulia V. Tatonova, Y.V. and Shumenko, P.G. Life cycle, morphology of developmental stages of Metorchis ussuriensis sp. nov. (Trematoda: Opisthorchiidae), and phylogenetic relationships with other opisthorchiids. J Zool Syst Evol Res. 57, 24–40. 2019. doi: 10.1111/jzs.12230.
Bhargava, D. et al. Anisakiasis of the tonsils. J. Laryngol. Otol., 110, 387, 1996. doi:10.1017/s0022215100133717.
Blair, D. Lung flukes of the genus Paragonimus: Ancient and re-emerging pathogens. Parasitology, 149, 1286, 2022. doi:10.1017/S0031182022000300.
Blair, D. , Nagasawa, K. , Freeman, M. , Forbes, L.B. , Walker, J. , Overstreet, R.M. and Robin M. Medical importance. In: Rohde, K. (Ed.) Marine Parasitology, CSIRO Publishing, Collingwood, Victoria, Australia, 427–446, 2005.
Bouchet, F. et al. Identification of parasitoses in a child burial from Adak Island (Central Aleutian Islands, Alaska). C. R. Acad. Sci. III, 324, 123, 2021. doi:10.1016/S0764-4469(00)01287-7.
Butt, A.A. , Aldridge, K.E. , and Sanders, C.V. Infections related to the ingestion of seafood. Part II: Parasitic infections and food safety. Lancet Infect. Dis., 4, 294, 2004. doi:10.1016/S1473-3099(04)01005-9.
Cabrera, R. , and Trillo-Altamirano, M.P. Anisakidosis: ¿Una zoonosis parasitaria marina desconocida o emergente en el Perú? Rev. Gastroenterol. Perú, 24, 335, 2004. doi:10.47892/rgp.2004.244.703.
Cameron, J.J. , Chanad, S.H. , and Andrew, J.F. Gnathostomiasis in remote northern Western Australia: The first confirmed cases acquired in Australia. Med. J. Aust., 195, 42–44, 2011. doi:10.5694/j.1326-5377.2011.tb03188.x.
Cammilleri, G. et al. Presence of Anisakis pegreffii in farmed sea bass (Dicentrarchus labrax L.) commercialized in Southern Italy: A first report. Vet. Parasitol., 259, 13, 2018. doi:10.1016/j.vetpar.2018.06.021.
Center for Food Safety and Applied Nutrition . Fish and Fisheries Products Hazards and Controls Guidance (3rd edn.). U.S. Food and Drug Administration, Washington, DC, Chapter 5, 2001. https://www.cfsan.fda.gov/comm/haccp4.html.
Center for Food Safety and Applied Nutrition . Food Code Report PB 2005-102200. U.S. Food and Drug Administration, College Park, MD, 2005, p. 75. https://www.cfsan.fda.gov/dms/fc05-toc.html.
Chai, J.Y. Human Intestinal Flukes. From Discovery to Treatment and Control. Springer Nature, Dordrecht, The Netherlands, 2019. doi:10.1007/978-94-024-1704-3.
Chai, J.Y. , and Jung, B.K. Fishborne zoonotic heterophyid infections: An update. Food Waterborne Parasitol., 8–9, 33, 2017. doi:10.1016/j.fawpar.2017.09.001.
Chai, J.Y. , Murrell, K.D. , and Lymbery, A.J. Fish-borne parasitic zoonoses: Status and issues. Int. J. Parasitol., 35, 1233, 2005. doi:10.1016/j.ijpara.2005.07.013.
Chai, J.Y. et al. Stictodora lari (Digenea: Heterophyidae): The discovery of the first human infections. J. Parasitol., 88, 627, 2002. doi:10.1645/0022-3395(2002)088(0627:SLDHTD)2.0.CO;2.
Chai, J.Y. et al. Gymnophalloides seoi: A new human intestinal trematode. Trends Parasitol., 19, 109, 2003. doi:10.1016/s1471-4922(02)00068-5.

Chai, J.Y. et al. Foodborne intestinal flukes in Southeast Asia. Korean J. Parasitol., 47, S69, 2009. doi:10.3347/kjp.2009.47.S.S69.
Chai, J.Y. and Jung, B.K. Epidemiology of Trematode Infections: An Update. In Digenetic Trematodes, Toledo, R. and Fried, B. Eds., Springer Nature, New York, Adv. Exp. Med. Biol., 1154, 359–409, 2019. doi: 10.1007/978-3-030-18616-6_12.
Cleveland, C.A. et al. Possible role of fish as transport hosts for Dracunculus spp. Larvae. Emerg. Infect. Dis., 23, 1590, 2017. doi:10.3201/eid2309.161931.
Cross, J.H. Fish and invertebrate-borne helminths, in Foodborne Disease Handbook (2nd ed.). Hui, Y.H. et al., Eds., Marcel Dekker Inc., New York, 2001, Chapter 12. doi:10.1201/9781351072083.
David, T.J. , and Petri, W.A. The blood- and tissue-dwelling nematodes, in Markell and Voge's Medical Parasitology (9th ed.). Elsevier, Saunders, London, 480 pages, 2006. ISBN 978-0-7216-4793-7.
Dias, M.L.G.G. , Eiras, J.C. , Eiras, J.C. , Machado, M.H. , Souza, G.T.R. and Pavanelli, G.C. The life cycle of Clinostomum complanatum Rudolphi, 1814 (Digenea, Clinostomidae) on the floodplain of the high Parani river, Brazil. Parasitol. Res. 89, 506–508, 2003. doi:10.1007/s00436-002-0796-z.
Eastburn, R.L. , Treitschke, T.R. , and Terhune, C.A. Jr., Human intestinal infection with Nanophyetus salmincola from salmonid fishes. Am. J. Trop. Med. Hyg., 36, 586, 1987. doi:10.4269/ajtmh.1987.36.586.
Ebert, M.B. , Fernández, M. , Valente, A.L.S. , Cremer, M.J. , de Castilho, P.V. , and da Silva, R.J. Ascocotyle longa (Digenea: Heterophyidae) infecting dolphins from the Atlantic Ocean. Parasitol. Res., 120(1), 347–353. 2021. doi: 10.1007/s00436-020-06956-1.
Esteban, J.G. et al. Diagnosis of human trematode infections, in Digenetic Trematodes (2nd ed.). Toledo, R. , and Fried, B. , Eds., Springer Nature, Cham, Switzerland, 2019, Chapter 14, 437–471. doi:10.1007/978-3-030-18616-6.
European Food Safety Authority . Scientific opinion on risk assessment of parasites in fishery products. EFSA J., 8, 91, 2010. doi:10.2903/j.efsa.2010.1543.
European Parliament and Council of the European Union . Regulation (EC) No. 853/2004 of 29 April 2004 laying down specific hygiene rules for on the hygiene of foodstuffs. Off. J. Eur. Union, L139/55, 2023, 30 April 2004 , section VIII, Current consolidated version: 15/02/2023 . https://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:02004R0853–20230215.
Fernández de Corres, L. et al. Prevalencia de la sensibilización a Anisakis simplex en tres áreas españolas, en relación a las diferentes tasas de consumo de pescado. Relevancia de la alergia a Anisakis simplex. Alergol. Immunol. Clín., 16, 337, 2001.
Fioravanti, M.L. et al. Negligible risk of zoonotic anisakid nematodes in farmed fish from European mariculture, 2016 to 2018. Eurosurveillance, 26, 611, 2021. doi:10.2807/1560-7917.ES.2021.26.2.1900717.
Fiorenza, E.A. et al. It’s a wormy world: Metaanalysis reveals several decades of change in the global abundance of the parasitic nematodes Anisakis spp. and Pseudoterranova spp. in marine fishes and invertebrates. Glo. Chang. Biol., 26, 2854–2866, 2020. doi:10.1111/gcb.15048.
Freire-Santos, A.M. et al. Detection of Cryptosporidium oocysts in bivalbe molluscs destined for human consumption. J. Parasitol., 86, 853, 2000. doi:10.1645/0022-3395(2000)086[0853:DOCOIB]2.0.CO;2.
Fritsche, T.R. et al. Praziquantel for treatment of human Nanophyetus salmincola (Troglotrema salmincola) infection. J. Infect. Dis., 160, 896, 1989. doi:10.1093/infdis/160.5.896.
Fürst, T. , Keiser, J. , and Utzinger, J. Global burden of human food-borne trematodiasis: A systematic review and meta-analysis. Lancet Infect. Dis., 12, 210, 2012. doi:10.1016/S1473-3099(11)70294-8.
Garcia, L.S. Diagnostic Medical Parasitology (6th edn.). ASM Press, Washington, DC, 2016. doi:10.1128/9781555819002.
García, M.L. , Esteban, M. , Rodríguez, F. , and Rodríguez, E. La alergia por Anisakis y medidas de prevención. Rev. Com. Cient. AESAN, 1, 19, 2005.
Gómez-Couso, H. et al. Contamination of bivalve molluscs by Crystosporidium oocysts: The need for new quality control standards. Int. J. Food Microbiol., 87, 97, 2003. doi:10.1016/s0168-1605(03)00057-6.
Gómez-Couso, H. et al. Detection of Crystosporidium and Giardia in molluscan shellfish by multiplexed nested-PCR. Int. J. Food Microbiol., 91, 279, 2004. doi:10.1016/j.ijfoodmicro.2003.07.003.
Graczyk, T.K. et al. Recovery, bioaccumulation and inactivation of human waterborne pathogens by the Chesapeake Bay nonnative oyster, Crassotrea ariakensis. Appl. Environ. Microbiol., 72, 3390, 2006. doi:10.1128/AEM.72.5.3390-3395.2006.
Guardone, L. et al. Ascaridoid nematode larvae in wild gilthead seabream (Sparus aurata) and European seabass (Dicentrarchus labrax) caught in the Tyrrhenian Sea (Western Mediterranean Sea): A contribute towards the parasitological risk assessment on two commercially important fish species. Food Control, 118, 107377, 2020. doi:10.1016/j.foodcont.2020.107377.
Guarneri, F. , Guarneri, C. , and Benvenga, S. Cross-reactivity of Anisakis simplex: Possible role of Ani s 2 and Ani s 3. Int. J. Dermatol., 46, 146, 2007. doi:10.1111/j.1365-4632.2006.03091.x.
Harrell, L.W. , and Deardorff, T.L. Human nanophyetiasis: Transmission by handling naturally infected coho salmon (Oncorhynchus kisutch). J. Infect. Dis., 161, 146, 1990. doi:10.1093/infdis/161.1.146.
Herreras, M.V. et al. Anisakid larvae in the musculature of the Argentinean Hake, Merluccius hubbsi. J. Food Prot., 63, 1141, 2000. doi:10.4315/0362-028x-63.8.1141.

Hwang, K.P. et al. Clinical features of human intestinal capillariasis in Taiwan. World J. Gastroenterol., 10, 2391–2393, 2004. doi:10.3748/wjg.v10.i16.2391.
Ibarrola, I. et al. Expression of a recombinant protein immunochemically equivalent to the major Anisakis simplex allergen Ani s 1. J. Investig. Allergol. Clin. Immunol., 18, 78, 2008.
Kasuya, S. , and Koga, K. Significance of detection of specific IgE in Anisakis-related diseases. Arerugi, 41, 106, 1992. [In Japanese].
Kawai, T. et al. Identification of Kudoa septempunctata as the causative agent of novel food poisoning outbreaks in Japan by consumption of Paralichthys olivaceus in raw fish. Clin. Infect. Dis., 54(8), 1046–1052, 2012. doi:10.1093/cid/cir1040.
Keiser, J. , and Utzinger, J. Food-bornetrematodiases. Clin. Microbiol. Rev., 22, 466, 2009. doi:10.1128/CMR.00012-09.
Kimura, S. , Takagi, Y. , and Gomi, K. IgE response to Anisakis simplex compared to seafood. Allergy, 54, 1224, 1999. doi:10.1034/j.1398-9995.1999.00329.x.
Klimpel, S. et al. Life cycle of Anisakis simplex in the Norwegian Deep (northern North Sea). Parasitol. Res., 94, 1, 2004. doi:10.1007/s00436-004-1154-0.
Ko, R.C. Fish-borne parasitic zoonoses, in Fish Diseases and Disorders. Vol. I. Protozoan and Metazoan Infections. Woo, P.T.K. , Ed., CAB International, Oxon, p. 631, 1995.
Ko, R.C. Fish-borne parasitic zoonoses, in Fish Diseases and Disorders (1st edn.). Woo, P.T.K. , Ed., CAB International, Wallingford, p. 592, 2006.
Køie, M. Experimental infections of copepods and sticklebacks Gasterosteus aculeatus with small ensheathed and large third-stage larvae of Anisakis simplex (Nematoda, Ascaridoidea, Anisakidae). Parasitol. Res., 87, 32, 2001. doi:10.1007/s004360000288.
Králová-Hromadová, I. et al. Ups and downs of infections with the broad fish tapeworm Dibothriocephalus latus in Europe from 1900 to 2020: Part I. Adv. Parasitol., 114, 75, 2021. doi:10.1016/bs.apar.2021.08.008.
Kuchta, R. , Serrano-Martínez, M. , and Scholz, T. Pacific broad tapeworm Adenocephalus pacificus as a causative agent of globally reemerging Diphyllobothriosis. Emerging Infect. Dis., 21, 1697, 2015. doi:10.3201/eid2110.150516.
Lee, S.H. and Chai, J.Y. A review of Gymnophalloides seoi (Digenea: Gymnophallidae) and human infections in the Republic of Korea. Korean J. Parasitol., 39, 85–118, 2001. doi: 10.3347/kjp.2001.39.2.85.
Le Bailly, M. , and Bouchet, F. Diphyllobothrium in the past: Review and new records. Int. J. Paleopathol., 3, 182, 2013. doi:10.1016/j.ijpp.2013.05.004.
Lima dos Santos, C.A.M. , and Howgate, P. Fishborne zoonotic parasites and aquaculture: A review. Aquaculture, 318, 253, 2011. doi:10.1016/j.aquaculture.2011.05.046.
Liu, Q. et al. Paragonimiasis: An important food-borne zoonosis in China. Trends Parasitol., 24, 318, 2008. doi:10.1016/j.pt.2008.03.014.
López-Verdejo, A. et al. Infection process, viability and establishment of Anisakis simplex s.l. L3 in farmed fish; A histopathological study in gilthead seabream. Vet. Parasitol., 311, 109805, 2022. doi:10.1016/j.vetpar.2022.109805.
Marino, A.F.P. et al. Toxoplasma gondii in edible fishes captured in the Mediterranean basin. Zoonoses Public Health, 66, 826, 2019. doi:10.1111/zph.12630.
Marino, F. et al. Experimental susceptibility of gilthead sea bream, Sparus aurata, via challenge with Anisakis pegreffii larvae. Biomed. Res. Int., 2013, 701828, 2013. doi:10.1155/2013/701828.
Mattiucci, S. et al. Genetic and ecological data on the Anisakis simplex complex with evidence for a new species (Nematoda, Ascaridoidea, Anisakidae). J. Parasitol., 83, 401, 1997. doi:10.2307/3284402.
McClelland, G. The trouble with sealworms (Pseudoterranova decipiens species complex, Nematoda): A review. Parasitology, 124, S183, 2002. doi:10.1017/s0031182002001658.
Millemann, R.E. , and Knapp, S.E. Biology of Nanophyetus salmincola and “salmon poisoning” disease. Adv. Parasitol., 8, 1, 1970. doi:10.1016/S0065-308X(08)60250-X.
Moneo, I. et al. Sensitization of the fish parasite Anisakis simplex: Clinical and laboratory aspects. Parasitol. Res., 101, 1051, 2007. doi:10.1007/s00436-007-0587-7.
Montero, E. et al. Human gnathostomosis in Spain: First report in humans. Acta Trop., 78, 59, 2001. doi:10.1016/S0001-706X(00)00168-6.
Mordvinov, V.A. , Yurlova, N.I. , Ogorodova, L.M. and Katokhin, A.V. Opisthorchis felineus and Metorchis bilis are the main agents of liver fluke infection of humans in Russia. Parasitol. Int., 61, 25–31, 2012. doi: 10.1016/j.parint.2011.07.021.
Nagasawa, K. Anisakiasis , in Marine Parasitology. Rhode, K. , Ed., CSIRO Publishing, Collingwood, Victoria, Australia, 2005, p. 430.
OECD/FAO . OECD-FAO Agricultural Outlook 2022–2031. OECD Publishing, Paris, 2022. doi:10.1787/f1b0b29c-en.
Peñalver, J. , Dolores, E.M. , and Muñoz, P. Absence of anisakid larvae in farmed European sea bass (Dicentrarchus labrax L.) and gilthead sea bream (Sparus aurata L.) in southeast Spain. J. Food Prot., 73, 1332–1334, 2010. doi:10.4315/0362-028x-73.7.1332.

Perri, A.R. et al. Detecting hidden diets and disease: Zoonotic parasites and fish consumption in Mesolithic Ireland. J. Archaeol. Sci., 97, 137, 2018. doi:10.1016/j.jas.2018.07.010.
Puente, P. et al. Anisakis simplex: The high prevalence in Madrid (Spain) and its relation with fish consumption. Exp. Parasitol., 118, 271, 2008. doi:10.1016/j.exppara.2007.07.002.
Radačovská, A. , Čisovská Bazsalovicsová, E. , and Králová-Hromadová, I. Mitochondrial and microsatellite data show close genetic relationships between Dibothriocephalus latus from South America (Argentina) and Europe (the Alpine lakes region). Parasitol. Res., 121, 3635, 2022. doi:10.1007/s00436-022-07690-6.
Rahmati, A.R. , Kiani, B. , Afshari, A. , Moghaddas, E. , Williams, M. and Shamsi, S. World-wide prevalence of Anisakislarvae in fish and its relationship to human allergic anisakiasis: a systematic review. Parasitol. Res., 119, 3585–3594, 2020. doi:10.1007/s00436-020-06892-0.
Ramirez, D.A. Parasites in the Atacama Desert: New insights into the lifestyles of ancient human populations (3000-500 BP). J. Archaeol. Sci., 39, 103171, 2021. doi:10.1016/j.jasrep.2021.103171.
Rodríguez-Pérez, R. et al. Cloning and expression of Ani s 9, a new Anisakis simplex allergen. Mol. Biochem. Parasitol., 159, 92, 2008. doi:10.1016/j.molbiopara.2008.02.008.
Salati, F. et al. Presence of Contracaecum spp. in teleosts cultured and fished in Sardinia. Vet. Parasitol., 196, 382, 2013. doi:10.1016/j.vetpar.2013.03.014.
Sánchez-Velasco, P. et al. Association of hypersensitivity to the nematode Anisakis simplex with HLA class II DRB1*1502-DQB1*0601 haplotype. Hum. Immunol., 61, 314, 2000. doi:10.1016/s0198-8859(99)00167-6.
Schmidt, G.D. Acanthocephalan infection of man, with two new records. J. Parasitol., 57, 582, 1971. doi:10.2307/3277920.
Scholz, T. , and Kuchta, R. Fish-borne , zoonotic cestodes (Diphyllobothrium and relatives) in cold climates: A never-ending story of neglected and (re)-emergent parasites. Food Waterborne Parasitol., 4, 23, 2016. doi:10.1016/j.fawpar.2016.07.002.
Scholz, T. , Kuchta, R. , and Brabec, J. Broad tapeworms (Diphyllobothriidae), parasites of wildlife and humans: Recent progress and future challenges. Int. J. Parasitol. Parasites Wildl., 9, 359, 2019. doi:10.1016/j.ijppaw.2019.02.001.
Scientific Committee, Spanish Agency of Food Security and Nutrition . La alergia por Anisakis y medidas de prevención. Rev. Com. Cient. AESAN, 1, 19, 2005. https://www.informacionconsumidor.org/Documentacioacuten/tabid/57/Default.aspx?xspc=anisakis.
Seo, M. et al. The changing pattern of parasitic infection among Korean populations by paleoparasitological study of Joseon Dynasty mummies. J. Parasitol., 100, 147, 2014a. doi:10.1645/12-60.1.
Seo, M. et al. Paleoparasitological studies on mummies of the Joseon Dynasty, Korea. Korean J. Parasitol., 52, 235, 2014b. doi:10.3347/kjp.2014.52.3.235.
Shamsi, S. Seafood-borne parasitic diseases: A ‘One-Health’ approach is needed. Fishes, 4, 9, 2019. doi:10.3390/fishes4010009.
Sharp, G.J.E. , Pike, A.W. , and Secombes, C.J. The immune response of wild rainbow trout, Salmo gairdneri Richardson, to naturally acquired plerocercoid infections of Diphyllobothrium dendriticum (Nitzsch, 1824) and D. ditremum (Creplin, 1825). J. Fish Biol., 35, 781, 1989. doi:10.1111/j.1095-8649.1989.tb03029.x.
Skírnisson, K. Hringormar berast í folk á Íslandi við neyslu á lítið elduðum fi ski. Læknablaðið, 92, 21, 2006.
Slifko, T.R. , Smith, H.V. , and Rose, J.B. Emerging parasite zoonoses associated with water and food. Int. J. Parasitol., 30, 1379, 2000. doi:10.1016/s0020-7519(00)00128-4.
Sotillo, J. et al. Trematode genomics and proteomics, in Digenetic Trematodes (2nd edn.). Toledo, R. , and Fried, B. , Eds., Springer Nature, Cham, 2019, Chapter 13. doi:10.1007/978-3-030-18616-6.
Søe, M.J. et al. Ancient DNA from latrines in Northern Europe and the Middle East (500 BC-1700 AD) reveals past parasites and diet. PLoS One, 13, e0195481, 2018. doi:10.1371/journal.pone.0195481.
Sugiyama, H. et al., Anisakiasis annual incidence and causative species, Japan, 2018–2019. Emerg. Infect. Dis., 28, 2105–2108, 2022. doi:10.3201/eid2810.220627.
Sulaiman, I.M. , and Cama, V. The biology of Giardia parasites, in Foodborne Parasites. Ortega, Y.R. , Ed., Springer, New York, 2006, Chapter 2. doi:10.1007/0-387-31197-1_2.
Sunnotel, O. et al. Effectiveness of standard UV depuration at inactivating Cryptosporidium parvum recovered from spiked Pacific Oysters (Crassostrea gigas). Appl. Environ. Microbiol., 73, 5083, 2007. doi:10.1128/AEM.00375-07.
Suzuki, J. et al. Detection and identification of Diphyllobothrium nihonkaiense plerocercoids from wild Pacific salmon (Oncorhynchus spp.) in Japan. J. Helminthol., 84, 434, 2010. doi:10.1017/S0022149X10000155.
Tantaleán, M.V. , and Cárdenas, J. Profilicollis altmani (Perry, 1942) Van Cleave, 1947 (Acanthocephala) en el Perú. Con notas sobre la infección experimental de mamiferos terrestres. Rev. Peruana Biol., 9, 1, 2013. doi:10.15381/rpb.v9i1.2522.
Toledo, R. , Bernal, M.D. , and Marcilla, A. Proteomics of foodborne trematodes. J. Proteomics, 74, 1485, 2011. doi:10.1016/j.jprot.2011.03.029.
Toledo, R. , and Fried, B. Digenetic Trematodes (2nd edn.). Springer Nature, Cham, 2019. doi:10.1007/978-3-030-18616-6.
Toro, C. et al. Seropositivity to a major allergen of Anisakis simplex, Ani s 1 in dyspeptic patients with Helicobacter pylori infection: Histological and laboratory findings and clinical significance. Clin. Microbiol.

Infect., 12, 453, 2006. doi:10.1111/j.1469-0691.2006.01376.x.
USA Food and Drug Administration . Fish and Fishery Products Hazards and Controls Guidance (FDA Hazards Guide) (4th edn.). US Department of Health and Human Services, Food and Drug Administration, Maryland, 2022. https://www.fda.gov/food/seafood-guidance-documents-regulatory-information/fish-and-fishery-products-hazards-and-controls.
Valls, A. , Pascual, C.Y. , and Esteban, M.M. Anisakis allergy: An update. Rev. Fr. Allergol. Immunol. Clin., 45, 108, 2005. doi:10.1016/j.allerg.2005.01.005.
Wang, Y. , Li, X. , Sun, Q. , Gong, P. , Zhang, N. , Zhang, X. , Wang, X. , Li, G. , and Li, J. First case report of Metorchis orientalis from Black Swan. Int J Parasitol Parasites Wildl., 13, 7–12. 2020. doi: 10.1016/j.ijppaw.2020.07.011.
Waeschenbach, A. et al. The catholic taste of broad tapeworms - Multiple routes to human infection. Int. J. Parasitol., 47, 831, 2017. doi:10.1016/j.ijpara.2017.06.004.
Wen-Yuan, Y. et al. Parasitologische Untersuchung einer alten Leiche aus der Chu-Dynastie der Streitenden Reiche aus dem Mazhuan-Grab Nr. 1, Kreis Jiangling, Provinz Hubei. Acta Acad. Med. Wuhan, 4, 23, 1984.
Wicht, B. , de Marval, F. , and Peduzzi, R. Diphyllobothrium nihonkaiense (Yamane et al ., 1986) in Switzerland: First molecular evidence and case reports. Parasitol. Int., 56, 195, 2007. doi:10.1016/j.parint.2007.02.002.
Wicht, B. et al. Multiplex PCR for differential identification of broad tapeworms (Cestoda: Diphyllobothrium) infecting humans. J. Clin. Microbiol., 48, 3111, 2010. doi:10.1128/JCM.00445-10.
Williams, H. , and Jones, A. Parasitic Worms of Fish. Taylor & Francis, London, 1994. doi:10.1201/b12595.
Williams, M. , Hernandez-Jover, M. , and Shamsi, S. Fish substitutions which may increase human health risks from zoonotic seafood borne parasites: A review. Food Control, 118, 107429, 2020. doi:10.1016/j.foodcont.2020.107429.
Wood, C.L. et al. A reconstruction of parasite burden reveals one century of climate-associated parasite decline. Proc. Natl. Acad. Sci. U.S.A., 120, e2211903120, 2023. doi:10.1073/pnas.2211903120.
World Health Organization . Integrating neglected tropical diseases into global health and development: fourth WHO report on neglected tropical diseases, 2017. ISBN 978-92-4-156544-8 https://apps.who.int/iris/handle/10665/255011.
Xiao, L. , and Cama, V. Cryptosporidium and cryptosporidiosis, in Foodborne Parasites. Ortega, Y.R. , Ed., Springer, New York, 2006, Chapter 4, 57–108, doi:10.1007/0-387-31197-1_2.
Yera, H. et al. Putative Diphyllobothrium nihonkaiense acquired from a Pacific salmon (Oncorhynchus keta) eaten in France; genomic identification and case report. Parasitol. Int., 55, 45, 2006. doi:10.1016/j.parint.2005.09.004.
Zhou, P. et al. Food-borne parasitic zoonoses in China: Perspective for control. Trends Parasitol., 24, 190, 2008. doi:10.1016/j.pt.2008.01.001.
Zhu, X.Q. et al. SSCP-based identification of members within the Pseudoterranova decipiens complex (Nematoda:Ascaridoidea:Anisakidae) using genetic markers in the internal transcribed spacers of ribosomal DNA. Parasitol., 124, 615, 2002. doi:10.1017/s0031182002001579.

Detection of Enteric Viruses in Seafood

Albertsson, P.-Å. (1970). Partition of cell particles and macromolecules in polymer two-phase systems. Advances in Protein Chemistry, 24, 309–341. doi:10.1016/S0065-3233(08)60244-2.
Araud, E. , DiCaprio, E. , Ma, Y. , Lou, F. , Gao, Y. , Kingsley, D. , et al . (2016). Thermal inactivation of enteric viruses and bioaccumulation of enteric foodborne viruses in live oysters (Crassostrea virginica). Applied and Environmental Microbiology, 82(7), 2086–2099. doi:10.1128/AEM.03573-15.
Atmar, R. L. , Neill, F. H. , Romalde, J. L. , Le Guyader, F. , Woodley, C. M. , Metcalf, T. G. , & Estes, M. K. (1995). Detection of Norwalk virus and hepatitis A virus in shellfish tissues with the PCR. Applied and Environmental Microbiology, 61(8), 3014–3018.
Baker, K. , Morris, J. , McCarthy, N. , Saldana, L. , Lowther, J. , Collinson, A. , & Young, M. (2011). An outbreak of norovirus infection linked to oyster consumption at a UK restaurant, February 2010. Journal of Public Health, 33(2), 205–211. doi:10.1093/pubmed/fdq089.
Bosch, A. , Gkogka, E. , Le Guyader, F. S. , Loisy-Hamon, F. , Lee, A. , van Lieshout, L. , et al . (2018). Foodborne viruses: Detection, risk assessment, and control options in food processing. International Journal of Food Microbiology, 285(November), 110–128. doi:10.1016/j.ijfoodmicro.2018.06.001.
Butt, A. A. , Aldridge, K. E. , & Sanders, C. V. (2004). Infections related to the ingestion of seafood part I: Viral and bacterial infections. The Lancet Intectious Diseases, 4(4), 201–212. doi:10.1016/S1473-3099(04)00969-7.
Cardemil, C. V. , & Hall, A. J. (2020). Chapter 4 Travel-Related Infectious Diseases. Norovirus. In: Brunette, G.W. and Nemhauser, B. (Eds.), CDC Yellow Book (p. 78). Centre for Disease Control and Prevention. New York: Oxford University Press. https://wwwnc.cdc.gov/travel/yellowbook/2020/travel-related-infectious-diseases/norovirus.

Chhabra, P. , de Graaf, M. , Parra, G. I. , Chan, M. C. W. , Green, K. , Martella, V. , et al . (2019). Updated classification of norovirus genogroups and genotypes. Journal of General Virology, 100(10), 1393–1406. doi:10.1099/JGV.0.001318.
Deamer, D. , Akeson, M. , & Branton, D. (2016). Three decades of nanopore sequencing. Nature Biotechnology, 34(5), 518–524. doi:10.1038/nbt.3423.
Desdouits, M. , Piquet, J. C. , Wacrenier, C. , Le Mennec, C. , Parnaudeau, S. , Jousse, S. , et al . (2021). Can shellfish be used to monitor SARS-CoV-2 in the coastal environment? Science of the Total Environment, 778(March). doi:10.1016/j.scitotenv.2021.146270.
Dolskiy, A. A. , Grishchenko, I. V. , & Yudkin, D. V. (2020). Cell cultures for virology: Usability, advantages, and prospects. International Journal of Molecular Sciences, 21(21), 7978. doi:10.3390/ijms21217978.
EFSA . (2011). Scientific opinion on an update on the present knowledge on the occurrence and control of foodborne viruses. EFSA Journal, 9(7), 1–96. doi:10.2903/j.efsa.2011.2190.
Fiorito, F. , Di Concilio, D. , Lambiase, S. , Amoroso, M. G. , Langellotti, A. L. , Martello, A. , et al . (2021). Oyster Crassostrea gigas, a good model for correlating viral and chemical contamination in the marine environment. Marine Pollution Bulletin, 172, 112825. doi:10.1016/j.marpolbul.2021.112825.
Flint, A. , Reaume, S. , Harlow, J. , Hoover, E. , Weedmark, K. , & Nasheri, N. (2021). Genomic analysis of human noroviruses using combined Illumina-Nanopore data. Virus Evolution, 7(2), 1–11. doi:10.1093/ve/veab079.
Fukuda, S. , Sasaki, Y. , Kuwayama, M. , & Miyazaki, K. (2007). Simultaneous detection and genogroup-screening test for norovirus genogroups I and II from fecal specimens in single tube by reverse transcription-loop-mediated isothermal amplification assay. Microbiology and Immunology, 51(5), 547–550. doi:10.1111/j.1348-0421.2007.tb03932.x.
Grodzki, M. , Schaeffer, J. , Piquet, J. C. , Le Saux, J. C. , Chevé, J. , Ollivier, J. , et al . (2014). Bioaccumulation efficiency, tissue distribution, and environmental occurrence of hepatitis E virus in bivalve shellfish from France. Applied and Environmental Microbiology, 80(14), 4269–4276. doi:10.1128/AEM.00978-14.
Hamza, I. A. , Jurzik, L. , & Wilhelm, M. (2014). Development of a Luminex assay for the simultaneous detection of human enteric viruses in sewage and river water. Journal of Virological Methods, 204, 65–72. doi:10.1016/j.jviromet.2014.04.002.
Heggelund, J. E. , Varrot, A. , Imberty, A. , & Krengel, U. (2017). Histo-blood group antigens as mediators of infections. Current Opinion in Structural Biology, 44, 190–200. doi:10.1016/j.sbi.2017.04.001.
Hernroth, B. , & Allard, A. (2007). The persistence of infectious adenovirus (type 35) in mussels (Mytilus edulis) and oysters (Ostrea edulis). International Journal of Food Microbiology, 113(3), 296–302. doi:10.1016/j.ijfoodmicro.2006.08.009.
Höfler, H. , Pütz, B. , Mueller, J. D. , Neubert, W. , Sutter, G. , & Gais, P. (1995). In situ amplification of measles virus RNA by the self-sustained sequence replication reaction. Laboratory Investigation; A Journal of Technical Methods and Pathology, 73(4), 577–585. https://www.ncbi.nlm.nih.gov/pubmed/7474930.
Hrdy, J. , & Vasickova, P. (2022). Virus detection methods for different kinds of food and water samples - The importance of molecular techniques. Food Control, 134, 108764. doi:10.1016/j.foodcont.2021.108764.
ISO /TS 15216-1:2017 . (2017). ISO 15216-1:2017 Microbiology of the food chain - Horizontal method for determination of hepatitis A virus and norovirus using real-time RT-PCR - Part 1: Method for quantification. https://www.iso.org/standard/65681.html.
Julian, T. R. , & Schwab, K. J. (2012). Challenges in environmental detection of human viral pathogens. Current Opinion in Virology, 2(1), 78–83. doi:10.1016/j.coviro.2011.10.027.
Keller, R. , Justino, J. F. , & Cassini, S. T. (2013). Assessment of water and seafood microbiology quality in a mangrove region in Vitória, Brazil. Journal of Water and Health, 11(3), 573–580. doi:10.2166/wh.2013.245.
Ko, S.-M. , Kim, J.-O. , Oh, M.-J. , & Kim, D. (2011). Effects of an oxidative agent and lectins on the binding inhibition of recombinant hepatitis A virus proteins to oyster digestive tissues. Journal of Food Protection, 74(1), 157–160. doi:10.4315/0362-028X.JFP-10-211.
Kumari, R. , Lim, J. W. , Sullivan, M. R. , Malampy, R. , Baush, C. , Smolina, I. , et al . (2022). A novel rolling circle amplification-based detection of SARS-CoV-2 with multi-region padlock hybridization. Diagnostics, 12(9), 2252. doi:10.3390/diagnostics12092252.
La Rosa, G. , Bonadonna, L. , Lucentini, L. , Kenmoe, S. , & Suffredini, E. (2020). Coronavirus in water environments: Occurrence, persistence and concentration methods - A scoping review. Water Research, 179(January), 115899. doi:10.1016/j.watres.2020.115899.
Le Guernic, A. , Palos Ladeiro, M. , Boudaud, N. , Do Nascimento , J., Gantzer, C. , Inglard, J.-C. , et al . (2022). First evidence of SARS-CoV-2 genome detection in zebra mussel (Dreissena polymorpha). Journal of Environmental Management, 301, 113866. doi:10.1016/j.jenvman.2021.113866.
Le Guyader, F. S. , Atmar, R. L. , & Le Pendu, J. (2012). Transmission of viruses through shellfish: When specific ligands come into play. Current Opinion in Virology, 2(1), 103–110. doi:10.1016/j.coviro.2011.10.029.
Le Guyader, F. S. , Le Saux, J. C. , Ambert-Balay, K. , Krol, J. , Serais, O. , Parnaudeau, S. , et al . (2008). Aichi virus, norovirus, astrovirus, enterovirus, and rotavirus involved in clinical cases from a French oyster-related gastroenteritis outbreak. Journal of Clinical Microbiology, 46(12), 4011–4017. doi:10.1128/JCM.01044-08.

Le Guyader, F. S. , Loisy, F. , Atmar, R. L. , Hutson, A. M. , Estes, M. K. , Ruvoën-Clouet, N. , et al . (2006). Norwalk virus-specific binding to oyster digestive tissues. Emerging Infectious Diseases, 12(6), 931–936.
Le Guyader, F. S. , Pommepuy, M. , & Atmar, R. L. (2009). Monitoring Viral Contamination in Shellfish Growing Areas. In G. Burnel (Ed.), New Technologies in Aquaculture: Improving Production Efficiency, Quality and Environmental Management (178th ed., p. 1232). Australia: Woodhead Publishing Limited. https://archimer.ifremer.fr.
Leberman, R. (1966). The isolation of plant viruses by means of “simple” coacervates. Virology, 30(3), 341–347. doi:10.1016/0042-6822(66)90112-7.
Lewis, G. D. , & Metcalf, T. G. (1988). Polyethylene glycol precipitation for recovery of pathogenic viruses, including hepatitis A virus and human rotavirus, from oyster, water, and sediment samples. Applied and Environmental Microbiology, 54(8), 1983–1988. doi:0099-2240/88/081983-06$02.00/0.
Li, Y. , Li, R. , Zou, L. , Zhang, M. , & Ling, L. (2017). Fluorometric determination of Simian virus 40 based on strand displacement amplification and triplex DNA using a molecular beacon probe with a guanine-rich fragment of the stem region. Microchimica Acta, 184(2), 557–562. doi:10.1007/s00604-016-2041-y.
Li, Y. , Xue, L. , Gao, J. , Cai, W. , Liang, Y. , Zhang, Z. , et al . (2023). Differences in the effectiveness of the high-efficient concentrated pretreatment method on the norovirus detection in oysters and mussels. International Journal of Food Microbiology, 384, 109957. doi:10.1016/j.ijfoodmicro.2022.109957.
Loosanoff, V. L. (1958). Some aspects of behavior of oysters at different temperatures. The Biological Bulletin, 114(1), 57–70. doi:10.2307/1538965.
Lund, E. , & Hedström, C. E. (1966). The use of an aqueous polymer phase system for enterovirus isolations from sewage. American Journal of Epidemiology, 84(2), 287–291. doi:10.1093/oxfordjournals.aje.a120642.
Maalouf, H. , Pommepuy, M. , & Le Guyader, F. S. (2010a). Environmental conditions leading to shellfish contamination and related outbreaks. Food and Environmental Virology, 2(3), 136–145. doi:10.1007/s12560-010-9043-4.
Maalouf, H. , Zakhour, M. , Le Pendu, J. , Le Saux, J. C. , Atmar, R. L. , & Le Guyader, F. S. (2010b). Distribution in tissue and seasonal variation of norovirus genogroup I and II ligands in oysters. Applied and Environmental Microbiology, 76(16), 5621–5630. doi:10.1128/AEM.00148-10.
Macaluso, G. , Guercio, A. , Gucciardi, F. , Di Bella, S. , La Rosa , G., Suffredini, E. , et al . (2021). Occurrence of human enteric viruses in shellfish along the production and distribution chain in Sicily, Italy. Foods, 10(6), 1384. doi:10.3390/foods10061384.
Mancusi, A. , Capuano, F. , Girardi, S. , Di Maro, O. , Suffredini, E. , Di Concilio, D. , et al . (2022). Detection of SARS-CoV-2 RNA in bivalve mollusks by droplet digital RT-PCR (dd RT-PCR). International Journal of Environmental Research and Public Health, 19(2), 1–13. doi:10.3390/ijerph19020943.
McKnight, K. L. , & Lemon, S. M. (2018). Hepatitis A virus genome organization and replication strategy. Cold Spring Harbor Perspectives in Medicine, 8(12), a033480. doi:10.1101/cshperspect.a033480.
McLeod, C. , Hay, B. , Grant, C. , Greening, G. , & Day, D. (2009). Localization of norovirus and poliovirus in Pacific oysters. Journal of Applied Microbiology, 106(4), 1220–1230. doi:10.1111/j.1365-2672.2008.04091.x.
McLeod, C. , Polo, D. , Le Saux, J. C. , & Le Guyader, F. S. (2017). Depuration and relaying: A review on potential removal of norovirus from oysters. Comprehensive Reviews in Food Science and Food Safety, 16(4), 692–706. doi:10.1111/1541-4337.12271.
Nagarajan, V. , Chen, J.-S. , Hsu, G.-J. , Chen, H.-P. , Chao, H.-C. , Huang, S.-W. , et al . (2022). Surveillance of adenovirus and norovirus contaminants in the water and shellfish of major oyster breeding farms and fishing ports in Taiwan. Pathogens, 11(3), 316. doi:10.3390/pathogens11030316.
Nappier, S. P. , Graczyk, T. K. , Tamang, L. , & Schwab, K. J. (2010). Co-localized Crassostrea virginica and Crassostrea ariakensis oysters differ in bioaccumulation, retention and depuration of microbial indicators and human enteropathogens. Journal of Applied Microbiology, 108(2), 736–744. doi:10.1111/j.1365-2672.2009.04480.x.
Newell, D. G. , Koopmans, M. , Verhoef, L. , Duizer, E. , Aidara-Kane, A. , Sprong, H. , et al . (2010). Food-borne diseases - The challenges of 20 years ago still persist while new ones continue to emerge. International Journal of Food Microbiology, 139, S3–S15. doi:10.1016/j.ijfoodmicro.2010.01.021.
Nupen, E. M. (1970). Virus studies on the Windhoek waste-water reclamation plant (South-West Africa). Water Research, 4(10), 661–672. doi:10.1016/0043-1354(70)90028-X.
Pilotto, M. R. , Souza, D. S. M. , & Barardi, C. R. M. (2019). Viral uptake and stability in Crassostrea gigas oysters during depuration, storage and steaming. Marine Pollution Bulletin, 149, 110524. doi:10.1016/j.marpolbul.2019.110524.
Pinheiro, L. B. , Coleman, V. A. , Hindson, C. M. , Herrmann, J. , Hindson, B. J. , Bhat, S. , & Emslie, K. R. (2012). Evaluation of a droplet digital polymerase chain reaction format for DNA copy number quantification. Analytical Chemistry, 84(2), 1003–1011. doi:10.1021/ac202578x.
Polo, D. , Álvarez, C. , Vilariño, M. L. , Longa, Á. , & Romalde, J. L. (2014). Depuration kinetics of hepatitis A virus in clams. Food Microbiology, 39, 103–107. doi:10.1016/j.fm.2013.11.011.
Polo, D. , Lois, M. , Fernández-Núñez, M. T. , & Romalde, J. L. (2021). Detection of SARS-CoV-2 RNA in bivalve mollusks and marine sediments. Science of the Total Environment, 786, 147534. doi:10.1016/j.scitotenv.2021.147534.

Provost, K. , Dancho, B. A. , Ozbay, G. , Anderson, R. S. , Richards, G. P. , & Kingsley, D. H. (2011). Hemocytes are sites of enteric virus persistence within oysters. Applied and Environmental Microbiology, 77(23), 8360–8369. doi:10.1128/AEM.06887-11.
Razafimahefa, R. M. , Ludwig-Begall, L. F. , Le Guyader, F. S. , Farnir, F. , Mauroy, A. , & Thiry, E. (2021). Optimisation of a PMAxxTM-RT-qPCR assay and the preceding extraction method to selectively detect infectious murine norovirus particles in mussels. Food and Environmental Virology, 13(1), 93–106. doi:10.1007/s12560-020-09454-w.
Rigotto, C. , Victoria, M. , Moresco, V. , Kolesnikovas, C. K. K. , Corrêa, A. , Souza, D. S. M. S. M. , et al . (2010). Assessment of adenovirus, hepatitis A virus and rotavirus presence in environmental samples in Florianopolis, South Brazil. Journal of Applied Microbiology, 109(6), 1979–1987. doi:10.1111/j.1365-2672.2010.04827.x.
Sannigrahi, S. , Arumugasamy, S. K. , Mathiyarasu, J. , Sudhakaran, R. , & Suthindhiran, K. (2021). Detection of white spot syndrome virus in seafood samples using a magnetosome-based impedimetric biosensor. Archives of Virology, 166(10), 2763–2778. doi:10.1007/s00705-021-05187-8.
Schrader, C. , Schielke, A. , Ellerbroek, L. , & Johne, R. (2012). PCR inhibitors - Occurrence, properties and removal. Journal of Applied Microbiology, 113(5), 1014–1026. doi:10.1111/j.1365-2672.2012.05384.x.
Silva, C. J. , Vázquez-Fernández, E. , Onisko, B. , & Requena, J. R. (2015). Proteinase K and the structure of PrPSc: The good, the bad and the ugly. Virus Research, 207, 120–126. doi:10.1016/j.virusres.2015.03.008.
Sincero, T. C. M. , Levin, D. B. , Simões, C. M. O. , & Barardi, C. R. M. (2006). Detection of hepatitis A virus (HAV) in oysters (Crassostrea gigas). Water Research, 40(5), 895–902. doi:10.1016/j.watres.2005.12.005.
Souza, D. S. M. , Dominot, A. F. Á. , Moresco, V. , & Barardi, C. R. M. (2018). Presence of enteric viruses, bioaccumulation and stability in Anomalocardia brasiliana clams (Gmelin, 1791). International Journal of Food Microbiology, 266(August 2017), 363–371. doi:10.1016/j.ijfoodmicro.2017.08.004.
Strubbia, S. , Schaeffer, J. , Oude Munnink, B. B. , Besnard, A. , Phan, M. V. T. , Nieuwenhuijse, D. F. , et al . (2019). Metavirome sequencing to evaluate norovirus diversity in sewage and related bioaccumulated oysters. Frontiers in Microbiology, 10(OCT), 2394. doi:10.3389/fmicb.2019.02394.
Sun, Z. , Niu, P. , Jin, M. , Gao, Q. , Wang, J. , & Ma, X. (2022). Detection and genetic correlation analysis of diarrhea cases and norovirus in oysters in Yantai, China. Frontiers in Public Health, 10, 819890. doi:10.3389/fpubh.2022.819890.
Tan, M. T. H. , Ho, S. X. , Chu, J. J. H. , & Li, D. (2021). Application of virome capture sequencing in shellfish sold at retail level in Singapore. Letters in Applied Microbiology, 73(4), 486–494. doi:10.1111/lam.13540.
Tian, P. , Engelbrektson, A. L. , Jiang, X. , Zhong, W. , & Mandrell, R. E. (2007). Norovirus recognizes histo-blood group antigens on gastrointestinal cells of clams, mussels, and oysters: A possible mechanism of bioaccumulation. Journal of Food Protection, 70(9), 2140–2147. doi:10.4315/0362-028X-70.9.2140.
Ueki, Y. , Amarasiri, M. , Kamio, S. , Sakagami, A. , Ito, H. , Uprety, S. , et al . (2021). Human norovirus disease burden of consuming Crassostrea gigas oysters: A case-study from Japan. Food Control, 121, 107556. doi:10.1016/j.foodcont.2020.107556.
Ueki, Y. , Shoji, M. , Suto, A. , Tanabe, T. , Okimura, Y. , Kikuchi, Y. , et al . (2007). Persistence of caliciviruses in artificially contaminated oysters during depuration. Applied and Environmental Microbiology, 73(17), 5698–5701. doi:10.1128/AEM.00290-07.
Varela, M. F. , Hooper, A. S. , Rivadulla, E. , & Romalde, J. L. (2016). Human sapovirus in mussels from Ría do Burgo, A Coruña (Spain). Food and Environmental Virology, 8(3), 187–193. doi:10.1007/s12560-016-9242-8.
Velusamy, V. , Arshak, K. , Korostynska, O. , Oliwa, K. , & Adley, C. (2010). An overview of foodborne pathogen detection: In the perspective of biosensors. Biotechnology Advances, 28(2), 232–254. doi:10.1016/j.biotechadv.2009.12.004.
Wang, D. , Cao, J. , Tian, Z. , Fang, B. , Qi, X. , Lei, Z. , et al . (2022). Development of a new concentration method for hepatitis A virus detection (ISO 15216-2:2019) in Manila clams (Ruditapes philippinarum). LWT, 172, 114172. doi:10.1016/j.lwt.2022.114172.
Widén, F. , Vågsholm, I. , Belák, S. , & Muradrasoli, S. (2011). Achievement V - Methods for breaking the transmission of pathogens along the food chain. Detection of viruses in food. Trends in Food Science and Technology, 22(SUPPL. 1), 49–57. doi:10.1016/j.tifs.2011.05.008.
Yu, Y. , Cai, H. , Hu, L. , Lei, R. , Pan, Y. , Yan, S. , & Wang, Y. (2015). Molecular epidemiology of oyster-related human noroviruses and their global genetic diversity and temporal-geographical distribution from 1983 to 2014. Applied and Environmental Microbiology, 81(21), 7615–7624. doi:10.1128/AEM.01729-15.
Zasada, A. A. , Mosiej, E. , Prygiel, M. , Polak, M. , Wdowiak, K. , Formińska, K. , et al . (2022). Detection of SARS-CoV-2 using reverse transcription helicase dependent amplification and reverse transcription loop-mediated amplification combined with lateral flow assay. Biomedicines, 10(9), 2329. doi:10.3390/biomedicines10092329.
Zhang, L. , Xue, L. , Gao, J. , Cai, W. , Jiang, Y. , Zuo, Y. , et al . (2020). Development of a high-efficient concentrated pretreatment method for noroviruses detection in independent oysters: An extension of the ISO/TS 15216-2:2013 standard method. Food Control, 111, 107032. doi:10.1016/j.foodcont.2019.107032.
Zhou, D. , Ma, L. , Zhao, F. , Yao, L. , Su, L. , & Li, X. (2013). An efficient method of noroviruses recovery from oysters and clams. Journal of Ocean University of China, 12(1), 85–90. doi:10.1007/s11802-013-2133-9.

Quilliam, M. A. , and Wright, J. L. C. , 1989. The amnesic shellfish poisoning mystery. Analytical Chemistry, 61, 1053A–1060A.
Pineiro, N. , Vaquero, E. , Leao, J. M. , Gago-Martinez, A. , and Vazquez, J. A. R. , 2001. Optimization of conditions for the liquid chromatographic-electrospray ionization-mass spectrometric analysis of amnesic shellfish poisoning toxins. Chromatographia, 53, S231–S235.
Furey, A. , Lehane, M. , Gillman, M. , Fernandez-Puente, P. , and James, K. J. , 2001. Determination of domoic acid in shellfish by liquid chromatography with electrospray ionization and multiple tandem mass spectrometry. Journal of Chromatography A, 938, 167–174.
Ciminiello, P. , Dell'Aversano, C. , Fattorusso, E. et al., 2005. Hydrophilic interaction liquid chromatography/mass spectrometry for determination of domoic acid in Adriatic shellfish. Rapid Communications in Mass Spectrometry, 19, 2030–2038.
McNabb, P. , Selwood, A. I. , Holland, P. T. et al., 2005. Multiresidue method for determination of algal toxins in shellfish: Single-laboratory validation and interlaboratory study. Journal of AOAC International, 88, 761–772.
Holland, P. T. , McNabb, P. , Selwood, A. I. , and Neil, T. , 2003. Amnesic shellfish poisoning toxins in shellfish: Estimation of uncertainty of measurement for a liquid chromatography/tandem mass spectrometry method. Journal of AOAC International, 86, 1095–1100.
de la Iglesia, P. , Barber, E. , Gimenez, G. , Rodriguez-Velasco, M. L. , Villar-Gonzalez, A. , and Diogene, J. , 2011. High-throughput analysis of amnesic shellfish poisoning toxins in shellfish by ultra-performance rapid resolution LC-MS/MS. Journal of AOAC International, 94, 555–564.
Wiese, M. , D'Agostino, P. M. , Mihali, T. K. , Moffitt, M. C. , and Neilan, B. A. , 2010. Neurotoxic alkaloids: Saxitoxin and its analogs. Marine Drugs, 8, 2185–2211.
Alexander, J. , Benford, D. , Cockburn, A. et al., 2009. Marine biotoxins in shellfish-Saxitoxin group. The European Food Safety Authority Journal, 1019, 1–76.
Oshima, Y. , 1995. Postcolumn derivatization liquid-chromatographic method for paralytic shellfish toxins. Journal of AOAC International, 78, 528–532.
Lawrence, J. F. , Niedzwiadek, B. , and Menard, C. , 2005. Quantitative determination of paralytic shellfish poisoning toxins in shellfish using prechromatographic oxidation and liquid chromatography with fluorescence detection: Collaborative study. Journal of AOAC International, 88, 1714–1732.
van de Riet, J. , Gibbs, R. S. , Muggah, P. M. , Rourke, W. A. , MacNeil, J. D. , and Quilliam, M. A. , 2011. Liquid chromatography post-column oxidation (PCOX) method for the determination of paralytic shellfish toxins in mussels, clams, oysters, and scallops: Collaborative study. Journal of AOAC International, 94, 1154–1176.
DeGrasse, S. L. , van de Riet, J. , Hatfield, R. , and Turner, A. , 2011. Pre- versus post-column oxidation liquid chromatography fluorescence detection of paralytic shellfish toxins. Toxicon, 57, 619–624.
Turner, A. D. , Hatfield, R. G. , Rapkova, M. et al., 2011. Comparison of AOAC 2005.06 LC official method with other methodologies for the quantitation of paralytic shellfish poisoning toxins in UK shellfish species. Analytical and Bioanalytical Chemistry, 399, 1257–1270.
Dell'Aversano, C. , Hess, P. , and Quilliam, M. A. , 2005. Hydrophilic interaction liquid chromatographymass spectrometry for the analysis of paralytic shellfish poisoning (PSP) toxins. Journal of Chromatographic A, 1081, 190–201.
Diener, M. , Erler, K. , Christian, B. , and Luckas, B. , 2007. Application of a new zwitterionic hydrophilic interaction chromatography column for determination of paralytic shellfish poisoning toxins. Journal of Separation Science, 30, 1821–1826.
Jaime, E. , Hummert, C. , Hess, P. , and Luckas, B. , 2001. Determination of paralytic shellfish poisoning toxins by high-performance ion-exchange chromatography. Journal of Chromatography A, 929, 43–49.
Buzy, A. , Thibault, P. , and Laycock, M. V. , 1994. Development of a capillary electrophoresis method for the characterization of enzymatic products arising from the carbamoylase digestion of paralytic shellfish poisoning toxins. Journal of Chromatography A, 688, 301–316.
Locke, S. J. , and Thibault, P. , 1994. Improvement in detection limits for the determination of paralytic shellfish poisoning toxins in shellfish tissues using capillary electrophoresis electrospray mass-spectrometry and discontinuous buffer systems. Analytical Chemistry, 66, 3436–3446.
Quilliam, M. A. , Hess, P. , and Dell'Aversano, C. , 2001. Recent developments in the analysis of phycotoxins by liquid chromatography-mass spectrometry, In Mycotoxins and Phycotoxins in Perspective at the Turn of the Century, de Koe, W. J. , Samson, R. A. , van Egmond, H. P. , Gilbert, J. , and Sabino, M. , Eds. Wageningen, Ponsen and Looijen, the Netherlands, pp. 383–391.
Turrell, E. , Stobo, L. , Lacaze, J. P. , Piletsky, S. , and Piletska, E. , 2008. Optimization of hydrophilic interaction liquid chromatography/mass spectrometry and development of solid-phase extraction for the determination of paralytic shellfish poisoning toxins. Journal of AOAC International, 91, 1372–1386.
Sayfritz, S. J. , Aasen, J. A. , and Aune, T. , 2008. Determination of paralytic shellfish poisoning toxins in Norwegian shellfish by liquid chromatography with fluorescence and tandem mass spectrometry detection. Toxicon, 52, 330–340.
Blay, P. , Hui, J. P. , Chang, J. , and Melanson, J. E. , 2011. Screening for multiple classes of marine biotoxins by liquid chromatography-high-resolution mass spectrometry. Analytical and Bioanalytical Chemistry, 400,

577–585.
Lajeunesse, A. , Segura, P. A. , Gelinas, M. et al., 2012. Detection and confirmation of saxitoxin analogues in freshwater benthic Lyngbya wollei algae collected in the St. Lawrence River (Canada) by liquid chromatography-tandem mass spectrometry. Journal of Chromatography A, 1219, 93–103.
Vale, P. , 2010. New saxitoxin analogues in the marine environment: Developments in toxin chemistry, detection and biotransformation during the 2000s. Phytochemistry Reviews, 9, 525–535.
Stobo, L. A. , Lacaze, J. P. , Scott, A. C. , Gallacher, S. , Smith, E. A. , and Quilliam, M. A. , 2005. Liquid chromatography with mass spectrometry-Detection of lipophilic shellfish toxins. Journal of AOAC International, 88, 1371–1382.
Gerssen, A. , Mulder, P. P. , McElhinney, M. A. , and de Boer, J. , 2009. Liquid chromatography-tandem mass spectrometry method for the detection of marine lipophilic toxins under alkaline conditions. Journal of Chromatography A, 1216, 1421–1430.
, 2011. Commission regulation (EU) No 15/2011 of 10 January 2011 amending regulation (EC) No 2074/2005 as regards recognised testing methods for detecting marine biotoxins in live bivalve molluscs 15/2011, C. R. E. N. Official Journal of European Communications, 2011, 3–6.
McCarron, P. , Kotterman, M. , de Boer, J. , Rehmann, N. , and Hess, P. , 2007. Feasibility of gamma irradiation as a stabilisation technique in the preparation of tissue reference materials for a range of shellfish toxins. Analytical and Bioanalytical Chemistry, 387, 2487–2493.
McCarron, P. , Kilcoyne, J. , Miles, C. O. , and Hess, P. , 2009. Formation of Azaspiracids-3, -4, -6, and -9 via decarboxylation of carboxy azaspiracid metabolites from shellfish. Journal of Agricultural and Food Chemistry, 57, 160–169.
Bencsath, F. A. , and Dickey, R. W. , 1991. Mass spectral characteristics of okadaic acid and simple derivatives. Rapid Communications in Mass Spectrometry, 5, 283–290.
Pleasance, S. , Quilliam, M. A. , and Marr, J. C. , 1992. Ion spray mass spectrometry of marine toxins. IV. Determination of diarrhetic shellfish poisoning toxins in muscle tissue by liquid chromatography/mass spectrometry. Rapid Communications in Mass Spectrometry, 6, 121–127.
Quilliam, M. A. , 1995. Analysis of diarrhetic shellfish poisoning toxins in shellfish tissue by liquid-chromatography with fluorometric and mass-spectrometric detection. Journal of AOAC International, 78, 555–570.
Gerssen, A. , Mulder, P. , van Rhijn, H. , and de Boer, J. , 2008. Mass spectrometric analysis of the marine lipophilic biotoxins pectenotoxin-2 and okadaic acid by four different types of mass spectrometers. Journal of Mass Spectrometry, 43, 1140–1147.
Carey, B. , Fidalgo Saez, M. J. , Hamilton, B. , O'Halloran, J. , van Pelt, F. N. , and James, K. J. , 2012. Elucidation of the mass fragmentation pathways of the polyether marine toxins, dinophysistoxins, and identification of isomer discrimination processes. Rapid Communications in Mass Spectrometry, 26, 1793–1802.
Torgersen, T. , Miles, C. O. , Rundberget, T. , and Wilkins, A. L. , 2008. New esters of okadaic acid in seawater and blue mussels (Mytilus edulis). Journal of Agricultural and Food Chemistry, 56, 9628–9635.
Torgersen, T. , Wilkins, A. L. , Rundberget, T. , and Miles, C. O. , 2008. Characterization of fatty acid esters of okadaic acid and related toxins in blue mussels (Mytilus edulis) from Norway. Rapid Communications in Mass Spectrometry, 22, 1127–1136.
Hu, T. M. , Curtis, J. M. , Walter, J. A. , McLachlan, J. L. , and Wright, J. L. C. , 1995. Two new water-soluble DSP toxin derivatives from the dinoflagellate Prorocentrum maculosum: Possible storage and excretion products. Tetrahedron Letters, 36, 9273–9276.
Cruz, P. G. , Daranas, A. H. , Fernandez, J. J. , Souto, M. L. , and Norte, M. , 2006. DTX5c, a new OA sulphate ester derivative from cultures of Prorocentrum belizeanum. Toxicon, 47, 920–924.
Suarez-Gomez, B. , Souto, M. L. , Cruz, P. G. , Fernandez, J. J. , and Norte, M. , 2005. New targets in diarrhetic shellfish poisoning control. Journal of Natural Products, 68, 596–599.
Suarez-Gomez, B. , Souto, M. L. , Norte, M. , and Fernandez, J. J. , 2001. Isolation and structural determination of DTX-6, a new okadaic acid derivative. Journal of Natural Products, 64, 1363–1364.
Paz, B. , Daranas, A. H. , Cruz, P. G. et al., 2007. Identification and characterization of DTX-5c and 7-hydroxymethyl-2-methylene-octa-4,7-dienyl okadaate from Prorocentrum belizeanum cultures by LC-MS. Toxicon, 50, 470–478.
Miles, C. O. , Wilkins, A. L. , Hawkes, A. D. et al., 2006. Isolation and identification of pectenotoxins-13 and -14 from Dinophysis acuta in New Zealand. Toxicon, 48, 152–159.
Miles, C. O. , Wilkins, A. L. , Samdal, I. A. et al., 2004. A novel pectenotoxin, PTX-12, in Dinophysis spp. and shellfish from Norway. Chemical Research in Toxicology, 17, 1423–1433.
Yasumoto, T. , Murata, M. , Oshima, Y. , Sano, M. , Matsumoto, G. K. , and Clardy, J. , 1985. Diarrhetic shellfish toxins. Tetrahedron, 41, 1019–1025.
Suzuki, T. , Mackenzie, L. , Stirling, D. , and Adamson, J. , 2001. Pectenotoxin-2 seco acid: A toxin converted from pectenotoxin-2 by the New Zealand Greenshell mussel, Perna canaliculus. Toxicon, 39, 507–514.
Goto, H. , Igarashi, T. , Yamamoto, M. et al., 2001. Quantitative determination of marine toxins associated with diarrhetic shellfish poisoning by liquid chromatography coupled with mass spectrometry. Journal of Chromatography A, 907, 181–189.

Suzuki, T. , Mitsuya, T. , Matsubara, H. , and Yamasaki, M. , 1998. Determination of pectenotoxin-2 after solid-phase extraction from seawater and from the dinoflagellate Dinophysis fortii by liquid chromatography with electrospray mass spectrometry and ultraviolet detection-Evidence of oxidation of pectenotoxin-2 to pectenotoxin-6 in scallops. Journal of Chromatography A, 815, 155–160.
Torgersen, T. , Sandvik, M. , Lundve, B. , and Lindegarth, S. , 2008. Profiles and levels of fatty acid esters of okadaic acid group toxins and pectenotoxins during toxin depuration. Part II: Blue mussels (Mytilus edulis) and flat oyster (Ostrea edulis). Toxicon, 52, 418–427.
Gerssen, A. , Mulder, P. P. , and de Boer, J. , 2011. Screening of lipophilic marine toxins in shellfish and algae: Development of a library using liquid chromatography coupled to orbitrap mass spectrometry. Analytica Chimica Acta, 685, 176–185.
Alexander, J. , Benford, D. , Cockburn, A. et al., 2009. Marine biotoxins in shellfish-Pectenotoxin group. The European Food Safety Authority Journal, 1109, 1–47.
de la Iglesia, P. , Gago-Martinez, A. , and Yasumoto, T. , 2007. Advanced studies for the application of high-performance capillary electrophoresis for the analysis of yessotoxin and 45-hydroxyyessotoxin. Journal of Chromatography A, 1156, 160–166.
Draisci, R. , Giannetti, L. , Lucentini, L. , Ferretti, E. , Palleschi, L. , and Marchiafava, C. , 1998. Direct identification of yessotoxin in shellfish by liquid chromatography coupled with mass spectrometry and tandem mass spectrometry. Rapid Communications in Mass Spectrometry, 12, 1291–1296.
Fux, E. , McMillan, D. , Bire, R. , and Hess, P. , 2007. Development of an ultra-performance liquid chromatography-mass spectrometry method for the detection of lipophilic marine toxins. Journal of Chromatography A, 1157, 273–280.
Draisci, R. , Giannetti, L. , Lucentini, L. , Ferretti, E. , Palleschi, L. , and Marchiafava, C. , 1998. Direct identification of yessotoxin in shellfish by liquid chromatography coupled with mass spectrometry and tandem mass spectrometry. Rapid Communications in Mass Spectrometry, 12, 1291–1296.
Murata, M. , Kumagai, M. , Lee, J. S. , and Yasumoto, T. , 1987. Isolation and structure of yessotoxin, a novel polyether compound implicated in diarrhetic shellfish poisoning. Tetrahedron Letters, 28, 5869–5872.
Amandi, M. F. , Furey, A. , Lehane, M. , Ramstad, H. , and James, K. J. , 2002. Liquid chromatography with electrospray ion-trap mass spectrometry for the determination of yessotoxins in shellfish. Journal of Chromatography A, 976, 329–334.
Miles, C. O. , Samdal, I. A. , Aasen, J. A. B. et al., 2005. Evidence for numerous analogs of yessotoxin in Protoceratium reticulatum. Harmful Algae, 4, 1075–1091.
Alexander, J. , Benford, D. , Cockburn, A. et al., 2008. Marine biotoxins in shellfish-Yessotoxin group. The European Food Safety Authority Journal, 907, 1–62.
Satake, M. , Tubaro, A. , Lee, J. S. , and Yasumoto, T. , 1997. Two new analogs of yessotoxin, homoyessotoxin and 45-hydroxyhomoyessotoxin, isolated from mussels of the Adriatic Sea. Natural Toxins, 5, 107–110.
Satake, M. , Ofuji, K. , Naoki, H. et al., 1998. Azaspiracid, a new marine toxin having unique spiro ring assemblies, isolated from Irish mussels, Mytilus edulis. Journal of the American Chemical Society, 120, 9967–9968.
Ofuji, K. , Satake, M. , McMahon, T. et al., 1999. Two analogs of azaspiracid isolated from mussels, Mytilus edulis, involved in human intoxication in Ireland. Natural Toxins, 7, 99–102.
Lehane, M. , Brana-Magdalena, A. , Moroney, C. , Furey, A. , and James, K. J. , 2002. Liquid chromatography with electrospray ion trap mass spectrometry for the determination of five azaspiracids in shellfish. Journal of Chromatography A, 950, 139–147.
Brombacher, S. , Edmonds, S. , and Volmer, D. A. , 2002. Studies on azaspiracid biotoxins. II. Mass spectral behavior and structural elucidation of azaspiracids analogs. Rapid Communications in Mass Spectrometry, 16, 2306–2316.
James, K. J. , Sierra, M. D. , Lehane, M. , Brana-Magdalena, A. , and Furey, A. , 2003. Detection of five new hydroxyl analogues of azaspiracids in shellfish using multiple tandem mass spectrometry. Toxicon, 41, 227–283.
Rehmann, N. , Hess, P. , and Quilliam, M. A. , 2008. Discovery of new analogs of the marine biotoxin azaspiracid in blue mussels (Mytilus edulis) by ultra-performance liquid chromatography/tandem mass spectrometry. Rapid Communications in Mass Spectrometry, 22, 549–558.
McCarron, P. , Kilcoyne, J. , Miles, C. O. , and Hess, P. , 2009. Formation of azaspiracids-3, -4, -6, and -9 via decarboxylation of carboxyazaspiracid metabolites from shellfish. Journal of Agricultural and Food Chemistry, 57, 160–169.
Gu, H. F. , Luo, Z. H. , Krock, B. , Witt, M. , and Tillmann, U. , 2013. Morphology, phylogeny and azaspiracid profile of Azadinium poporum (Dinophyceae) from the China Sea. Harmful Algae, 21–22, 64–75.
Krock, B. , Tillmann, U. , Voss, D. et al., 2012. New azaspiracids in Amphidomataceae (Dinophyceae). Toxicon, 60, 830–839.
Hu, T. M. , Curtis, J. M. , Oshima, Y. et al., 1995. Spirolide-B and spirolide-D, 2 novel macrocycles isolated from the digestive glands of shellfish. Journal of the Chemical Society-Chemical Communications, 1995, 2159–2161.
Cembella, A. D. , Lewis, N. I. , and Quilliam, M. A. , 2000. The marine dinoflagellate Alexandrium ostenfeldii (Dinophyceae) as the causative organism of spirolide shellfish toxins. Phycologia, 39, 67–74.

Aasen, J. A. B. , MacKinnon, S. L. , LeBlanc, P. et al., 2005. Detection and identification of spirolides in Norwegian shellfish and plankton. Chemical Research in Toxicology, 18, 509–515.
Aasen, J. A. B. , Hardstaff, W. , Aune, T. , and Quilliam, M. A. , 2006. Discovery of fatty acid ester metabolites of spirolide toxins in mussels from Norway using liquid chromatography/tandem mass spectrometry. Rapid Communications in Mass Spectrometry, 20, 1531–1537.
Seki, T. , Satake, M. , Mackenzie, L. , Kaspar, H. F. , and Yasumoto, T. , 1995. Gymnodimine, a new marine toxin of unprecedented structure isolated from New-Zealand oysters and the dinoflagellate, Gymnodinium sp. Tetrahedron Letters, 36, 7093–7096.
Miles, C. O. , Wilkins, A. L. , Stirling, D. J. , and MacKenzie, A. L. , 2000. New analogue of gymnodimine from a Gymnodinium species. Journal of Agricultural and Food Chemistry, 48, 1373–1376.
Miles, C. O. , Wilkins, A. L. , Stirling, D. J. , and MacKenzie, A. L. , 2003. Gymnodimine C, an isomer of gymnodimine B, from Karenia selliformis. Journal of Agricultural and Food Chemistry, 51, 4838–4840.
Van Wagoner, R. M. , Misner, I. , Tomas, C. R. , and Wright, J. L. C. , 2011. Occurrence of 12-methylgymnodimine in a spirolide-producing dinoflagellate Alexandrium peruvianum and the biogenetic implications. Tetrahedron Letters, 52, 4243–4246.
de la Iglesia, P. , McCarron, P. , Diogene, J. , and Quilliam, M. A. , 2013. Discovery of gymnodimine fatty acid ester metabolites in shellfish using liquid chromatography/mass spectrometry. Rapid Communications in Mass Spectrometry, 27, 643–653.
Uemura, D. , Chou, T. , Haino, T. et al., 1995. Pinnatoxin A - a toxic amphoteric macrocycle from the Okinawan bivalve Pinna-muricata. Journal of the American Chemical Society, 117, 1155–1156.
Takada, N. , Umemura, N. , Suenaga, K. et al., 2001. Pinnatoxins B and C, the most toxic components in the pinnatoxin series from the Okinawan bivalve Pinna muricata. Tetrahedron Letters, 42, 3491–3494.
Chou, T. , Haino, T. , Kuramoto, M. , and Uemura, D. , 1996. Isolation and structure of pinnatoxin D, a new shellfish poison from the Okinawan bivalve Pinna muricata. Tetrahedron Letters, 37, 4027–4030.
Selwood, A. I. , Miles, C. O. , Wilkins, A. L. et al., 2010. Isolation, structural determination and acute toxicity of pinnatoxins E, F and G. Journal of Agricultural and Food Chemistry, 58, 6532–6542.
McCarron, P. , Rourke, W. A. , Hardstaff, W. , Pooley, B. , and Quilliam, M. A. , 2012. Identification of pinnatoxins and discovery of their fatty acid ester metabolites in mussels (Mytilus edulis) from eastern Canada. Journal of Agricultural and Food Chemistry, 60, 1437–1446.
Rundberget, T. , Aasen, J. A. B. , Selwood, A. I. , and Miles, C. O. , 2011. Pinnatoxins and spirolides in Norwegian blue mussels and seawater. Toxicon, 58, 700–711.
Alexander, J. , Benford, D. , Cockburn, A. et al., 2010. Scientific opinion on marine biotoxins in shellfish-Cyclic imines (spirolides, gymnodimines, pinnatoxins and pteriatoxins). The European Food Safety Authority Journal, 1628, 1–39.
Pottier, I. , Vernoux, J. P. , Jones, A. , and Lewis, R. J. , 2002. Characterisation of multiple Caribbean ciguatoxins and congeners in individual specimens of horse-eye jack (Caranx latus) by high-performance liquid chromatography/mass spectrometry. Toxicon, 40, 929–939.
Yogi, K. , Oshiro, N. , Inafuku, Y. , Hirama, M. , and Yasumoto, T. , 2011. Detailed LC-MS/MS analysis of ciguatoxins revealing distinct regional and species characteristics in fish and causative alga from the Pacific. Analytical Chemistry, 83, 8886–8891.
Hamilton, B. , Hurbungs, M. , Jones, A. , and Lewis, R. J. , 2002. Multiple ciguatoxins present in Indian Ocean reef fish. Toxicon, 40, 1347–1353.
Lewis, R. J. , Holmes, M. J. , Alewood, P. F. , and Jones, A. , 1994. Ionspray mass spectrometry of ciguatoxin-1, maitotoxin-2 and -3, and related marine polyether toxins. Natural Toxins, 2, 56–63.
Murata, M. , Naoki, H. , Matsunaga, S. , Satake, M. , and Yasumoto, T. , 1994. Structure and partial stereochemical assignments for maitotoxin, the most toxic and largest natural non-biopolymer. Journal of the American Chemical Society, 116, 7098–7107.
Lewis, R. J. , Jones, A. , and Vernoux, J. P. , 1999. HPLC/tandem electrospray mass spectrometry for the determination of sub-ppb levels of Pacific and Caribbean ciguatoxins in crude extracts of fish. Analytical Chemistry, 71, 247–250.
Abraham, A. , Jester, E. L. E. , Granade, H. R. , Plakas, S. M. , and Dickey, R. W. , 2012. Caribbean ciguatoxin profile in raw and cooked fish implicated in ciguatera. Food Chemistry, 131, 192–198.
Tubaro, A. , Dell'Ovo, V. , Sosa, S. , and Florio, C. , 2010. Yessotoxins: A toxicological overview. Toxicon, 56, 163–172.
Miles, C. O. , Wilkins, A. L. , Munday, R. et al., 2004. Isolation of pectenotoxin-2 from Dinophysis acuta and its conversion to pectenotoxin-2 seco acid, and preliminary assessment of their acute toxicities. Toxicon, 43, 1–9.
, 2005. Commission Regulation (EC) No 2074/2005 of 5 December 2005 laying down implementing measures for certain products under Regulation (EC) No 853/2004 of the European Parliament and of the Council and for the organisation of official controls under Regulation (EC) No 854/2004 of the European Parliament and of the Council and Regulation (EC) No 882/2004 of the European Parliament and of the Council, derogating from Regulation (EC) No 852/2004 of the European Parliament and of the Council and amending Regulations (EC) No 853/2004 and (EC) No 854/2004 (Text with EEA relevance), 2074/2005, C. R. E. N. Official Journal of European Communications, L338, 27–59.

, 2002. Commission Decision of 12 August 2002 implementing Council Directive 96/23/EC concerning the performance of analytical methods and the interpretation of results (2002/657/EC). Official Journal of the European Communities, L221, 8–36.
, 2011. Method validation and quality control procedures for pesticide residues analysis in food and feed, SANCO/12495/2011, D. N. https://ec.europa.eu/food/plant/plant_protection_products/guidance_documents/docs/qualcontrol_en.pdf, 2011, last accessed February 10, 2013 .
, 2004. Commission Directive 2004/853/EC specific hygiene rules for food of animal origin, 2004/853/ EC, C. d. Official Journal of European Communications, L226, 22–82.
, 2008. Standard for live and raw bivalve molluscs, 292–2008, C. S.
McNabb, P. , Selwood, A. I. , and Holland, P. T. , 2005. Multiresidue method for determination of algal toxins in shellfish: Single-laboratory validation and interlaboratory study. Journal of AOAC International, 88, 761–772.
Stobo, L. A. , Lacaze, J. P. C. L. , Scott, A. C. , Gallacher, S. , Smith, E. A. , and Quilliam, M. A. , 2005. Liquid chromatography with mass spectrometry-Detection of lipophilic shellfish toxins. Journal of AOAC International, 88, 1371–1382.
These, A. , Klemm, C. , Nausch, I. , and Uhlig, S. , 2011. Results of a European interlaboratory method validation study for the quantitative determination of lipophilic marine biotoxins in raw and cooked shellfish based on high-performance liquid chromatography-tandem mass spectrometry. Part I: Collaborative study. Analytical and Bioanalytical Chemistry, 399, 1245–1256.
van den Top, H. J. , Gerssen, A. , McCarron, P. , and van Egmond, H. P. , 2011. Quantitative determination of marine lipophilic toxins in mussels, oysters and cockles using liquid chromatography-mass spectrometry: Inter-laboratory validation study. Food Additives and Contaminants Part A, 28, 1745–1757.
Gerssen, A. , Klijnstra, M. , Cubbon, S. , and Gledhill, A. , UPLC-MS/MS method for the routine quantification of regulated and non-regulated lipophilic marine biotoxins in shellfish. https://www.waters.com/webassets/cms/library/docs/720004601en.pdf, 2013, last accessed February 10, 2013 .
Blay, P. , Hui, J. P. , Chang, J. , and Melanson, J. E. , 2011. Screening for multiple classes of marine biotoxins by liquid chromatography-high-resolution mass spectrometry. Analytical and Bioanalytical Chemistry, 400, 577–585.
Kittler, K. , Preiss-Weigert, A. , and These, A. , 2010. Identification strategy using combined mass spectrometric techniques for elucidation of phase I and phase II in vitro metabolites of lipophilic marine biotoxins. Analytical Chemistry, 82, 9329–9335.
Peters, R. J. , Oosterink, J. E. , Stolker, A. A. , Georgakopoulos, C. , and Nielen, M. W. , 2010. Generic sample preparation combined with high-resolution liquid chromatography-time-of-flight mass spectrometry for unification of urine screening in doping-control laboratories. Analytical and Bioanalytical Chemistry, 396, 2583–2598.
Stolker, A. A. , Rutgers, P. , Oosterink, E. et al., 2008. Comprehensive screening and quantification of veterinary drugs in milk using UPLC-ToF-MS. Analytical and Bioanalytical Chemistry, 391, 2309–2322.
Vonaparti, A. , Lyris, E. , Angelis, Y. S. et al., 2010. Preventive doping control screening analysis of prohibited substances in human urine using rapid-resolution liquid chromatography/high-resolution time-of-flight mass spectrometry. Rapid Communications in Mass Spectrometry, 24, 1595–1609.
Martinez-Villalba, A. , Vaclavik, L. , Moyano, E. , Galceran, M. T. , and Hajslova, J. , 2013. Direct analysis in real time high-resolution mass spectrometry for high-throughput analysis of antiparasitic veterinary drugs in feed and food. Rapid Communications in Mass Spectrometry, 27, 467–475.
Monge, M. E. , Harris, G. A. , Dwivedi, P. , and Fernandez, F. M. , 2013. Mass spectrometry: Recent advances in direct open air surface sampling/ionization. Chemical Reviews, 113, 2269–2308.
Lapthorn, C. , Pullen, F. , and Chowdhry, B. Z. , 2013. Ion mobility spectrometry-mass spectrometry (IMS-MS) of small molecules: Separating and assigning structures to ions. Mass Spectrometry Reviews, 32, 43–71.
Armenta, S. , Alcala, M. , and Blanco, M. , 2011. A review of recent, unconventional applications of ion mobility spectrometry (IMS). Analytica Chimica Acta, 703, 114–123.

Biogenic Amines in Seafood Products

Al Bulushi, I. , Poole, S. , Deeth, H.C. , and Dykes, G.A. Biogenic amines in fish: Roles in intoxication, spoilage, and nitrosamine formation-A review. Crit. Rev. Food Sci. Nutr., 49, 369, 2009.
Alonso-Lomillo, M.A. , Domínguez-Renedo, O. , Matos, P. , and Arcos-Martínez, M.J. Disposable biosensors for determination of biogenic amines. Anal. Chim Acta., 665(1), 26, 2010.
AOAC (Association of Official Analytical Chemists) . Histamine in seafood: Fluorometric method Sec. 35.1.32, method 977.13. In Official Methods of Analysis of AOAC International; Cunniff, P.A. , Ed.; AOAC International: Gaithersburg, MD; pp. 16–17; 1995.

Arulkumar, A. , Paramithiotis, S. , and Paramasivam, S. Biogenic amines in fresh fish and fishery products and emerging control. Aquac. Fish., 8, 431, 2021.
Auerswald, L. , Morren, C. , and Lopata, AL . Histamine levels in seventeen species of fresh and processed South African seafood. Food Chem., 98, 231, 2006.
Baixas-Nogueras, S. , Bover-Cid, S. , Veciana-Nogués, M.T. , Mariné-Font, A. , and Vidal-Carou, M.C. Biogenic amines index for freshness evaluation in iced Mediterranean hake (Merluccius merluccius). J. Food Prot., 68, 2433, 2005.
Barbieri, F. , Montanari, C. , Gardini, F. , and Tabanelli, G. Biogenic amine production by lactic acid bacteria: A review. Foods, 8(1), 17, 2019.
Bóka, B. , Adányi, N. , Virág, D. , Sebela, M. , and Kiss, A. Spoilage detection with biogenic amine biosensors, comparison of different enzyme electrodes. Electroanalysis, 24(1), 181, 2012.
Carelli, D. , Centonze, D. , Palermo, C. , Quinto, M. , and Rotunno, T. An interference free amperometric biosensor for the detection of biogenic amines in food products. Biosens. Bioelectron., 23, 640, 2007.
Castilho, T.J. , Sotomayor, M.D.P.T. , and Kubota, L.T. Amperometric biosensor based on horseradish peroxidase for biogenic amine determinations in biological samples. J. Pharm. Biomed. Anal., 37, 785, 2005.
Cinquina, A.L. , Calí, A. , Longo, F. , DeSantis, L. , Severoni, A. , and Aballe, F. Determination of biogenic amines in fish tissues by ion-exchange chromatography with conductivity detection. J. Chromatogr., 1032, 73, 2004.
Compagnone, D. , Isoldi, G. , Moscone, D. , and Palleschi, G. Amperometric detection of biogenic amines in cheese using immobilised diamine oxidase. Anal. Lett., 34, 841, 2001.
Do Lago, C.L. , dos Santos, V.B. , Vidal, D.T.R. , and Daniel, D. Analyze biogenic amines in salmon and shrimp by capillary electrophoresis-tandem MS, (Agilent technology 2022) https://hpst.cz/sites/default/files/oldfiles/5991-6255en.pdf.
Draisci, R. , Volpe, G. , Lucentini, L. , Cecilia, A. , Federico, R. , and Palleschi, G. Determination of biogenic amines with an electrochemical biosensor and its application to salted anchovies. Food Chem., 62, 225, 1998.
Du, W.X. , Lin, C.M. , Phu, A.T. , Cornell, J.A. , Marshall, M.R. , and Wei, C.I. Development of biogenic amines in yellowfin tuna (Thunnus albacore): Effect of storage and correlation with decarboxylase-positive bacterial flora. J. Food Sci., 67, 292, 2002.
Duflos, G. , Inglebert, G. , Himber, C. , Degremont, S. , Lombard, B. , and Brisabois, A. Validation of standard method EN ISO 19343 for the detection and quantification of histamine in fish and fishery products using high-performance liquid chromatography. Int. J. Food Microbiol., 288, 97, 2009.
EFSA . Scientific opinion on risk based control of biogenic amine formation in fermented foods. EFSA J., 9, 2393, 2011.
Emborg, J. , Laursen, B.G. , Rathjen, T. , and Dalgaard, P. Microbial spoilage and formation of biogenic amines in fresh and thawed modified atmosphere packed salmon (Salmo salar) at 2°C. J. Appl. Microbiol., 92, 790, 2002.
European Commission (EC) . Commission Regulation No. 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs. Off. J. Eur. Union, 50, 1, 2005.
FDA (Food and Drug Administration) . Fish and Fishery Products Hazards and Controls Guidance, 4th ed.; 2022. Available online: https://www.fda.gov/media/80637/download.
Fernández-No, I.C. , Böhme, K. , Gallardo, J.M. , Barros-Velázquez, J. , Cañas, B. , and Calo-Mata, P. Differential characterization of biogenic amine-producing bacteria involved in food poisoning using MALDI-TOF mass fingerprinting. Electrophoresis, 31, 116, 2010.
Fernandez-Reina, A. , Urdiales, J.L. , and Sánchez-Jiménez, F. What we know and what we need to know about aromatic and cationic biogenic amines in the gastrointestinal tract. Foods, 7, 145, 2018.
Frébort, I. , Skoupa, L. , and Pec, P. Amine oxidase-based flow biosensor for the assessment of fish freshness. Food Control, 11, 13, 2000.
Hongpattarakere, T. , Buntin, N. , and Nuylert, A. Histamine development and bacterial diversity in microbially-challenged tonggol (Thunnus tonggol) under temperature abuse during canning manufacture. J. Food Sci. Technol., 53(1), 245, 2016.
Huang, J. , Gan, N. , Lv, F. , Cao, Y. , Ou, C. , and Tang, H. Environmentally friendly solid-phase microextraction coupled with gas chromatography and mass spectrometry for the determination of biogenic amines in fish samples. J. Sep. Sci., 39, 4384, 2016.
Hungerford, J.M. , and Arefyev, A.A. Flow-injection assay of enzyme inhibition in fish using immobilized diamine oxidase. Anal. Chim. Acta, 261, 351, 1992.
Hungerford, J.M. , Hollingworth, T.A. , and Wekell, M.M. Automated kinetics-enhanced flow injection method for histamine in regulatory laboratories: Rapid screening and suitability requirements. Anal. Chim. Acta, 438, 123, 2001.
Hungerford, J.M. , Walker, K.D. , Wekell, M.M. , LaRose, J.E. , and Throm, H.R. Selective determination of histamine by flow injection analysis. Anal. Chem., 62, 1971, 1990.
Hungerford, J.M. , and Wu, W-H. Comparison study of three rapid test kits for histamine in fish: BiooScientific MaxSignal enzymatic assay, Neogen Veratox ELISA, and the Neogen Reveal Histamine Screening test. Food Control, 25(2), 448, 2012.

Hwang, B.-S. , Wang, J.-T. , and Choong, Y.-M. A rapid gas chromatographic method for the determination of histamine in fish and fish products. Food Chem., 82(2), 329, 2003.
Jorgensen, L.V. , Dalgaard, P. , and Huss, H.H. Multiple compound quality index for cold-smoked salmon (Salmo salar) developed by multivariate regression of biogenic amines and pH. J. Agric. Food Chem., 48, 2448, 2000.
Kivirand, K. , and Rinken, T. Biosensors for biogenic amines: The present state of art mini-review. Anal. Lett., 44(17), 2821, 2011.
Kočar, D. , Köse, S. , Tufan, B. , Ščavničar, A. , and Pompe, M. Determination of biogenic amines in fresh fish and processed fish products using IC-MS/MS. Foods, 10(8), 1746, 2021.
Lange, J. , Thomas, K. , and Wittmann, C. Comparison of a capillary electrophoresis method with high-performance liquid chromatography for the determination of biogenic amines in various food samples. J. Chromatogr. B Analyt. Technol. Biomed. Life Sci., 779, 229, 2002.
Lange, J. , and Wittmann, C. Enzyme sensor array for the determination of biogenic amines in food samples. Anal. Bioanal. Chem., 372, 276, 2002.
Lapa-Guimarães, J. , and Pickova, J. New solvent systems for thin-layer chromatographic determination of nine biogenic amines in fish and squid. J. Chromatogr. A, 1045, 223, 2004.
Latorre-Moratalla, M.L. , Bosch-Fusté, J. , Lavizzari, T. , Bover-Cid, S. , Veciana-Nogués, M.T. , and Vidal-Carou, M.C. Validation of an ultra-high pressure liquid chromatographic method for the determination of biologically active amines in food. J. Chromatogr. A, 1216(45), 7715, 2009b.
Latorre-Moratalla, M.L. , Bover-Cid, S. , Veciana-Nogués, T. , and Vidal-Carou, M.C. Thin-layer chromatography for the identification and semi-quantification of biogenic amines produced by bacteria. J. Chromatogr., 1216, 4128, 2009a.
Lee, H. , Kim, S.-H. , Sang, C.I. , Jun, H. , Eun, J.B. , and An, H. Histamine and other biogenic amines and bacterial isolation in retail canned anchovies. J. Food Sci., 70, C145, 2005.
Lehane, L. , and Olley, J. Histamine fish poisoning revisited. Int. Food. Microbiol., 58, 1, 2000.
Mah, J.-H. , Park, Y.K. , Jin, Y.H. , Lee, J.-H. , and Hwang, H.-J. Bacterial production and control of biogenic amines in Asian fermented soybean foods. Foods, 8, 85, 2019.
Mah, J-H. , and Ruiz-Capillas C. Editorial: The Microbiological Functionality and Safety of Fermented Foods. Frontiers in Microbiology, 13, 979329, 2022.
Mei, Y. , Ran, L. , Ying, X. , Yuan, Z. , and Xin, S. A sequential injection analysis/chemiluminescent plant tissue-based biosensor system for the determination of diamine. Biosensor. Bioelectron., 22, 871, 2007.
Mendes, R. , Alves Silva, H. , Nunes, M.L. , and Abecassis Empis, J.M. Effect of low-dose irradiation and refrigeration on the microflora, sensory characteristics and biogenic amines of Atlantic horse mackerel (Trachurus trachurus). Eur. Food Res. Technol., 221, 329, 2005.
Mendes, R. , Goncalves, A. , and Nunes, M.L. Changes in free amino acids and biogenic amines during ripening of fresh and frozen sardine. J. Food Biochem., 23, 295, 1999.
Mietz, J.L. , and Karmas, E. Polyamine and histamine content of rockfish, salmon, lobster and shrimp as an indicator of decomposition. J. Assoc. Offic. Anal. Chem., 61, 139, 1977.
Mohammed, G.I. , Bashammakh, A.S. , Alsibaai, A.A. , Alwael, H. , and El-Shahawi, M.S. A critical overview on the chemistry, clean-up and recent advances in analysis of biogenic amines in foodstuffs. Trends Anal. Chem., 78, 84, 2016.
Munir, M.A. , Assim, Z. , and Ahmad, F. Characterisation of biogenic amines in fish collected from Sarawak using gas chromatography. B.J.R.S.T., 6(2), 21, 2017.
Munir, M.A. , and Badri, K.H. The importance of derivatizing reagent in chromatography applications for biogenic amine detection in food and beverages. J. Anal. Methods Chem., 2020, 5814389, 2020.
Naila, A. , Flint, S. , Fletcher, G. , Bremer, P. , and Meerdink, G. Control of biogenic amines in food-existing and emerging approaches. J. Food Sci., 75(7), R139, 2010.
Niculescu, M. , Frébort, I. , Pec, P. , Galuszka, P. , Mattiasson, B. , and Csöregi, E. Amine oxidase based amperometric biosensors for histamine detection. Electroanalysis, 12, 369, 2000a.
Niculescu, M. , Nistor, C. , Frébort, I. , Peč, P. , Mattiasson, B. , and Csöregi, E. Redox hydrogel-based amperometric bienzyme electrodes for fish freshness monitoring. Anal. Chem., 72, 1591, 2000b.
Önal, A. A review: Current analytical methods for the determination of biogenic amines in foods. Food Chem., 103, 1475, 2007.
Özogul, F. , and Özogul, Y. Biogenic amine content and biogenic amine quality indices of sardines (Sardina pilchardus) stored in modified atmosphere packaging and vacuum packaging. Food Chem., 99, 574, 2006.
Paarup, T. , Sanchez, J.A. , Pelaez, C. , and Moral, A. Sensory, chemical and bacteriological changes in vacuum-packed pressurised squid mantle (Todaropsis eblanae) stored at 4°C. Int. J. Food Microbiol., 74, 1, 2002.
Papageorgiou, M. , Lambropoulou, D. , Morrison, C. , Kłodzínska, E. , Namiésnik, J. , and Płotka-Wasylka, J. Literature update of analytical methods for biogenic amines determination in food and beverages. Trends Anal. Chem., 98, 128, 2018.
Pegg, A.E. Toxicity of polyamines and their metabolic products. Chem. Res. Toxicol., 26, 1782, 2013.

Pons-Sánchez-Cascado, S. , Veciana-Nogués, M.T. , Bover-Cid, S. , Mariné-Font, A. , and Vidal-Carou, M.C. Use of volatile and non-volatile amines to evaluate the freshness of anchovies stored in ice. J. Sci. Food Agric., 86, 699, 2006.
Roig-Sagués, A.X. , Ruiz-Capillas, C. , Espinosa, D. , and Hernández, M. The decarboxylating bacteria present in foodstuffs and the effect of emerging technologies on their formation (Chapter 8). In Biological Aspects of Biogenic Amines, Polyamines and Conjugates; Dandrifosse, G. , Ed.; Transworld Research Network: Kerala, India; 2009.
Rosa, R. , and Nunes, M.L. Nutritional quality of red shrimp, Aristeus antennatus (Risso), pink shrimp, Parapenaeus longirostris (Lucas), and Norway lobster, Nephrops norvegicus (Linnaeus). J. Sci. Food Agric., 84, 89, 2003.
Ruiz-Capillas, C. , and Herrero, A. Impact of biogenic amines on food quality and safety. Foods, 8(2), 62, 2019.
Ruiz-Capillas, C. , Herrero, A.M. , and Jiménez-Colmenero, F. Determination of biogenic amines (Chapter 34). In Flow Injection Analysis of Food Additives; Ruiz-Capillas, C. , and Nollet, L.M.L. , Eds.; CRC Press, Taylor and Francis Group: Boca Raton, FL; pp. 675–690; 2016.
Ruiz-Capillas, C. , and Horner, W.F.A. Determination of trimethylamine nitrogen and total volatile basic nitrogen in fresh fish by flow injection analysis. J. Sci. Food Agric., 79, 1982, 1999.
Ruiz-Capillas, C. , and Jiménez-Colmenero, F. Biogenic amines in meat and meat products. Crit. Rev. Food Sci., 44, 489, 2004.
Ruiz-Capillas, C. , and Jiménez-Colmenero, F. Biogenic amines in seafood products (Chapter 46). In Handbook of Seafood and Seafood Products Analysis; Nollet, L.M.L. , and Toldra, F. , Eds.; CRCPress, Member of Francis & Taylor Group: Boca Raton; pp. 833–850; 2009.
Ruiz-Capillas, C. , and Jiménez-Colmenero, F. Biogenic amines in seafood products (Chapter 27). In Safety Analysis of Food Animal Origin; Nollet, L.M.L. , and Toldra, F. , Eds.; CRCPress, Member of Francis & Taylor Group: Boca Raton; pp. 743–760; 2011.
Ruiz-Capillas, C. , and Moral, A. Production of biogenic amines and their potential use as quality control indices for hake (Merluccius merluccius L.) stored in ice. J. Food Sci., 66, 1030, 2001a.
Ruiz-Capillas, C. , and Moral, A. Correlation between biochemical and sensory quality indices in hake stored in ice. Food Res. Int., 34, 441, 2001b.
Ruiz-Capillas, C. , and Moral, A. Effect of controlled and modified atmospheres on the production of biogenic amines and free amino acids during storage of hake. Eur. Food Res. Techn. A., 214, 476, 2002.
Ruiz-Capillas, C. , and Moral, A. Free amino acids and biogenic amines in red and white muscle of tuna stored in controlled atmospheres. Amino Acids., 26, 125, 2004.
Ruiz-Capillas, C. , and Moral, A. Sensory and biochemical aspects of quality of whole bigeye tuna (Thunnus obesus) during bulk storage in controlled atmospheres. Food Chem., 89, 347, 2005.
Ruiz-Capillas, C. , Morales, J. , and Moral, A. Preservation of bulk-stored Norway lobster at 1ºC in controlled and modified atmospheres. Eur. Food Res. Technol., 217, 466, 2003.
Saaid, M. , Saad, B. , Hashim, N.H. , Ali, A.S.M. , and Saleh, M.I. Determination of biogenic amines in selected Malaysian food. Food Chem., 113, 1356, 2009.
Sagratini, G. , Fernández-Franzón, M. , De Berardinis, F. , Font, G. , Vittori, S. , and Mañes, J. Simultaneous determination of eight underivatised biogenic amines in fish by solid phase extraction and liquid chromatography-tandem mass spectrometry. Food Chem., 132, 537, 2012.
Sánchez, J.A. , and Ruiz-Capillas, C. Application of the simplex method for optimization of chromatographic analysis of biogenic amines in fish. Eur. Food Res. Technol., 234, 285, 2012.
Sarkadi, L.S. Determination of biogenic amines by capillary electrophoresis. J. Chromatogr. A, 836, 305, 1999.
Self, R.L. , Wu, W.-H. , and Marks, H.S. Simultaneous quantification of eight biogenic amine compounds in tuna by matrix solid-phase dispersion followed by HPLC-orbitrap mass spectrometry. J. Agric. Food Chem., 59(11), 5906, 2011.
Shakila, R.J. , Vasundhara, T.S. , and Kumudavally, K.V. A comparison of the TLC-densitometry and HPLC method for the determination of biogenic amines in fish and fishery products. Food Chem., 75, 255, 2001.
Shiono, K. , Tsutsumi, T. , Nabeshi, H. , Ikeda, A. , Yokoyama, J. , and Akiyama, H. Simple and rapid determination of biogenic amines in fish and fish products by liquid chromatography-tandem mass spectrometry using 2,4,6-triethyl-3,5-dimethyl pyrylium trifluoromethanesulfonate as a derivatization reagent. J. Chromatogr. A, 1643, 462046, 2021.
Simat, V. , and Dalgaard, P. Use of small diameter column particles to enhance HPLC determination of histamine and other biogenic amines in seafood. LWT-Food Sci. Technol., 44, 399, 2011.
Sivamaruthi, B.S. , Kesika, P. , and Chaiyasut, C. A narrative review on biogenic amines in fermented fish and meat products. J. Food Sci. Technol., 58, 1623, 2021.
Staruszkiewicz, W.F. , and Rogers, P.L. Performance of histamine test kits for applications to seafood. Presentation on October 26, 4th World Fish Inspection & Quality Control Congress, Vancouver, BC, 2001.
Steiner, M.-S. , Meier, R.J. , Spangler, C. , Duerkop, A. , and Wolfbeis, O.S. Determination of biogenic amines by capillary electrophoresis using a chameleon type of fluorescent stain. Microchim. Acta, 167(3), 259, 2009.
Tahmouzi, S. , Khaksar, R. , and Ghasemlou, M. Development and validation of an HPLC-FLD method for rapid determination of histamine in skipjack tuna fish (Katsuwonus pelamis). Food Chem., 126, 756, 2011.

Takagi, K. , and Shikata, S. Flow injection determination of histamine with a histamine dehydrogenase-based electrode. Anal. Chim. Acta, 505, 189, 2004.
Tao, Z. , Sato, M. , Han, Y. , Tan, Z. , Yamaguchi, T. , and Nakano, T. A simple and rapid method for histamine analysis in fish and fishery products by TLC determination. Food Control, 22, 1154, 2011.
Tapia-Salazar, M. , Smith, T.K. , and Harris, A. High performance liquid chromatographic method for detection of biogenic amines in feedstuffs, complete feeds and animal tissues. J. Agric. Food Chem., 48, 1708, 2000.
Taylor, S.L. , Lieber, E.R. , and Leatherwood, M. A simplified method for histamine analysis of foods. J. Food Sci., 43, 247, 1978.
Triki, M. , Jiménez-Colmenero, F. , Herrero, A.M. , and Ruiz-Capillas, C. Optimisation of a chromatographic procedure for determining biogenic amine concentrations in meat and meat products employing a cation-exchange column with a post-column system. Food Chem., 130, 1066, 2012.
Tsai, Y.H. , Lin, C.-Y. , Chang, S.C. , Chen, H.-C. , Kung, H.-F. , Wei, C.-I. , and Hwang, D.-F. Occurrence of histamine and histamine-forming bacteria in salted mackerel in Taiwan. Food Microbiol., 22, 461, 2005.
Vasconcelos, H. , Coelho, L.C.C. , Matias, A. , Saraiva, C. , Jorge, P.A.S. , and de Almeida, J.M.M.M. Biosensors for biogenic amines: A review. Biosensors (Basel), 11(3), 82, 2021.
Veciana-Nogués, M.T. , Hernandez-Jover, T. , Mariné Font, A. , and Vidal Carou, M.C. Liquid chromatographic method for determination of biogenic amines in fish and fish products. J. AOAC Int., 78(4), 1045, 1995.
Veciana-Nogués, M.T. , Mariné Font, A. , and Vidal Carou, M.C. Biogenic amines as hygienic quality indicators of tuna. Relationships with microbial counts, ATP-related compounds, volatile and organoleptic changes. J. Agric. Food Chem., 45, 2036, 1997.
Zhao, Q.X. , Xu, J. , Xue, C.H. , Sheng, W.J. , Gao, R.C. , Xue, Y. , and Li, Z.J. Determination of biogenic amines in squid and white prawn by high-performance liquid chromatography with postcolumn derivatization. J. Agric. Food Chem., 55, 3083, 2007.

Detection of Genetically Modified Ingredients in Fish Feed

Alasaad N , Alzubi H , Kader AA (2016) Data in support of the detection of genetically modified organisms (GMOs) in food and feed samples. Data Brief 7: 243–252.
Arugula MA , Zhang Y , Simonian AL (2014) Biosensors as 21st century technology for detecting genetically modified organisms in food and feed. Anal. Chem. 86: 119−129.
Bandara T (2018) Alternative feed ingredients in aquaculture: Opportunities and challenges. J. Entomol. Zool. Stud. 6: 3087–3094.
Bawa AS , Anilakumar KR (2013) Genetically modified foods: Safety, risks and public concerns: A review. J. Food Sci. Technol. 50: 1035–1046.
Breitenbach J , Nogueira M , Farré G , Zhu C , Capell T , Christou P et al. (2016) Engineered maize as a source of astaxanthin: Processing and application as fish feed. Transgenic Res. 25: 785–793.
Brown PB , Wilson KA , Jonker Y , Nickson, TE (2003) Glyphosate tolerant canola meal is equivalent to the parental line in diets fed to rainbow trout. J. Agric. Food Chem. 51: 4268–4272.
Cankar K , Stebih D , Dreo T , Zel J , Gruden K. (2006) Critical points of DNA quantification by real-time PCR-effects of DNA extraction method and sample matrix on quantification of genetically modified organisms. BMC Biotechnol. 6: 1–5.
Cellini F , Chesson A , Colquhoun I , Constable A , Davies HV , Engel KH et al. (2004) Unintended effects and their detection in genetically modified crops. Food Chem. Toxicol. 42(7): 1089–1125. doi:10.1016/j.fct.2004.02.003.
Dingle TC , Sedlak RH , Cook L , Jerome KR (2013) Tolerance of droplet-digital PCR vs real-time quantitative PCR to inhibitory substances. Clin. Chem. 59: 1670–1672.
Doi H , Uchii K , Takahara T , Matsuhashi S , Yamanaka H , Minamoto T (2015) Use of droplet digital PCR for estimation of fish abundance and biomass in environmental DNA surveys. PLoS One 10: e0122763.
Dong S , Zhang D , Yu C , Zhang Z , Liu Y (2021) Using droplet digital PCR to detect plant DNA in tissues of zebrafish (Danio rerio) fed genetically modified maize. Aquac. Res. 00: 1–8. doi:10.1111/ are.15285.
Demeke T , Dobnik D (2018) Critical assessment of digital PCR for the detection and quantification of genetically modified organisms. Anal. Bioanal. Chem. 410: 4039–4050.
Demeke T , Holigroski M , Eng M , Xing J (2016) Absolute quantification of genetically engineered traits with droplet digital PCR: Effect of DNA treatments and spiking with non-target DNA. Food Control 68: 105–111.
Demeke T , Lee SJ , Eng M (2022) Increasing the efficiency of canola and soybean GMO detection and quantification using multiplex droplet digital PCR. Biology 11: 201–210. doi:10.3390/ biology11020201.
Eze BU , Akinrotimi OA , Onwujiariri CA (2021) The roles of biotechnology in fish nutrition for sustainable aquaculture production in Nigeria. Proceedings of the 36th Annual Conference of Fison, held at University of Port Harcourt, Choba, Rivers State Garden City 24th–29th October, 2021, pp. 897–901.
FAO (2020) The State of World Fisheries and Aquaculture 2020: Sustainability in Action. FAO, Rome. Accessed on 15th of July, 2022 . doi:10.4060/ca9229en.

FAO STAT (2016) Food and Agriculture Data 2016. Food and Agriculture Organization of the United Nations (FAO), Rome. Accessed 20 August 2022 .
Feriotto G , Borgatti M , Mischiati C , Bianchi N , Gambthari R (2002) Biosensor technology and surface plasmon resonance for real-time detection of genetically modified roundup ready soybean gene sequences. J. Agric. Food Chem. 50: 955–962.
Gelvin, SB . (2003) Agrobacterium-mediated plant transformation: The biology behind the “gene-jockeying” tool. Microbiol. Mol. Biol. Rev. 67: 16–37. doi:10.1128/MMBR.67.1.16-37.2003.
Giraldo PA , Shinozuka H , Spangenberg GC , Cogan NO , Smith KF (2019) Safety assessment of genetically modified feed: Is there any difference from food? Front. Plant Sci. 10: 1–17.
Glencross B , Curnow J , Hawkins W , Kissil GWM , Peterson D (2003) Evaluation of the feed value of a transgenic strain of the narrow-leaf lupin (Lupinus angustifolius) in the diet of the marine fish, Pagrus auratus. Aquac. Nutr. 9(3): 197–206. doi:10.1046/j.1365-2095.2003.00247.x.
Green MR , Sambrook J (2019) Nested polymerase chain reaction (PCR). Cold Spring Harb. Protoc. 2019(2): pdb–rot095182.
Hemre GI , Sagstad A , BakkeMckellep AM , Danieli A , Acierno R , Maffia M et al. (2007) Nutritional, physiological, and histological responses in Atlantic salmon, Salmo salar L. fed diets with genetically modified maize. Aquac. Nutr. 13: 186–199.
Hunter MC , Smith RG , Schipanski ME , Atwood LW , Mortensen DA (2017) Agriculture in 2050: Recalibrating targets for sustainable intensification. Bio Sci. 67: 386–391.
James C (2009) Global Status of Commercialized Biotech/GM Crops. ISAAA, Ithaca, New York.
Karamollaoglu İ , Oktem HA , Mutlu M (2009) QCM-based DNA biosensor for detection of genetically modified organisms (GMOs). Biochem. Eng. J. 44: 142–150.
Karimi-Maleh H , Orooji Y , Karimi F , Alizadeh M , Baghayeri M , Rouhi J et al. (2021) Critical review on the use of potentiometric based biosensors for biomarkers detection. Biosens. Bioelectron. 184: 113252.
Kaushik SJ , Hemre GI (2008) Plant proteins as alternative sources for fish feed and farmed fish quality. In Improving Farmed Fish Quality and Safety, edited by Ø Lie . Woodhead Publishing Limited, CRC Press, Cambridge, UK. pp. 300–319.
Li MH , Hartnell GF , Robinson EH , Kronenberg JM , Healy CE , Oberle DF , Hoberg JR (2008) Evaluation of cottonseed meal derived from genetically modified cotton as feed ingredients for channel catfish, Ictalurus punctatus. Aquacult. Nutr. 14(6): 490–498. doi:10.1111/j.1365-2095.2007.00554.x.
Lucas DM , Taylor ML , Hartnell GF , Nemeth MA , Glenn KC , Davis SW (2007) Broiler performance and carcass characteristics when fed diets containing lysine maize (LY038 or LY038 × MON 810), control, or conventional reference maize. Poult. Sci. 86: 2152–2161.
Marmiroli N , Maestri E (2007) Polymerase chain reaction (PCR). In Food Toxicants Analysis Techniques, Strategies and Development, edited by Y Picò . Elsevier, Amsterdam. pp. 147–187. ISBN 978-0-444-52483-8.
Marmiroli N , Peano C , Maestri E (2003) Advanced PCR techniques in identifying food components. In Food Authenticity and Traceability, edited by M Lees . CRC Press, Cambridge. pp. 3–33. ISBN 1-85573-526-1.
Mariotti E , Minunni M , Mascini M (2002) Surface plasmon resonance biosensor for genetically modified organisms detection. Anal. Chim. Acta 453: 165–172.
McCann MC , Liu K , Trujillo WA , Dobert RC (2005) Glyphosate-tolerant soybeans remain compositionally equivalent to conventional soybeans (Glycine max L.) during three years of field testing. J. Agric. Food Chem. 53(13): 5331–5335. doi:10.1021/jf0504317.
Morisset D , Stebih D , Milavec M , Gruden K , Zel J (2013) Quantitative analysis of food and feed samples with droplet digital PCR. PLoS One 8: e62583.
Nadal A , Coll A , La Paz JL , Esteve T , Pla M (2006) A new PCR-CGE (size and color) method for simultaneous detection of genetically modified maize events. Electrophoresis 27: 3879–3888.
Naseem S , Bhat SU , Gani A , Bhat FA (2020) Perspectives on utilization of macrophytes as feed ingredient for fish in future aquaculture. Rev. Aquac. 13: 282–300.
Nixon G , Garson JA , Grant P , Nastouli E , Foy CA , Huggett JF (2014) Comparative study of sensitivity, linearity, and resistance to inhibition of digital and non-digital polymerase chain reaction and loop mediated isothermal amplification assays for quantification of human cytomegalovirus. Anal. Chem. 86: 4387–4394.
Onishi M , Matsuoka T , Kodama T , Kashiwaba K , Futo S , Akiyama H et al. (2005) Development of a multiplex polymerase chain reaction method for simultaneous detection of eight events of genetically modified maize. J. Agric. Food 53: 9713–9721.
Papst C , Utz HF , Melchinger AE , Eder J , Magg T , Klein D , Bohn M (2005) Mycotoxins produced by Fusarium spp. in isogenic Bt vs. non-Bt maize hybrids under European corn borer pressure. Agron. J. 97: 219–224.
Park H , Weier S , Razvi F , Pena PA , Sims NA , Lowell J et al. (2017) Towards the development of a sustainable soya beanbased feedstock for aquaculture. Plant Biotechnol. J. 15: 227–236.
Peano C , Bordoni R , Gulli M , Mezzelani A , Samson MC , De Bellis G , Marmiroli N (2005) Multiplex polymerase chain reaction and ligation detection reaction/universal array technology for the traceability of genetically modified organisms in foods. Anal. Biochem. 346: 90–100.
Pinheiro LB , Coleman VA , Hindson CM , Herrmann J , Hindson BJ , Bhat S , Emslie KR (2012) Evaluation of a droplet digital polymerase chain reaction format for DNA copy number quantification. Anal. Chem. 84:

1003–1011.
Placido A , Ferreira-da-Silva F , Leite JRSA , de-los-Santos-Álvarez N , Delerue-Matos C (2020) A convenient renewable surface plasmon resonance chip for relative quantification of genetically modified soybean in food and feed. PLoS One 15(2): e0229659. doi:10.1371/journal.pone.0229659.
Ran T , Mei L , Lei W , Aihua L , Ru H , Jie S (2009) Detection of transgenic DNA in tilapias (Oreochromis niloticus, GIFT strain) fed genetically modified soybeans (Roundup Ready). Aquac. Res. 40: 1350–1357.
Ravindran V , Tabe LM , Molvig L , Higgins TJV , Bryden WL (2002) Nutritional evaluation of transgenic high-methionine lupins (Lupinus angustifolius L) with broiler chickens. J. Sci. Food Agric. 82: 280–285.
Sissener NH , Sanden M , Krogdahl A , Bakke AM , Johannessen LE , Hemre GI (2011) Genetically modified plants as fish feed ingredients. Can. J. Fish. Aquat. Sci. 68: 563–574.
Sousa JB , Ramos-Jesus J , Fonseca RA , Delerue-Matos C , Barroso MF , Santos Jr JR (2018) Biosensors as advanced device for the transgenic plants and food and detection. In: Alina Maria Holban and Alexandru Mihai Grumezescu (Eds.) Genetically Engineered Foods, pp. 221–245. Academic Press. doi: 10.1016/C2016-0-00358-3.
Suharman I , Satoh S , Haga Y , Takeuchi T , Endo M , Hirono I , Aoki T (2009) Utilization of genetically modified soybean meal in Nile tilapia Oreochromis niloticus diets. Fish. Sci. 75: 967–973.
The United States Food and Drug Administration (2008) https://www.cfsan.fda.gov/~lrd/biotechm.html. Accessed 30 July 2022 .
Vazquez-Padron RI , Gonzáles-Cabrera J , García-Tovar C , Neri-Bazan L , Lopéz-Revilla R , Hernández M et al. (2000) Cry1Ac protoxin from Bacillus thuringiensis sp. kurstaki HD73 binds to surface proteins in the mouse small intestine. Biochem. Biophys. Res. Commun. 271(1): 54–58. doi:10.1006/bbrc.2000.2584.
Whale AS , Huggett JF , Cowen S , Speirs V , Shaw J , Ellison S et al. (2012) Comparison of microfluidic digital PCR and conventional quantitative PCR for measuring copy number variation. Nucleic Acids Res. 40: e82.
WHO (2022) Food, genetically modified. https://www.who.int/topics/food_genetically_modified/en/. Accessed 16 August 2022 .
WiikNielsen CR , HolstJensen A , Bøydler C , Berdal KG (2011) Quantification of dietary DNA in tissues of Atlantic salmon (Salmo salar L.) fed genetically modified feed ingredients. Aquac. Nutr. 17: e668–74.
Zhao Y , Xia Q , Yin Y , Wang Z (2016) Comparison of droplet digital PCR and quantitative PCR assays for quantitative detection of Xanthomonas citri Subsp. citri. PLoS One, 11, e0159004.

Detection of Adulterations

Teletchea, F. , Maudet, C. , and Hanni, C. , Food and forensic molecular identification: update and challenges, Trends Biotechnol., 23, 359, 2005.
Woolfe, M. , and Primrose, S. , Food forensics: using DNA technology to combat misdescription and fraud, Trends Biotechnol., 22, 222, 2004.
Pascal, G. , and Mahé, S. , Identity, traceability, acceptability and substantial equivalence of food, Cell. Mol. Biol., 47, 1329, 2001.
Asensio Gil, L. , PCR-based methods for fish and fishery products authentication, Trends Food Sci. Technol., 18, 558, 2007.
Mackie, I.M. , Identifying species of fish, Analyt. Proc., 27, 89, 1990.
Scobbie, A.E. , and Mackie, I.M. , The use of sodium dodecyl sulphate polyacrylamide gel electrophoresis in fish species identification - a procedure suitable for cooked and raw fish, J. Sci. Food Agric., 44, 343, 1988.
Rehbein, H. , Etienne, M. , Jerome, M. , Hattula, T. , Knudsen, L.B. , Jessen, F. , Luten, J.B. , Bouquet, W. , Mackie, I.M. , Ritchie, A.H. , Martin, R. , and Mendes, R. , Influence of variation in methodology on the reliability of the isoelectric focusing method of fish species identification, Food Chem., 52, 193, 1995.
Rehbein, H. , Kundiger, R. , Yman, I.M. , Ferm, M. , Etienne, M. , Jerome, M. , Craig, A. , Mackie, I. , Jessen, F. , Martinez, I. , Mendes, R. , Smelt, A. , Luten, J. , Pineiro, C. , and Perez-Martin, R. , Species identification of cooked fish by urea isoelectric focusing and sodium dodecylsulfate polyacrylamide gel electrophoresis: a collaborative study, Food Chem., 67, 333, 1999.
Etienne, M. , Jerome, M. , Fleurence, J. , Rehbein, H. , Kundiger, R. , Mendes, R. , Costa, H. , and Martinez, I. , Species identification of formed fishery products and high pressure-treated fish by electrophoresis: a collaborative study, Food Chem., 72, 105, 2001.
Piñeiro, C. , Barros-Velázquez, J. , Pérez-Martín, R.I. , Martínez, I. , Jacobsen, T. , Rehbein, H. , Kündiger, R. , Mendes, R. , Etienne, M. , Jerome, M. , Craig, A. , Mackie, I.M. , and Jessen, F. , Development of a sodium dodecyl sulfate-polyacrylamide gel electrophoresis reference method for the analysis and identification of fish species in raw and heat-processed samples: a collaborative study, Electrophoresis, 20, 1425, 1999.
Etienne, M. , Jérôme, M. , Fleurence, J. , Rehbein, H. , Kündiger, R. , Mendes, R. , Costa, H. , Pérez-Martín, R. , and Piñeiro-González, C. , Identification of fish species after cooking by SDS-PAGE and urea IEF: a collaborative study, J. Agric. Food Chem., 48, 2653, 2000.

Craig, A. , Ritchie, A.H. , and Mackie, I.M. , Determining the authenticity of raw reformed breaded scampi (Nephrops norvegicus) by electrophoretic techniques, Food Chem., 52, 451, 1995.
European Commission , EU Project FAR UP-3-783. 1992–1995, Identification and quantitation of species in marine products, 1992–1995.
Podeszewski, Z. , and Zarzycki, B. , Identification of fish species by testing the minced-meat tissue, Food/Nahrung, 22, 377, 1978.
Renon, P. , Bernardi, C. , Malandra, R. , and Biondi, P.A. , Isoelectric focusing of sarcoplasmic proteins to distinguish swordfish, blue marlin and Mediterranean spearfish, Food Control, 16, 473–477, 2005.
Rodríguez, E.M. , and Ortea, I. , Food authentication of seafood species, In Proteomics in Food Science, Ed, Colgrave, M.L. , Academic Press, Cambridge, MA, pp. 331–342, 2017.
Piñeiro, C. , Barros-Velázquez, J. , Pérez-Martín, R.I. , and Gallardo, J.M. , Specific enzyme detection following isoelectric focusing as a complimentary tool for the differentiation of related Gadoid fish species, Food Chem., 70, 241–245, 2000.
Bossier, P. , and Cooreman, K. , A databank able to be used for identifying and authenticating commercial flatfish (Pleuronectiformes) products at the species level using isoelectric focusing of native muscle proteins, Int. J. Food Sci. Technol., 35(6), 563–568, 2000.
AOAC , Official Methods of Analysis of the Association of Official Analytical Communities International, 16th ed., AOAC, Washington, DC, 1995.
U.S. Food and Drug Administration , Regulatory Fish Encyclopedia (RFE). https://www.fda.gov/food/science-research-food/regulatory-fish-encyclopedia-rfe. Accessed on 08.08.2022 .
Pepe, T. , Ceruso, M. , Carpentieri, A. , Ventrone, I. , Amoresano, A. , and Anastasio, A. , Proteomics analysis for the identification of three species of Thunnus, Vet. Res. Commun., 34, S153–S155, 2010.
Martinez, I. , and Friis, T.J. , Application of proteome analysis to seafood authentication, Proteomics, 4, 347–354, 2004.
Piñeiro, C. , Barros-Velázquez, J. , Sotelo, C.G. , Pérez-Martín, R.I. , and Gallardo, J.M. , Two-dimensional electrophoretic study of the water-soluble protein fraction in white muscle of gadoid fish species, J. Agric. Food Chem., 46, 3991–3997, 1998.
Piñeiro, C. , Barros-Velázquez, J. , Sotelo, C.G. , and Gallardo, J.M. , The use of two-dimensional electrophoresis in the characterization of the water-soluble protein fraction of commercial flat fish species, Z. Lebensm. Unters. Forsch. A, 208, 342–348, 1999.
López, J.L. , Marina, A. , Vázquez, J. , and Álvarez, G. , A proteomic approach to the study of the marine mussels Mytilus edulis and M. galloprovincialis, Mar. Biol., 141, 217–223, 2002.
James, P. , Quadroni, M. , Carafoli, E. , and Gonnet, G. , Protein identification by mass profile fingerprinting, Biochem. Biophys. Res. Commun., 195(1), 58–64, 1993.
Mørtz, E. , O'Connor, P.B. , Roepstorff, P. , Kelleher, N.L. , Wood, T.D. , McLafferty, F.W. , and Mann, M. , Sequence tag identification of intact proteins by matching tandem mass spectral data against sequence data bases, Proc. Natl. Acad. Sci. U.S.A., 93(16), 8264–8267, 1996.
Aebersold, R. , and Mann, M. , Mass spectrometry-based proteomics, Nature, 422, 198–207, 2003.
Kelleher, N.L. , Top-down proteomics, Anal. Chem., 76, 197–203, 2004.
Piñeiro, C. , Carrera, M. , Cañas, B. , Lekube, X. , and Martinez, I. , Proteomics and food analysis: principles, techniques, and applications, In Handbook of Food Analysis, Eds, Nollet, L.M. , and Toldrá, F. , 3rd ed., CRC Press, Boca Raton, FL, Chapter 18, pp. 369–391, 2015.
Ortea, I. , O'Connor, G. , and Maquet, A. , Review on proteomics for food authentication, J. Proteom., 147, 212–225, 2016.
Čapla, J. , Zajác, P. , Čurlej, J. , Belej, Ľ. , Kročko, M. , Bobko, M. , Benešová, L. , Jakabová, S. , and Vlčko, T. , Procedures for the identification and detection of adulteration of fish and meat products, Slovak J. Food Sci., 14, 978–994, 2020.
López, J.L. , Marina, A. , Álvarez, G. , and Vázquez, J. Application of proteomics for fast identification of species-specific peptides from marine species, Proteomics, 2, 1658–1665, 2002.
Wulff, T. , Nielsen, M.E. , Deelder, A.M. , Jessen, F. , and Palmblad, M. , Authentication of fish products by large-scale comparison of tandem mass spectra, J. Proteome Res., 12, 5253–5259, 2013.
Barik, S.K. , Banerjee, S. , Bhattacharjee, S. , Das Gupta, S.K. , Mohanty, S. , and Mohanty, B.P. , Proteomic analysis of sarcoplasmic peptides of two related fish species for food authentication, Appl. Biochem. Biotechnol., 171(4), 1011–1021, 2013.
Piñeiro, C. , Vázquez, J. , Marina, A. , Barros-Velázquez, J. , and Gallardo, J.M. , Characterization and partial sequencing of species-specific sarcoplasmic polypeptides from commercial hake species by mass spectrometry following two-dimensional electrophoresis, Electrophoresis, 22, 1545–1552, 2001.
Carrera, M. , Cañas, B. , Piñeiro, C. , Vázquez, J. , and Gallardo, J.M. , Identification of commercial hake and grenadier species by proteomic analysis of the parvalbumins fraction, Proteomics, 6, 5278–5287, 2006.
Carrera, M. , Cañas, B. , Piñeiro, C. , Vázquez, J. , and Gallardo, J.M. , De novo mass spectrometry sequencing and characterization of species-specific peptides from nucleoside diphosphate kinase B for the classification of commercial fish species belonging to the family Merlucciidae. J. Proteome Res., 6(8), 3070–3080, 2007.

Pepe, T. , Ceruso, M. , Carpentieri, A. , Ventrone, I. , Amoresano, A. , Anastasio, A. , and Cortesi, M.L. , Differentiation of four tuna species by two-dimensional electrophoresis and mass spectrometric analysis, In Proteomic Application in Biology, Eds, Heazlewood, J.L. , and Petzold, C.J. , InTech, Rijeka, Croatia, 191–208, 2012.

Pascoal, A. , Ortea, I. , Gallardo, J.M. , Cañas, B. , Barros-Velázquez, J. , and Calo-Mata, P. , Species identification of the Northern shrimp (Pandalus borealis) by polymerase chain reaction-restriction fragment length polymorphism and proteomic analysis, Anal. Biochem., 421, 56–67, 2012.

Mathew, S. , Raman, M. , Parameswaran, M.K. , and Rajan, D.P. , Fish and Fishery Products Analysis (A Theoretical and Practical Perspective), eBook, Springer Nature, Singapore, 2019.

Verrez, V. , Benyamin, Y. , and Roustan, C. , Detection of marine invertebrates in surimi-based products, In Quality Assurance in the Fish Industry, Eds, Huss, H.H. , Jakobsen, M. , and Liston, J. , Elsevier Science Publisher B.V., Amsterdam, p. 441, 1992.

Verrez-Bagnis, V. , and Escriche Roberto, I. , The performance of ELISA and dot-blot methods for the detection of crab flesh in heated and sterilized surimi-based products, J. Sci. Food Agricul., 63, 445, 1993.

Taylor, W.J. , and Leighton Jones, J. , An immunoassay for distinguishing between crustacean tailmeat and white fish, Food Agric. Immunol., 4, 177, 1992.

Taylor, W.J. , and Jones, J.L. , An immunoassay for verifying the identity of canned sardines, Food Agric. Immunol., 4, 169–175, 1992.

Céspedes, A. , García, T. , Carrera, E. , González, I. , Fernández, A. , Asensio, L. , Hernández, P.E. , and Martín, R. , Indirect ELISA for the identification of sole (Solea solea), European plaice (Pleuronectes platessa), flounder (Platichthys flesus), and Greenland halibut (Reinhardtius hippoglossoides), J. Food Prot., 62, 1178–1182, 1999.

Fernández, A. , García, T. , Asensio, L. , Rodríguez, M.A. , González, I. , Lobo, E. , Hernández, P. , and Martín, R. , Identification of the clam species Ruditapes decussatus (grooved carpet shell), Venerupis romboides (yellow carpet shell) and Venerupis pullastra (pullet carpet shell) by ELISA, Food Agric. Immunol., 14, 65–71, 2002.

Huang, T. , Marshall, M.R. , Kao, K. , Otwell, W.E. , and Wei, C. , Development of monoclonal antibodies for red snapper (Lutjanus campechanus) identification using enzyme-linked immunosorbent assay, J. Agric. Food Chem., 43, 2301–2307, 1995.

Asensio, L. , González, I. , Rodríguez, M.A. , Hernández, P.E. , García, T. , and Martín, R. , Development of a monoclonal antibody for grouper (Epinephelus marginatus) and wreck fish (Polyprion americanus) authentication using an indirect enzyme-linked immunosorbent assay, J. Food Sci., 68, 1900–1903, 2003.

Asensio, L. , González, I. , Rodríguez, M.A. , Mayoral, B. , López-Calleja, I. , Hernández, P.E. , García, T. , and Martín, R. , Development of a monoclonal antibody for grouper (Epinephelus guaza) identification using and indirect enzyme-linked immunosorbent assay, J. Food Prot., 66, 869–886, 2003.

Asensio, L. , González, I. Pavón, M.A. , García, T. , and Martín, R. , An indirect ELISA and a PCR technique for the detection of Grouper (Epinephelus marginatus) mislabeling, Food Addit. Contam. Part A, 25(6), 677–683, 2008.

Carrera, E. , Terni, M. , Montero, A. , García, T. , González, I. , and Martín, R. , ELISA-based detection of mislabeled albacore (Thunnus alalunga) fresh and frozen fish fillets, Food Agric. Immunol., 25(4), 569–577, 2014.

Taboada, L. , Sánchez, A. , Velasco, A. , Santaclara, F.J. , Pérez-Martín, R.I. , and Sotelo, C.G. , Identification of Atlantic cod (Gadus morhua), ling (Molva molva), and Alaska pollock (Gadus chalcogrammus) by PCR-ELISA using duplex PCR, J. Agric. Food Chem., 62(24), 5699–5706, 2014.

Baumgartner, S. , Steiner, I. , Kloiber, S. , Hirmann, D. , Krska, R. , and Yeung, J. , Towards the development of a dipstick immunoassay for the detection of trace amounts of egg proteins in food, Eur. Food Res. Technol., 214, 168, 2002.

Jiang, T.L. , Cai, Q.F. , Shen, J.D. , Huang, M.J. , Zhang, L.J. , Liu, G.M. , and Cao, M.J. , Establishment of immunological methods for the detection of soybean proteins in surimi products. LWT Food Sci. Technol., 64(1), 344–349, 2015.

Dreyfuss, M.S. , Cutrufelli, M.E. , Mageau, R.P. , and McNamara, A.M. , Agar-gel immunodiffusion test for rapid identification of pollock surimi in raw meat products, J. Food Sci., 62, 972, 1997.

Ruethers, T. , Taki, A.C. , Khangurha, J. , Roberts, J. , Buddhadasa, S. , Clarke, D. , Hedges, C.E. , Campbell, D.E. , Kamath, S.D. , Lopata, A. , and Koeberl, M. , Commercial fish ELISA kits have a limited capacity to detect different fish species and their products, J. Sci. Food Agric., 100(12), 4353–4363, 2020.

van Raamsdonk, L.W.D. , von Holst, C. , Baeten, V. , Berben, G. , Boix, A. , and de Jong, J. , New developments in the detection and identification of processed animal proteins in feeds, Anim. Feed Sci. Technol., 133, 63, 2007.

Garrido-Varo, A. , Pérez-Marín, M.D. , Guerrero, J.E. , Gómez-Cabrera, A. , Haba, M.J.D.L. , Bautista, J. , Soldado, A. , Vicente, F. , Martínez, A. , Roza-Delgado, B.D.L. , and Termes, S. , Near infrared spectroscopy for enforcement of European legislation concerning the use of animal by-products in animal feeds, Biotechnol. Agron. Soc. Environ., 9, 3, 2005.

Murray, I. , Aucott, L.S. , and Pike, I.H. , Use of discriminant analysis on visible and near infrared reflectance spectra to detect adulteration of fishmeal with meat and bone meal, J. Near Infrared Spectrosc., 9, 297, 2001.

European Commission , Commission decision of 27 March 2002 (2002/248/EC) amending council decision 2000/766/EC and commission decision 2001/9/EC with regard to transmissible spongiform encephalopathies and the feeding of animal proteins, Off. J. Eur. Comm., L84 28/3/2002 , 71, 2002.
Gayo, J. , and Hale, S.A. , Detection and quantification of species authenticity and adulteration in crabmeat using visible and near-infrared spectroscopy, J. Agric. Food Chem., 55, 585, 2007.
Gayo, J. , Hale, S.A. , and Blanchard, S.M. , Quantitative analysis and detection of adulteration in crab meat using visible and near-infrared spectroscopy, J. Agric. Food Chem., 54, 1130, 2006.
Qin, J. , Vasefi, F. , Hellberg, R.S. , Akhbardeh, A. , Isaacs, R.B. , Yilmaz, A.G. , Hwang, C. , Baek, I. , Schmidt, W.F. , and Kim, M.S. , Detection of fish fillet substitution and mislabeling using multimode hyperspectral imaging techniques, Food Control, 114, 107234, 2020.
Alamprese, C. , and Casiraghi, E. , Application of FT-NIR and FTIR spectroscopy to fish fillet authentication, LWT Food Sci. Technol., 63(1), 720–725, 2015.
Grassi, S. , Casiraghi, E. , and Alamprese, C. , Handheld NIR device: a non-targeted approach to assess authenticity of fish fillets and patties, Food Chem., 243, 382–388, 2018.
Sciuto, S. , Esposito, G. , Dell'Atti, L. , Rossi, F. , Riina, M.V. , Merlo, G. , Magnani, L. , Benso, A. , Bozzetta, E.M. , and Acutis, P.L. , A new approach against food frauds: the portable near-infrared device for fish fillets identification, Schol. J. Food Nutr., 4(1), 442–447, 2021.
Sousa, N. , Moreira, M. , Saraiva, C. , and de Almeida, J. , Applying fourier transform mid infrared spectroscopy to detect the adulteration of Salmo salar with Oncorhynchus mykiss, Foods, 7, 55, 2018.
Ghidini, S. , Varrà, M.O. , and Zanardi, E. , Approaching authenticity issues in fish and seafood products by qualitative spectroscopy and chemometrics, Molecules, 24, 1812, 2019.
Hassoun, A. , Mage, I. , Schmidt, W.F. , Temiz, H.T. , Li, L. , Kim, H. , Nilsen, H. , Biancolillo, A. , Ait-Kaddour, A. , Sikorski, M. , Sikorska, E. , Grassi, S. , and Cozzolino, D. , Fraud in animal origin food products: advances in emerging spectroscopic detection methods over the past five years, Foods, 9(8), 1069, 2020.
European Commission , Commission Directive 2003/126/EC of 23 December 2003 on the analytical method for the determination of constituents of animal origin for the official control of feedingstuffs, Off. J. Eur. Comm., L339 24/12/2003 , 0078, 2003.
Santaclara, F.J. , Espiňeira, M. , Cabado, A.G. , and Vieites, J.M. , Detection of land animal remains in fish meals by the polymerase chain reaction-restriction fragment length polymorphism technique, J. Agric. Food Chem., 55, 305, 2007.
Geng, J. , Liu, J. , Kong, X. , Shen, B. , and Niu, Z. , The fishmeal adulteration identification based on microscopic image and deep learning, Comput. Electron. Agric., 198, 1–9, 2022.
Ebert, M. , and Islam, R. , Kaviar und Kaviarimitate: Verfälschungen des teuren Störrogens mit histologischer Methode nachweisbar (Caviar and caviar imitations adulterations of sturgeon roe provable by histological method), Fleischwirtschaft, 87, 124, 2007.
U.S. Food and Drug Administration , Macroanalytical procedures manual (MPM), chapter V-7-A Method for Microscopic Detection of Fish Tissue in Crab Meat or Crab Cakes, Electronic revised version (V2) from FDA Technical Bulletin Number 5, Macroanalytical Procedures Manual 1984. Olsen, A.R. , Knight S.A. , and Ziobro, G.C. (Eds.). https://www.fda.gov/food/laboratory-methods-food/mpm-v-7-seafood#Crab, Accessed on 13-11-2023 .
Ashoor, S.H. , and Knox, M.J. , Identification of fish species by high-performance liquid chromatography, J. Chromatogr. A, 324, 199–202, 1985.
Knuutinen, J. , and Harjula, P. , Identification of fish species by reversed-phase high-performance liquid chromatography with photodiode-array detection, J. Chromatogr. B. Biomed. Sci. App., 705, 11–21, 1998.
Chou, C.-C. , Lin, S.-P. , Lee, K.-M. , Hsu, C.-T. , Vickroy, T.W. , and Zen, J.-M. , Fast differentiation of meats from fifteen animal species by liquid chromatography with electrochemical detection using copper nanoparticle plated electrodes, J. Chromatogr. B, 846, 230, 2007.
Lasch, P. , Uhlig, P. , Uhlig, C. , Wilhelm, C. , Bergmann, N. , and Wittke, S. , Development and in-house validation of an LC-MS and LC-MS/MS assay for the determination of food fraud for different fish species, J. AOAC Int., 102(5), 1330–1338, 2019.
Lockley, A.K. , and Bardsley, R.G. , DNA-based methods for food authentication, Trends Food Sci. Technol., 11, 67, 2000.
Mackie, I.M. , Authenticity of fish, In Food Authentification, Eds, Ashurt, P.R. , and Dennis, M.J. , Blackie Academic and Professional, London, p. 140, 1996.
Leighton Jones, J. , DNA probes: applications in the food industry, Trends Food Sci. Technol., 2, 28, 1991.
Sotelo, C.G. , Pinciro, C. , Gallardo, J.M. , and Perez-Martin, R.I. , Fish species identification in seafood products, Trends Food Sci. Technol., 4, 395, 1993.
Mackie, I.M. , Fish speciation, Food Technol. Int. Europe, 1, 177, 1994.
Martinez, I. , and Malmheden Yman, I. , Species identification in meat products by RAPD analysis, Food Res. Int., 31, 459, 1998.
Primrose, S.B. , The role of DNA analysis in the determination of food authenticity, In: Malcolm Burns, Lucy Foster and Michael Walker (Eds.) DNA Techniques to Verify Food Authenticity: Applications in Food Fraud, The Royal Society of Chemistry, London, UK, pp. 1–11, 2019.

Rapley, R. , Enhancing PCR amplification and sequencing using DNA-binding proteins. Mol. Biotechnol., 2, 295–298, 1994.
Galimberti, A. , de Mattia, F. , Losa, A. , Bruni, I. , Federici, S. , Casiraghi, M. , Martellos, S. , and Labra, M. , DNA barcoding as a new tool for food traceability. Food Res. Int., 50, 55–63, 2013.
Böhme, K. , Calo-Mata, P. , Barros-Velázquez, J. , and Ortea, I. , Review of recent DNA-based methods for main food-authentication topics, J. Agric. Food Chem., 67, 3854–3864, 2019.
Jerome, M. , Lemaire, C. , Verrez-Bagnis, V. , and Etienne, M. , Direct sequencing method for species identification of canned sardine and sardine-type products, J. Agric. Food Chem., 51, 7326, 2003.
Dawnay, D.N. , Ogden, R. , McEwing, R. , Carvalho, G.R. , and Thorpe, R.S. , Validation of the barcoding gene COI for use in forensic genetic species identification, Forensic Sci Int., 173(1), 1–6, 2007.
Ward, R.D. , Hanner, R. , and Hebert, P.D.N. , The campaign to DNA barcode all fishes, Fish Bol. J. Fish Biol., 74(2), 329–356, 2009.
Staats, M. , Arulandhu, A.J. , Gravendeel, B. , Holst-Jensen, A. , Scholtens, I. , Peelen, T. , Prins, T.W. , and Kok, E. , Advances in DNA metabarcoding for food and wildlife forensic species identification, Anal Bioanal Chem., 408(17), 4615–4630, 2016.
Di Muri, C. , Vandamme, S.G. , Peace, C. , Barnes, W. , and Mariani, S. , Biodiversity defrosted: unveiling non-compliant fish trade in ethnic food stores, Biol. Conserv., 217, 419–427, 2018.
Sevilla, R.G. , Diez, A. , Noren, M. , Mouchel, O. , Jerome, M. , Verrez-Bagnis, V. , Van Pelt, H. , Favre-Krey, L. , Krey, G. , Consortium, T.F. , and Bautista, J.M. , Primers and polymerase chain reaction conditions for DNA barcoding teleost fish based on the mitochondrial cytochrome b and nuclear rhodopsin genes, Mol. Ecol. Notes, 7, 730, 2007.
FishTrace, Genetic catalogue . https://data.jrc.ec.europa.eu/dataset/jrc-fad-fishtrace. Accessed on 13-11-2023 .
Barcode of Life Data System (BOLD System V4) , https://www.boldsystems.org/. Accessed on 13-11-2023 .
Quinteiro, J. , Sotelo, C.G. , Rehbein, H. , Pryde, S.E. , Medina, I. , Pérez-Martin, R.I. , Rey-Méndez, M. , and Mackie, I.M. , Use of mtDNA direct polymerase chain reaction (PCR) sequencing and PCR-restriction fragment length polymorphism methodologies in species identification of canned tuna, J. Agric. Food Chem., 46, 1662, 1998.
Sebastio, P. , Zanelli, P. , and Neri, T.M. , Identification of anchovy (Engraulis encrasicholus L.) and gilt sardine (Sardinella aurita) by polymerase chain reaction, sequence of their mitochondrial cytochrome b gene, and restriction analysis of polymerase chain reaction products in semipreserves, J. Agric. Food Chem., 49, 1194, 2001.
Ram, J.L. , Ram, M.L. , and Baidoun, F.F. , Authentication of canned tuna and bonito by sequence and restriction site analysis of polymerase chain reaction products of mitochondrial DNA, J. Agric. Food Chem., 44, 2460, 1996.
Shokralla, S. , Spall, J.L. , Gibson, J.F. , and Hajibabaei, M. , Next-generation sequencing technologies for environmental DNA research, Mol Ecol., 21(8), 1794–1805, 2012.
Ji, Y. , Ashton, L. , Pedley, S.M. , Edwards, D.P. , Tang, Y. , Nakamura, A. , Kitching, R. , Dolman, P.M. , Woodcock, P. , Edwards, F.A. , Larsen, T.H. , Hsu, W.W. , Benedick, S. , Hamer, K.C. , Wilcove, D.S. , Bruce, C. , Wang, X. , Levi, T. , Lott, M. , Emerson, B.C. , and Yu, D.W. , Reliable, verifiable and efficient monitoring of biodiversity via metabarcoding, Ecol Lett., 16(10), 1245–1257, 2013.
Varunjikar, M.S. , Moreno-Ibarguen, C. , Andrade-Martinez, J.S. , Tung, H.S. , Belghit, I. , Palmblad, M. , Olsvik, P. , Reyes, A. , Rasinger, J. , and Lie, K.K. , Comparing novel shotgun DNA sequencing and state-of-theart proteomics approaches for authentication of fish species in mixed samples, Food Control, 131, 108417, 2022.
Edwards, M.C. , and Gibbs, R.A. , Multiplex PCR: advantages, development, and applications, PCR Methods Appl., 3, S65, 1994.
Colombo, F. , Trezzi, I. , Bernardi, C. , Cantoni, C. , and Renon, P. , A case of identification of pectinid scallop (Pecten jacobaeus, Pecten maximus) in a frozen and seasoned food product with PCR technique, Food Control, 15, 527, 2004.
Bellagamba, F. , Valfre, F. , Panseri, S. , and Moretti, V.M. , Polymerase chain reaction-based analysis to detect terrestrial animal protein in fish meal, J. Food Prot., 66, 682, 2003.
Bottero, M.T. , Dalmasso, A. , Cappelletti, M. , Secchi, C. , and Civera, T. , Differentiation of five tuna species by a multiplex primer-extension assay, J. Biotechnol., 129, 575, 2007.
Zhang, J. , and Cai, Z. , Differentiation of the rainbow trout (Oncorhynchus mykiss) from Atlantic salmon (Salmon salar) by the AFLP-derived SCAR, Eur. Food Res. Technol., 223, 413, 2006.
Zhang, J. , Wang, H. , and Cai, Z. , The application of DGGE and AFLP-derived SCAR for discrimination between Atlantic salmon (Salmo salar) and rainbow trout (Oncorhynchus mykiss), Food Control, 18, 672, 2007.
Hold, G.L. , Russell, V.J. , Pryde, S.E. , Rehbein, H. , Quinteiro, J. , Vidal, R. , Rey-Mendez, M. , Sotelo, C.G. , Perez-Martin, R.I. , Santos, A.T. , and Rosa, C. , Development of a DNA-based method aimed at identifying the fish species present in food products, J. Agric. Food Chem., 49, 1175, 2001.
Horstkotte, B. , and Rehbein, H. , Fish species identification by means of restriction fragment length polymorphism and high-performance liquid chromatography, J. Food Sci., 68, 2658, 2003.
Lundberg, D.S. , Yourstone, S. , Mieczkowski, P. , Jones, C.D. , and Dangl, J.L. , Practical innovations for high-throughput amplicon sequencing, Nat. Methods, 10(10), 999–1002, 2013.

Heid, C.A. , Stevens, J. , Livak, K.J. , and Williams, P.M. , Real time quantitative PCR, Genome Res., 6, 986, 1996.
Sotelo, C.G. , Chapela, M.J. , Rey, M. , and Pérez-Martin, R.I. , Development of an identification and quantitation system for cod (Gadus morhua) using Taqman assay, In First Joint Trans-Atlantic Fisheries Technology Conference, Reykjavik, Iceland, 195–198, 2003.
Trotta, M. , Schonhuth, S. , Pepe, T. , Cortesi, M.L. , Puyet, A. , and Bautista, J.M. , Multiplex PCR method for use in real-time PCR for identification of fish fillets from grouper (Epinephelus and Mycteroperca species) and common substitute species, J. Agric. Food Chem., 53, 2039, 2005.
Hird, H.J. , Hold, G.L. , Chisholm, J. , Reece, P. , Russell, V.J. , Brown, J. , Goodier, R. , and MacArthur, R. , Development of a method for the quantification of haddock (Melanogrammus aeglefinus) in commercial products using real-time PCR, Eur. Food Res. Technol., 220, 633, 2005.
Lopez, I. , and Pardo, M.A. , Application of relative quantification TaqMan real-time polymerase chain reaction technology for the identification and quantification of Thunnus alalunga and Thunnus albacares, J. Agric. Food Chem., 53, 4554, 2005.
Fitzcharles, E.M. , Rapid discrimination between four Antarctic fish species, genus Macrourus, using HRM analysis, Fish. Res., 127–128, 166–170, 2012.
Fernandes, T.J.R. , Silva, C.R. , Costa, J. , Oliveira, M.B.P.P. , and Mafra, I. , High resolution melting analysis of a COI mini-barcode as a new approach for Penaeidae shrimp species discrimination, Food Control, 82, 8–17, 2017.
Telmo, J.R. , Fernandes, J.C. , Beatriz, P.P. , and Oliveira, I.M. , COI barcode-HRM as a novel approach for the discrimination of hake species, Fish. Res., 197, 50–59, 2018.
Quintrel, M. , Jilberto, F. , Sepúlveda, M. , Marín, M.E. , Véliz, D. , Araneda, C. , and Larraín, M.A. , Development and validation of a multi-locus pcr-hrm method for species identification in mytilus genus with food authenticity purposes, Foods, 10(8), 1684, 2021.
Deconinck, D. , Hostens, K. , Taverniers, I. , Volckaert, F.A.M. , Robbens, J. , and Derycke, S. , Identification and semi-quantification of Atlantic salmon in processed and mixed seafood products using Droplet Digital PCR (ddPCR), Food Chem. Toxicol., 154, 112329, 2021.
Cao, W. , Li, Y. , Chen, X. , Chang, Y. , Li, L. , Shi, L. , Bai, W. , and Ye, L. , Species identification and quantification of silver pomfret using the droplet digital PCR assay, Food Chem., 302, 125331, 2020.
Doi, H. , Takahara, T. , Minamoto, T. , Matsuhashi, S. , Uchii, K. , and Yamanaka, H. , Droplet digital polymerase chain reaction (PCR) outperforms real-time PCR in the detection of environmental DNA from an invasive fish species, Environ. Sci. Technol., 49, 5601–5608, 2015.
Kappel, K. , Eschbach, E. , Fischer, M. , and Fritsche, J. , Design of a user-friendly and rapid DNA microarray assay for the authentication of ten important food fish species, Food Chem., 311, 125884, 2020.
Kappel, K. , Fafińska, J. , Fischer, M. , and Fritsche, J. , A DNA microarray for the authentication of giant tiger prawn (Penaeus monodon) and whiteleg shrimp (Penaeus (Litopenaeus) vannamei): a proof-of-principle, Anal. Bioanal. Chem., 413(19), 4837–4846, 2021.
Spielmann, G. , Ziegler, S. , Haszprunar, G. , Busch, U. , Huber, I. , and Pavlovic, M. , Using loop-mediated isothermal amplification for fast species delimitation in eels (genus Anguilla), with special reference to the European eel (Anguilla anguilla), Food Control, 101, 156–162, 2019.
Xiong, X. , Huang, M. , Xu, W. , Li, Y. , Cao, M. , and Xiong, X. , Using real time fluorescence loop-mediated isothermal amplification for rapid species authentication of Atlantic salmon (Salmo salar), J. Food Compos. Anal., 95, 103659, 2021.
Saull, J. , Duggan, C. , Hobbs, G. , and Edwards, T. , The detection of Atlantic cod (Gadus morhua) using loop mediated isothermal amplification in conjunction with a simplified DNA extraction process, Food Control, 59, 306–313, 2016.
Xiong, X. , Xu, W. , Guo, L. , An, J. , Huang, L. , Qian, H. , Cui, X. , Li, Y. , Cao, M. , Xiong, X. , Ying, X. , and Wang, L. , Development of loop-mediated isothermal amplification (LAMP) assay for rapid screening of skipjack tuna (Katsuwonus pelamis) in processed fish products, J. Food Compos. Anal., 104038, 2021.

Detection of Adulteration

Abbadi, M. , Marciano, S. , Tosi, F. , De Battisti, C. , Panzarin, V. , Arcangeli, G. , et al . (2017). Species identification of bivalve molluscs by pyrosequencing. Journal of the Science of Food and Agriculture, 97(2), 512–519, (WOS:000390708500016). doi:10.1002/jsfa.7754.
Abbas, O. , Zadravec, M. , Baeten, V. , Mikuš, T. , Lešić, T. , Vulić, A. , et al . (2018). Analytical methods used for the authentication of food of animal origin. Food Chemistry, 246, 6–17.
Abdullah, A. , & Rehbein, H. (2016). The differentiation of tuna (family: Scombridae) products through the PCR-based analysis of the cytochrome b gene and parvalbumin introns. Journal of the Science of Food and Agriculture, 96(2), 456–464. doi:10.1002/jsfa.7111.

Afzali, B. , Rahimi Mianji, G. , & Gholizadeh, M. (2013). Genetic variability of rainbow trout (Oncorhynchus mykiss) cultured in Iran using molecular RAPD markers. Iranian Journal of Fisheries Sciences, 12(3), 511–521. Retrieved from https://www.sid.ir/en/journal/ViewPaper.aspx?ID1/4425866.
Ahmadi Shalhe, M. , Khodanazary, A. , & Hosseini, S. M. (2018). Development of a quality index method (QIM) scheme for whole Gold lined seabream Rhabdosargus sarba stored in ice. International Journal of Food Properties, 21(1), 2539–2549. doi:10.1080/10942912.2018.1536147.
Ahmed, M. M. M. , Ali, B. A. , & Ei-Zaeem, S. Y. (2004). Application of RAPD markers in fish: Part I-some genera (Tilapia, Sarotherodon and Oreochromis) and species (Oreochromis aureus and Oreochromis niloticus) of Tilapia. International Journal of Biotechnology, 6(1), 86–93.
Alamprese, C. , Casale, M. , Sinelli, N. , Lanteri, S. , & Casiraghi, E. (2013). Detection of minced beef adulteration with turkey meat by UV-vis, NIR and MIR spectroscopy. LWT - Food Science and Technology, 53(1), 225–232.
Alamprese, C. , & Casiraghi, E. (2015). Application of FT-NIR and FT-IR spectroscopy to fish fillet authentication. LWT - Food Science and Technology, 63(1), 720–725.
Armani, A. , Guardone, L. , La Castellana, R. , Gianfaldoni, D. , Guidi, A. , & Castigliego, L. (2015). DNA barcoding reveals commercial and health issues sold on the Italian market in ethnic seafood. Food Control, 55, 206–214, (WOS:000353850500027). doi:10.1016/j.foodcont.2015.02.030.
Asensio, L. , González, I. , Pavón, M. A. , García, T. , & Martín, R. (2008). An indirect ELISA and a PCR technique for the detection of grouper (Epinephelus marginatus) mislabeling. Food Additives and Contaminants, 25(6), 677–683.
Asensio, L. , Gonzalez, I. , Rodriguez, M. A. , Hernandez, P. E. , Garcia, T. , & Martin, R. (2004). PCR-ELISA for the semiquantitative detection of Nile perch (Lates niloticus) in sterilized fish muscle mixtures. Journal of Agricultural and Food Chemistry, 52(14), 4419–4422. doi:10.1021/jf0350010.
Barbosa, A. J. , Sampaio, I. , da Silva, E. M. , Alcântara, J. V. L. , & Santos, S. (2020). Molecular authentication by DNA barcoding and multiplex PCR assay reveals mislabeling and commercial fraud of the Acoupa weakfish (Cynoscion acoupa), an economically important sciaenid marketed in Brazil. Food Control, 117, 107351. doi:10.1016/j.foodcont.2020.107351.
Berrini, A. , Tepedino, V. , Borromeo, V. , & Secchi, C. (2006). Identification of freshwater fish commercially labelled “perch” by isoelectric focusing and two-dimensional electrophoresis. Food Chemistry, 96(1), 163–168.
Bojolly, D. , Doyen, P. , Le Fur, B. , Christaki, U. , Verrez-Bagnis, V. , & Grard, T. (2017). Development of a qPCR method for the identification and quantification of two closely related tuna species, bigeye tuna (Thunnus obesus) and yellowfin tuna (Thunnus albacares), in canned tuna. Journal of Agricultural and Food Chemistry, 65(4), 913–920. doi:10.1021/acs.jafc.6b04713.
Buddhachat, K. , Attakitbancha, C. , Ritbamrung, O. , Chanthap, K. , Suwannapoom, C. , & Nganvongpanit, K. (2021). Using mini-barcodes coupled with high resolution melting (minibar-HRM) method for species discrimination across Pangasianodon gigas, Pangasianodon hypophthalmus and Pangasius larnaudii. Aquaculture, 530, 735773. doi:10.1016/j.aquaculture.2020.735773.
Camin, F. , Boner, M. , Bontempo, L. , Fauhl-Hassek, C. , Kelly, S. D. , Riedl, J. , & Rossmann, A. (2017). Stable isotope techniques for verifying the declared geographical origin of food in legal cases. Trends in Food Science & Technology, 61, 176–187.
Camin, F. , Perini, M. , Bontempo, L. , Galeotti, M. , Tibaldi, E. , & Piasentier, E. (2018). Stable isotope ratios of H, C, O, N and S for the geographical traceability of Italian rainbow trout (Oncorhynchus mykiss). Food Chemistry, 267, 288–295.
Candoğan, K. , Altuntas, E. G. , & İğci, N. (2021). Authentication and quality assessment of meat products by Fourier-transform infrared (FTIR) spectroscopy. Food Engineering Reviews, 13(1), 66–91.
Cao, W. , Li, Y. , Chen, X. , Chang, Y. , Li, L. , Shi, L. , et al . (2020). Species identification and quantification of silver pomfret using the droplet digital PCR assay. Food Chemistry, 302, 125331. doi:10.1016/j.foodchem.2019.125331.
Capuano, E. , Lommen, A. , Heenan, S. , de la Dura, A. , Rozijn, M. , & van Ruth, S. (2012). Wild salmon authenticity can be predicted by 1HNMR spectroscopy. Lipid Technology, 24(11), 251–253).
Carrera, E. , Terni, M. , Montero, A. , García, T. , González, I. , & Martín, R. (2014). ELISA-based detection of mislabeled albacore (Thunnus alalunga) fresh and frozen fish fillets. Food and Agricultural Immunology, 25(4), 569–577.
Carrera, M. , & Gallardo, J. M. (2017). Determination of the geographical origin of all commercial hake species by stable isotope ratio (SIR) analysis. Journal of Agricultural and Food Chemistry, 65(5), 1070–1077.
Carvalho, D. C. , Palhares, R. M. , Drummond, M. G. , & Gadanho, M. (2017). Food metagenomics: Next generation sequencing identifies species mixtures and mislabeling within highly processed cod products. Food Control, 80, 183–186, (WOS:000404198800024). doi:10.1016/j.foodcont.2017.04.049.
Castigliego, L. , Armani, A. , Tinacci, L. , Gianfaldoni, D. , & Guidi, A. (2015). Two alternative multiplex PCRs for the identification of the seven species of anglerfish (Lophius spp.) using an end-point or a melting curve analysis real-time protocol. Food Chemistry, 166, 1–9. doi:10.1016/j.foodchem.2014.06.014.
Chai, Z. , Wang, C. , & Bi, H. (2021). Rapid identification between two fish species using UV-Vis spectroscopy for substitution detection. Molecules, 26(21), 6529.

Chakrabarti, S. , Chowdhury, S. , Nath, S. , Murmu, P. , & Dey, D. (2020). Near-infrared spectroscopy: A non-invasive tool for quality evaluation of seafood. Science Archives, 1(3), 132–141.
Chen, T. Y. , & Hwang, D. F. (2002). Electrophoretic identification of muscle proteins in 7 puffer species. Journal of food science, 67(3), 936–942.
Chen, Z. , Wu, T. , Xiang, C. , Xu, X. , & Tian, X. (2019). Rapid identification of rainbow trout adulteration in Atlantic salmon by Raman spectroscopy combined with machine learning. Molecules, 24(15), 2851.
Chiu, T.-H. , Su, Y.-C. , Pai, J.-Y. , & Chang, H.-C. (2012). Molecular markers for detection and diagnosis of the giant grouper (Epinephelus lanceolatus). Food Control, 24(1), 29–37. doi:10.1016/j.foodcont.2011.08.033.
Danezis, G. P. , Tsagkaris, A. S. , Camin, F. , Brusic, V. , & Georgiou, C. A. (2016). Food authentication: Techniques, trends & emerging approaches. TrAC Trends in Analytical Chemistry, 85, 123–132.
De Battisti, C. , Marciano, S. , Magnabosco, C. , Busato, S. , Arcangeli, G. , & Cattoli, G. (2014). Pyrosequencing as a tool for rapid fish species identification and commercial fraud detection. Journal of Agricultural and Food Chemistry, 62(1), 198–205. doi:10.1021/jf403545m.
de Brito, M. A. , Schneider, H. , Sampaio, I. , & Santos, S. (2015). DNA barcoding reveals high substitution rate and mislabeling in croaker fillets (Sciaenidae) marketed in Brazil: The case of “pescada branca” (Cynoscion leiarchus and Plagioscion squamosissimus). Food Research International, 70, 40–46. doi:10.1016/j.foodres.2015.01.031.
Domingo, J. L. (2016). Nutrients and chemical pollutants in fish and shellfish. Balancing health benefits and risks of regular fish consumption. Critical Reviews in Food Science and Nutrition, 56(6), 979988.
Eischeid, A. C. , Kim, B. , & Kasko, S. M. (2013). Two quantitative real-time PCR assays for the detection of penaeid shrimp and blue crab, crustacean shellfish allergens. Journal of Agricultural and Food Chemistry, 61(24), 5669–5674. doi:10.1021/jf3031524.
FAO (2018). Overview of food fraud in the fisheries sector, by Alan Reilly. Fisheries and aquaculture circular no. 1165.
FAO (2019). Globefish Highlights No. 2–2019. A Quarterly Update on World Seafood Markets April 2019 Issue, with January–December 2018 Statistics. FAO.
Feng, C.-H. , Makino, Y. , Oshita, S. , & García Martín , J. F. (2018). Hyperspectral imaging and multispectral imaging as the novel techniques for detecting defects in raw and processed meat products: Current state-of-the-art research advances. Food Control, 84, 165–176.
Fernandes, T. J. R. , Costa, J. , Oliveira, M. , & Mafra, I. (2017). DNA barcoding coupled to HRM analysis as a new and simple tool for the authentication of Gadidae fish species. Food Chemistry, 230, 49–57, (WOS:000400533200007). doi:10.1016/j.foodchem.2017.03.015.
Fernandes, T. J. R. , Costa, J. , Oliveira, M. B. P. P. , & Mafra, I. (2018a). Exploiting 16S rRNA gene for the detection and quantification of fish as a potential allergenic food: A comparison of two real-time PCR approaches. Food Chemistry, 245, 1034–1041. doi:10.1016/j.foodchem.2017.11.068.
Fernandes, T. J. R. , Costa, J. , Oliveira, M. , & Mafra, I. (2018b). COI barcode-HRM as a novel approach for the discrimination of hake species. Fisheries Research, 197, 50–59, (WOS:000413879700008). doi:10.1016/j.fishres.2017.09.014.
Fiorino, G. M. , Losito, I. , De Angelis, E. , Arlorio, M. , Logrieco, A. F. , & Monaci, L. (2018). Assessing fish authenticity by direct analysis in real time-high resolution mass spectrometry and multivariate analysis: Discrimination between wild-type and farmed salmon. Food Research International, 116, 1258–1265.
Galal-Khallaf, A. , Ardura, A. , Mohammed-Geba, K. , Borrell, Y. J. , & Garcia-Vazquez, E. (2014). DNA barcoding reveals a high level of mislabeling in Egyptian fish fillets. Food Control, 46, 441–445. doi:10.1016/j.foodcont.2014.06.016.
Ghidini, S. , Varrà, M. O. , & Zanardi, E. (2019). Approaching authenticity issues in fish and seafood products by qualitative spectroscopy and chemometrics. Molecules, 24(9), 1812.
Giusti, A. , Armani, A. , & Sotelo, C. G. (2017a). Advances in the analysis of complex food matrices: Species identification in surimi-based products using next generation sequencing technologies. PLoS One, 12(10), e0185586, (WOS:000412029600027). doi:10.1371/journal.pone.0185586.
Giusti, A. , Castigliego, L. , Rubino, R. , Gianfaldoni, D. , Guidi, A. , & Armani, A. (2016). A conventional multiplex PCR assay for the detection of toxic Gemfish species (Ruvettus pretiosus and Lepidocybium flavobrunneum): A simple method to combat health frauds. Journal of Agricultural and Food Chemistry, 64(4), 960–968. doi:10.1021/acs.jafc.5b04899.
Giusti, A. , Tinacci, L. , Sotelo, C. G. , Marchetti, M. , Guidi, A. , Zheng, W. , et al . (2017b). Seafood identification in multispecies products: Assessment of 16SrRNA, cytb, and COI universal primers’ efficiency as a preliminary analytical step for setting up metabarcoding next-generation sequencing techniques. Journal of Agricultural and Food Chemistry, 65(13), 2902–2912. doi:10.1021/acs.jafc.6b05802.
Han, K. , & Ely, B. (2002). Use of AFLP analyses to assess genetic variation in Morone and Thunnus species. Marine Biotechnology, 4(2), 141–145. doi:10.1007/s10126-001-0080-8.
Handy, S. M. , Chizhikov, V. , Yakes, B. J. , Paul, S. Z. , Deeds, J. R. , & Mossoba, M. M. (2014). Microarray chip development using infrared imaging for the identification of cat-fish species. Applied Spectroscopy, 68(12), 1365–1373. doi:10.1366/14-07505.
Hanner, R. , Becker, S. , Ivanova, N. V. , & Steinke, D. (2011). FISH-BOL and seafood identification: Geographically dispersed case studies reveal systemic market substitution across Canada. Mitochondrial DNA,

22, 106–122, (WOS:000295726100014). doi:10.3109/19401736.2011.588217.
Hatzakis, E. (2019). Nuclear magnetic resonance (NMR) spectroscopy in food science: A comprehensive review. Comprehensive Reviews in Food Science and Food Safety, 18, 189–220.
Hellberg, R. S. , DeWitt, C. A. M. , & Morrissey, M. T. (2012). Risk-benefit analysis of seafood consumption: A review. Comprehensive Reviews in Food Science and Food Safety, 11(5), 490517.
Hellberg, R. S. , & Morrissey, M. T. (2011). Advances in DNA-based techniques for the detection of seafood species substitution on the commercial market. Journal of Laboratory Automation, 16(4), 308–321. doi:10.1016/j.jala.2010.07.004.
Hellberg, R. S. , Pollack, S. J. , & Hanner, R. H. (2016). Seafood species identification using DNA sequencing. In: Amanda M. Naaum , Robert H. Hanner (Eds.) Seafood Authenticity and Traceability: A DNA-Based Perspective (pp. 113–132). Academic Press. ISBN: 9780128015926 (WOS:000413431500007). doi:10.1016/b978-0-12-801592-6.00006-1.
Hindson, C. M. , Chevillet, J. R. , Briggs, H. A. , Gallichotte, E. N. , Ruf, I. K. , Hindson, B. J. , et al . (2013). Absolute quantification by droplet digital PCR versus analog real-time PCR. Nature Methods, 10(10), 1003–1005. doi:10.1038/nmeth.2633.
Herrero, B. , Madrinan, M. , Vieites, J. M. , & Espineira, M. (2010). Authentication of Atlantic cod (Gadus morhua) using real time PCR. Journal of Agricultural and Food Chemistry, 58(8), 4794–4799. doi:10.1021/jf904018h.
Hu, Y. , Huang, S. Y. , Hanner, R. , Levin, J. , & Lu, X. (2018). Study of fish products in metro Vancouver using DNA barcoding methods reveals fraudulent labeling. Food Control, 94, 38–47. doi:10.1016/j.foodcont.2018.06.023.
Huidobro, A. , Pastor, A. , & Tejada, M. (2000). Quality index method developed for raw gilthead seabream (Sparus aurata). Journal of Food Science, 65(7), 1202–1205. doi:10.1111/j.1365-2621.2000.tb10265.x.
Hulley, E. N. , Tharmalingam, S. , Zarnke, A. , & Boreham, D. R. (2019). Development and validation of probe-based multiplex real-time PCR assays for the rapid and accurate detection of freshwater fish species. PLoS One, 14(1), e0210165, (WOS:000457155600022). doi:10.1371/journal.pone.0210165.
Ivády, G. , Madar, L. , Dzsudzsák, E. , Koczok, K. , Kappelmayer, J. , Krulisova, V. , et al . (2018). Analytical parameters and validation of homopolymer detection in a pyrosequencing based next generation sequencing system. BMC Genomics, 19, 158. doi:10.1186/s12864-018-4544-x.
Ivanova, N. V. , Zemlak, T. S. , Hanner, R. H. , & Hebert, P. D. N. (2007). Universal primer cocktails for fish DNA barcoding. Molecular Ecology Notes, 7(4), 544–548. doi:10.1111/j.1471-8286.2007.01748.x.
Jacobs, S. , Sioen, I. , Pieniak, Z. , De Henauw, S. , Maulvault, A. L. , Reuver, M. , et al ., (2015). Consumers' health risk–benefit perception of seafood and attitude toward the marine environment: Insights from five European countries. Environmental Research, 143, 1119.
Jilberto, F. , Araneda, C. , & Larrain, M. A. (2017). High resolution melting analysis for identification of commercially-important Mytilus species. Food Chemistry, 229, 716–720, (WOS:000400033000090). doi:10.1016/j.foodchem.2017.02.109.
Kappel, K. , Haase, I. , Kaeppel, C. , Sotelo, C. G. , & Schroeder, U. (2017). Species identification in mixed tuna samples with next-generation sequencing targeting two short cytochrome b gene fragments. Food Chemistry, 234, 212–219, (WOS:000403510700029). doi:10.1016/j.foodchem.2017.04.178.
Kizil, R. , & Irudayaraj, J. (2018). Spectroscopic technique: Fourier Transform Raman (FT-Raman) spectroscopy. In: Da-Wen Sun (Ed.) Modern Techniques for Food Authentication, Second edition, (pp. 193–217). Academic Press. doi: 10.1016/B978-0-12-814264-6.00006-2.
Kochzius, M. , Noelte, M. , Weber, H. , Silkenbeumer, N. , Hjoerleifsdottir, S. , Hreggvidsson, G. O. , et al . (2008). DNA microarrays for identifying fishes. Marine Biotechnology, 10(2), 207–217. doi:10.1007/s10126-007-9068-3.
Kochzius, M. , Seidel, C. , Antoniou, A. , Botla, S. K. , Campo, D. , Cariani, A. , et al . (2010). Identifying fishes through DNA barcodes and microarrays. PLoS One, 5(9), e12620. doi:10.1371/journal.pone.0012620.
Liu, Z. , Li, P. , Argue, B. J. , & Dunham, R. A. (1998a). Inheritance of RAPD markers in channel catfish (Ictalurus punctatus), blue catfish (I. furcatus), and their F1, F2 and backcross hybrids. Animal Genetics, 29(1), 58–62. doi:10.1046/j.1365-2052.1998.00284.x.
Liu, Z. , Nichols, A. , Li, P. , & Dunham, R. A. (1998b). Inheritance and usefulness of AFLP markers in channel catfish (Ictalurus punctatus), blue catfish (I. furcatus), and their F1, F2, and backcross hybrids. Molecular and General Genetics, 258(3), 260. doi:10.1007/s004380050730.
Made, D. , & Rohmberger, D. (2017). Development of sensitive and specific real-time PCR systems for the detection of crustaceans in food. European Food Research and Technology, 243(12), 2105–2113. doi:10.1007/s00217-017-2911-5.
Marín, A. , Serna, J. , Robles, C. , Ramírez, B. , Reyes-Flores, L. E. , Zelada-Mázmela, E. , et al . (2018). A glimpse into the genetic diversity of the Peruvian seafood sector: Unveiling species substitution, mislabeling and trade of threatened species. PLoS One, 13(11), e0206596. doi:10.1371/journal.pone.0206596.
Martinez, I. , Šližytė, R. , & Daukšas, E. (2007). High resolution two-dimensional electrophoresis as a tool to differentiate wild from farmed cod (Gadus morhua) and to assess the protein composition of klipfish. Food Chemistry, 102(2), 504–510.

Mata, W. , Chanmalee, T. , Punyasuk, N. , & Thitamadee, S. (2020). Simple PCR-RFLP detection method for genus-and species-authentication of four types of tuna used in canned tuna industry. Food Control, 108, 106842.
Mitchell, J. K. , & Hellberg, R. S. (2016). Use of the mitochondrial control region as a potential DNA mini-barcoding target for the identification of canned tuna species. Food Analytical Methods, 9(10), 2711. doi:10.1007/s12161-016-0460-3.
Mondal, D. , & Mandal, N. (2020). Molecular phylogeny of mitochondrial DNA: Shrimp species identification by multiplex and real-time PCR. Food Control, 108, 106868. doi:10.1016/j.foodcont.2019.106868.
Moretti, V. M. , Turchini, G. M. , Bellagamba, F. , & Caprino, F. (2003). Traceability issues in fishery and aquaculture products. Veterinary Research Communications, 27(1), 497–505.
Mueller, S. , Handy, S. M. , Deeds, J. R. , George, G. O. , Broadhead, W. J. , Pugh, S. E. , et al . (2015). Development of a COX1 based PCR-RFLP method for fish species identification. Food Control, 55, 39–42. doi:10.1016/j.foodcont.2015.02.026.
Naaum, A. M. , & Hanner, R. (2015). Community engagement in seafood identification using DNA barcoding reveals market substitution in Canadian seafood. DNA Barcodes, 3(1), 74–79. doi:10.1515/dna-2015-0009.
Nebola, M. , Borilova, G. , & Kasalova, J. (2010). PCR-RFLP analysis of DNA for the differentiation of fish species in seafood samples. Bulletin of the Veterinary Institute in Pulawy, 54(1), 49–53.
Nimbkar, S. , Auddy, M. , Manoj, I. , & Shanmugasundaram, S. (2021). Novel techniques for quality evaluation of fish: A review. Food Reviews International, 39, 1–24.
Noh, E. S. , Park, Y. J. , Kim, E. M. , Park, J. Y. , Shim, K. B. , Choi, T.-J. , et al . (2019). Quantitative analysis of Alaska pollock in seafood products by droplet digital PCR. Food Chemistry, 275, 638–643. doi:10.1016/j.foodchem.2018.09.093.
Notomi, T. , Okayama, H. , Masubuchi, H. , Yonekawa, T. , Watanabe, K. , Amino, N. , et al . (2000). Loop-mediated isothermal amplification of DNA. Nucleic Acids Research, 28(12), e63. doi:10.1093/nar/28.12.e63.
Olafsdóttir, G. , Martinsdóttir, E. , Oehlenschlager, J. , Dalgaard, P. , Jensen, B. , Undeland, I. , et al . (1997). Methods to evaluate fish freshness in research and industry. Trends in Food Science & Technology, 8, 258–265. doi:10.1016/S0924-2244(97)01049-2.
Panprommin, D. , Soontornprasit, K. , & Pangeson, T. (2019). Comparison of three molecular methods for species identification of the family Cichlidae in Kwan Phayao, Thailand. Mitochondrial DNA. Part A, DNA Mapping, Sequencing, and Analysis, 30(1), 184–190, (WOS:000461357300021). doi:10.1080/24701394.2018.1472248.
Pardo, M. A. , Jimenez, E. , & Perez-Villarreal, B. (2016). Misdescription incidents in seafood sector. Food Control, 62, 277–283, (WOS:000368220000039). doi:10.1016/j.foodcont.2015.10.048.
Pinheiro, L. B. , Coleman, V. A. , Hindson, C. M. , Herrmann, J. , Hindson, B. J. , Bhat, S. , et al . (2012). Evaluation of a droplet digital polymerase chain reaction format for DNA copy number quantification. Analytical Chemistry, 84(2), 1003–1011. doi:10.1021/ac202578x.
Pollack, S. J. , Kawalek, M. D. , Williams-Hill, D. M. , & Hellberg, R. S. (2018). Evaluation of DNA barcoding methodologies for the identification of fish species in cooked products. Food Control, 84, 297–304, (WOS:000415769700038). doi:10.1016/j.foodcont.2017.08.013.
Qu, J.-H. , Cheng, J.-H. , Sun, D.-W. , Pu, H. , Wang, Q.-J. , & Ma, J. (2015). Discrimination of shelled shrimp (Metapenaeus ensis) among fresh, frozen-thawed and cold-stored by hyperspectral imaging technique. LWT - Food Science and Technology, 62, 202–209.
Rasmussen, R. S. , & Morrissey, M. T. (2008). DNA-based methods for the identification of commercial fish and seafood species. Comprehensive Reviews in Food Science and Food Safety, 7(3), 280–295. doi:10.1111/j.1541-4337.2008.00046.x.
Rehbein, H. (2005). Identification of the fish species of raw or cold-smoked salmon and salmon caviar by single-strand conformation polymorphism (SSCP) analysis. European Food Research and Technology, 220(5), 625–632. doi:10.1007/s00217-004-1067-2.
Rehbein, H. , Kress, G. , & Schmidt, T. (1997). Application of PCR-SSCP to species identification of fishery products. Journal of the Science of Food and Agriculture, 74(1), 35–41. doi:10.1002/(SICI)1097-0010(199705)74:1<35::AID-JSFA765>3.0.CO;2–2.
Rehbein, H. , Mackie, I. M. , Pryde, S. , Gonzales-Sotelo, C. , Medina, I. , Perez-Martin, R. , et al . (1999). Fish species identification in canned tuna by PCR-SSCP: Validation by a collaborative study and investigation of intra-species variability of the DNA-patterns. Food Chemistry, 64(2), 263–268. doi:10.1016/S0308-8146(98)00125-3.
Reid, L. M. , O'Donnell, C. P. , & Downey, G. (2006). Recent technological advances for the determination of food authenticity. Trends in Food Science & Technology, 17(7), 344–353.
Rohman, A. (2019). The employment of Fourier transform infrared spectroscopy coupled with chemometrics techniques for traceability and authentication of meat and meat products. Journal of Advanced Veterinary and Animal Research, 6(1), 9.
Sánchez-Alonso, I. , Carmona, P. , & Careche, M. (2012). Vibrational spectroscopic analysis of hake (Merluccius merluccius L.) lipids during frozen storage. Food Chemistry, 132(1), 160–167.
Santaclara, F. J. , Velasco, A. , Perez-Martin, R. I. , Quinteiro, J. , Rey-Mendez, M. , Angel Pardo, M. , et al . (2015). Development of a multiplex PCR-ELISA method for the genetic authentication of Thunnus species and

Katsuwonus pelamis in food products. Food Chemistry, 180, 9–16. doi:10.1016/j.foodchem.2014.11.076.
Sarri, C. , Stamatis, C. , Sarafidou, T. , Galara, I. , Godosopoulos, V. , Kolovos, M. , et al . (2014). A new set of 16S rRNA universal primers for identification of animal species. Food Control, 43, 35–41. doi:10.1016/j.foodcont.2014.02.036.
Saull, J. , Duggan, C. , Hobbs, G. , & Edwards, T. (2016). The detection of Atlantic cod (Gadus morhua) using loop mediated isothermal amplification in conjunction with a simplified DNA extraction process. Food Control, 59, 306–313. doi:10.1016/j.foodcont.2015.05.038.
Shi, R. , Xiong, X. , Huang, M. , Xu, W. , Li, Y. , Cao, M. , et al . (2020). High resolution melting (HRM) analysis of a 12S rRNA mini barcode as a novel approach for codfish species authentication in processed fish products. European Food Research and Technology, 246(5), 891–899. doi:10.1007/s00217-020-03456-5.
Shokralla, S. , Hellberg, R. S. , Handy, S. M. , King, I. , & Hajibabaei, M. (2015). A DNA mini-barcoding system for authentication of processed fish products. Scientific Reports, 5, 15894, (WOS:000363778900001). doi:10.1038/srep15894.
Silva, A. J. , & Hellberg, R. S. (2021). DNA-based techniques for seafood species authentication. In: Fidel Toldrá (Ed.) Advances in Food and Nutrition Research (Vol. 95, pp. 207–255). Academic Press, United States. ISBN: 9780128215203, doi: 10.1016/bs.afnr.2020.09.001.
Silva, A. J. , Kawalek, M. , Williams-Hill, D. M. , & Hellberg, R. S. (2020). PCR cloning combined with DNA barcoding enables partial identification of fish species in a mixed-species product. Frontiers in Ecology and Evolution, 8, 28. doi:10.3389/fevo.2020.00028.
Sinelli, N. , Limbo, S. , Torri, L. , Di Egidio, V. , & Casiraghi, E. (2010). Evaluation of freshness decay of minced beef stored in high-oxygen modified atmosphere packaged at different temperatures using NIR and MIR spectroscopy. Meat Science, 86(3), 748–752.
Sotelo, C. G. , Velasco, A. , Perez-Martin, R. I. , Kappel, K. , Schroder, U. , Verrez-Bagnis, V. , et al . (2018). Tuna labels matter in Europe: Mislabelling rates in different tuna products. PLoS One, 13(5), e0196641, (WOS:000432329200038). doi:10.1371/journal.pone.0196641.
Sue, M. J. , Yeap, S. K. , Omar, A. R. , & Tan, S. W. (2014). Application of PCR-ELISA in molecular diagnosis. BioMed Research International, 2014, 6. doi:10.1155/2014/653014.
Sun, H. , Song, Y. , Zhang, H. , Zhang, X. , Liu, Y. , Wang, X. , et al . (2020). Characterization of lipid composition in the muscle tissue of four shrimp species commonly consumed in China by UPLC− Triple TOF−MS/MS. LWT, 128, 109469.
Taboada, L. , Sánchez, A. , Perez-Martín, R. I. , & Sotelo, C. G. (2017a). A new method for the rapid detection of Atlantic cod (Gadus morhua), Pacific cod (Gadus macrocephalus), Alaska pollock (Gadus chalcogrammus) and ling (Molva molva) using a lateral flow dipstick assay. Food Chemistry, 233, 182–189. doi:10.1016/j.foodchem.2017.04.087.
Taboada, L. , Sánchez, A. , & Sotelo, C. G. (2017b). A new real-time PCR method for rapid and specific detection of ling (Molva molva). Food Chemistry, 228, 469–475. doi:org/10.1016/j.foodchem.2017.01.117.
Taboada, L. , Sanchez, A. , Velasco, A. , Santaclara, F. J. , Perez-Martin, R. I. , & Sotelo, C. G. (2014). Identification of Atlantic cod (Gadus morhua), ling (Molva molva), and Alaska pollock (Gadus chalcogrammus) by PCR-ELISA using duplex PCR. Journal of Agricultural and Food Chemistry, 62(24), 5699–5706. doi:10.1021/jf500173j.
Teletchea, F. , Bernillon, J. , Duffraisse, M. , Laudet, V. , & Hanni, C. (2008). Molecular identification of vertebrate species by oligonucleotide microarray in food and forensic samples. Journal of Applied Ecology, 45(3), 967–975. doi:10.1111/j.1365-2664.2007.01415.x.
Tinacci, L. , Stratev, D. , Vashin, I. , Chiavaccini, I. , Susini, F. , Guidi, A. , et al . (2018). Seafood labelling compliance with European legislation and species identification by DNA barcoding: A first survey on the Bulgarian market. Food Control, 90, 180–188, (WOS:000432100800023). doi:10.1016/j.foodcont.2018.03.007.
Tomas, C. , Ferreira, I. M. P. L. V. O. , & Faria, M. A. (2017). Codfish authentication by a fast short amplicon high resolution melting analysis (SA-HRMA) method. Food Control, 71, 255–263. doi:10.1016/j.foodcont.2016.07.004.
Trevisan, J. , Angelov, P. P. , Carmichael, P. L. , Scott, A. D. , & Martin, F. L. (2012). Extracting biological information with computational analysis of Fourier-transform infrared (FTIR) biospectroscopy datasets: Current practices to future perspectives. Analyst, 137(14), 3202–3215.
Trotta, M. , Schonhuth, S. , Pepe, T. , Cortesi, M. L. , Puyet, A. , & Bautista, J. M. (2005). Multiplex PCR method for use in real-time PCR for identification of fish fillets from grouper (Epinephelus and Mycteroperca species) and common substitute species. Journal of Agricultural and Food Chemistry, 53(6), 2039–2045, (WOS:000227736100031). doi:10.1021/jf048542d.
Ulrich, R. M. , John, D. E. , Barton, G. W. , Hendrick, G. S. , Fries, D. P. , & Paul, J. H. (2013). Ensuring seafood identity: Grouper identification by real-time nucleic acid sequence- based amplification (RT-NASBA). Food Control, 31(2), 337–344. doi:10.1016/j.foodcont.2012.11.012.
van Dijk, E. L. , Auger, H. , Jaszczyszyn, Y. , & Thermes, C. (2014). Ten years of next-generation sequencing technology. Trends in Genetics, 30(9), 418–426. doi:org/10.1016/j.tig.2014.07.001.
Velioğlu, H. M. , Temiz, H. T. , & Boyaci, I. H. (2015). Differentiation of fresh and frozen-thawed fish samples using Raman spectroscopy coupled with chemometric analysis. Food Chemistry, 172, 283–290.

Verrez-Bagnis, V. , Sotelo, C. G. , Mendes, R. , Silva, H. , Kappel, K. , & Schroder, U. (2018). Methods for seafood authenticity testing in Europe. In Bioactive Molecules in Food (pp. 2063–2117). doi:10.1007/978-3-319-78030-6_69.

Wang, K. , & Sun, D. W. (2018). Imaging spectroscopic technique: Raman chemical imaging. In: Da-Wen Sun (Ed.) Modern Techniques for Food Authentication (pp. 287–319). Academic Press, doi: 10.1016/B978-0-12-814264-6.00009-8.

Wang, Y. , Feng, J. , & Tian, X. (2019). Application of loop-mediated isothermal amplification (LAMP) for rapid detection of Atlantic cod (Gadus morhua), Pacific cod (Gadus macrocephalus) and haddock (Melanogrammus aeglefinus). Molecular and Cellular Probes, 47. doi:10.1016/j.mcp.2019.07.003.

Wilwet, L. , Jeyasekaran, G. , Shakila, R. J. , Sivaraman, B. , & Padmavathy, P. (2018). A single enzyme PCR-RFLP protocol targeting 16S rRNA/tRNA(val) region to authenticate four commercially important shrimp species in India. Food Chemistry, 239, 369–376. doi:10.1016/j.foodchem.2017.06.132.

Wolf, C. , Burgener, M. , Hubner, P. , & Luthy, J. (2000). PCR-RFLP analysis of mitochondrial DNA: Differentiation of fish species. LWT - Food Science and Technology, 33(2), 144–150. doi:10.1006/fstl.2000.0630.

Workman Jr, J. (Ed.). (2000). The Handbook of Organic Compounds, Three-Volume Set: NIR, IR, R, and UV-Vis Spectra Featuring Polymers and Surfactants. Elsevier.

Xu, J. L. , Riccioli, C. , & Sun, D. W. (2015). An overview on non-destructive spectroscopic techniques for lipid and lipid oxidation analysis in fish and fish products. Comprehensive Reviews in Food Science and Food Safety, 4, 466–477.

Xu, J. L. , Riccioli, C. , & Sun, D. W. (2017). Comparison of hyperspectral imaging and computer vision for automatic differentiation of organically and conventionally farmed salmon. Journal of Food Engineering, 196, 170–182.

Xu, J. L. , & Sun, D. W. (2018). Imaging spectroscopic technique: Hyperspectral imaging. In: Da-Wen Sun (Ed.) Modern Techniques for Food Authentication (pp. 253–286). Academic Press, doi: 10.1016/B978-0-12-814264-6.00008-6

Xu, K. H. , Feng, J. L. , Ma, X. T. , Wang, X. , Zhou, D. , & Dai, Z. Y. (2016). Identification of tuna species (Thunnini tribe) by PCR-RFLP analysis of mitochondrial DNA fragments. Food and Agricultural Immunology, 27(3), 301–313, (WOS:000372023700001). doi:10.1080/09540105.2015.1086978.

Yang, D. , & Ying, Y. (2011). Applications of Raman spectroscopy in agricultural products and food analysis: A review. Applied Spectroscopy Reviews, 46(7), 539–560.

Yaseen, T. , Sun, D. W. , & Cheng, J. H. (2017). Raman imaging for food quality and safety evaluation: Fundamentals and applications. Trends in Food Science & Technology, 62, 177–189.

Yu, X. , Li, L. , Wang, H. , Song, G. , Wang, J. , Li, S. , et al . (2020). Lipidomics study of rainbow trout (Oncorhynchus mykiss) and salmons (Oncorhynchus tshawytscha and Salmo salar) using hydrophilic interaction chromatography and mass spectrometry. LWT-Food Science and Technology, 121, 108988.

Zhao, Y. , Song, W. , Li, R. , Wang, C. , & Mu, C. (2020). A high-resolution melting analysis method for the effective discrimination of three Sepia species. Journal of Consumer Protection and Food Safety, 15, 383–385. doi:10.1007/s00003-020-01289-8.

DNA Barcoding Methodologies for the Identification of Fish Species in Cooked Products

Abdullah, A. , Nurilmala, M. , Muttaqin, E. , & Yulianto, I. (2020). DNA-based analysis of shark products sold on the Indonesian market towards seafood labelling accuracy program. Biodiversitas, 21(4), 1385–1390. doi:10.13057/biodiv/d210416.

Armani, A. , Guardone, L. , Castigliego, L. , D'Amico, P. , Messina, A. , Malandra, R. , Gianfaldoni, D. , & Guidi, A. (2015a). DNA and mini-DNA barcoding for the identification of Porgies species (family Sparidae) of commercial interest on the international market. Food Control, 50, 589–596. doi:10.1016/j.foodcont.2014.09.025.

Armani, A. , Guardone, L. , La Castellana, R. , Gianfaldoni, D. , Guidi, A. , & Castigliego, L. (2015b). DNA barcoding reveals commercial and health issues sold on the Italian market in ethnic seafood. Food Control, 55, 206–214. doi:10.1016/j.foodcont.2015.02.030.

Armani, A. , Tinacci, L. , Lorenzetti, R. , Benvenuti, A. , Susini, F. , Gasperetti, L. , Ricci, E. , Guarducci, M. , & Guidi, A. (2017). Is raw better? A multiple DNA barcoding approach (full and mini) based on mitochondrial and nuclear markers reveals low rates of misdescription in sushi products sold on the Italian market. Food Control, 79, 126–133. doi:10.1016/j.foodcont.2017.03.030.

Armani, A. , Tinacci, L. , Xiong, X. , Castigliego, L. , Gianfaldoni, D. , & Guidi, A. (2015c). Fish species identification in canned pet food by BLAST and forensically informative nucleotide sequencing (FINS) analysis of short fragments of the mitochondrial 16s ribosomal RNA gene (16S rRNA). Food Control, 50, 821–830. doi:10.1016/j.foodcont.2014.10.018.

Baetscher, D. , Locatelli, N. , Won, E. , Fitzgerald, T. , McIntyre, P. , & Therkildsen, N. O. (2021). Optimizing a metabarcoding primer portfolio for species-level detection of taxa in complex mixtures of diverse fishes. Authorea. doi:10.22541/au.163861686.62434613/v1.

Bartlett, S. E. , & Davidson, W. S. (1991). Identification of Thunnus tuna species by the polymerase chain reaction and direct sequence analysis of their mitochondrial cytochrome b genes. Canadian Journal of Fisheries and Aquatic Sciences, 48(2), 309–317. doi:10.1139/f91-043.

Bénard-Capelle, J. , Guillonneau, V. , Nouvian, C. , Fournier, N. , Le Loët, K. , & Dettai, A. (2015). Fish mislabelling in France: Substitution rates and retail types. PeerJ, 2, e714 doi:10.7717/peerj.714.

Biffi, D. , López-Mobilia, A. , Kelez, S. , Williams, D. A. , Chumchal, M. M. , & Weinburgh, M. (2020). Mislabelling and high mercury content hampers the efforts of market-based seafood initiatives in Peru. Scientific Reports, 10(1), 20390. doi:10.1038/s41598-020-77338-x.

Burgener, M. (1997). Molecular species differentiation of fish and mammals. Ph.D. Thesis. University of Bern, Switzerland.

Calosso, M. C. , Claydon, J. A. B. , Mariani, S. , & Cawthorn, D.-M. (2020). Global footprint of mislabelled seafood on a small island nation. Biological Conservation, 245, 108557. doi:10.1016/j.biocon.2020.108557.

Cardeñosa, D. , Fields, A. , Abercrombie, D. , Feldheim, K. , Shea, S. K. H. , & Chapman, D. D. (2017). A multiplex PCR mini-barcode assay to identify processed shark products in the global trade. PLoS One, 12(10), e0185368. doi:10.1371/journal.pone.0185368.

Cardeñosa, D. , Fields, A. T. , Babcock, E. A. , Zhang, H. , Feldheim, K. , Shea, S. K. H. , Fischer, G. A. , & Chapman, D. D. (2018). CITES-listed sharks remain among the top species in the contemporary fin trade. Conservation Letters, 11(4), e12457. doi:10.1111/conl.12457.

Carlucci, D. , Nocella, F. , De Devitiis, B. , Viscecchia, R. , Bimbo, F. , & Nardone, G. (2015). Consumer purchasing behaviour towards fish and seafood products: Patterns and insights from a sample of international studies. Appetite, 84, 212–227.

Carvalho, D. C. , Palhares, R. M. , Drummond, M. G. , & Frigo, T. B. (2015). DNA barcoding identification of commercialized seafood in South Brazil: A governmental regulatory forensic program. Food Control, 50, 784–788. doi:10.1016/j.foodcont.2014.10.025.

Chang, C.-H. , Kao, Y.-T. , Huang, T.-T. , & Wang, Y.-C. (2021). Product authentication using two mitochondrial markers reveals inconsistent labeling and substitution of canned tuna products in the Taiwanese market. Foods, 10(11), 2655. doi:10.3390/foods10112655.

Chen, P.-Y. , Ho, C.-W. , Chen, A.-C. , Huang, C.-Y. , Liu, T.-Y. , & Liang, K.-H. (2020). Investigating seafood substitution problems and consequences in Taiwan using molecular barcoding and deep microbiome profiling. Scientific Reports, 10(1), 21997. doi:10.1038/s41598-020-79070-y.

Chin, T. C. , Adibah, A. B. , Danial Hariz, Z. A. , & Siti Azizah, M. N. (2016). Detection of mislabelled seafood products in Malaysia by DNA barcoding: Improving transparency in food market. Food Control, 64, 247–256. doi:10.1016/j.foodcont.2015.11.042.

Christiansen, H. , Fournier, N. , Hellemans, B. , & Volckaert, F. A. M. (2018). Seafood substitution and mislabeling in Brussels' restaurants and canteens. Food Control, 85, 66–75. doi:10.1016/j.foodcont.2017.09.005.

Cohen, N. J. , Deeds, J. R. , Wong, E. S. , Hanner, R. H. , Yancy, H. F. , White, K. D. , Thompson, T. M. , Wahl, I. , Pham, T. D. , Guichard, F. M. , Huh, I. , Austin, C. , Dizikes, G. , & Gerber, S. I. (2009). Public health response to puffer fish (Tetrodotoxin) poisoning from mislabeled product. Journal of Food Protection, 72(4), 810–817. doi:10.4315/0362-028x-72.4.810.

Cutarelli, A. , Galiero, G. , Capuano, F. , & Corrado, F. (2018). Species identification by means of mitochondrial cytochrome b DNA sequencing in processed anchovy, sardine and tuna products. Food and Nutrition Sciences, 9, 369–375. doi:10.4236/fns.2018.94029.

De Battisti, C. , Marciano, S. , Magnabosco, C. , Busato, S. , Arcangeli, G. , & Cattoli, G. (2014). Pyrosequencing as a tool for rapid fish species identification and commercial fraud detection. Journal of Agricultural and Food Chemistry, 62(1), 198–205. doi:10.1021/jf403545m.

Deconinck, D. , Volckaert, F. A. M. , Hostens, K. , Panicz, R. , Eljasik, P. , Faria, M. , Monteiro, C. S. , Robbens, J. , & Derycke, S. (2020). A high-quality genetic reference database for European commercial fishes reveals substitution fraud of processed Atlantic cod (Gadus morhua) and common sole (Solea solea) at different steps in the Belgian supply chain. Food and Chemical Toxicology, 141, 111417. doi:10.1016/j.fct.2020.111417.

Dettai, A. , Lautredou, A. C. , Bonillo, C. , Goimbault, E. , Busson, F. , Causse, R. , Couloux, A. , Cruaud, C. , Duhamel, G. , Denys, G. , Hautecoeur, M. , Iglesias, S. , Koubbi, P. , Lecointre, G. , Moteki, M. , Pruvost, P. , Tercerie, S. , & Ozouf, C. (2011). The actinopterygian diversity of the CEAMARC cruises: Barcoding and molecular taxonomy as a multi-level tool for new findings. Deep Sea Research Part II: Topical Studies in Oceanography, 58(1), 250–263. doi:10.1016/j.dsr2.2010.05.021.

FAO . (2022). Food and Agriculture Organization of the United Nations. The State of World Fisheries and Aquaculture (SOFIA) 2022: Towards Blue Transformation. FAO. Retrieved 9/7/2022 from https://www.fao.org/documents/card/en/c/cc0461en.

Fernandes, T. J. R. , Amaral, J. S. , & Mafra, I. (2021). DNA barcode markers applied to seafood authentication: An updated review. Critical Reviews in Food Science and Nutrition, 61(22), 3904–3935. doi:10.1080/10408398.2020.1811200.

Fields, A. T. , Abercrombie, D. L. , Eng, R. , Feldheim, K. , & Chapman, D. D. (2015). A novel mini-DNA barcoding assay to identify processed fins from internationally protected shark species. PLoS One, 10(2), e0114844. doi:10.1371/journal.pone.0114844.
Fields, A. T. , Fischer, G. A. , Shea, S. K. H. , Zhang, H. , Abercrombie, D. L. , Feldheim, K. A. , Babcock, E. A. , & Chapman, D. D. (2018). Species composition of the international shark fin trade assessed through a retail-market survey in Hong Kong. Conservation Biology, 32(2), 376–389. doi:10.1111/cobi.13043.
Folmer, O. , Black, M. , Hoeh, W. , Lutz, R. , & Vrijenhoek, R. (1994). DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Molecular Marine Biology and Biotechnology, 3(5), 294–299.
Franco, C. M. , Ambrosio, R. L. , Cepeda, A. , & Anastasio, A. (2021). Fish intended for human consumption: From DNA barcoding to a next-generation sequencing (NGS)-based approach. Current Opinion in Food Science, 42, 86–92. doi:10.1016/j.cofs.2021.05.005.
Frigerio, J. , Marchesi, C. , Magoni, C. , Saliu, F. , Ballabio, D. , Consonni, V. , Gorini, T. , De Mattia, F. , Galli, P. , & Labra, M. (2021). Application of DNA mini-barcoding and infrared spectroscopy for the authentication of the Italian product “bottarga”. LWT, 139, 110603. doi:10.1016/j.lwt.2020.110603.
Gense, K. , Peterseil, V. , Licina, A. , Wagner, M. , Cichna-Markl, M. , Dobrovolny, S. , & Hochegger, R. (2021). Development of a DNA metabarcoding method for the identification of bivalve species in seafood products. Foods, 10(11), 2618. doi:10.3390/foods10112618.
Giusti, A. , Armani, A. , & Sotelo, C. G. (2017a). Advances in the analysis of complex food matrices: Species identification in surimi-based products using next generation sequencing technologies. PLoS One, 12(10), e0185586. doi:10.1371/journal.pone.0185586.
Giusti, A. , Tinacci, L. , Sotelo, C. G. , Marchetti, M. , Guidi, A. , Zheng, W. , & Armani, A. (2017b). Seafood identification in multispecies products: Assessment of 16SrRNA, cytb, and COI universal primers’ efficiency as a preliminary analytical step for setting up metabarcoding next-generation sequencing techniques. Journal of Agricultural and Food Chemistry, 65(13), 2902–2912. doi:10.1021/acs.jafc.6b05802.
Gordoa, A. , Carreras, G. , Sanz, N. , & Viñas, J. (2017). Tuna species substitution in the Spanish commercial chain: A knock-on effect. PLoS One, 12(1), e0170809. doi:10.1371/journal.pone.0170809.
Griffiths, A. M. , Sotelo, C. G. , Mendes, R. , Pérez-Martín, R. I. , Schröder, U. , Shorten, M. , Silva, H. A. , Verrez-Bagnis, V. , & Mariani, S. (2014). Current methods for seafood authenticity testing in Europe: Is there a need for harmonisation? Food Control, 45, 95–100. doi:10.1016/j.foodcont.2014.04.020.
Guardone, L. , Tinacci, L. , Costanzo, F. , Azzarelli, D. , D'Amico, P. , Tasselli, G. , Magni, A. , Guidi, A. , Nucera, D. , & Armani, A. (2017). DNA barcoding as a tool for detecting mislabeling of fishery products imported from third countries: An official survey conducted at the Border Inspection Post of Livorno-Pisa (Italy). Food Control, 80, 204–216. doi:10.1016/j.foodcont.2017.03.056.
Günther, B. , Raupach, M. J. , & Knebelsberger, T. (2017). Full-length and mini-length DNA barcoding for the identification of seafood commercially traded in Germany. Food Control, 73, 922–929. doi:10.1016/j.foodcont.2016.10.016.
Handy, S. , Deeds, J. , Ivanova, N. , Hebert, P. , Hanner, R. , Ormos, A. , Weigt, L. , Moore, M. , & Yancy, H. (2011). A single-laboratory validated method for the generation of DNA barcodes for the identification of fish for regulatory compliance. Journal of AOAC International, 94(1), 201–210. doi:10.1093/jaoac/94.1.201.
Hanner, R. , Becker, S. , Ivanova, N. V. , & Steinke, D. (2011). FISH-BOL and seafood identification: Geographically dispersed case studies reveal systemic market substitution across Canada. Mitochondrial DNA, 22(sup1), 106–122. doi:10.3109/19401736.2011.588217.
Haye, P. A. , Segovia, N. I. , Vera, R. , Gallardo, M. D. L. Á. , & Gallardo-Escárate, C. (2012). Authentication of commercialized crab-meat in Chile using DNA barcoding. Food Control, 25(1), 239–244. doi:10.1016/j.foodcont.2011.10.034.
Hebert, P. D. , Cywinska, A. , Ball, S. L. , & deWaard, J. R. (2003). Biological identifications through DNA barcodes. Proceedings of the Royal Society: Biological Science, 270(1512), 313–321. doi:10.1098/rspb.2002.2218.
Helgoe, J. , Oswald, K. J. , & Quattro, J. M. (2020). A comprehensive analysis of the mislabeling of Atlantic cod (Gadus morhua) products in Spain. Fisheries Research, 222, 105400. doi:10.1016/j.fishres.2019.105400.
Hellberg, R. S. , DeWitt, C. A. M. , & Morrissey, M. T. (2012). Risk-benefit analysis of seafood consumption: A review. Comprehensive Reviews in Food Science and Food Safety, 11(5), 490–517. doi:10.1111/j.1541-4337.2012.00200.x.
Hellberg, R. S. , Isaacs, R. B. , & Hernandez, E. L. (2019). Identification of shark species in commercial products using DNA barcoding. Fisheries Research, 210, 81–88. doi:10.1016/j.fishres.2018.10.010.
Hellberg, R. S. , Pollack, S. J. , & Hanner, R. H. (2016). Seafood species identification using DNA sequencing. In R. Hanner & A. Naaum (Eds.), Seafood Authenticity and Traceability (pp. 113–132). Academic Press.
Ho, J. K. I. , Puniamoorthy, J. , Srivathsan, A. , & Meier, R. (2020). MinION sequencing of seafood in Singapore reveals creatively labelled flatfishes, confused roe, pig DNA in squid balls, and phantom crustaceans. Food Control, 112, 107144. doi:10.1016/j.foodcont.2020.107144.
Hobbs, C. A. D. , Potts, R. W. A. , Bjerregaard Walsh, M. , Usher, J. , & Griffiths, A. M. (2019). Using DNA barcoding to investigate patterns of species utilisation in UK shark products reveals threatened species on sale. Scientific Reports, 9(1), 1028. doi:10.1038/s41598-018-38270-3.

Horreo, J. L. , Ardura, A. , Pola, I. G. , Martinez, J. L. , & Garcia-Vazquez, E. (2013). Universal primers for species authentication of animal foodstuff in a single polymerase chain reaction. Journal of the Science of Food and Agriculture, 93(2), 354–361. doi:10.1002/jsfa.5766.
Horreo, J. L. , Fitze, P. S. , Jiménez-Valverde, A. , Noriega, J. A. , & Pelaez, M. L. (2019). Amplification of 16S rDNA reveals important fish mislabeling in Madrid restaurants. Food Control, 96, 146–150. doi:10.1016/j.foodcont.2018.09.020.
Hossain, M. A. M. , Uddin, S. M. K. , Chowdhury, Z. Z. , Sultana, S. , Johan, M. R. , Rohman, A. , Erwanto, Y. , & Ali, M. E. (2019). Universal mitochondrial 16s rRNA biomarker for mini-barcode to identify fish species in Malaysian fish products. Food Additives & Contaminants: Part A, 36(4), 493–506. doi:10.1080/19440049.2019.1580389.
Hu, Y. , Huang, S. Y. , Hanner, R. , Levin, J. , & Lu, X. (2018). Study of fish products in Metro Vancouver using DNA barcoding methods reveals fraudulent labeling. Food Control, 94, 38–47. doi:10.1016/j.foodcont.2018.06.023.
Hu, Y. , Yuan, C. , Yu, K. , Qu, Y. , Chen, S. , Wang, X. , & Kimura, I. (2014). An online survey study of consumer preferences on aquatic products in China: Current seafood consumption patterns and trends. Fisheries and Aquaculture Journal, 5(2), 1000094. doi:10.4172/2150-3508.1000094.
Huxley-Jones, E. , Shaw, J. L. A. , Fletcher, C. , Parnell, J. , & Watts, P. C. (2012). Use of DNA barcoding to reveal species composition of convenience seafood. Conservation Biology, 26(2), 367–371. doi:10.1111/j.1523-1739.2011.01813.x.
Isaacs, R. B. , & Hellberg, R. S. (2020). Authentication of red snapper (Lutjanus campechanus) fillets using a combination of real-time PCR and DNA barcoding. Food Control, 118, 107375. doi:10.1016/j.foodcont.2020.107375.
Ivanova, N. V. , Zemlak, T. S. , Hanner, R. H. , & Hebert, P. D. N. (2007). Universal primer cocktails for fish DNA barcoding. Molecular Ecology Notes, 7(4), 544–548. doi:10.1111/j.1471-8286.2007.01748.x.
Jacobs, S. , Sioen, I. , Pieniak, Z. , De Henauw, S. , Maulvault, A. L. , Reuver, M. , Fait, G. , Cano-Sancho, G. , & Verbeke, W. (2015). Consumers' health risk-benefit perception of seafood and attitude toward the marine environment: Insights from five European countries. Environmental Research, 143, 11–19. doi:10.1016/j.envres.2015.02.029.
Jérôme, M. , Lemaire, C. , Verrez-Bagnis, V. , & Etienne, M. (2003). Direct sequencing method for species identification of canned sardine and sardine-type products. Journal of Agricultural and Food Chemistry, 51(25), 7326–7332. doi:10.1021/jf034652t.
Kappel, K. , Haase, I. , Käppel, C. , Sotelo, C. G. , & Schröder, U. (2017). Species identification in mixed tuna samples with next-generation sequencing targeting two short cytochrome b gene fragments. Food Chemistry, 234, 212–219. doi:10.1016/j.foodchem.2017.04.178.
Kappel, K. , & Schröder, U. (2016). Substitution of high-priced fish with low-priced species: Adulteration of common sole in German restaurants. Food Control, 59, 478–486. doi:10.1016/j.foodcont.2015.06.024.
Kitch, C. J. , Tabb, A. M. , Marquis, G. E. , & Hellberg, R. S. (2023). Species substitution and mislabeling of ceviche, poke, and sushi dishes sold in Orange County, California. Food Control, 146, 109525. doi:10.1016/j.foodcont.2022.109525.
Labrador, K. , Agmata, A. , Palermo, J. D. , Follante, J. , & Pante, M. J. (2019). Authentication of processed Philippine sardine products using HotSHOT DNA extraction and minibarcode amplification. Food Control, 98, 150–155. doi:10.1016/j.foodcont.2018.11.027.
Leray, M. , Yang, J.Y. , Meyer, C.P. , Mills, S.C. , Agudelo, N. , Ranwez, V. , Boehm, J.T. , & Machida, R.J. (2013). A new versatile primer set targeting a short fragment of the mitochondrial COI region for metabarcoding metazoan diversity: application for characterizing coral reef fish gut contents. Frontiers in Zoology, 10, 34. doi:10.1186/1742-9994-10-34.
Liou, P. , Banda, A. , Isaacs, R. B. , & Hellberg, R. S. (2020). Labeling compliance and species authentication of fish fillets sold at grocery stores in Southern California. Food Control, 112, 107137. doi:10.1016/j.foodcont.2020.107137.
Love, D. C. , Asche, F. , Conrad, Z. , Young, R. , Harding, J. , Nussbaumer, E. M. , Thorne-Lyman, A. L. , & Neff, R. (2020). Food sources and expenditures for seafood in the United States. Nutrients, 12(6), 1810. doi:10.3390/nu12061810.
Lowenstein, J. H. , Amato, G. , & Kolokotronis, S.-O. (2009). The real maccoyii: Identifying tuna sushi with DNA barcodes - Contrasting characteristic attributes and genetic distances. PLoS One, 4(11), e7866. doi:10.1371/journal.pone.0007866.
Mariani, S. , Ellis, J. , O'Reilly, A. , Bréchon, A. L. , Sacchi, C. , & Miller, D. D. (2014). Mass media influence and the regulation of illegal practices in the seafood market. Conservation Letters, 7(5), 478–483. doi:10.1111/conl.12085.
Mariani, S. , Griffiths, A. M. , Velasco, A. , Kappel, K. , Jérôme, M. , Perez-Martin, R. I. , Schröder, U. , Verrez-Bagnis, V. , Silva, H. , Vandamme, S. G. , Boufana, B. , Mendes, R. , Shorten, M. , Smith, C. , Hankard, E. , Hook, S. A. , Weymer, A. S. , Gunning, D. , & Sotelo, C. G. (2015). Low mislabeling rates indicate marked improvements in European seafood market operations. Frontiers in Ecology and the Environment, 13(10), 536–540. doi:10.1890/150119.

Marín, A. , Serna, J. , Robles, C. , Ramírez, B. , Reyes-Flores, L. E. , Zelada-Mázmela, E. , Sotil, G. , & Alfaro, R. (2018). A glimpse into the genetic diversity of the Peruvian seafood sector: Unveiling species substitution, mislabeling and trade of threatened species. PLoS One, 13(11), e0206596. doi:10.1371/journal.pone.0206596.

Meusnier, I. , Singer, G. A. C. , Landry, J.-F. , Hickey, D. A. , Hebert, P. D. N. , & Hajibabaei, M. (2008). A universal DNA mini-barcode for biodiversity analysis. BMC Genomics, 9(1), 214. doi:10.1186/1471-2164-9-214.

Milan, M. , Maroso, F. , Dalla Rovere, G. , Carraro, L. , Ferraresso, S. , Patarnello, T. , Bargelloni, L. , Cardazzo, B. , & Fariselli, P. (2019). Tracing seafood at high spatial resolution using NGS-generated data and machine learning: Comparing microbiome versus SNPs. Food Chemistry, 286, 413–420. doi:10.1016/j.foodchem.2019.02.037.

Miller, D. D. , & Mariani, S. (2010). Smoke, mirrors, and mislabeled cod: Poor transparency in the European seafood industry. Frontiers in Ecology and the Environment, 8(10), 517–521. doi:10.1890/090212.

Minoudi, S. , Karaiskou, N. , Avgeris, M. , Gkagkavouzis, K. , Tarantili, P. , Triantafyllidou, D. , Palilis, L. , Avramopoulou, V. , Tsikliras, A. , Barmperis, K. , & Triantafyllidis, A. (2020). Seafood mislabeling in Greek market using DNA barcoding. Food Control, 113, 107213. doi:10.1016/j.foodcont.2020.107213.

Mitchell, J. K. , & Hellberg, R. S. (2016). Use of the mitochondrial control region as a potential DNA mini-barcoding target for the identification of canned tuna species. Food Analytical Methods, 9(10), 2711–2720. doi:10.1007/s12161-016-0460-3.

Muñoz-Colmenero, M. , Juanes, F. , Dopico, E. , Martinez, J. L. , & Garcia-Vazquez, E. (2017). Economy matters: A study of mislabeling in salmon products from two regions, Alaska and Canada (Northwest of America) and Asturias (Northwest of Spain). Fisheries Research, 195, 180–185. doi:10.1016/j.fishres.2017.07.012.

Muttaqin, E. , Abdullah, A. , Nurilmala, M. , Ichsan, M. , Simeone, B. M. , Yulianto, I. , & Booth, H. (2019). DNA-barcoding as molecular marker for seafood forensics: Species identification of locally consumed shark fish products in the world’s largest shark fishery. IOP Conference Series: Earth and Environmental Science, 278(1), 012049. doi:10.1088/1755-1315/278/1/012049.

Nicolè, S. , Negrisolo, E. , Eccher, G. , Mantovani, R. , Patarnello, T. , Erickson, D. L. , Kress, J. W. , & Barcaccia, G. (2012). DNA barcoding as a reliable method for the authentication of commercial seafood products. Food Technology and Biotechnology, 50(4), 387–398. doi:hrcak.srce.hr/94367.

Palumbi, S. R. (1996). Nucleic acids II: The polymerase chain reaction. Molecular Systematics, 2(1), 205–247.

Palumbi, S. R. , Martin, A. , Romano, S. , McMillan, W. O. , Stice, L. , & Grabowski, G. (1991). The simple fool’s guide to PCR, version 2.0, privately published document compiled by S. Palumbi. Dept. Zoology, Univ, Hawaii, Honolulu, HI.

Pardo, M. Á. , & Jiménez, E. (2020). DNA barcoding revealing seafood mislabeling in food services from Spain. Journal of Food Composition and Analysis, 91, 103521. doi:10.1016/j.jfca.2020.103521.

Pardo, M. Á. , Jiménez, E. , Viðarsson, J. R. , Ólafsson, K. , Ólafsdóttir, G. , Daníelsdóttir, A. K. , & Pérez-Villareal, B. (2018). DNA barcoding revealing mislabeling of seafood in European mass caterings. Food Control, 92, 7–16. doi:10.1016/j.foodcont.2018.04.044.

Park, J. Y. , Lee, S. Y. , An, C. M. , Kang, J.-H. , Kim, J.-H. , Chai, J. C. , Chen, J. , Kang, J. S. , Ahn, J. J. , Lee, Y. S. , & Hwang, S. Y. (2012). Comparative study between next generation sequencing technique and identification of microarray for species identification within blended food products. BioChip Journal, 6(4), 354–361. doi:10.1007/s13206-012-6407-x.

Peterson, A. M. , Mcbride, G. E. , Jhita, S. K. , & Hellberg, R. S. (2021). An investigation into country of origin labeling, species authentication and short weighting of commercially sold frozen fish fillets. Heliyon, 7(4), e06713. doi:10.1016/j.heliyon.2021.e06713.

Piredda, R. , Mottola, A. , Cipriano, G. , Carlucci, R. , Ciccarese, G. , & Di Pinto, A. (2022). Next generation sequencing (NGS) approach applied to species identification in mixed processed seafood products. Food Control, 133, 108590. doi:10.1016/j.foodcont.2021.108590.

Pollack, S. J. , Kawalek, M. D. , Williams-Hill, D. M. , & Hellberg, R. S. (2018). Evaluation of DNA barcoding methodologies for the identification of fish species in cooked products. Food Control, 84, 297–304. doi:10.1016/j.foodcont.2017.08.013.

Rey, J. T. S. , Pereda, J. M. R. , Ventolero, M. F. H. , Pol, R. T. A. , Mangonon, V. C. B. , Poniente, J. A. , & Santos, M. D. (2023). DNA barcoding seafood products for export from the Philippines. Regional Studies in Marine Science, 58, 102765. doi:10.1016/j.rsma.2022.102765.

Roungchun, J. B. , Tabb, A. M. , & Hellberg, R. S. (2022). Identification of tuna species in raw and processed products using DNA mini-barcoding of the mitochondrial control region. Food Control, 134, 108752. doi:10.1016/j.foodcont.2021.108752.

Santaclara, F. J. , Espiñeira, M. , & Vieites, J. M. (2007). Genetic identification of squids (families Ommastrephidae and Loliginidae) by PCR-RFLP and FINS methodologies. Journal of Agricultural and Food Chemistry, 55(24), 9913–9920. doi:10.1021/jf0707177.

Shokralla, S. , Hellberg, R. S. , Handy, S. M. , King, I. , & Hajibabaei, M. (2015). A DNA mini-barcoding system for authentication of processed fish products. Scientific Reports, 5(1), 15894. doi:10.1038/srep15894.

Silva, A. J. , & Hellberg, R. S. (2021). DNA-based techniques for seafood species authentication. In F. Toldra (Ed.), Advances in Food and Nutrition Research (Vol. 95, pp. 207–255). Academic Press/Elsevier. doi:10.1016/bs.afnr.2020.09.001.

Silva, A. J. , Hellberg, R. S. , & Hanner, R. H. (2021). Seafood fraud. In R. S. Hellberg , K. Everstine , & S. A. Sklare (Eds.), Food Fraud: A Global Threat with Public Health and Economic Consequences (pp. 109–137). Academic Press/Elsevier.
Silva, A. J. , Kawalek, M. , Williams-Hill, D. M. , & Hellberg, R. S. (2020). PCR cloning combined with DNA barcoding enables partial identification of fish species in a mixed-species product. Frontiers in Ecology and Evolution, 8. doi:10.3389/fevo.2020.00028.
Sotelo, C. G. , Velasco, A. , Perez-Martin, R. I. , Kappel, K. , Schröder, U. , Verrez-Bagnis, V. , Jérôme, M. , Mendes, R. , Silva, H. , Mariani, S. , & Griffiths, A. (2018). Tuna labels matter in Europe: Mislabelling rates in different tuna products. PLoS One, 13(5), e0196641. doi:10.1371/journal.pone.0196641.
Sultana, S. , Ali, M. E. , Hossain, M. A. M. , Asing , Naquiah, N. , & Zaidul, I. S. M. (2018). Universal mini COI barcode for the identification of fish species in processed products. Food Research International, 105, 19–28. doi:10.1016/j.foodres.2017.10.065.
Tang, Q. , Luo, Q. , Duan, Q. , Deng, L. , & Zhang, R. (2022). DNA barcode identification of fish products from Guiyang markets in southwestern People’s Republic of China. Journal of Food Protection, 85(4), 583–590. doi:10.4315/jfp-21-258.
Tinacci, L. , Guardone, L. , Castro-Palomino Rubio, J. , Riina, M. V. , Stratev, D. , Guidi, A. , & Armani, A. (2019). Labelling compliance and species identification of herring products sold at large scale retail level within the Italian market. Food Control, 106, 106707. doi:10.1016/j.foodcont.2019.106707.
Tinacci, L. , Stratev, D. , Vashin, I. , Chiavaccini, I. , Susini, F. , Guidi, A. , & Armani, A. (2018). Seafood labelling compliance with European legislation and species identification by DNA barcoding: A first survey on the Bulgarian market. Food Control, 90, 180–188. doi:10.1016/j.foodcont.2018.03.007.
Varunjikar, M. S. , Moreno-Ibarguen, C. , Andrade-Martinez, J. S. , Tung, H.-S. , Belghit, I. , Palmblad, M. , Olsvik, P. A. , Reyes, A. , Rasinger, J. D. , & Lie, K. K. (2022). Comparing novel shotgun DNA sequencing and state-of-the-art proteomics approaches for authentication of fish species in mixed samples. Food Control, 131, 108417. doi:10.1016/j.foodcont.2021.108417.
Velasco, A. , Aldrey, A. , Pérez-Martín, R. I. , & Sotelo, C. G. (2016). Assessment of the labelling accuracy of Spanish semipreserved anchovies products by FINS (forensically informative nucleotide sequencing). Heliyon, 2(6), e00124. doi:10.1016/j.heliyon.2016.e00124.
Viñas, J. , & Tudela, S. (2009). A validated methodology for genetic identification of tuna species (genus Thunnus). PLoS One, 4(10), 1–10. doi:10.1371/journal.pone.0007606.
Voorhuijzen-Harink, M. M. , Hagelaar, R. , van Dijk, J. P. , Prins, T. W. , Kok, E. J. , & Staats, M. (2019). Toward on-site food authentication using nanopore sequencing. Food Chemistry X, 2, 100035. doi:10.1016/j.fochx.2019.100035.
Wainwright, B.J. , Ip, Y.C.A. , Neo, M.L. , Chang, J.J.M. , Gan, C.Z. , Clark-Shen, N. , Huang, D. , & Rao, M. (2018). DNA barcoding of traded shark fins, meat and mobulid gill plates in Singapore uncovers numerous threatened species. Conservation Genetics, 19, 1393–1399. doi:10.1007/s10592-018-1108-1.
Wang, N. , Xing, R.-R. , Zhou, M.-Y. , Sun, R.-X. , Han, J.-X. , Zhang, J.-K. , Zheng, W.-J. , & Chen, Y. (2021). Application of DNA barcoding and metabarcoding for species identification in salmon products. Food Additives & Contaminants: Part A, 38(5), 754–768. doi:10.1080/19440049.2020.1869324.
Ward, R. D. , Hanner, R. , & Hebert, P. D. N. (2009). The campaign to DNA barcode all fishes, FISH-BOL. Journal of Fish Biology, 74(2), 329–356. doi:10.1111/j1095-8649.2008.02080.x.
Warner, K. , Timme, W. , Lowell, B. , & Hirshfield, M. (2012). Widespread Seafood Fraud Found in Los Angeles. Retrieved 9/7/2022 from https://oceana.org/reports/widespread-seafood-fraud-found-los-angeles/.
Warner, K. , Timme, W. , Lowell, B. , & Hirshfield, M. (2013). Oceana Study Reveals Seafood Fraud Nationwide. Retrieved 9/7/2022 from https://oceana.org/reports/oceana-study-reveals-seafood-fraud-nationwide/.
Wen, J. , Tinacci, L. , Acutis, P. L. , Riina, M. V. , Xu, Y. , Zeng, L. , Ying, X. , Chen, Z. , Guardone, L. , Chen, D. , Sun, Y. , Zhao, J. , Guidi, A. , & Armani, A. (2017). An insight into the Chinese traditional seafood market: Species characterization of cephalopod products by DNA barcoding and phylogenetic analysis using COI and 16SrRNA genes. Food Control, 82, 333–342. doi:10.1016/j.foodcont.2017.07.011.
Wong, E. H. K. , & Hanner, R. H. (2008). DNA barcoding detects market substitution in North American seafood. Food Research International, 41(8), 828–837. doi:10.1016/j.foodres.2008.07.005.
Xing, B. , Zhang, Z. , Sun, R. , Wang, Y. , Lin, M. , & Wang, C. (2020a). Mini-DNA barcoding for the identification of commercial fish sold in the markets along the Taiwan Strait. Food Control, 112, 107143. doi:10.1016/j.foodcont.2020.107143.
Xing, R.-R. , Hu, R.-R. , Han, J.-X. , Deng, T.-T. , & Chen, Y. (2020b). DNA barcoding and mini-barcoding in authenticating processed animal-derived food: A case study involving the Chinese market. Food Chemistry, 309, 125653. doi:10.1016/j.foodchem.2019.125653.
Xing, R.-R. , Hu, R.-R. , Wang, N. , Zhang, J.-K. , Ge, Y.-Q. , & Chen, Y. (2021). Authentication of sea cucumber products using NGS-based DNA mini-barcoding. Food Control, 129, 108199. doi:10.1016/j.foodcont.2021.108199.
Xiong, X. , Guardone, L. , Giusti, A. , Castigliego, L. , Gianfaldoni, D. , Guidi, A. , & Andrea, A. (2016). DNA barcoding reveals chaotic labeling and misrepresentation of cod (, Xue) products sold on the Chinese market. Food Control, 60, 519–532. doi:10.1016/j.foodcont.2015.08.028.

Xiong, X. , Yao, L. , Ying, X. , Lu, L. , Guardone, L. , Armani, A. , Guidi, A. , & Xiong, X. (2018). Multiple fish species identified from China's roasted Xue Yu fillet products using DNA and mini-DNA barcoding: Implications on human health and marine sustainability. Food Control, 88, 123–130. doi:10.1016/j.foodcont.2017.12.035.
Xiong, X. , Yuan, F. , Huang, M. , Lu, L. , Xiong, X. , & Wen, J. (2019). DNA barcoding revealed mislabeling and potential health concerns with roasted fish products sold across China. Journal of Food Protection, 82(7), 1200–1209. doi:10.4315/0362-028x.Jfp-18-514.
Zahn, R. J. , Silva, A. J. , & Hellberg, R. S. (2020). Development of a DNA mini-barcoding protocol targeting COI for the identification of elasmobranch species in shark cartilage pills. Food Control, 109, 106918. doi:10.1016/j.foodcont.2019.106918.
Zhang, X. , Armani, A. , Wen, J. , Giusti, A. , Zhao, J. , & Li, X. (2021). DNA barcoding for the identification of shark lips (): A nationwide survey for analyzing a never investigated product in the Chinese market. Food Control, 126, 108075. doi:10.1016/j.foodcont.2021.108075.

Differentiation between Fresh and Frozen–Thawed Fish

Code of practice for fish and fishery products . 2009. First edition, World Health Organization & Food and Agricultural Organization of the United Nations, Rome, 2009. https://www.fao.org/3/a1553e/a1553e00.pdf.
Rehbein H. 1992. Physical and biochemical methods for the differentiation between fresh and frozen–thawed fish or fillets. Ital J Food Sci. 2: 75–86.
Uddin M , Okazaki E. 2004. Classification of fresh and frozen–thawed fish by near-infrared spectroscopy. J Food Sci. 69: C665–C668.
Duflos G , Le Fur B , Mulak V , Becel P , Malle P. 2002. Comparison of methods of differentiating between fresh and frozen–thawed fish or fillets. J Sci Food Agric. 82: 1341–1345.
Bozzetta E , Pezzolato M , Cencetti E , Varello K , Abramo F , Mutinelli F , Ingravalle F , Teneggi E. 2012. Histology as a valid and reliable tool to differentiate fresh from frozen–thawed fish. J Food Prot. 75: 1536–1541.
Meistro S , Pezzolato M , Muscolino D , Giarratana F , Baioni E , Panebianco A , Bozzetta E. 2016. Histology as a valid tool to diferentiate fresh from frozen–thawed marinated fish. J Food Prot. 79: 1457–1459.
Chiesa LM , Pavlovic R , Nobile M , Di Cesare F , Malandra R , Pessina D , Panseri S. 2020. Discrimination between fresh and frozen–thawed fish involved in food safety and fraud protection. Foods. 9(12): 1896.
Tinacci L , Armani A , Guidi A , Nucera D , Shvartzman D , Miragliotta V , Coli A , Giannessi E , Stornelli MR , Fronte B. 2018. Histological discrimination of fresh and frozen/thawed fish meat: European hake (Merluccius merluccius) as a possible model for white meat fish species. Food Control. 92: 154–161.
Orlova D , Kalyuzhnaya T , Tokarev A , Kuznetsov Y. 2020. New method for veterinary and sanitary control of defrosted meat and fish. Int J Vet Sci. 9: 317–319.
Watanabe M , Suzuki T , Ichimaida K , Hattori T , Ueda R. 2020. Do consumers actually sense that sashimi made from frozen–thawed fish tastes worse than non-frozen one? Int J Refrig. 111: 94–102.
Kimiya T , Sivertsen AH , Heia K. 2013. VIS/NIR spectroscopy for non-destructive freshness assessment of Atlantic salmon (Salmo salar L.) fillets. J Food Eng. 116: 758–764.
Reis MM , Martínez E , Saitua E , Rodríguez R , Perez I , Olabarrieta I. 2017. Non-invasive diferentiation between fresh and frozen/thawed tuna fillets using near infrared spectroscopy (Vis-NIRS). LWT. 78: 129–137.
Leduc F , Krzewinski F , Le Fur B , N'Guessan A , Malle P , Kol O , Duflos G. 2012. Diferentiation of fresh and frozen/thawed fish, European sea bass (Dicentrarchus labrax), gilthead seabream (Sparus aurata), cod (Gadus morhua) and salmon (Salmo salar), using volatile compounds by SPME/GC/MS. J Sci Food Agric. 92: 2560–2568.
Iglesias J , Medina I , Bianchi F , Careri M , Mangia A , Musci M. 2009. Study of the volatile compounds useful for the characterisation of fresh and frozen–thawed cultured gilthead sea bream fish by solid-phase microextraction gas chromatography-mass spectrometry. Food Chem. 115: 1473–1478.
Shumilina E , Møller IA , Dikiy A. 2020. Differentiation of fresh and thawed Atlantic salmon using NMR metabolomics. Food Chem. 314: 126227.
Pezzolato M , Baioni E , Maurella C , Varello K , Meistro S , Balsano A , Bozzetta E. 2020. Distinguishing between fresh and frozen–thawed smoked salmon: histology to detect food adulteration in high-value products. J Food Prot. 83: 52–53.
Duflos G , Le Fur B , Mulak V , Becel P , Malle P. 2002. Comparison of methods of diferentiating between fresh and frozen–thawed fish or fillets. J Sci Food Agric. 82: 1341–1345.
Popelka P , Nagy J , Pipová M , Marcinčák S , Lenhardt L '. 2014. Comparison of chemical, microbiological and histological changes in fresh, frozen and double frozen rainbow trout (Oncorhynchus mykiss). Acta Vet Brno. 83: 157–161.
Marlard S , Doyen P , Grard T. 2019. Rapid multiparameters approach to diferentiate fresh skinless sea bass (Dicentrarchus labrax) fillets from frozen–thawed ones. J Aquat Food Prod Technol. 28: 253–262.
Yoshioka K , Kitamikado M. 1983. Differentiation of freeze-thawed fish from fresh fish by the examination of medulla of crystalline lens. Bull Jpn Soc Sci Fish. 49: 151–155.

Okazaki E , Yamashita Y , Uddin M. 2006. Classification of fresh and frozen–thawed fish-a review. Refrigeration. 81: 175–181.
Sakaguchi M , Murata M , Kim JB . 1989. The effects of repeated freeze-thaw cycle on torrymeter readings of carp fillets. Nippon Suisan Gakkaishi. 55: 1665–1669
Uddin M. 2003. Unpublished data. National Research Institute of Fisheries Science (NRIFS). Yokohama, Japan.
Yoshioka K , Kitamikado M. 1988. Differentiation of freeze-thawed fish fillet from fresh fish fillet by examination of erythrocyte. Nippon Suisan Gakkaishi. 54: 1221–1225.
Rehbein H. 1979. Development of an enzymatic method to differentiate fresh and sea-frozen and thawed fish fillets. Z Lebensm Unters-Forsch. 169: 263–265.
Karvinen VP , Bamford DH , Granroth B. 1982. Changes in muscle subcellular fraction of Baltic herring (Clupea harengus membras). J Sci Food Agric. 33: 763–772.
Yoshioka K. 1983. Differentiation of freeze-thawed fish from fresh fish by the determination of hematocrit value. Bull Jpn Soc Sci Fish. 49: 149–151.
Uddin M , Okazaki E. 2004. Classification of fresh and frozen–thawed fish by near-infrared spectroscopy. J Food Sci. 69: C665–C668.
Yuan CS , Yoshioka K , Ueno R. 1988. Differentiation of frozen–thawed fish from unfrozen fish by determination of neutral β-N-acetylglucosaminidase activity in the blood. Bull Jpn Soc Sci Fish. 54: 2143–2148.
Rehbein H , Kress G , Schreiber W. 1978. An enzymic method for differentiating thawed and fresh fish fillets. J Sci Food Agric. 29: 1076–1082.
Vincenzo S , Francesco F , Giovanna P. 1985. A micromethod for the differentiation of fresh from frozen fish muscle. J Sci Food Agric. 39: 811–814.
Gottesmann P , Hamm R. 1983. New biochemical methods of differentiating between fresh meat and thawed, frozen meat. Fleischwirtschaft. 63: 219–220.
Hoz L , Yustes C , Camara JM , Ramos MA , Garcia de Fernando GD . 1992. β-Hydroxyacyl-CoA-dehydrogenase (HADH) differentiates unfrozen from frozen–thawed crawfish (Procambarus clarkii) and trout (Salmo gairdneri) meat. Int J Food Sci Technol. 27: 133–136.
Fernandez M , Mano S , Garcia de Fernando GD , Ordonez JA , Hoz L. 1999. Use of β-hydroxyacyl-CoA-dehydrogenase (HADH) activity to differentiate frozen from unfrozen fish and shellfish. Eur Food Res Technol. 209: 205–208.
Gould E , Medler MJ . 1970. Fish and other marine products-test to determine whether shucked oyster have been frozen and thawed. J Assoc Anal Chem. 53: 1237–1241.
Chhatbar SK , Velankar NK . 1977. A biochemical test for the distinction of fresh fish from frozen and thawed fish. Fish Technnol. 14: 131–133.
Salfi V , Fucetola F , Pannunzio G. 1985. A micromethod for the differentiation of fresh from frozen fish muscle. J Sci Food Agric. 36: 811.
Damodaran ND , Gopakumar K. 1990. Effect of freezing and thawing on press juices enzyme activity in the muscle of farmed fish and shellfish. Sci Tech Froid (France). 3: 229–233.
Barbagli C , Crescenzy GS . 1982. Influence of freezing and thawing on the release of cytochrome oxidase from chicken’s liver and from beef and trout muscle. J Food Sci. 46: 491–496.
Frigerio R , Ardemagni A , Cantoni C. 1980. Variazoni quantitative della succino-deidrogenasi durante la lavorazione di molluschi. Arch Vet Ital. 31: 162–166.
Salfi V , Fucetola F , Verticelli V , Arata P. 1986. Optimized procedures of biochemical analysis for the differentiation between fresh and frozen thawed fish products. Test of mitochondrial malate dehydrogenase. Ind Alim. 25: 634.
Kitamikado M , Yuan CS , Ueno R. 1990. An enzymatic method designed to differentiate between fresh and frozen–thawed fish. J Food Sci. 55: 74–76.
Nilsson K , Ekstrand B. 1993. The effect of storage on ice and various freezing treatments on enzyme leakage in muscle tissue of rainbow trout. Z Lebensm Untersuch Forsch. 197: 3–7
Foucat L , Taylor RG , Labas R , Renou JP . 2001. Characterization of frozen fish by NMR imaging and histology. Am Lab. 33: 38–43.
Karoui R , Thomas E , Dufour E. 2006. Utilisation of a rapid technique based on front-face fluorescence spectroscopy for differentiating between fresh and frozen–thawed fish fillets. Food Res Inter. 39: 349–355.
Uddin M , Kimiya T , Okazaki E. 2008. Near infrared spectroscopy-a rapid and non-destructive technology in seafood analysis. 5th World Fisheries Congress, Key Note Paper No. 4D1 (7). Yokohama, Japan.
Rehbein H , Cakli S. 2000. The lysosomal enzyme activities of fresh, cooled, frozen and smoked salmon fish (Onchorhyncus keta and Salmo salar). Turkish J Vet Animal Sci. 24: 103–108.
Lin M , Mousavi M , Al-Holy M , Cavinato AG , Rasco BA . 2006. Rapid near infrared spectroscopic method for the detection of spoilage in rainbow trout (Oncorhynchus mykiss) fillet. J Food Sci. 71: S18–S23.
Uddin M , Ishizaki S , Okazaki E , Tanaka M. 2002. Near-infrared reflectance spectroscopy for determining end-point temperature of heated fish and shellfish meats. J Sci Food Agric. 82: 286–292.
Uddin M , Okazaki E , Ahmed MU , Fukuda Y , Tanaka M. 2006. NIR spectroscopy: a nondestructive fast technique to verify heat treatment of fish-meat gel. Food Control. 17: 660–664.

Uddin M , Okazaki E , Fukushima H , Turza S , Yumiko Y , Fukuda Y. 2006. Nondestructive determination of water and protein in surimi by near-infrared spectroscopy. Food Chem. 69: 491–495.
Uddin M , Turza S , Okazaki E. 2007. Rapid determination of intact sardine fat by NIRS using surface interactance fibre probe. Int J Food Engine. 3(6): Art. 12.
Uddin M , Okazaki E , Turza S , Yumiko Y , Fukuda Y , Tanaka M. 2005. Non-destructive visible/NIR spectroscopy for differentiation of fresh and frozen–thawed fish. J Food Sci. 70: C506–C510.
Wold S. 1976. Pattern recognition by means of disjoint principal components models. Pattern Recognit. 8: 127–139.
McLachlan GJ . 1992. Discrimimant Analysis and Statistical Pattern Recognition. Chichester, UK: John Wiley & Sons.
Uddin M , Okazaki E , Fukuda Y. 2005. Classification of fresh and frozen–thawed fish by dry extract spectroscopy by infrared reflection. NIR News. 16: 4–7.
Dufour É , Frencia JP , Kane E. 2003. Development of a rapid method based on front-face fluorescence spectroscopy for the monitoring of fish freshness. Food Res Int. 36: 415–423.
Rahman MM , Shibata M , ElMasry G , Nakazawa N , Nakauchi S , Hagiwara T , Osako K , Okazaki E. 2019. Expeditious prediction of post-mortem changes in frozen fish meat using three-dimensional fluorescence fingerprints. Biosci Biotechnol Biochem. 83: 1–13.
Shibata M , ElMasry G , Moriya K , Rahman MM , Miyamoto Y , Ito K , Nakazawa N , Nakauchi S , Okazaki E. 2018. Smart technique for accurate monitoring of ATP content in frozen fish fillets using fluorescence fingerprint. LWT. 92: 258–264.
Hassoun A , Karoui R. 2015. Front-face fluorescence spectroscopy coupled with chemometric tools for monitoring fish freshness stored under diferent refrigerated conditions. Food Control. 54: 240–249.
Liao Q , Suzuki T , Shirataki Y , Kuramoto M , Kondo N. 2018. Freshness related fluorescent compound changes in Japanese dace fish (Tribolodon hakonensis) eye fluid during storage. Eng Agric Environ Food. 11: 95–100.
Omwange KA , Al Riza DF , Sen N , Shiigi T , Kuramoto M , Ogawa Y , Kondo N , Suzuki T. 2020. Fish freshness monitoring using UV-fluorescence imaging on Japanese dace (Tribolodon hakonensis) fisheye. J Food Eng. 287: 110111.
Rahman A , Kondo N , Ogawa Y , Suzuki T , Shirataki Y , Wakita Y. 2016. Classification of fresh and spoiled Japanese dace (Tribolodon hakonensis) fish using ultraviolet-visible spectra of eye fluid with multivariate analysis. Eng Agric Environ Food. 9: 64–69.
Washburn KE , Stormo SK , Skjelvareid MH , Heia K. 2017. Non-invasive assessment of packaged cod freeze-thaw history by hyperspectral imaging. J Food Eng. 205: 64–73.
Sivertsen AH , Kimiya T , Heia K. 2011. Automatic freshness assessment of cod (Gadus morhua) fillets by Vis/Nir spectroscopy. J Food Eng. 103: 317–323.
Fasolato L , Balzan S , Riovanto R , Berzaghi P , Mirisola M , Ferlito JC , Serva L , Benozzo F , Passera R , Tepedino V , Novelli, E. 2012. Comparison of visible and near-infrared reflectance spectroscopy to authenticate fresh and frozen–thawed swordfish (Xiphias gladius L). J Aquat Food Prod Technol. 21: 493–507.
Cheng J-H , Sun D-W , Pu H-B , Chen X , Liu Y , Zhang H , Li J-L. 2015. Integration of classifiers analysis and hyperspectral imaging for rapid discrimination of fresh from cold-stored and frozen–thawed fish fillets. J Food Eng. 161: 33–39.
Ottavian M , Fasolato L , Facco P , Barolo M. 2013. Foodstuff authentication from spectral data: toward a species-independent discrimination between fresh and frozen–thawed fish samples. J Food Eng. 119: 765–775.
Ottavian M , Fasolato L , Serva L , Facco P , Barolo M. 2014. Data fusion for food authentication: fresh/frozen–thawed discrimination in west African Goatfish (Pseudupeneus prayensis) fillets. Food Bioprocess Technol. 7: 1025–1036.
Careche M , Sánchez-Alonso I , Martinez I. 2018. Estimation of quality in frozen fish by low field NMR. In Modern Magnetic Resonance, 2nd ed.; Webb GA , Ed.; Springer International Publishing AG: Cham, Switzerland; pp. 1901–1916.
Shumilina E , Ciampa A , Capozzi F , Rustad T , Dikiy A. 2015. NMR approach for monitoring post-mortem changes in Atlantic salmon fillets stored at 0 and 4°C. Food Chem. 184: 12–22.
Sánchez-Alonso I , Moreno P , Careche M. 2014. Low field nuclear magnetic resonance (LF-NMR) relaxometry in hake (Merluccius merluccius, L.) muscle after different freezing and storage conditions. Food Chem. 153: 250–257.
Sánchez-Alonso I , Martinez I , Sánchez-Valencia J , Careche M. 2012. Estimation of freezing storage time and quality changes in hake (Merluccius merluccius, L.) by low field NMR. Food Chem. 135: 1626–1634.
Fuentes A , Masot R , Fernández-Segovia I , Ruiz-Rico M , Alcañiz M , Barat JM . 2013. Differentiation between fresh and frozen–thawed sea bream (Sparus aurata) using impedance spectroscopy techniques. Innov Food Sci Emerg Technol. 19: 210–217.
Fernández-Segovia I , Fuentes A , Aliño M , Masot R , Alcañiz M , Barat JM . 2012. Detection of frozen–thawed salmon (Salmo salar) by a rapid low-cost method. J Food Eng. 113: 210–216.
Hassoun A , Shumilina E , Di Donato F , Foschi M , Simal-Gandara J , Biancolillo A. 2020. Emerging techniques for differentiation of fresh and frozen–thawed seafoods: highlighting the potential of spectroscopic

techniques. Molecules. 25(19): 4472.

Veterinary Drugs

Nomura I. , State of the World Aquaculture 2006, FAO Fisheries Technical Paper 500, FAO, Rome, Italy, 2006.
Serrano P. , Responsible Use of Antibiotics in Aquaculture, FAO Fisheries Technical Paper 469, FAO, Rome, Italy, 2005.
Pillay T.V.R. and Kutty M.N. , Aquaculture Principles and Practices, 2nd edn., Blackwell Publishing, Oxford, UK, 2005.
Stickney R.R. , Aquaculture: An Introductory Text, CABI Publishing, Oxfordshire, UK, 2005.
Kuiper R.V. , Scherpenisse P. and Bergwerff A.A. , Persistence of residues of malachite green in Europeaneel after water-born exposure of juvenile eels, Poster Euroresidue IV, Veldhoven, the Netherlands, 2000.
Kennedy G. , Antibiotic residues in aquaculture systems, Lecture at Annual Conference of the Shellfish Association of Great Britain, London, 2004.
Oka H. , Nakszawa H. , Harada K. and MacNeil J. , Chemical Analysis for Antibiotics Used in Agriculture, AOAC International, Airlington, TX, 1995.
Kurtz D. , Skerritt J. and Stanker L. , New Frontiers in Agrochemical Immunoassay, AOAC International, Airlington, TX, 1995.
Franek M. and Diblikove I. , Broad-specificity immunoassays for sulfonamide detection: Immunochemical strategy for generic antibodies and competitors, Anal. Chem. 78, 1559, 2006.
Kaufmann A. and Pacciarelli B. , Bestimmung von Rückständen von Tetracyclinen in Lebensmittlen, Mitt. Lebenms. Hyg. 90, 167, 1999.
Bogialli S. , Curini R. , Di Corcia A. , Nazzari M. and Saperi R. , A liquid chromatography-mass s pectrometry assay for analyzing sulfonamide antibioticals in callte and fish muscle tissues, Anal. Chem. 75, 1798, 2003.
Potter R.A. , Burns B.G. , Van De Riet J.M. , North D.H. and Darvesh R. , Simultaneous determination of 17 sulfonamides and the potentiators ormetoprim and trimethoprim in salmon muscle with liquid chromatography with tandem mass spectrometry detection, JAOAC 90, 343, 2007.
Brillantes S. , Tanasomwang V. , Thongrod S. and Dachanantawitaya N. , Oxytetracycline residues in Gian Freshwater Prawn, J. Agric. Food Chem. 49, 4995, 2001.
Schneider M. , Vazquez-Moreno L. and Barraza R. , Multiresidue determination of fluoroquinolones in shrimp by liquid chromatography-fluorescence-mass spectrometry, JAOAC 88, 1160, 2005.
Leitner A. , Zöllner P. and Lindner W. , Determination of the metabolites of nitrofuran antibiotics in animal tissue by high-performance liquid chromatography-tandem mass spectrometry. J. Chromatogr. A 939, 49, 2001.
Hoenicke K. , Gatermann R. , Hartig L. and Mandix M. , Formation of semicarbazide (SEM) in food by hypochlorite treatment: Is SEM a specific marker for nitrofurazone abuse? Food Addit. Contam. 21, 526, 2004.
Saari L. and Peltonen K. , Novel source of semicarbazide: Levels of semicarbazide in cooked crayfish samples determined by LC/MS/MS, Food Addit. Contam. 21, 825, 2004.
Shen H. and Jiang H. , Screening determination and confirmation of chloramphenicol in seafood, meat and honey using ELISA, HPLC-UVD, GC-ECD, GC-MS-EI-SIM and GCMS-NCI-SIM methods, Anal. Chim. Acta 535, 33, 2005.
Kaufmann A. and Butcher P. , Quantitative liquid chromatography/tandem mass spectrometry determination of chloramphenicol in food using sub-2 mm particulate high-performance liquid chromatography columns for sensitivity and speed, Rapid Commun. Mass Spectrom. 19, 3694, 2005.
Van de Riet J. , Potter R. and Christine-Fougere M. , Simultaneous determination of residues of chloramphenicol, thiamphenicol, florfenicol, and florfenicol amine in farmed aquatic species, JAOAC 86, 510, 2003.
Horie M. , Harumi T. and Kazuo T. , Determination of macrolide antibiotics in meat and fish by liquid chromatography-electrospray mass spectrometry. Anal. Chim. Acta 492, 187, 2003.
Kaufmann A. and Maden K. , Determination of 11 aminoglycosides in meat and liver by liquid chromatography with tandem mass spectrometry, JAOAC 88, 1118, 2005.
Mottier P. , Huré I. , Gremaud E. and Guy P. , Analysis of four 5-nitroimidazoles and their corresponding hydroxylated metabolites in egg, processed egg, and chicken meat by isotope dilution liquid chromatography tandem mass spectrometry, J. Agric. Food Chem. 54, 2018, 2006.
Scherpenisse P. and Bergwerff A. , Determination of residues of tricaine in fish using liquid chromatography tandem mass spectrometry, Anal. Chim. Acta 586, 407, 2007.
Kim-Kang H. , Bova A. , Crouch L. and Wislocki P. , Tissue distribution, metabolism, and residue depletion study in Atlantic salmon following oral administration of [3H] emamectin benzoate, J. Agric. Food Chem. 52, 2108, 2004.
Shaikh B. , Rummel N. and Reimschuessel R. , Determination of albendazole and its major metabolites in the muscle of atlantic salmon, tilapia, and rainbow trout by high performance liquid chromatography with fluorescence detection, J. Agric. Food Chem. 51, 3254, 2003.

Chu P. , Lopez M. , Serfling S. and Gieseker C. , Determination of 17α-methyltestosterone in muscle tissues of tilapia, rainbow trout, and salmon using liquid chromatography-tandem mass spectrometry, J. Agric. Food Chem. 54, 3193, 2006.

Spectrochemical Methods for the Determination of Metal(loid) Ions in Seafood

M.M. de Souza , C.C. Windmöller , and V. Hatje , Shellfish from Todos os Santos Bay, Bahia, Brazil: treat or threat? Marine Pollution Bulletin, (2011), 62, 2254–2263. doi:10.1016/j.marpolbul.2011.07.010.

A.P. DeFilippis and L.S. Sperling , Understanding omega-3's, American Heart Journal, (2006), 151, 564–570. doi:10.1016/j.ahj.2005.03.051.

N.M. Zatsick and P. Mayket , Fish oil: getting to the heart of it, Journal for Nurse Practitioners, (2007), 3, 104–109. doi:10.1016/j.nurpra.2006.09.003.

W.S. Harris , M. Miller , A.P. Tighe , M.J. Davidson , and E.J. Schaefer , Omega-3 fatty acids and coronary heart disease risk: clinical and mechanistic perspectives, Atherosclerosis, (2008), 197, 12–24. doi:10.1016/j.atherosclerosis.2007.11.008.

USDA, Composition of foods raw, processed, prepared . National Nutrient Database for Standard Reference, Release 23, (2010). Available from: https://www.nal.usda.gov.

A. Ikem and N. Egeibor , Assessment of trace elements in canned fishes (mackerel, tuna, salmon, sardines and herrings) marketed in Georgia and Alabama (United States of America), Journal of Food Composition and Analysis, (2005), 18, 771–787. doi:10.1016/j.jfca.2004.11.002.

G. Khalaf , Assessment of surface fresh water resources. In: H. Kouyoumijian and M. Hamzé (eds) Review and Perspective of Environmental Studies in Lebanon. INCAM-EU/CNRS, Lebanon, pp. 57–78, (2012).

S. Rajeshkumar and X. Li , Bioaccumulation of heavy metals in fish species from the Meiliang Bay, Taihu Lake, China, Toxicology Reports, (2018), 5, 288–295. doi:10.1016/j.toxrep.2018.01.007.

C.T. Driscoll , C. Yan , C.L. Schofield , R. Munson , and J. Holsapple , The mercury cycle and fish in the Adirondack lakes, Environmental Science & Technology, (1994), 28, 136A–143A. doi:10.1021/es00052a003.

F.K. Görür , R. Keser , N. Akçay , and S. Dizman , Radioactivity and heavy metal concentrations of some commercial fish species consumed in the Black Sea Region of Turkey, Chemosphere, (2012), 87, 356–361. doi:10.1016/j.chemosphere.2011.12.022.

Z. Petrović , V. Teodorović , M. Dimitrijević , S. Borozan , M. Beuković , and D. Milićević , Environmental Cd and Zn concentrations in liver and kidney of European hare from different Serbian regions: age and tissue differences, Bulletin of Environmental Contamination and Toxicology, (2013), 90, 203–207. doi:10.1007/s00128-012-0901-7.

C.R.T. Tarley , W.K.T. Coltro , M. Matsushita , and N.E. de Souza , Characteristic levels of some heavy metals from Brazilian canned sardines (Sardinella brasiliensis), Journal of Food Composition and Analysis, (2001), 14, 611–617. doi:10.1006/jfca.2001.1028.

M.I. Castro-González and M. Méndez-Armenta , Heavy metals: implications associated to fish consumption, Environmental Toxicology and Pharmacology, (2008), 26, 263–271. doi:10.1016/j.etap.2008.06.001.

K.A. Francesconi , Arsenic species in seafood: origin and human health implications, Pure and Applied Chemistry, (2010), 82, 373–381. doi:10.1351/PAC-CON-09-07-01.

L.H.J. Lajunen , Spectrochemical Analysis by Atomic Absorption and Emission. Royal Society of Chemistry, Cambridge, England, (1992).

S.J. Haswell (ed), Atomic Absorption Spectrometry: Theory, Design and Applications. Elsevier Science Publishers, Amsterdam, The Netherlands, (1991).

J. Nolte , ICP-Emission Spectrometry-A Practical Guide. Wiley-VCH, Hoboken, NJ, (2003).

I.I. Sobelman , Atomic Spectra and Radiative Transitions, Second Edition. Springer-Verlag, Berlin, Germany, (1992).

J. Sneddon (ed), Sample Introduction in Atomic Spectrometry. Elsevier Science Publishers, Amsterdam, The Netherlands, (1990).

D.J. Butcher and J. Sneddon , A Practical Guide to Graphite Furnace Atomic Absorption Spectrometry. John Wiley & Sons, New York, (1997).

D.J. Butcher , Recent highlights in graphite furnace atomic absorption spectrometry, Applied Spectroscopy Reviews, (2017), 52, 755–773. doi:10.1080/05704928.2017.1303504.

F.G. Bordwell and M.L. Douglass , Reduction of alkylmercuric hydroxides by sodium borohydride, Journal of the American Chemical Society, (1966), 88, 993–999. doi:10.1021/ja00957a024.

U.S. EPA Method 7473 , Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry. USEPA, Washington, DC, (2007).

D.P. Torres , M.B. Martins-Teixeira , E.F. Silva , and H.M. Queiroz , Method development for the control determination of mercury in seafood by solid-sampling thermal decomposition amalgamation atomic absorption spectrometry (TDA AAS), Food Additives & Contaminants: Part A, (2012), 29, 625–632. doi:10.1080/19440049.2011.642310.

https://pubchem.ncbi.nlm.nih.gov/compound/Dimethylmercury.
P. Dornbos , S. Strom , and N. Basu , Mercury exposure and neurochemical biomarkers in multiple brain regions of Wisconsin River Otters (Lontra canadensis), Ecotoxicology, (2013), 22, 469–475. doi:10.1007/s10646-013-1040-6.
E. Covaci , M. Senila , M. Ponta , E. Darvasi , D. Petreus , M. Frentiu , and T. Frentiu , Methylmercury determination in seafood by photochemical vapor generation capacitively coupled plasma microtorch optical emission spectrometry, Talanta, (2017), 170, 464–472. doi:10.1016/j.talanta.2017.04.036.
L.A.H. Fung , J.M.R. Antoine , C.N. Grant , and D.S.A. Buddo , Evaluation of dietary exposure to minerals, trace elements and heavy metals from the muscle tissue of the lionfish Pterois volitans (Linnaeus 1758), Food and Chemical Toxicology, (2013) 60, 205–212. doi:10.1016/j.fct.2013.07.044.
F. Ferraris , F. Iacoponi , A. Raggi , F. Baldi , M. Fretigny , A. Mantovani , and F. Cubadda , Essential and toxic elements in sustainable and underutilized seafood species and derived semi-industrial ready-to-eat products, Food and Chemical Toxicology, (2012), 154, 112331. doi:10.1016/j.fct.2021.112331.
J. Alexander , H. Autrup , D. Bard , C. Bergsten , A. Carere , L.G. Costa , J.-P. Cravedi , A. Di Domenico , R. Fanelli , J. Fink-Gremmels , J. Gilbert , P. Grandjean , N. Johansson , A. Oskarsson , A. Renwick , J. Ruprich , J. Schlatter , G. Schoeters , D. Schrenk , R. van Leeuwen , and P. Verger , Opinion of the scientific panel on contaminants in the food chain on a request from the commission related to mercury and methylmercury in food, EFSA Journal, (2004), 34, 1–14.
A. Montaser and D.W. Golightly (eds), Inductively Coupled Plasmas in Analytical Atomic Spectrometry, Second Edition. VCH Publishers, Inc., New York, (1992).
Jackson School of Geosciences , The University of Texas at Austin. https://www.jsg.utexas.edu/icp-ms/icp-ms/. Last accessed date: October 6, 2023 .
J. Sneddon , C. Hardaway , K.K. Bobbadi , and A.K. Reddy , Sample preparation of solid samples for metal determination by atomic spectroscopy-an overview and selected recent applications, Applied Spectroscopy Reviews, (2006), 41, 23–42. doi:10.1080/05704920500385445.
J. Sneddon , P.W. Rode , M.A. Hamilton , S. Pingeli , and J.P. Hagen , Determination of metals in seafood, Applied Spectroscopy Reviews, (2007), 42, 1–16. doi:10.1080/05704920601006072.
J. Sneddon , Use of spectrochemical methods for the determination of metals in fish and other seafood in Louisiana. In: S. Caroli (ed) The Determination of Chemical Elements in Food: Applications for Atomic and Mass Spectrometry. John Wiley & Sons, Hoboken, NJ, pp. 437–454, (2007).
J.C. Richert and J. Sneddon , Determination of inorganics and organics in crawfish, Applied Spectroscopy Reviews, (2008), 43, 1–17. doi:10.1080/05704920701702950.
H.M. Kingston and S.J. Haswell (eds), Microwave-Enhanced Chemistry, Fundamentals, Sample Preparation and Applications. American Chemical Society, Washingon, DC, (1997).
H. Matusiewicz , Wet digestion methods. In: Z. Mester and R. Sturgeon (eds) Comprehensive Analytical Chemistry. Sample Preparation for Trace Element Analysis. Elsevier, Amsterdam, (2003), ch. 6, 193–233.
E. Silva , Z.C.V. Viana , N.F.A. Souza , M.G.A. Korn , and V.L.C.S. Santos , Assessment of essential elements and chemical contaminants in thirteen fish species from the Bay Aratu, Bahia, Brasil, Brazilian Journal of Biology, (2016), 76, 871–877. doi:10.1590/1519-6984.02415.
M. Ghosn , R. Chekri , C. Mahfouz , G. Khalaf , R. Amara , and P. Jitaru , Levels of Pb, Cd, Hg and As in fishery products from the eastern Mediterranean and human health risk assessment due to their consumption, International Journal of Environmental Research, (2019), 13, 443–455. doi:10.1007/s41742-019-00185-w.
M. Durmuş , Evaluation of nutritional and mineral-heavy metal contents of horse mackerel (Trachurus trachurus) in the Middle Black Sea in terms of human health, Biological Trace Element Research, (2019), 190, 208–216. doi:10.1007/s12011-018-1523-7.
Y. Jiao , J. Chen , W. Li , Y. Liu , C. Xin , and L. Yang , Trace elements concentrations in squids consumed in Shandong Province China and their associated risks to the human health, Marine Pollution Bulletin, (2018), 128, 267–274. doi:10.1016/j.marpolbul.2018.01.038.
T. Forleo , A. Zappi , D. Melucci , M. Ciriaci , F. Griffoni , S. Bacchiocchi , M. Siracusa , T. Tavoloni , and A. Piersanti , Inorganic elements in Mytilus galloprovincialis shells: geographic traceability by multivariate analysis of ICP-MS data, Molecules, (2021), 26, 2634. doi:10.3390/molecules26092634.
J.V. Maciel , C.L. Knorr , E.M.M. Flores , E.I. Müller , M.F. Mesko , E.G. Primel , and F.A. Duarte , Feasibility of microwave-induced combustion for trace element determination in Engraulis anchoita by ICP-MS, Food Chemistry, (2014), 145, 927–931. doi:10.1016/j.foodchem.2013.08.119.
G. Grindlay , J. Mora , M. de Loos-Vollebregt , and F. Vanhaecke , A systematic study on the influence of carbon on the behavior of hard-to-ionize elements in inductively coupled plasma-mass spectrometry, Spectrochimica Acta Part B, (2013), 86, 42–49. doi:10.1016/j.sab.2013.05.002.
G. Karanikolopoulos , A. Gerakis , K. Papadopoulou , and I. Mastrantoni , Determination of synthetic food colorants in fish products by an HPLC-DAD method, Food Chemistry, (2015), 177, 197–203. doi:10.1016/j.foodchem.2015.01.026.
D. Mendil , Determination of Cd(II), Cu(II) and Pb(II) in some foods by FAAS after preconcentration on modified silica gels with thiourea, Journal of Food Science, (2012), 77, T181–T186. doi:10.1111/j.1750-3841.2012.02858.x.

D. Citak , M. Tuzen , and M. Soylak , Simultaneous coprecipitation of lead, cobalt, copper, cadmium, iron and nickel in food samples with zirconium(IV) hydroxide prior to their flame atomic absorption spectrometric determination, Food and Chemical Toxicology, (2009), 47, 2302–2307. doi:10.1016/j.fct.2009.06.021.

J. Moreda-Piñeiro , A. Moreda-Piñeiro , V. Romarís Hortas , R. Domínguez-González , E. Alonso-Rodriguez , P. Lopez-Mahia , S. Muniategui-Lorenzo , D. Prada-Rodriguez , and P. Bermejo-Barrera , Trace metals in marine foodstuff: bioavailability estimation and effect of major food constituents, Food Chemistry, (2012), 134, 339–345. doi:10.1016/j.foodchem.2012.02.165.

J.P. Meador , D.W. Ernest , and A.N. Kagley , A comparison of the non-essential elements cadmium, mercury and lead found in fish and sediment from Alaska and California, Science of the Total Environment, (2005), 339, 189–205. doi:10.1016/j.scitotenv.2004.07.028.

P. Olmedo , A. Pla , A.F. Hernández , F. Barbier , L. Ayouni , and F. Gil , Determination of toxic elements (mercury, cadmium, lead, tin, and arsenic) in fish and shellfish samples. Risk assessment for the consumers, Environment International, (2013), 59, 63–72. doi:10.1016/j.envint.2013.05.005.

A. Iken and N.O. Egiebor , Assessment of trace elements in canned fishes (mackerel, tuna, salmon, sardines and herrings) marketed in Georgia and Alabama (United States of America), Journal of Food Composition and Analysis, (2005), 18, 771–787. doi:10.1016/j.jfca.2004.11.002.

S. Mol , Levels of selected trace metals in canned tuna fish produced in Turkey, Journal of Food Composition and Analysis, (2011), 24, 66–69. doi:10.1016/j.jfca.2010.04.009.

M.C. Yebra-Biurrun and S. Cancela-Pérez , Continuous approach for ultrasound-assisted acid extraction-minicolumn preconcentration of chromium and cobalt from seafood samples prior to flame atomic absorption spectrometry, Analytical Sciences, (2007), 23, 993–996. doi:10.2116/analsci.23.993.

J. Abolhasani and M. Behbahani , Application of 1-(2-pyridylazo)-2-naphthol-modified nanoporous silica as a technique in simultaneous trace monitoring and removal of toxic heavy metals in food and water samples, Environmental Monitoring and Assessment, (2015), 187, 4176. doi:10.1007/s10661-014-4176-9.

M.C. Barciela-Alonso , V. Plata-García , A. Rouco-López , A. Moreda-Piñeiro , and P. Bermejo-Barrera , Ionic imprinted polymer based solid phase extraction for cadmium and lead pre-concentration/determination in seafood, Microchemical Journal, (2014), 114, 106–110. doi:10.1016/j.microc.2013.12.008.

M. Behbahani , A. Bagheri , M. Taghizadeh , M. Salarian , O. Sadeghi , L. Adlnasab , and K. Jalali , Synthesis and characterisation of nano structure lead (II) ion-imprinted polymer as a new sorbent for selective extraction and preconcentration of ultra trace amounts of lead ions from vegetables, rice, and fish samples, Food Chemistry, (2013), 138, 2050–2056. doi:10.1016/j.foodchem.2012.11.042.

X.N. Zhao , X.J. Liu , Z.X. Zhao , C.J. Huang , M.H. Zhang , H.L. Wang , and X.D. Wang , Homogeneous liquid-liquid extraction combined with high performance liquid chromatography-fluorescence detection for determination of polycyclic aromatic hydrocarbons in vegetables, Journal of Separation Science, (2009), 32, 2051–2057. doi:10.1002/jssc.200900019.

S.C. Vardali , N. Manousi , M. Barczak , and D.A. Giannakoudakis , Novel approaches utilizing metal-organic framework composites for the extraction of organic compounds and metal traces from fish and seafood, Molecules, (2020), 25, 513. doi:10.3390/molecules25030513.

P. Rocío-Bautista , T. Taima-Mancera , J. Pasán , and V. Pino , Metal-organic frameworks in green analytical chemistry, Separations, (2019), 6, 33. doi:10.3390/separations6030033.

N. Li , J. Xu , R. Feng , T.L. Hu , and X.H. Bu , Governing metal-organic frameworks towards high stability, Chemical Communications, (2016), 52, 8501–8513. doi:10.1039/C6CC02931K.

M. Rezaei Kahkha , S. Daliran , A. Oveisi , M. Kaykhaii , and Z. Sepehri , The mesoporous porphyrinic zirconium metal-organic framework for pipette-tip solid-phase extraction of mercury from fish samples followed by cold vapor atomic absorption spectrometric determination, Food Analytical Methods, (2017), 10, 2175–2184. doi:10.1007/s12161-016-0786-x.

M. Sohrabi , Preconcentration of mercury(II) using a thiol-functionalized metal-organic framework nanocomposite as a sorbent, Microchimica Acta, (2013), 181, 435–444. doi:10.1007/s00604-013-1133-1.

A. Bagheri , M. Taghizadeh , M. Behbahani , A. Akbar Asgharinezhad , M. Salarian , A. Dehghani , H. Ebrahimzadeh , and M. Amini , Synthesis and characterization of magnetic metal-organic framework (MOF) as a novel sorbent, and its optimization by experimental design methodology for determination of palladium in environmental samples, Talanta, (2012), 99, 132–139. doi:10.1016/j.talanta.2012.05.030.

A. Tadjarodi and A. Abbaszadeh , A magnetic nanocomposite prepared from chelator-modified magnetite (Fe3O4) and HKUST-1 (MOF-199) for separation and preconcentration of mercury(II), Microchimica Acta, (2016), 183, 1391–1399. doi:10.1007/s00604-016-1770-2.

M. Sohrabi , Z. Matbouie , A. Asgharinezhad , and A. Dehghani , Solid-phase extraction of Cd(II) and Pb(II) using a magnetic metal-organic framework, and their determination by FAAS, Microchimica Acta, 2013, 180, 589–597. doi:10.1007/s00604-013-0952-4.

E. Ghorbani-Kalhor , A metal-organic framework nanocomposite made from functionalized magnetite nanoparticles and HKUST-1 (MOF-199) for preconcentration of Cd(II), Pb(II), and Ni(II), Microchimica Acta, (2016), 183, 2639–2647. doi:10.1007/s00604-016-1896-2.

M. Taghizadeh , A. Asgharinezhad , M. Pooladi , M. Barzin , A. Abbaszadeh , and A. Tadjarodi , A novel magnetic metal-organic framework nanocomposite for extraction and preconcentration of heavy metal ions, and its optimization via experimental design methodology, Microchimica Acta, (2013), 180, 1073–1084.

doi:10.1007/s00604-013-1010-y.
M. Babazadeh , R. Hosseinzadeh Khanmiri , J. Abolhasani , E. Ghorbani-Kalhor , and A. Hassanpour , Synthesis and application of a novel functionalized magnetic metal-organic framework sorbent for determination of heavy metal ions in fish samples, Bulletin of the Chemical Society of Japan, (2015), 88, 871–879. doi:10.1246/bcsj.20140380.
T.A. Vu , G.H. Le , C.D. Dao , L.Q. Dang , K.T. Nguyen , Q.K. Nguyen , P.T. Dang , H.T.K. Tran , Q.T. Duong , T.V. Nguyen , and G.D. Lee , Arsenic removal from aqueous solutions by adsorption using novel MIL-53(Fe) as a highly efficient adsorbent, RSC Advances, (2015), 5, 5261–5268. doi:10.1039/C4RA12326C.
P. Zhou , R. Zheng , W. Zhang , W. Liu , Y. Li , H. Wang , and X. Wang , Development of an effervescent tablet microextraction method using NiFe2O4-based magnetic nanoparticles for preconcentration/extraction of heavy metals prior to ICP-MS analysis of seafood, Journal of Analytical Atomic Spectrometry, (2019), 34, 598–606. doi:10.1039/c8ja00331a.
A. Galitsopoulou , D. Georgantelis , and M. Kontominas , The influence of industrial-scale canning on cadmium and lead levels in sardines and anchovies from commercial fishing centres of the Mediterranean Sea, Food Additives and Contaminants: Part B, (2012), 5, 75–81. doi:10.1080/19393210.2012.658582.
G. Grybauskaitė , D. Laurinavičienė , and E. Cikockaitė , Cd and Pb concentrations in the main groups of foodstuff, The 9th Conference Environmental Engineering. Selected Papers, Article number: enviro.2014.022, (2014). doi:10.3846/enviro.2014.022.
J. Montoya-Mendoza , E. Alarcón-Reyes , M.R. Castañeda-Chávez , F. Lango-Reynoso , and R.E. Zamudio-Alemán , Heavy metals in muscle tissue of Pterois volitans from the Veracruz Reef System National Park, Mexico, International Journal of Environmental Research and Public Health, (2019), 16, 4611. doi:10.3390/ijerph16234611.
A. Gholamhosseini , N. Shiry , S. Soltanian , and M. Banaee , Bioaccumulation of metals in marine fish species captured from the northern shores of the Gulf of Oman, Iran, Regional Studies in Marine Science, (2021), 41, 101599. doi:10.1016/j.rsma.2020.101599.
D. Elaarabi , A. Laissaoui , A. Guessous , A. Benkdad , E.M. Chakir , and S. Said , Trace metals content in marine species from the north-western Moroccan Atlantic waters, Egyptian Journal of Aquatic Biology & Fisheries, (2022), 26, 443–458. doi:10.21608/EJABF.2022.231582.
J.P. Hagen and J. Sneddon , Determination of copper, iron and zinc in crawfish (Procambrus clarkii) by inductively coupled plasma-optical emission spectrometry, Spectroscopy Letters, (2009), 42, 58–61. doi:10.1080/00387010802375065.
J.C. Richert and J. Sneddon , Determination of heavy metals in crawfish (Procambrus clarkii) by inductively coupled plasma-optical emission spectrometry: a study over the season in Southwest Louisiana, Analytical Letters, (2008), 41, 3198–3209. doi:10.1080/00032710802462834.
V.H. Migues , M. de Almeida Bezerra , A.K. de Francisco , M.C. Guerazzi , and P.R.A. de Mello Affonso, Accumulation of trace metals in two commercially important shrimp species from Camamu Bay, Northeastern Brazil, Bulletin of Environmental Contamination and Toxicology, (2012), 91, 292–297. doi:10.1007/s00128-013-1058-8.
F.A. Ababneh and I.F. Al-Momani , Levels of mercury, cadmium, lead and other selected elements in canned tuna fish commercialised in Jordan, International Journal of Environmental Analytical Chemistry, (2013), 93, 755–766. doi:10.1080/03067319.2012.672981.
M.A. Salam , S.C. Paul , R.A.M.M. Zain , S. Bhowmik , M.R. Nath , S.A. Siddiqua , M.A. Iqbal , W.R. Kadir , R.B. Ahamad , M.A. Khaleque , A.E. Rak , and M.F.M. Amin , Trace metals contamination potential and health risk assessment of commonly consumed fish of Perak River, Malaysia, PLoS One, (2020), 15, e0241320. doi:10.1371/journal.pone.0241320.
D.A. Almashhadany , H.S. Khalid , and H.S. Ali , Determination of heavy metals and selenium contents in fish meat sold at Erbil City, Kurdistan Region, Iraq, Italian Journal of Food Safety, (2020), 9, 8753. doi:10.4081/ijfs.2020.8753.
H. Agah , M. Leermakers , M. Elskens , S.M.R. Fatemi , and W. Baeyens , Accumulation of trace metals in the muscle and liver tissues of five fish species from the Persian Gulf, Environmental Monitoring and Assessment, (2009), 157, 499–514. doi:10.1007/s10661-008-0551-8.
S. Mol , Levels of heavy metals in canned bonito, sardines, and mackerel produced in Turkey, Biological Trace Element Research, (2011), 143, 974–982. doi:10.1007/s12011-010-8909-5.
D. Aydın and Ş. Tokalıoğlu , Trace metals in tissues of the six most common fish species in the Black Sea, Turkey, Food Additives & Contaminants: Part B: Surveillance, (2015), 8, 25–31. doi:10.1080/19393210.2014.949873.
F. Conte , C. Copat , S. Longo , G. Oliveri Conti , A. Grasso , G. Arena , M.V. Brundo , and M. Ferrante , First data on trace elements in Haliotis tuberculata (Linnaeus, 1758) from southern Italy: safety issues, Food and Chemical Toxicology, (2015) 81, 143–150. doi:10.1016/j.fct.2015.04.020.
A. Salvo , N. Cicero , R. Vadalà , A.F. Mottese , D. Bua , D. Mallamace , C. Giannetto , and G. Dugo , Toxic and essential metals determination in commercial seafood: Paracentrotus lividus by ICP-MS, Natural Product Research, (2016), 30, 657–664. doi:10.1080/14786419.2015.1038261.
A. Güngör and D. Kara , Toxicities and risk assessment of heavy metals of the six most consumed fish from the Marmara Sea, Environmental Science and Pollution Research, (2018), 25, 2672–2682. doi:10.1007/s11356-

017-0672-0.
G. Cammilleri , P. Galluzzo , A. Pulvirenti , I.E. Giangrosso , G.M. Lo Dico , G. Montana , N. Lampiasi , M.A. Mobilia , A. Lastra , M. Vazzana , A. Vella , P. La Placa , A. Macaluso , and V. Ferrantelli , Toxic mineral elements in Mytilus galloprovincialis from Sicilian coasts (Southern Italy), Natural Product Research, (2020), 34, 177–182. doi:10.1080/14786419.2019.1610963.
R. Shalini , G. Jeyasekaran , R. Jeya Shakila , U. Arisekar , S. Sundhar , P. Jawahar , S. Aanand , and A.H. Malini , Concentrations of trace elements in the organs of commercially exploited crustaceans and cephalopods caught in the waters of Thoothukudi, South India, Marine Pollution Bulletin, (2020) 154, 111045. doi:10.1016/j.marpolbul.2020.111045.
A. Grasso , M. Ferrante , G. Arena , R. Salemi , P. Zuccarello , M. Fiore , and C. Copat , Chemical characterization and quantification of silver nanoparticles (Ag-NPs) and dissolved Ag in deafood by single particle ICP-MS: assessment of dietary exposure, International Journal of Environmental Research and Public Health, (2021), 18, 4076. doi:10.3390/ijerph18084076.
N.D. Le , T.T.H. Hoang , V.P. Phung , T.L. Nguyen , T.T. Duong , L.M. Dinh , T.M.H. Pham , T.X.B. Phung , T.D. Nguyen , T.N. Duong , T.M.H. Le , P.T. Le , and T.P.Q. Le , Trace metal element analysis in some seafood in the coastal zone of the Red River (Ba Lat Estuary, Vietnam) by green sample preparation and inductively coupled plasma-mass spectrometry (ICP-MS), Journal of Analytical Methods in Chemistry, (2021), 2021, 6649362. doi:10.1155/2021/6649362.
A.V. Zmozinski , T. Llorente-Mirandes , I.C.F. Damin , J.F. Lopez-Sanchez , M.G.R. Vale , B. Welz , and M.M. Silva , Direct solid sample analysis with graphite furnace atomic absorption spectrometry - a fast and reliable screening procedure for the determination of inorganic arsenic in fish and seafood, Talanta, (2015), 134, 224–231. doi:10.1016/j.talanta.2014.11.009.
J.M.R. Antoine , L.A.H. Fung , and C.N. Grant , Assessment of the potential health risks associated with the aluminium, arsenic, cadmium and lead content in selected fruits and vegetables grown in Jamaica, Toxicology Reports, (2017) 29, 181–187. doi:10.1016/j.toxrep.2017.03.006.
T. Guérin , R. Chekri , C. Vastel , V. Sirot , J.-L. Volatier , J.-C. Leblanc , and L. Noël , Determination of 20 trace elements in fish and other seafood from the French market, Food Chemistry, (2011), 127, 934–942. doi:10.1016/j.foodchem.2011.01.061.

Food Irradiation and Its Detection

Murano, E.A. and Cross, H.R. Enhancing food safety through irradiation, The International Consultative Group on Food Irradiation (ICGFI), Vienna, Austria, 1999.
Kilgen, M. Economic benefits of irradiation of molluscan shellfish in Louisiana, Cost-Benefit Aspects of Food Irradiation Processing, STI/PUB/905, IAEA, Vienna, Austria, 1993.
https://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html.
Mead, P.S. , Slutsker, L. , Dietz, V. , McCaig, L.F. , Bresee, J.S. , Shapiro, C. , Griffin, P.M. , and Tauxe, R.V. Food-related illness and death in the United States. Emerging Infectious Diseases, 5(5), 607, 1999.
Adak, G.K. , Long, S.M. , and O'Brien, S.J. Trends in indigenous foodborne disease and deaths, England and Wales: 1992 to 2000. Gut, 51, 832, 2002.
https://www.who.int/news-room/fact-sheets/detail/food-safety#:~:text=Foodborne%20illnesses%20are%20usually%20infectious,term%20diseases%2C%20such%20as%20cancer.
Loaharanu, P. Food irradiation: Current and future prospects, In New Methods of Food Preservation, Gould, G.W. (Ed.), Dekker, New York, 1995, chap. 5, 90–111.
Rahman, M.S. Irradiation preservation of foods, In Handbook of Food Preservation, Rahman, M.S. (Ed.), Dekker, New York, 1999, chap. 13.
Dickson, J.S. Radiation inactivation of microorganisms, In Food Irradiation: Principles and Applications, Molins, R.A. (Ed.), Wiley Inter-Science, New York, 2001, chap. 2, 23–35.
Diehl, J.F. Food irradiation-past, present and future. Radiation Physics and Chemistry, 63, 211, 2002.
Miller, R.B. Introduction to food irradiation, In Electronic Irradiation of Foods, Springer Science, New York, 2005, chap. 1, 1–15.
Farkas, J. Irradiation for better foods. Trends Food Science and Technology, 17, 148, 2006.
FAO. Codex general standards for irradiation foods and recommended international code of practice for the operation of radiation facilities used for the treatment of foods, Codex Alimentarius Commission, XV, E-1, Food and Agriculture Organizations (FAO) of the United Nations, Rome, Italy, 1984.
IAEA. Energy applications of radiation processing, TECDOC Series No. 1386, International Atomic Energy Agency (IAEA), Vienna, Austria, 2004.
Cleland, M.R. Advances in gamma ray, electron beam, and X-ray technologies for food irradiation, In Food Irradiation Research and Technology, Sommers, C.H. and Fan, X. (Eds.), Blackwell Publishing, Ames, IA, 2006, chap. 2, 11–35.

Murano, E.A. Irradiation of fresh meats. Food Technology, 49, 52, 1995.
Stewart, E.M. Food radiation chemistry, In Food Irradiation: Principles and Applications, Molins, R.A. (Ed.), Wiley Inter-Science, New York, 2001, chap. 3, 37–68.
WHO . Wholesomeness of irradiated food, Joint FAO/IAEA/WHO Expert Committee on Food Irradiation, WHO Technical Report Series No. 659, Geneva, Switzerland, 1981.
Stewart, E.M. Food irradiation: More pros than cons? Biologist, 51, 91, 2004.
Venugopal, V. , Doke, S.N. , and Thomas, P. Radiation processing to improve the quality of fishery products. Critical Reviews in Food Science and Nutrition, 39, 391, 1999.
Loaharanu, P. and Murrell, D. A role for irradiation in the control of foodborne parasites. Trends in Food Science and Nutrition, 5, 190, 1994.
Kaperstein, F.K. and Moy, G.G. Public health aspects of food irradiation. Journal of Public Health Policy, 14, 149, 1993.
Swallow, A.J. Wholesomeness and safety of irradiated foods, In Nutritional and Toxicological Consequences of Food Processing, Friedman, M. (Ed.), Plenum Press, New York, 1991, pp. 11–31.
https://food.ec.europa.eu/safety/biological-safety/food-irradiation_en.
Directive 1999/2/EC on the irradiation of foods and food ingredients .
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31999L0003.
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32002D.
https://eur-lex.europa.eu/EN/legal-content/summary/foodstuffs-treated-with-ionising-radiation.html.
https://www.fda.gov/media/81259/download.
https://www.cdc.gov/foodsafety/communication/food-irradiation.html.
https://www.canada.ca/en/health-canada/services/food-nutrition/food-safety/food-irradiation/technical-summary-safety-evaluation-irradiation-fresh-frozen-ground-beef.html#fn6-0-rf 107.
Tauxe, R.V. Food safety and irradiation: Protecting the public from foodborne infections. Emerging Infectious Diseases, 7(7), 516, 2001.
FAO, IAEA , WHO. High-Dose Irradiation: Wholesomeness of Food Irradiated with Doses Above 10 kGy: Report of a Joint FAO/IAEA/WHO Study Group, World Health Organization, Geneva, 1999, p. 109.
Stachowicz, W. , Malec-Czechowska, K. , Dancewicz, A.M. , Szot, Z. , and Chmielewski, A.G. Accredited laboratory for detection of irradiated foods in Poland. Radiation Physics and Chemistry, 63(3–6), 427–429, 2002.
McMurray, C.H. , Stewart, E.M. , Gray, R. , and Peaece, J. (Eds.), Detection Methods for Irradiated Foods - Current Status, Royal Society of Chemistry, London, UK, 1996.
Stewart, E.M. Detection methods for irradiated food, In Food Irradiation: Principles and Applications, Molins, R.A. (Ed.), Wiley Inter-Science, New York, 2001, chap. 14, 347–386.
Marchioni, E. Detection of irradiated foods, In Food Irradiation Research and Technology, Sommers, C.H. and Fan, X. (Eds.), Blackwell Publishing, Ames, IA, 2006, chap. 6, 85–103.
Ikeya, M. and Miki, T. ESR dating of animal and human bones. Science, 207, 977, 1980.
Desrosiers, M.F. and Schauer, D.A. Electron paramagnetic resonance (EPR) biodosimetry. Nuclear Instruments and Methods in Physics Research, Section B, 184, 219, 2001.
Regulla, D.F. ESR spectrometry: A future-oriented tool for dosimetry and dating. Applied Radiation and Isotopes, 62, 117, 2005.
Dodd, N.J.F. and Swallow, A.J. Use of ESR to identify irradiated food. Radiation Physics and Chemistry, 26, 451, 1985.
Dodd, N.J.F. , Lea, J.S. , and Swallow, A.J. ESR detection of irradiated food. Nature, 334, 387, 1988.
Chawla, S.P. , Thomas, P. , and Bongirwar, D.R. Factors influencing the yield of radiation induced electron spin resonance (ESR) signal in lamb bones. Food Research International, 35, 467, 2002.
Köksal, F. and Köseoğlu, R. Detection of free radicals in γ-irradiated seasnail hard tissues by electron paramagnetic resonance. Applied Radiation and Isotopes, 59, 73, 2003.
Bhushan, B. , Bhat, R. , and Sharma, A. Status of free radicals in Indian monsooned coffee beans γ-irradiated for disinfestations. Journal of Agricutural and Food Chemistry, 51, 4960, 2003.
Eschrig, U. , Stahl, M. , Delincée, H. , Schaller, H.J. , and Röder, O. Electron seed dressing of barley-aspects of its verification. European Food Research and Technology, 224, 489–497.
Yordanov, N.D. and Pachova, Z. Gamma-irradiated dry fruits. An example of a wide variety of long-time dependent EPR spectra. Spectrochimica Acta Part A, 63, 891, 2006.
Ukai, M. , Nakamura, H. , and Shimoyama, Y. An ESR protocol based on relaxation phenomena of irradiated Japanese pepper. Spectrochimica Acta Part A, 63, 879, 2006.
Chiaravalle, A.E. , Mangiacotti, M. , Marchesani, G. , and Vegliante, G. Electron spin resonance (ESR) detection of irradiated fish containing bone (gilthead sea bream, cod, and swordfish). Veterinary Research Communication, 34(Suppl 1), 149–152, 2010.
Goulas, A.E. , Stahl, M. , and Riganakos, K.A. Effect of various parameters on detection of irradiated fish and oregano using the ESR and PSL methods. Food Control, 19(11), 1076–1085, 2008.
Marrone, R. , Carosielli, L. , Mangiacotti, M. , Chiaravalle, E. , Smaldone, G. , and Anastasio, A. Monitoring of irradiated food products marketed in Italy and evaluation of electron spin resonance signal sensitivity of

experimentally irradiated fish scales. Italian Journal of Food Safety, 3(2), 1602, 2014.
LeTellier, P.R. and Nawar, W.W. 2-Alkycyclobutanones from the radiolysis of triglycerides. Lipids, 7, 75, 1972.
Delincée, H. and Pool-Zobel, B.L. Genotoxic properties of 2-dodecylcyclobutanone, a compound formed on irradiation of food containing fat. Radiation Physics and Chemistry, 52, 39, 1998.
Raul, F. , Gossé, F. , Delincé, H. , Hartwig, A. , Marchioni, E. , Miesch, M. , Werner, D. , and Burnouf, D. Food-borne radiolytic compounds (2-alkylcyclobutanones) may promote experimental colon carcinogenesis. Nutrition and Cancer, 44(2), 189–191, 2002.
Marchioni, E. , Raul, F. , Burnouf, D. , Miesch, M. , Delincee, H. , Hartwig, A. , and Werner, D. Toxicological study on 2-alkylcyclobutanones-results of a collaborative study. Radiation Physics and Chemistry, 71(1–2), 147–150, 2004.
Sommers, C.H. 2-Dodecylcyclobutanone does not induce mutations in the Escherichia coli tryptophan reverse mutation assay. Journal of Agricultural and Food Chemistry, 51, 6367, 2003.
Gadgil, P. and Smith, J.S. Mutagenicity and acute toxicity evaluation of 2-dodecylcyclobutanone. Journal of Food Science, 69, C713, 2004.
Sommers, C.H. and Schiestl, R. 2-Dodecylcyclobutanone does not induce mutations in the Salmonella mutagenicity test or intrachromosomal recombination in Saccharomyces cerevisiae. Journal of Food Protection, 67, 1293, 2004.
Stevenson, M.H. , Crone, A.V.J. , and Hamilton, J.T.G. Irradiation detection. Nature, 344, 202, 1990.
Boyd, D.R. , Crone, A.V. , Hamilton, J.T. , Hand, M.V. , Stevenson, M.H. , and Stevenson, P.J. Synthesis, characterization, and potential use of 2-dodecylcyclobutanone as a marker for irradiated chicken. Journal of Agricultural and Food Chemistry, 39(4), 789–792, 1991.
Obana, H. , Furuta, M. , and Tanaka, Y. Analysis of 2-alkylcyclobutanones with accelerated solvent extraction to detect irradiated meat and fish. Journal of Agricultural and Food Chemistry, 53, 6603, 2005.
Stewart, E.M. , Moore, S. , Graham, W.D. , McRoberts, W.C. , and Hamilton, J.T.G. 2Alkylcyclobutanones as markers for the detection of irradiated mango, papaya, Camembert cheese and salmon meat. Journal of the Science of Food and Agriculture, 80(1), 121–130, 2000.
Tewik, I.H. , Ismail, H.M. , and Sumar, S. A rapid supercritical fluid extraction method for the qualitative detection of 2-alkylcyclobutanone in gamma-irradiated fresh and sea water fish. International Journal of Food Sciences and Nutrition, 50, 51, 1999.
Kim, K.S. , Seo, H.Y. , Lee, J.M. , Park, E.R. , Kim, J.H. , Hong, C.H. , and Byun, M.W. Analysis of radiation-induced hydrocarbons and 2-alkylcyclobutanones from dried shrimps (Penaeus aztecus). Journal of Food Protection, 67(1), 142–147, 2004.
Stevenson, M.H. , Crone, A.V.J. , Hamilton, J.T.G. , and McMurray, C.H. The use of 2-alkylcyclobutanones for the identification of irradiated chicken meat and eggs. Radiation Physics and Chemistry, 42, 363, 1993.
Stevenson, M.H. Identification of irradiated food. Food Technology, 48, 141, 1994.
Sin, D.W.M. , Wong, Y.C. , and Yao, M.W.Y. Analysis of γ-irradiated melon, pumpkin and sunflower seeds by electron paramagnetic resonance spectroscopy and gas chromatography-mass spectrometry. Journal of Agricultural and Food Chemistry, 54, 7159, 2006.
Stevenson, M.H. , Meier, W. , and Kilpatrick, D.J. A European Collaborative Blind Trial using Volatile Hydrocarbons and 2-Dodecylcyclobutanone to Detect Irradiated Chicken Meat, Report EUR 15969 EN, Commission of the European communities (BCR), Brussels, Belgium, 1994.
Elliott, C.T. , Hamilton, L. , Stevenson, M.H. , McCaughey, W.J. , and Boyd, D. Detection of irradiated chicken meat by analysis of lipid extracts for 2-substituted cyclobutanones using an enzyme linked immunosorbent assay. Analyst, 120(9), 2337–2341, 1995.
Sin, D.W.M. , Wong, Y.C. , and Yao, M.W.Y. Application of pentafluorophenyl hydrazine on detecting 2-dodecylcyclobutanone and 2-tetradecylcyclobutanone in irradiated chicken, pork and mangoes by gas chromatography-mass spectrometry. European Food Research and Technology, 222, 674, 2006.
Horvatovich, P. , Miesch, M. , Hasselmann, C. , and Marchioni, E. Supercritical fluid extraction of hydrocarbons and 2-alkylcyclobutanones for the detection of irradiated foodstuffs. Journal of Chromatography A, 897(1–2), 259–268, 2000.
Gadgil, P. , Smith, J.S. , Hachmeister, K.A. , and Kropf, D.H. Evaluation of 2-dodecylcyclobutanone as an irradiation dose indicator in fresh irradiated ground beef. Journal of Agricultural and Food Chemistry, 53(6), 1890–1893, 2005.
Tewik, I.H. , Ismail, H.M. , and Sumar, S. A rapid supercritical fluid extraction method for the qualitative detection of 2-alkylcyclobutanone in gamma-irradiated fresh and sea water fish. International Journal of Food Science and Nutrition, 50, 51, 1999.
Sin, D.W.M. , Wong, Y.C. , and Yao, M.W.Y. Application of pentafluorophenyl hydrazine on detecting 2-dodecylcyclobutanone and 2-tetradecylcyclobutanone in irradiated chicken, pork and mangoes by gas chromatography-mass spectrometry. European Food Research and Technology, 222, 674, 2006.
Chen, S. , Morita, Y. , Saito, K. , Kameya, H. , Nakajima, M. , and Todoriki, S. Identification of irradiated prawn (Penaeus monodon) using thermoluminescence and 2-alkylcyclobutanone analyses. Journal of Agricultural and Food Chemistry, 59(1), 78–84, 2011.
Takahashi, K. , Ishii, R. , and Matsumoto, R. Rapid analysis of 2-alkylcyclobutanones in irradiated meats, cheese and salmon by direct solvent extraction followed by GPC. Food Hygiene and Safety Science (Shokuhin

Eiseigaku Zasshi), 54(3), 173–177, 2013.
Östling, O. and Johanson, K.J. Microelectrophoretic study of radiation-induced DNA damages in individual mammalian cells. Biochemical and Biophysical Research Communications, 123, 291, 1984.
Fairbairn, D.W. , Olive, P.L. , and O'Neil, K.L. The comet assay: A comprehensive review. Mutation Research, 339, 37, 1995.
Nawar, W.W. and Balboni, J.J. Detection of irradiation treatment in foods. Journal of AOAC International, 53, 726, 1970.
Newar, W.W. Volatiles from food irradiation. Food Reviews International, 21, 45, 1986.
Morehouse, K.M. and Ku, Y. Gas chromatographic and electron spin resonance investigations of gamma-irradiated shrimp. Journal of Agricultural and Food Chemistry, 40, 1963, 1992.
Kwon, J.H. , Kausar, T. , Noh, J. , Kim, D.H. , Byun, M.W. , Kim, K.S. , and Kim, K.S. The identification of irradiated seasoned filefish (Thamnaconus modestus) by different analytical methods. Radiation Physics and Chemistry, 76(11–12), 1833–1836, 2007.
Miyahara, M. , Saito, A. , Kamimura, T. , Nagasawa, T. , Kobayashi, Y. , Ito, H. , and Maitani, T. Detection of hydrocarbons in irradiated foods. Journal of Health Science, 49(3), 179–188, 2003.
Hartmann, M. , Ammon, J. , and Berg, H. Determination of radiation-induced hydrocarbons in processed food and complex lipid matrices. Zeitschrift für Lebensmittel Untersuchung und Forschung A, 204, 231, 1997.
Kim, H. , Cho, W.J. , Ahn, J.S. , Cho, D.H. , and Cha, Y.J. Identification of radiolytic marker compounds in the irradiated beef extract powder by volatile analysis. Microchemical Journal, 80(2), 127–137, 2005.
Eric, M. Detection of irradiated foods, In: Christopher H. Sommers, Xuetong Fan (Eds.) Food Irradiation Research and Technology, Blackwell Publishing and the Institute of Food Technologists, 2012, pp. 123–145.
Akram, K. , Ahn, J.J. , and Kwon, J.H. Analytical methods for the identification of irradiated foods, In: Eduard Belotserkovsky , Ziven Ostaltsov (Eds.) Ionizing Radiation: Applications, Sources and Biological Effects, 2012, pp. 1–36.
Solar, S. Reaction of OH with phenylalanine in neutral aqueous solution. Radiation Physics and Chemistry, 26, 103, 1985.
Karam, L.R. and Simic, M.G. detecting irradiated foods: Use of hydroxyl radical biomarkers. Analytical Chemistry, 60, 1117A, 1988.
Chauqui-Offermanns, N. and McDougall, T. An HPLC method to determine o-tyrosine in chicken meat. Journal of Agricultural and Food Chemistry, 39, 300, 1991.
Miyahara, M. , Nagasawa, T. , Kamimura, T. , Ito, H. , Toyoda, M. , and Saito, Y. Identification of irradiation of boned chicken by determination of o-tyrosine and electron spin resonance spectrometry. Journal of Health Science, 48(1), 79–82, 2002.
Hart, R.J. , White, J.A. , and Reid, W.J. Occurrence of o-tyrosine in nonirradiated foods. International Journal of Food Science and Technology, 23, 643, 1988.
Hein, W.G. , Simat, T.J. , and Steinhart, H. Determination of non-protein bound o-tyrosine as a marker for the detection of irradiated shrimps. European Food Research and Technology, 210, 299, 2000.
Krach, C. , Sontag, G. , and Solar, S. Determination of o- and m-tyrosine for identification of irradiated shrimps. Zeitschrift für Lebensmittel Untersuchung und Forschung A, 204, 417, 1997.
Furuta, M. , Dohmaru, T. , Katayama, T. , Toratani, H. , and Takeda, A. Detection of irradiated frozen deboned seafood with the level of radiolytic H2 and CO gases as a probe. Journal of Agricultural and Food Chemistry, 45(10), 3928–3931, 1997.
McKelvey-Martin, V.J. , Green, M.H.L. , Schmezer, P. , Pool-Zobel, B.L. , De Meo, M.P. , and Collins, A. The single cell gel electrophoresis assay (comet assay): A European review. Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis, 288(1), 47–63, 1993.
Praveen Kumar , P.K., Shyama Soorambail, K. , Harisingh, S.B. , D'Costa, A. , and Chandra, C.R. The effect of gamma radiation on the common carp (Cyprinus carpio): In vivo genotoxicity assessment with the micronucleus and comet assays. Mutation Research/Genetic Toxicology and Environmental Mutagenesis, 792, 19–25, 2015.
Şakalar, E. and Mol, S. Determination of irradiation dose and distinguishing between irradiated and non irradiated fish meat by real-time PCR. Food Chemistry, 182, 150–155, 2015.
Shyama, S.K. , D'Costa, A. , Kadam, S.B. , Sonaye, B.H. , and Chaubey, R.C. Evaluation of DNA damage induced by gamma radiation in gill and muscle tissues of Cyprinus carpio and their relative sensitivity. Ecotoxicology and Environmental Safety, 144, 166–170, 2017.
Marchioni, E. and Hasselmann, C. Alterations in mitochondrial DNA: A technique for the detection of irradiated beef (No. EUR–13331), 1991.
McMurray, Cecil H. , Stewart E.M. , Gray, R. , and Pearce, J. Detection of irradiated fresh, chilled and frozen foods by the mitochondrial DNA method, In Detection Methods for Irradiated Foods - Current Status, Marchioni, E. et al. (Eds.), Royal Society of Chemistry, Cambridge, 1996, pp. 355–366.
Deeble, D.J. , Jabir, A.W. , Parsons, B.J. , Smith, C.J. , and Wheatley, P. Changes in DNA as a possible means of detecting irradiated food, In: D. E. Johnston , M. H. Stevenson (Eds.) Food Irradiation and the Chemist, Royal Society of Chemistry, Cambridge, 1990, pp. 57–79.
Deeble, D.J. , Christiansen, J.F. , Jones, M. , Tyreman, A.L. , Smith, C.J. , Beaumont, P.C. , and Williams, J.H.H. Detection of irradiated food based on DNA bases changes. Food Science and Technology Today, 8, 96,

1994.
Tyreman, A.L. and Bonwick, G. Detection of food irradiation by ELISA. Food Science and Technology Today, 12, 108, 1998.
Tyreman, A.L. , Bonwick, G.A. , Smith, C.J. , Coleman, R.C. , Beaumont, P.C. , and Williams, J.H. Detection of irradiated food by immunoassay-development and optimization of an ELISA for dihydrothymidine in irradiated prawns. Journal of Food Science and Technology, 39, 533, 2004.
Fukui, N. , Takatori, S. , Kitagawa, Y. , Fujiwara, T. , Ishikawa, E. , Fujiyama, T. , Kajimura, K. , Furuta, M. , and Obana, H. Rapid and reliable method for determining irradiation histories of ground beef and prawns by measuring 5,6-dihydrothymidine. Journal of Agricultural and Food Chemistry, 65(42), 9342–9352, 2017.
Autio, T. and Pinnioja, S. Identification of irradiated foods by the thermoluminescene of mineral contamination. Zeitschrift für Lebensmittel Untersuchung und Forschung, 191, 177, 1990.
Leonardi, M. , Raffi, J.J. , and Belliardo, J. Identification of irradiated foods by the thermoluminescene of contaminating minerals, In Recent Advances on Detection of Irradiated Food, Autio, T. and Pinnioja, S. (Eds.), EUR-14315: Commission of the European Communities, Luxembourg, 1992, pp. 177–183.
Sanderson, D.C.W. , Carmicheal, L.A. , and Naylor, J.D. Recent advances in thermoluminescence and photostimulated luminescence detection methods for irradiated foods, In Detection Methods for Irradiated Foods - Current Status, McMurray, C.H. , Stewart, E.M. , Gray, R. , and Pearce, J. (Eds.), Royal Society of Chemistry, Cambridge, London, 1996, pp. 124–138.
Carmichael, L.A. and Sanderson, D.C.W. The use of acid hydrolysis for extracting minerals from shellfish for thermoluminescence detection of irradiation. Food Chemistry, 68, 233, 2000.
Sanderson, D. C. , Carmichael, L. A. , Spencer, J. Q. , and Naylor, J. D. Luminescence detection of shellfish, In Detection Methods for Irradiated Foods - Current Status, McMurray, C.H. , Stewart, E.M. , Gray, R. , and Pearce, J. (Eds.), Royal Society of Chemistry, Cambridge, London, 1996, pp. 139–148.
https://www.gla.ac.uk/surrc/luminescene/psl.html.
Sanderson, D.C.W. , Carmichael, L.A. , and Naylor, J.D. Photostimulated luminescence and thermoluminescene techniques for the detection of irradiated food. Food Science and Technology Today, 9, 150, 1995.
Sanderson, D.C.W. , Carmichael, L.A. , and Fisk, S. Establishing luminescence methods to detect irradiated food. Food Science and Technology Today, 12, 97, 1998.
Sanderson, D.C.W. , Carmichael, L.A. , and Fisk, S. Photostimulated luminescence detection of irradiated shellfish: International interlaboratory trial. Journal of AOAC International, 86, 983, 2003.
Sanderson, D.C.W. , Carmichael, L.A. , and Fisk, S. Photostimulated luminescence detection of irradiated herbs, spices, and seasonings: International interlaboratory trial. Journal of AOAC International, 86, 990, 2003.
Park, E.J. , Jang, H.N. , Jo, D. , Kim, G.R. , and Kwon, J.H. Physicochemical quality and luminescence characteristics of gamma-irradiated dried fish products. Korean Journal of Food Science and Technology, 45(2), 167–173, 2013.
Kim, M.Y. , Kim, G.R. , Ahn, J.J. , Park, K.S. , Kim, E.J. , Lee, K.J. , and Kwon, J.H. Luminescence detection characteristics for irradiated dried fishes using PSL-TL system. Korean Journal of Food Science and Technology, 45(1), 8–12, 2013.
Kim, M.Y. , Ahn, J.J. , Kim, G.R. , Kwak, J.Y. , Park, K.S. , Lee, K.J. , and Kwon, J.H. Luminescence identification characteristics for irradiated dried fishery products. Journal of The Korean Society of Food Science and Nutrition, 42(11), 1837–1842, 2013.
Kim, M.Y. , Ahn, J.J. , Akram, K. , Kim, G.R. , Jeong, M.S. , Kwak, J.Y. , and Kwon, J.H. Study of photo and thermoluminescence properties to identify irradiated dried-fishery products. Journal of Aquatic Food Product Technology, 25(3), 299–306, 2016.
Kim, B.K. , Shahbaz, H.M. , Akram, K. , Kim, C.T. , Ahn, J.J. , and Kwon, J.H. The impact of mineral separation procedure on thermoluminescence analysis of non-irradiated dried fish and shellfish. Acta Alimentaria, 44(3), 400–408, 2015.
Pettipher, G.L. and Rodrigues, U.M. Rapid enumeration of microorganisms in foods by the direct epifluorescent filter technique. Applied and Environmental Microbiology, 44(4), 809–813, 1982.
Jones, K.L. , MacPhee, S. , Turner, A. , Stuckey, T. , and Betts, R. The DEFT/APC screening method for the detection of irradiated frozen stored foods. A collaborative trial. Food Science and Technology Today, 10(3), 175–178, 1996.
Wirtanen, G. , Sjöberg, A.M. , Boisen, F. , and Alanko, T. Microbiological screening method for indication of irradiation of spices and herbs: A BCR collaborative study. Journal of AOAC International, 76(3), 674–681, 1993.
Oh, K.N. , Lee, S.Y. , Lee, H.J. , Kim, K.E. , and Yang, J.S. Screening of gamma irradiated spices in Korea by using a microbiological method (DEFT/APC). Food Control, 14(7), 489–494, 2003.
Scotter, S.L. , Beardwood, K. , and Wood, R. Limulus ameobocyte lysate test/gram negative bacteria count method for the detection of irradiated poultry: Results of two interlaboratory studies. Food Science and Technology Today, 8, 106, 1994.
Scotter, S.L. , Beardwood, K. , and Wood, R. Detection of irradiation treatment of poultry meat using the Limulus amoebocyte lysate test in conjunction with a gram negative bacteria count. Journal of the Association of Public Analysts, 31, 163, 1995.

Guatam, S. , Sharma, A. , and Thomas, P. Improved bacterial turbidimetric method for detection of irradiated spices. Jouranl of Agricultural and Food Chemistry, 46, 5110, 1998.
Zhao, Y. , Li, L. , Wang, C. , Ji, P. , Wang, C. , and Wang, Z. Detection of irradiated food by using direct epifluorescent filter technique/aerobic plate count method (DEFT/APC). Journal of Nuclear Agricultural Sciences, 24(5), 1006–1010, 2010.
Chung, N. , Ameer, K. , Jo, Y. , and Kwon, J.H. Comparison of electronic sensing techniques for screening dried shrimps irradiated using three types of approved radiation with standard analytical methods. Food Chemistry, 286, 395–404, 2019.
Rodrigues, P. and Venâncio, A. Biological techniques, In: Isabel C F R Ferreira, Amilcar L Antonio, Sandra Cabo Verde (Eds.) Food Irradiation Technologies: Concepts, Applications and Outcomes, 4, 2017, Royal Society of Chemistry, p. 314.

Analysis of Dioxins in Seafood and Seafood Products

Ahmed, F. E. (2003). Analysis of polychlorinated biphenyls in food products. TrAC - Trends in Analytical Chemistry, 22(3), 170–185. doi:10.1016/S0165-9936(03)00305-4.
Ahn, Y. G. , Seo, J. , Shin, J. H. , Khim, J. , & Hong, J. (2006). Development of new cleanup method of polychlorinated dibenzo-p-dioxins/dibenzofurans in fish by freezing-lipid filtration. Analytica Chimica Acta, 576(1), 31–36. doi:10.1016/J.ACA.2006.03.010.
Aoki, Y. (2001). Polychlorinated biphenyls, polychloronated dibenzo-p-dioxins, and polychlorinated dibenzofurans as endocrine disrupters - What we have learned from Yusho disease. Environmental Research, 86(1), 2–11. doi:10.1006/enrs.2001.4244.
Barone, G. , Storelli, A. , Quaglia, N. C. , Dambrosio, A. , Garofalo, R. , Chiumarulo, R. , & Storelli, M. M. (2019). Dioxin and PCB residues in meats from Italy: Consumer dietary exposure. Food and Chemical Toxicology, 133, 110717. doi:10.1016/J.FCT.2019.110717.
Baughman, R. , & Meselson, M. (1973). An analytical method for detecting TCDD (dioxin): Levels of TCDD in samples from Vietnam. Environmental Health Perspectives, 5, 27. doi:10.1289/EHP.730527.
Behnisch, P. A. , Hosoe, K. , & Sakai, S. I. (2001). Bioanalytical screening methods for dioxins and dioxin-like compounds a review of bioassay/biomarker technology. Environment International, 27(5), 413–439. doi:10.1016/S0160-4120(01)00028-9.
Bergkvist, C. , Öberg, M. , Appelgren, M. , Becker, W. , Aune, M. , Ankarberg, E. H. , Berglund, M. , & Håkansson, H. (2008). Exposure to dioxin-like pollutants via different food commodities in Swedish children and young adults. Food and Chemical Toxicology, 46(11), 3360–3367. doi:10.1016/J.FCT.2008.07.029.
Bhavsar, S. P. , Fletcher, R. , Hayton, A. , Reiner, E. J. , & Jackson, D. A. (2007). Composition of dioxin-like PCBs in fish: An application for risk assessment. Environmental Science and Technology, 41(9), 3096–3102. doi:10.1021/ES062402Y.
Bordajandi, L. R. , Gómara, B. , & González, M. J. (2009). Analysis of dioxins in seafood and seafood products. In: Leo M.L. Nollet and Fidel Toldra (Eds.) Handbook of Seafood and Seafood Products Analysis (pp. 797–815). CRC Press: Boca Raton. doi:10.1201/ebk1439848173-28.
Bordajandi, L. R. , Gómez, G. , Fernández, M. A. , Abad, E. , Rivera, J. , & González, M. J. (2003). Study on PCBs, PCDD/Fs, organochlorine pesticides, heavy metals and arsenic content in freshwater fish species from the River Turia (Spain). Chemosphere, 53(2), 163–171. doi:10.1016/S0045-6535(03)00417-X.
Buzitis, J. , Ylitalo, G. M. , & Krahn, M. M. (2006). Rapid method for determination of dioxin-like polychlorinated biphenyls and other congeners in marine sediments using sonic extraction and photodiode array detection. Archives of Environmental Contamination and Toxicology, 51(3), 337–346. doi:10.1007/S00244-005-0162-0.
Chang, J. W. , Liao, P. C. , & Lee, C. C. (2012). Dietary intake of PCDD/Fs and dioxin-like PCBs from fresh foods around Taiwan. Journal of Food and Drug Analysis, 20(4), 12. doi:10.6227/jfda.2012200409.
Cheremisinoff, N. P. (2016). Dioxins. In: Nicholas P. Cheremisinoff (Ed.) Pollution Control Handbook for Oil and Gas Engineering (pp. 355–365). John Wiley & Sons, Inc.,: Hoboken, New Jersey, doi:10.1002/9781119117896.CH27.
Chobtang, J. , de Boer, I. J. M. , Hoogenboom, R. L. A. P. , Haasnoot, W. , Kijlstra, A. , & Meerburg, B. G. (2011). The need and potential of biosensors to detect dioxins and dioxin-like polychlorinated biphenyls along the milk, eggs and meat food chain. Sensors, 11(12), 11692–11716. doi:10.3390/S111211692.
Cocco, E. , Guignard, C. , Hoffmann, L. , & Bohn, T. (2011). Rapid analysis of polychlorinated biphenyls in fish by pressurised liquid extraction with in-cell cleanup and GC-MS. International Journal of Environmental Analytical Chemistry, 91(4), 333–347. doi:10.1080/03067319.2010.496048.
Commission Regulation (EC) No. 1883/2006/EC. (n.d.) . Commission Regulation (EC) No. 1883/2006/EC laying down methods of sampling and analysis for the official control of the levels of nitrates in certain foodstuffs. Official Journal of the European Community, L364/32, December 2006-Google Search.
Connor, K. , & Finley, B. (2003). Naturally occurring Ah-receptor agonists in foods: Implications regarding dietary dioxin exposure and health risk. Human and Ecological Risk Assessment, 9(7), 1747–1763.

doi:10.1080/714044795.
Costopoulou, D. , Vassiliadou, I. , & Leondiadis, L. (2013). Infant dietary exposure to dioxins and dioxin-like compounds in Greece. Food and Chemical Toxicology: An International Journal Published for the British Industrial Biological Research Association, 59, 316–324. doi:10.1016/J.FCT.2013.06.012.
Danielsson, C. , Wiberg, K. , Korytár, P. , Bergek, S. , Brinkman, U. A. T. , & Haglund, P. (2005). Trace analysis of polychlorinated dibenzo-p-dioxins, dibenzofurans and WHO polychlorinated biphenyls in food using comprehensive two-dimensional gas chromatography with electron-capture detection. Journal of Chromatography A, 1086(1–2), 61–70. doi:10.1016/J.CHROMA.2004.11.071.
de Lacerda, J. P. A. (2019). The history of the dioxin issue in Brazil: From citrus pulp crisis to food monitoring (review). Environment International, 122, 11–20. doi:10.1016/J.ENVINT.2018.11.016.
Dindal, A. , Thompson, E. , Strozier, E. , & Billets, S. (2011). Application of GC-HRMS and GC×GC-TOFMS to aid in the understanding of a dioxin assay's performance for soil and sediment samples. Environmental Science & Technology, 45(24), 10501–10508. doi:10.1021/ES202149K.
Ding, G. , Wang, L. , Zhang, S. , Li, S. , Xie, Q. , Xu, L. , Zhou, Z. , He, Y. F. , & Zhao, B. (2021). Simple and rapid determination of dioxin in fish and sea food using a highly sensitive reporter cell line, CBG 2.8D. Journal of Environmental Sciences (China), 100, 353–359. doi:10.1016/J.JES.2020.07.006.
Dorman, F. , Reese, S. , Reiner, E. , MacPherson, K. , Focant, J. , & Cochran, J. (2004). Improved separation and quantification of dioxin and furan congeners using novel low-bleed capillary gas chromatography columns and mass spectrometry. Organohalogen Compounds, 66, 821–824.
Eljarrat, E. , & Barceló, D. (2002). Congener-specific determination of dioxins and related compounds by gas chromatography coupled to LRMS, HRMS, MS/MS and TOFMS. Journal of Mass Spectrometry, 37(11), 1105–1117. doi:10.1002/JMS.373.
Fayez, B. L. , Reiner, J. E. , Kolic, M. T. , Brunato, R. , Lega, R. , & MacPherson, A. K. (2008). AN Automated extraction/sample preparation method for the determination of PCDD/F, DLPCBs, BDEs and PCNs in biota in a single analysis. Organohalogen Compounds, 70, 001296–001299. https://www.google.com/search?q=AN+AUTOMATED+EXTRACTION%2FSAMPLE+PREPARATION+METHOD+FOR+THE+DETERMINATION+OF+PCDD%2FF%2C+DLPCBs%2C+BDEs+AND+PCNs+IN+BIOTA+IN+A+SINGLE+ANALYSIS&oq=AN+AUTOMATED+EXTRACTION%2FSAMPLE+PREPARATION+METHOD+FOR+THE+DETERMINATION+OF+PCDD%2FF%2C+DLPCBs%2C+BDEs+AND+PCNs+IN+BIOTA+IN+A+SINGLE+ANALYSIS&aqs=chrome.69i57.337j0j9&sourceid=chrome&ie=UTF-8.
Fillos, D. , Scott, L. L. F. , De Sylor, M. A. , Grespin, M. , Luksemburg, W. J. , & Finley, B. (2012). PCB concentrations in shrimp from major import markets and the United States. Environmental Toxicology and Chemistry, 31(5), 1063–1071. doi:10.1002/ETC.1803.
Fishman, V. N. , Martin, G. D. , & Lamparski, L. L. (2007). Comparison of a variety of gas chromatographic columns with different polarities for the separation of chlorinated dibenzo-p-dioxins and dibenzofurans by high-resolution mass spectrometry. Journal of Chromatography A, 1139(2), 285–300. doi:10.1016/J.CHROMA.2006.11.025.
Focant, J. F. , Eppe, G. , Pirard, C. , & De Pauw, E. (2001). Fast clean-up for polychlorinated dibenzo-p-dioxins, dibenzofurans and coplanar polychlorinated biphenyls analysis of high-fat-content biological samples. Journal of Chromatography A, 925(1–2), 207–221. doi:10.1016/S0021-9673(01)01047-0.
Focant, J. F. , Eppe, G. , Scippo, M. L. , Massart, A. C. , Pirard, C. , Maghuin-Rogister, G. , & De Pauw, E. (2005). Comprehensive two-dimensional gas chromatography with isotope dilution time-of-flight mass spectrometry for the measurement of dioxins and polychlorinated biphenyls in foodstuffs. Comparison with other methods. Journal of Chromatography A, 1086(1–2), 45–60. doi:10.1016/J.CHROMA.2005.05.090.
Focant, J. F. , Pirard, C. , & De Pauw, E. (2004). Automated sample preparation-fractionation for the measurement of dioxins and related compounds in biological matrices: A review. Talanta, 63(5), 1101–1113. doi:10.1016/J.TALANTA.2004.05.025.
García-Bermejo, Á. , Ábalos, M. , Sauló, J. , Abad, E. , González, M. J. , & Gómara, B. (2015). Triple quadrupole tandem mass spectrometry: A real alternative to high resolution magnetic sector instrument for the analysis of polychlorinated dibenzo-p-dioxins, furans and dioxin-like polychlorinated biphenyls. Analytica Chimica Acta, 889, 156–165. doi:10.1016/J.ACA.2015.07.039.
Grabic, R. , Novak, J. , & Pacakova, V. (2000). Optimization of a GCMS/MS method for the analysis of PCDDs and PCDFs in human and fish tissue. Journal of High Resolution Chromatography, 23(10), 595–599. https://onlinelibrary.wiley.com/doi/abs/10.1002/1521-4168%2820001001%2923%3A10%3C595%3A%3AAID-JHRC595%3E3.0.CO%3B2-T.
Haglund, P. , Korytár, P. , Danielsson, C. , Diaz, J. , Wiberg, K. , Leonards, P. , Brinkman, U. A. T. , & De Boer, J. (2008). GC × GC-ECD: A promising method for the determination of dioxins and dioxin-like PCBs in food and feed. Analytical and Bioanalytical Chemistry, 390(7), 1815–1827. doi:10.1007/S00216-008-1896-0.
Hartmann, R. (2013). Extraction of PCDD/Fs and PCBs in fish using SpeedExtractor E-914. Procedia Environmental Sciences, 18, 875–881. doi:10.1016/j.proenv.2013.04.118.
Hasegawa, J. , Guruge, K. S. , Seike, N. , Shirai, Y. , Yamata, T. , Nakamura, M. , Handa, H. , Yamanaka, N. , & Miyazaki, S. (2007). Determination of PCDD/Fs and dioxin-like PCBs in fish oils for feed ingredients by congener-specific chemical analysis and CALUX bioassay. Chemosphere, 69(8), 1188–1194. doi:10.1016/J.CHEMOSPHERE.2007.06.021.

Hayward, D. G. , Archer, J. C. , Andrews, S. , Fairchild, R. D. , Gentry, J. , Jenkins, R. , McLain, M. , Nasini, U. , & Shojaee, S. (2018). Application of a high-resolution quadrupole/orbital trapping mass spectrometer coupled to a gas chromatograph for the determination of persistent organic pollutants in cow's and human milk. Journal of Agricultural and Food Chemistry, 66(44), 11823–11829. doi:10.1021/ACS.JAFC.8B03721.

Hoogenboom, R. L. A. P. , Kotterman, M. J. J. , Hoek-van Nieuwenhuizen, M. , van der Lee, M. K. , Mennes, W. C. , Jeurissen, S. M. F. , & van Leeuwen, S. P. J. (2015). Dioxins, PCBs and heavy metals in Chinese mitten crabs from Dutch rivers and lakes. Chemosphere, 123, 1–8. doi:10.1016/J.CHEMOSPHERE.2014.10.055.

Ingelido, A. M. , Brambilla, G. , Abballe, A. , Di Domenico, A. , Fulgenzi, A. R. , Iacovella, N. , Valentini, A. L. I. S. , & Felip, E. D. (2012). PCDD, PCDF, and DL-PCB analysis in food: Performance evaluation of the high-resolution gas chromatography/low-resolution tandem mass spectrometry technique using consensus-based samples. Rapid Communications in Mass Spectrometry, 26(3), 236–242. doi:10.1002/RCM.5324.

Inuyama, Y. , Nakamura, C. , Oka, T. , Yoneda, Y. , Obataya, I. , Santo, N. , & Miyake, J. (2007). Simple and high-sensitivity detection of dioxin using dioxin-binding pentapeptide. Biosensors and Bioelectronics, 22(9–10), 2093–2099. doi:10.1016/J.BIOS.2006.09.016.

Kalachova, K. , Pulkrabova, J. , Cajka, T. , Drabova, L. , & Hajslova, J. (2012). Implementation of comprehensive two-dimensional gas chromatography-time-of-flight mass spectrometry for the simultaneous determination of halogenated contaminants and polycyclic aromatic hydrocarbons in fish. Analytical and Bioanalytical Chemistry, 403(10), 2813–2824. doi:10.1007/S00216-012-6095-3.

Kannan, K. , & Aldous, K. M. (2004). Dioxins. In: Paul Worsfold , Alan Townshend and Colin Poole (Eds.) Encyclopedia of Analytical Science: Second Edition (pp. 274–281). Elsevier: Wadsworth Center, Albany, NY, USA. doi:10.1016/B0-12-369397-7/00106-0.

Karl, H. , Ruoff, U. , & Blüthgen, A. (2002). Levels of dioxins in fish and fishery products on the German market. Chemosphere, 49(7), 765–773. doi:10.1016/S0045-6535(02)00399-5.

Kimbrough, R. D. , Carter, C. D. , Liddle, J. A. , & Cline, R. E. (1977). Epidemiology and pathology of a tetrachlorodibenzodioxin poisoning episode. Archives of Environmental Health, 32(2), 77–85. doi:10.1080/00039896.1977.10667259.

Kitamura, K. , Takazawa, Y. , Hashimoto, S. , Choi, J. W. , Ito, H. , & Morita, M. (2004). Effective extraction method for dioxin analysis from lipid-rich biological matrices using a combination of pressurized liquid extraction and dimethyl sulfoxide/acetonitrile/hexane partitioning. Analytica Chimica Acta, 512(1), 27–37. doi:10.1016/J.ACA.2004.02.040.

Kiviranta, H. , Ovaskainen, M. L. , & Vartiainen, T. (2004). Market basket study on dietary intake of PCDD/Fs, PCBs, and PBDEs in Finland. Environment International, 30(7), 923–932. doi:10.1016/J.ENVINT.2004.03.002.

Knutsen, H. K. , Alexander, J. , Barregård, L. , Bignami, M. , Brüschweiler, B. , Ceccatelli, S. , Cottrill, B. , Dinovi, M. , Edler, L. , Grasl-Kraupp, B. , Hogstrand, C. , Nebbia, C. S. , Oswald, I. P. , Petersen, A. , Rose, M. , Roudot, A.-C. , Schwerdtle, T. , Vleminckx, C. , Vollmer, G. , Wallace, H. , Fürst, P. , Håkansson, H. , Halldorsson, T. , Lundebye, A.-K. , Pohjanvirta, R. , Rylander, L. , Smith, A. , van Loveren, H. , Waalkens-Berendsen, I. , Zeilmaker, M. , Binaglia, M. , Ruiz, J. Á. G. , Horváth, Z. , Christoph, E. , Ciccolallo, L. , Bordajandi, L. R. , Steinkellner, H. , & (Ron) Hoogenboom, L. (2018). Risk for animal and human health related to the presence of dioxins and dioxin-like PCBs in feed and food. EFSA Journal, 16(11), e05333. doi:10.2903/J.EFSA.2018.5333.

Kojima, H. , Takeuchi, S. , Tsutsumi, T. , Yamaguchi, K. , Anezaki, K. , Kubo, K. , Iida, M. , Takahashi, T. , Kobayashi, S. , Jin, K. , & Nagai, T. (2011). Determination of dioxin concentrations in fish and seafood samples using a highly sensitive reporter cell line, DR-EcoScreen cells. Chemosphere, 83(6), 753–759. doi:10.1016/J.CHEMOSPHERE.2011.02.062.

Kulkarni, P. S. (2016). Dioxins. In: Maximilian Lackner , Franz Winter , Avinash Kumar Agarwal and JoAnn Slama Lighty (Eds.) Handbook of Combustion (pp. 1–28). WileyVCH Verlag GmbH & Co. KGaA. doi:10.1002/9783527628148.HOC096.

Larsen, J. C. (2006). Risk assessments of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and dioxin-like polychlorinated biphenyls in food. Molecular Nutrition and Food Research, 50(10), 885–896. doi:10.1002/MNFR.200500247.

Leong, Y. H. , & Majid, M. I. A. (2017). Dioxins and dioxin-like polychlorinated biphenyls in seafood: Dietary exposure amongst Malaysian adult populations and its association with sociodemographic factors. International Food Research Journal, 24(2), 755–769.

Leong, Y. H. , Gan, C. Y. , & Majid, M. I. A. (2014). Dioxin-like polychlorinated biphenyls, polychlorinated dibenzop-dioxins, and polychlorinated dibenzofurans in seafood samples from Malaysia: Estimated human intake and associated risks. Archives of Environmental Contamination and Toxicology, 67(1), 21–28. doi:10.1007/S00244-014-0019-5.

Lindén, J. , Lensu, S. , Tuomisto, J. , & Pohjanvirta, R. (2010). Dioxins, the aryl hydrocarbon receptor and the central regulation of energy balance. Frontiers in Neuroendocrinology, 31(4), 452–478. doi:10.1016/J.YFRNE.2010.07.002.

Maciel, G. P. D. S. , Silva, J. M. D. , Bispo, M. D. , Krause, L. C. , Jacques, R. A. , Zini, C. A. , Caramão, E. B. , Maciel, G. P. D. S. , Silva, J. M. D. , Bispo, M. D. , Krause, L. C. , Jacques, R. A. , Zini, C. A. , & Caramão, E. B. (2017). Comprehensive two-dimensional gas chromatography and its application to the investigation of pyrolytic

liquids. Pyrolysis, 1, 89–124. doi:10.5772/68077.
Malavia, J. , Abalos, M. , Santos, F. J. , Abad, E. , Rivera, J. , & Galceran, M. T. (2007). Analysis of polychlorinated dibenzo-p-dioxins, dibenzofurans and dioxin-like polychlorinated biphenyls in vegetable oil samples by gas chromatography-ion trap tandem mass spectrometry. Journal of Chromatography A, 1149(2), 321–332. doi:10.1016/j.chroma.2007.03.052.
Malisch, R. , & Kotz, A. (2014). Dioxins and PCBs in feed and food - Review from European perspective. Science of the Total Environment, 491–492, 2–10. doi:10.1016/j.scitotenv.2014.03.022.
Mamoon, H. A. (2013). Evaluation of the separation capacity of different GC columns for tetra- to octachlorinated PCDD/Fs. April.
Marinković, N. , Pašalić, D. , Ferenčak, G. , Gršković, B. , & Rukavina, A. S. (2010). Dioxins and human toxicity. Arhiv Za Higijenu Rada i Toksikologiju, 61(4), 445–453. doi:10.2478/10004-1254-61-2010-2024.
Mehouel, F. , Bouayad, L. , Berber, A. , Boutaleb, S. , Miri, M. , & Scippo, M. L. (2021). Health risk assessment of exposure to polychlorinated dibenzo-p-dioxins/dibenzofurans (PCDD/Fs) and dioxin-like polychlorinated biphenyls (DL-PCBs) in swordfish from the Mediterranean Sea. Environmental Science and Pollution Research, 28(20), 26106–26111. doi:10.1007/S11356-021-12479-8/TABLES/1.
Moxness Reksten, A. , Bøkevoll, A. , Frantzen, S. , Lundebye, A. K. , Kögel, T. , Kolås, K. , Aakre, I. , & Kjellevold, M. (2020). Sampling protocol for the determination of nutrients and contaminants in fish and other seafood - The EAF-Nansen Programme. MethodsX, 7, 101063. doi:10.1016/J.MEX.2020.101063.
Nakatani, T. , Yamamoto, A. , & Ogaki, S. (2011). A survey of dietary intake of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and dioxin-like coplanar polychlorinated biphenyls from food during 2000–2002 in Osaka City, Japan. Archives of Environmental Contamination and Toxicology, 60(3), 543–555. doi:10.1007/S00244-010-9553-Y.
Nollet, L. M. L. , & Toldrá, F. (2009). Handbook of seafood and seafood products analysis. In: Leo M.L. Nollet , Fidel Toldra (Eds.) Handbook of Seafood and Seafood Products Analysis (pp. 1–930). CRC Press: Boca Raton. doi:10.1201/9781420046359/HANDBOOK-SEAFOOD-SEAFOOD-PRODUCTS-ANALYSIS- LEO-NOLLET-FIDEL-TOLDRA.
Norstrom, R. J. , Simon, M. , & Mulvihill, M. J. (2006). A gel-permeation/column chromatography cleanup method for the determination of CDDs in animal tissue. International Journal of Environmental Analytical Chemistry, 23(4), 267–287. doi:10.1080/03067318608076450.
Otaka, H. , Shimono, H. , & Hashimoto, S. (2004). Optimization of solid-phase extraction procedure for determination of polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls in humic acid containing water. Analytical and Bioanalytical Chemistry, 378(7), 1854–1860. doi:10.1007/S00216-004-2510-8.
Otake, T. , Aoyagi, Y. , Numata, M. , & Yarita, T. (2008). Evaluation of microwave-assisted extraction for the analysis of polychlorinated biphenyls and organochlorine pesticides in fish. Journal of AOAC International, 91(5), 1124–1129. doi:10.1093/JAOAC/91.5.1124.
Parvez, S. , Evans, A. M. , Lorber, M. , Hawkins, B. S. , Swartout, J. C. , Teuschler, L. K. , & Rice, G. E. (2013). A sensitivity analysis using alternative toxic equivalency factors to estimate U.S. dietary exposures to dioxin-like compounds. Regulatory Toxicology and Pharmacology, 67(2), 278–284. doi:10.1016/J.YRTPH.2013.08.007.
Perez, G. , Mascini, M. , Lanzone, V. , Sergi, M. , Del Carlo, M. , Esposito, M. , & Compagnone, D. (2013). Peptides trapping dioxins: A docking-based inverse screening approach. Journal of Chemistry, 2013, 1–8. doi:10.1155/2013/491827.
Petronijevic, R. , Radicevic, T. , & Jankovic, V. (2015). Methods for determination of dioxins and dioxin-like compounds - A brief review of recent advances. Procedia Food Science, 5, 227–230. doi:10.1016/J.PROFOO.2015.09.036.
Phillips, J. B. , & Beens, J. (1999). Comprehensive two-dimensional gas chromatography: A hyphenated method with strong coupling between the two dimensions. Journal of Chromatography A, 856(1–2), 331–347. doi:10.1016/S0021-9673(99)00815-8.
Planche, C. , Ratel, J. , Mercier, F. , Blinet, P. , Debrauwer, L. , & Engel, E. (2015). Assessment of comprehensive two-dimensional gas chromatography-time-of-flight mass spectrometry based methods for investigating 206 dioxin-like micropollutants in animal-derived food matrices. Journal of Chromatography A, 1392, 74–81. doi:10.1016/J.CHROMA.2015.02.054.
Puga, A. , Tomlinson, C. R. , & Xia, Y. (2005). Ah receptor signals cross-talk with multiple developmental pathways. Biochemical Pharmacology, 69(2), 199–207. doi:10.1016/J.BCP.2004.06.043.
Reiner, E. J. (2010). The analysis of dioxins and related compounds. Mass Spectrometry Reviews, 29(4), 526–559. doi:10.1002/MAS.20255.
Rodriguez-Mozaz, S. , Lopez De Alda, M. J. , & Barceló, D. (2006). Biosensors as useful tools for environmental analysis and monitoring. Analytical and Bioanalytical Chemistry, 386(4), 1025–1041. doi:10.1007/S00216-006-0574-3/TABLES/1.
Ryan, J. J. , Conacher, H. B. S. , Panopio, L. G. , Lau, B. P. Y. , Hardy, J. A. , & Masuda, Y. (1991). Gas chromatographic separations of all 136 tetra- to octapolychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans on nine different stationary phases. Journal of Chromatography A, 541(C), 131–183. doi:10.1016/S0021-9673(01)95990-4.

Rysavy, N. M. , Maaetoft-Udsen, K. , & Turner, H. (2013). Dioxins: Diagnostic and prognostic challenges arising from complex mechanisms. Journal of Applied Toxicology: JAT, 33(1), 1–8. doi:10.1002/JAT.2759.
Schecter, A. , Birnbaum, L. , Ryan. J. J. , & Constable, J. D. (2006). Dioxins: An overview. Environmental Research, 101, 419–428. doi:10.1016/J.ENVRES.2005.12.003.
Schecter, A. , Quynh, H. T. , Pavuk, M. , Päpke, O. , Malisch, R. , & Constable, J. D. (2003). Food as a source of dioxin exposure in the residents of Bien Hoa City, Vietnam. Journal of Occupational and Environmental Medicine, 45(8), 781–788. doi:10.1097/01.jom.0000085786.50835.71.
Schmid, P. , Gujer, E. , Degen, S. , Zennegg, M. , Kuchen, A. , & Wüthrich, C. (2002). Levels of polychlorinated dibenzo-p-dioxins and dibenzofurans in food of animal origin. The Swiss dioxin monitoring program. Journal of Agricultural and Food Chemistry, 50(25), 7482–7487. doi:10.1021/JF025669Z.
Sciuto, S. , Prearo, M. , Desiato, R. , Bulfon, C. , Burioli, E. A. V. , Esposito, G. , Guglielmetti, C. , Dell'atti, L. , Ru, G. , Volpatti, D. , Acutis, P. L. , & Martucci, F. (2018). Dioxin-like compounds in lake fish species: Evaluation by DR-CALUX bioassay. Journal of Food Protection, 81(5), 842–847. doi:10.4315/0362-028X.JFP-17-476.
Shimomura, M. , Nomura, Y. , Zhang, W. , Sakino, M. , Lee, K. H. , Ikebukuro, K. , & Karube, I. (2001). Simple and rapid detection method using surface plasmon resonance for dioxins, polychlorinated biphenylx and atrazine. Analytica Chimica Acta, 434(2), 223–230. doi:10.1016/S0003-2670(01)00809-1.
Smith, L. M. , Stalling, D. L. , & Johnson, J. L. (1984). Determination of part-per-trillion levels of polychlorinated dibenzofurans and dioxins in environmental samples. Analytical Chemistry, 56(11), 1830–1842. doi:10.1021/AC00275A018.
Srogi, K. (2007). Overview of analytical methodologies for dioxin analysis. Analytical Letters, 40(9), 1647–1671. doi:10.1080/00032710701385748.
Strandberg, B. , Bergqvist, P. A. , & Rappe, C. (1998). Dialysis with semipermeable membranes as an efficient lipid removal method in the analysis of bioaccumulative chemicals. Analytical Chemistry, 70(3), 526–533. doi:10.1021/AC970647A.
Takeuchi, S. , Iida, M. , Yabushita, H. , Matsuda, T. , & Kojima, H. (2008). In vitro screening for aryl hydrocarbon receptor agonistic activity in 200 pesticides using a highly sensitive reporter cell line, DR-EcoScreen cells, and in vivo mouse liver cytochrome P450-1A induction by propanil, diuron and linuron. Chemosphere, 74(1), 155–165. doi:10.1016/J.CHEMOSPHERE.2008.08.015.
Tavakoly Sany, S. B. , Narimani, L. , Soltanian, F. K. , Hashim, R. , Rezayi, M. , Karlen, D. J. , & Mahmud, H. N. M. E. (2016). An overview of detection techniques for monitoring dioxin-like compounds: Latest technique trends and their applications. RSC Advances, 6(60), 55415–55429. doi:10.1039/c6ra11442c.
Tian, W. , Wang, L. , Lei, H. , Sun, Y. , & Xiao, Z. (2018). Antibody production and application for immunoassay development of environmental hormones: A review. Chemical and Biological Technologies in Agriculture, 5(1), 5. doi:10.1186/S40538-018-0117-0.
Tian, W. , Xie, H. Q. , Fu, H. , Pei, X. , & Zhao, B. (2012). Immunoanalysis methods for the detection of dioxins and related chemicals. Sensors (Basel, Switzerland), 12(12), 16710. doi:10.3390/S121216710.
Tsutsumi, T. , Amakura, Y. , Nakamura, M. , Brown, D. J. , Clark, G. C. , Sasaki, K. , Toyoda, M. , & Maitani, T. (2003). Validation of the CALUX bioassay for the screening of PCDD/Fs and dioxin-like PCBs in retail fish. The Analyst, 128(5), 486–492. doi:10.1039/B300339F.
Tsutsumi, T. , Amakura, Y. , Okuyama, A. , Tanioka, Y. , Sakata, K. , Sasaki, K. , & Maitani, T. (2006). Application of an ELISA for PCB 118 to the screening of dioxin-like PCBs in retail fish. Chemosphere, 65(3), 467–473. doi:10.1016/J.CHEMOSPHERE.2006.01.059.
Van Den Berg, M. , Birnbaum, L. , Bosveld, A. T. C. , Brunström, B. , Cook, P. , Feeley, M. , Giesy, J. P. , Hanberg, A. , Hasegawa, R. , Kennedy, S. W. , Kubiak, T. , Larsen, J. C. , Van Leeuwen, F. X. R. , Liem, A. K. D. , Nolt, C. , Peterson, R. E. , Poellinger, L. , Safe, S. , Schrenk, D. , Tillitt, D. , Tysklind, M. , Younes, M. , Waern, F. , and Zacharewski, T. (1998). Toxic equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. Environmental Health Perspectives, 106(12), 775. doi:10.1289/EHP.98106775.
Van Den Berg, M. , Birnbaum, L. S. , Denison, M. , De Vito, M. , Farland, W. , Feeley, M. , Fiedler, H. , Hakansson, H. , Hanberg, A. , Haws, L. , Rose, M. , Safe, S. , Schrenk, D. , Tohyama, C. , Tritscher, A. , Tuomisto, J. , Tysklind, M. , Walker, N. , & Peterson, R. E. (2006). The 2005 World Health Organization reevaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicological Sciences: An Official Journal of the Society of Toxicology, 93(2), 223–241. doi:10.1093/TOXSCI/KFL055.
Van Den Berg, M. , Kypke, K. , Kotz, A. , Tritscher, A. , Lee, S. Y. , Magulova, K. , Fiedler, H. , & Malisch, R. (2017). WHO/UNEP global surveys of PCDDs, PCDFs, PCBs and DDTs in human milk and benefit-risk evaluation of breastfeeding. Archives of Toxicology, 91(1), 83–96. doi:10.1007/S00204-016-1802-Z/TABLES/2.
Weir, E. (2005). Public health: Dioxin contamination and poisoning. CMAJ: Canadian Medical Association Journal, 172(7), 873. doi:10.1503/CMAJ.045283.
White, S. S. , & Birnbaum, L. S. (2009). An overview of the effects of dioxins and dioxin-like compounds on vertebrates, as documented in human and ecological epidemiology. Journal of Environmental Science and Health. Part C, Environmental Carcinogenesis & Ecotoxicology Reviews, 27(4), 197. doi:10.1080/10590500903310047.

Wiberg, K. , Sporring, S. , Haglund, P. , & Björklund, E. (2007). Selective pressurized liquid extraction of polychlorinated dibenzo-p-dioxins, dibenzofurans and dioxin-like polychlorinated biphenyls from food and feed samples. Journal of Chromatography A, 1138(1–2), 55–64. doi:10.1016/j.chroma.2006.10.074.
Wong, W. W. K. , Yip, Y. C. , Choi, K. K. , Ho, Y. Y. , & Xiao, Y. (2013). Dietary exposure to dioxins and dioxin-like PCBs of Hong Kong adults: Results of the first Hong Kong total diet study. Food Additives and Contaminants - Part A, 30(12), 2152–2158. doi:10.1080/19440049.2013.849388.
Wu, W. L. , Deng, X. L. , Zhou, S. J. , Liang, H. , Yang, X. F. , Wen, J. , Li, X. M. , Zhang, C. Z. , Zhang, Y. H. , & Zou, F. (2018). Levels, congener profiles, and dietary intake assessment of polychlorinated dibenzo-p-dioxins/dibenzofurans and dioxin-like polychlorinated biphenyls in beef, freshwater fish, and pork marketed in Guangdong Province, China. Science of the Total Environment, 615, 412–421. doi:10.1016/j.scitotenv.2017.09.273.
Xia, D. , Gao, L. , Zheng, M. , Wang, S. , & Liu, G. (2016). Simultaneous analysis of polychlorinated biphenyls and polychlorinated naphthalenes by isotope dilution comprehensive two-dimensional gas chromatography high-resolution time-of-flight mass spectrometry. Analytica Chimica Acta, 937, 160–167. doi:10.1016/J.ACA.2016.07.018.
Zhang, L. , Li, J. , Liu, X. , Zhao, Y. , Li, X. , Wen, S. , & Wu, Y. (2013). Dietary intake of PCDD/Fs and dioxin-like PCBs from the Chinese total diet study in 2007. Chemosphere, 90(5), 1625–1630. doi:10.1016/J.CHEMOSPHERE.2012.08.040.
Zhang, W. , Sargis, R. M. , Volden, P. A. , Carmean, C. M. , Sun, X. J. , & Brady, M. J. (2012). PCB 126 and other dioxin-like PCBs specifically suppress hepatic PEPCK expression via the aryl hydrocarbon receptor. PLoS One, 7(5), 37103. doi:10.1371/JOURNAL.PONE.0037103.
Zhou, X. C. , & Cao, L. (2001). High sensitivity microgravimetric biosensor for qualitative and quantitative diagnostic detection of polychlorinated dibenzo-p-dioxins. Analyst, 126(1), 71–78. doi:10.1039/b006221i.

Environmental Contaminants

Anastassiades, M. , & Lehotay, D. (2003). Fast and easy multiresidue method employing acetonitrile extraction/partitioning and “dispersive solid-phase extraction” for the determination of pesticide residues in produce. Journal of AOAC International, 86(2), 412–431. doi:10.1093/jaoac/86.2.412.
Antunes, P. , Gil, O. , & Bernardo-Gil, M. (2003). Supercritical fluid extraction of organochlorines from fish muscle with different sample preparation. The Journal of Supercritical Fluids, 25(2), 135–142. doi:10.1016/S0896-8446(02)00141-9.
Ayris, S. , Currado, G. M. , Smith, D. , & Harrad, S. (1997). GC/MS procedures for the determination of PCBs in environmental matrices. Chemosphere, 35(5), 905–917. doi:10.1016/S0045-6535(97)00187-2.
Bartle, K.D. (1991). Analysis and occurrence of polycyclic aromatic hydrocarbons in food. In: L.S. Creases and R. Purchase . (Eds.), Food contaminants: Sources and surveillance, pp. 41–60. London: Royal Society of Chemistry.
Björklund, E. , Bøwadt, S. , Nilsson, T. , & Mathiasson, L. (1999). Pressurized fluid extraction of polychlorinated biphenyls in solid environmental samples. Journal of Chromatography A, 836(2), 285–293. doi:10.1016/S0021-9673(99)00077-1.
Björklund, E. , Muller, A. , & von Holst, C. (2001). Comparison of fat retainers in accelerated solvent extraction for the selective extraction of PCBs from fat-containing samples. Analytical Chemistry, 73(16), 4050–4053. doi:10.1021/ac010178j.
Björklund, E. , Sporring, S. , Wiberg, K. , Haglund, P. , & Holst, C. V. (2006). New strategies for extraction and clean-up of persistent organic pollutants from food and feed samples using selective pressurized liquid extraction. TrAC - Trends in Analytical Chemistry, 25(4), 318–325. doi:10.1016/j.trac.2005.10.003.
Bøwadt, S. , Johansson, B. , Fruekilde, P. , Hansen, M. , Zilli, D. , Larsen, B. , & de Boer, J. (1994). Supercritical fluid extraction of polychlorinated biphenyls from lyophilized fish tissue. Journal of Chromatography A, 675(1–2), 189–204. doi:10.1016/0021-9673(94)85272-3.
Bye, T. , Romundstad, P. R. , Ronneberg, A. , & Hilt, B. (1998). Health survey of former workers in a Norwegian coke plant: Part 2. Cancer incidence and cause specific mortality. Occupational and Environmental Medicine, 55, 622. doi:10.1136/oem.55.9.622.
Camel, V. (2001). Recent extraction techniques for solid matrices - Supercritical fluid extraction, pressurized fluid extraction and microwave-assisted extraction: Their potential and pitfalls. Analyst, 126(7), 1182–1193. doi:10.1039/b008243k.
Chatterjee, N. S. , Utture, S. , Banerjee, K. , Ahammed Shabeer, T. P. , Kamble, N. , Mathew, S. , & Ashok Kumar, K. (2016). Multiresidue analysis of multiclass pesticides and polyaromatic hydrocarbons in fatty fish by gas chromatography tandem mass spectrometry and evaluation of matrix effect. Food Chemistry, 196, 1–8. doi:10.1016/j.foodchem.2015.09.014.
Chiang, C. F. , Hsu, K. C. , Tsai, T. Y. , Cho, C. Y. , Hsu, C. H. , & Yang, D. J. (2021). Evaluation of optimal QuEChERS conditions of various food matrices for rapid determination of EU priority polycyclic aromatic hydrocarbons in various foods. Food Chemistry, 334, 127471. doi:10.1016/j.foodchem.2020.127471.

Cloutier, P. L. , Fortin, F. , Groleau, P. E. , Brousseau, P. , Fournier, M. , & Desrosiers, M. (2017). QuEChERS extraction for multi-residue analysis of PCBs, PAHs, PBDEs and PCDD/Fs in biological samples. Talanta, 165(December 2016), 332–338. doi:10.1016/j.talanta.2016.12.080.
Covaci, A. , Voorspoels, S. , & de Boer, J. (2003). Determination of brominated flame retardants, with emphasis on polybrominated diphenyl ethers (PBDEs) in environmental and human samples - A review. Environment International, 29(6), 735–756. doi:10.1016/S0160-4120(03)00114-4.
De Boer, J. , & Law, R. J. (2003). Developments in the use of chromatographic techniques in marine laboratories for the determination of halogenated contaminants and polycyclic aromatic hydrocarbons. Journal of Chromatography A, 1000(1–2), 223–251. doi:10.1016/S0021-9673(03)00309-1.
Dione, C. , Delhomme, O. , & Diagne, I. , Diebakate, C. , Ndiaye, B. , Cisse, D. , Maoudo, H. , Dione, M. , Diouf, S. , Diop, A. , Ndiaye, M. , & Millet, M. (2022). Application of the QuEChERS method for the determination of pesticides, PAHs and PCBs in fish in Senegal. Journal of Environmental Science and Health, Part A. 57. 1–11. doi: 10.1080/10934529.2022.2123188.
Dong, M. W. , & Greenberg, A. (1988). Liquid chromatographic analysis of polynuclear aromatic hydrocarbons with diode array detection. Journal of Liquid Chromatography, 11(9–10), 1887–1905. doi:10.1080/01483918808069032.
Eljarrat, E. , De La Cal, A. , Raldua, D. , Duran, C. , & Barcelo, D. (2004). Occurrence and bioavailability of polybrominated diphenyl ethers and hexabromocyclododecane in sediment and fish from the Cinca River, a tributary of the Ebro River (Spain). Environmental Science and Technology, 38(9), 2603–2608. doi:10.1021/es0301424.
Fazio, T. , White, R. H. , & Howard, J. W. (1973). Collaborative study of the multicomponent method for polycyclic aromatic hydrocarbons in foods. Journal - Association of Official Analytical Chemists, 56(1), 68–70. doi:10.1093/jaoac/56.1.68.
Fidalgo-Used, N. , Blanco-González, E. , & Sanz-Medel, A. (2007). Sample handling strategies for the determination of persistent trace organic contaminants from biota samples. Analytica Chimica Acta, 590(1), 1–16. doi:10.1016/j.aca.2007.03.004.
Focant, J. F. , Eppe, G. , Pirard, C. , & De Pauw, E. (2001). Fast clean-up for polychlorinated dibenzo-p-dioxins, dibenzofurans and coplanar polychlorinated biphenyls analysis of high-fat-content biological samples. Journal of Chromatography A, 925(1–2), 207–221. doi:10.1016/S0021-9673(01)01047-0.
Gómez-Ariza, J. L. , Bujalance, M. , Giráldez, I. , Velasco, A. , & Morales, E. (2002). Determination of polychlorinated biphenyls in biota samples using simultaneous pressurized liquid extraction and purification. Journal of Chromatography A, 946(1–2), 209–219. doi:10.1016/S0021-9673(01)01534-5.
Grimalt, S. , & Dehouck, P. (2016). Review of analytical methods for the determination of pesticide residues in grapes. Journal of Chromatography A, 1433, 1–23. doi:10.1016/j.chroma.2015.12.076.
Hale, R. C. , & Gaylor, M. O. (1995). Determination of PCBs in fish tissues using supercritical fluid extraction. Environmental Science and Technology, 29(4), 1043–1047. doi:10.1021/es00004a026.
Harrad, S. J. , Sewart, A. S. , Boumphrey, R. , Duerte-Davidson, R. , & Jones, K. (1992). A method for the determination of PCB congeners 77, 126 and 169 in biotic and abiotic matrices. Chemosphere, 24(8), 1147–1154. doi:10.1016/0045-6535(92)90205-6.
Heftmann, E. (2004). Journal of Chromatographic Library-vol. 69A. Chromatography-Fundamentals and Applications of Chromatography and Related Differential Migration Techniques. Part A. Fundamentals and Techniques Sixth Edition. Orinda, CA, USA: Elsevier Science.
Hess, P. , de Boer, J. , Cofino, W. P. , Leonards, P. E. G. , & Wells, D. E. (1995). Critical review of the analysis of non- and mono-ortho-chlorobiphenyls. Journal of Chromatography A, 703(1–2), 417–465. doi:10.1016/0021-9673(95)00298-2.
Hubert, A. , Wenzel, K. D. , Engelwald, W. , & Schüürmann, G. (2001). Accelerated solvent extraction - More efficient extraction of pops and pahs from real contaminated plant and soil samples. Reviews in Analytical Chemistry, 20(2), 101–144. doi:10.1515/REVAC.2001.20.2.101.
Jánská, M. , Tomaniová, M. , Hajšlová, J. , & Kocourek, V. (2004). Appraisal of “classic” and “novel” extraction procedure efficiencies for the isolation of polycyclic aromatic hydrocarbons and their derivatives from biotic matrices. Analytica Chimica Acta, 520(1–2), 93–103. doi:10.1016/j.aca.2004.05.073.
Järemo, M. , Björklund, E. , Nilsson, N. , Karlsson, L. , & Mathiasson, L. (2000). Utilization of fat retainers in supercritical fluid extraction for the selective extraction of polychlorinated biphenyls from a model fat sample. Journal of Chromatography A, 877(1–2), 167–180. doi:10.1016/S0021-9673(00)00160-6.
Jinadasa, B. K. K. K. , Monteau, F. , & Morais, S. (2020). Critical review of micro-extraction techniques used in the determination of polycyclic aromatic hydrocarbons in biological, environmental and food samples. Food Additives and Contaminants - Part A Chemistry, Analysis, Control, Exposure and Risk Assessment, 37(6), 1004–1026. doi:10.1080/19440049.2020.1733103.
Kalachova, K. , Pulkrabova, J. , Drabova, L. , Cajka, T. , Kocourek, V. , & Hajslova, J. (2011). Simplified and rapid determination of polychlorinated biphenyls, polybrominated diphenyl ethers, and polycyclic aromatic hydrocarbons in fish and shrimps integrated into a single method. Analytica Chimica Acta, 707(1–2), 84–91. doi:10.1016/j.aca.2011.09.016.
Kim, L. , Lee, D. , Cho, H. K. , & Choi, S. D. (2019). Review of the QuEChERS method for the analysis of organic pollutants: Persistent organic pollutants, polycyclic aromatic hydrocarbons, and pharmaceuticals.

Trends in Environmental Analytical Chemistry, 22, e00063. doi:10.1016/j.teac.2019.e00063.
Kitamura, K. , Takazawa, Y. , Hashimoto, S. , Choi, J. W. , Ito, H. , & Morita, M. (2004). Effective extraction method for dioxin analysis from lipid-rich biological matrices using a combination of pressurized liquid extraction and dimethyl sulfoxide/acetonitrile/hexane partitioning. Analytica Chimica Acta, 512(1), 27–37. doi:10.1016/j.aca.2004.02.040.
Lebo, J. A. , Zajicek, J. L. , Schwartz, T. R. , Smith, L. M. , & Beasley, M. P. (1991). Determination of monocyclic and polycyclic aromatic hydrocarbons in fish tissue. Journal - Association of Official Analytical Chemists, 74(3), 538–544. doi:10.1093/jaoac/74.3.538.
Ledesma, E. , Rendueles, M. , & Díaz, M. (2016). Contamination of meat products during smoking by polycyclic aromatic hydrocarbons: Processes and prevention. Food Control, 60, 64–87. doi:10.1016/j.foodcont.2015.07.016.
Lehotay, S. J. (2011). QuEChERS sample preparation approach for mass. Methods in Molecular Biology, 747(1), 65–84. doi:10.1007/978-1-61779-136-9.
Lehotay, S. J. , O'Neil, M. , Tully, J. , García, A. V. , Contreras, M. , Mol, H. , Heinke, V. , Anspach, T. , Lach, G. , Fussell, R. , Mastovska, K. , Poulsen, M. E. , Brown, A. , Hammack, W. , Cook, J. M. , Alder, L. , Lindtner, K. , Vila, M. G. , Hopper, M. , de Kok, A. , Hiemstra, M. , Schenck, F. , Williams, A. , & Parker, A. (2007). Determination of pesticide residues in foods by acetonitrile extraction and partitioning with magnesium sulfate: Collaborative study. Journal of AOAC International, 90(2), 485–520. doi:10.1093/jaoac/90.2.485.
Lopez-Avila, V. , Young, R. , & Teplitsky, N. (1996). Microwave-assisted extraction as an alternative to soxhlet, sonication, and supercritical fluid extraction. Journal of AOAC International, 79(1), 142–156. doi:10.1093/jaoac/79.1.142.
Page, D. S. , Huggett, R. J. , Stegeman, J. J. , Parker, K. R. , Woodin, B. , Brown, J. S. , & Bence, A. E. (2004). Polycyclic aromatic hydrocarbon sources related to biomarker levels in fish from Prince William Sound and the Gulf of Alaska. Environmental Science and Technology, 38(19), 4928–4936. doi:10.1021/es0403209.
Ramalhosa, M. J. , Paíga, P. , Morais, S. , Delerue-Matos, C. , & Oliveira, M. B. P. P. (2009). Analysis of polycyclic aromatic hydrocarbons in fish: Evaluation of a quick, easy, cheap, effective, rugged, and safe extraction method. Journal of Separation Science, 32(20), 3529–3538. doi:10.1002/jssc.200900351.
Ramos, J. J. , Dietz, C. , González, M. J. , & Ramos, L. (2007). Miniaturised selective pressurised liquid extraction of polychlorinated biphenyls from foodstuffs. Journal of Chromatography A, 1152(1–2), 254–261. doi:10.1016/j.chroma.2006.11.097.
Richter, B. E. , Jones, B. A. , Ezzell, J. L. , Porter, N. L. , Avdalovic, N. , & Pohl, C. (1996). Accelerated solvent extraction: A technique for sample preparation. Analytical Chemistry, 68(6), 1033–1039. doi:10.1021/ac9508199.
Santos, F. J. , & Galceran, M. T. (2003). Modern developments in gas chromatography-mass spectrometry-based environmental analysis. Journal of Chromatography A, 1000(1–2), 125–151. doi:10.1016/S0021-9673(03)00305-4.
Schantz, M. M. , Bøwadt, S. , Benner, B. A. , Wise, S. A. , & Hawthorne, S. B. (1998). Comparison of supercritical fluid extraction and Soxhlet extraction for the determination of polychlorinated biphenyls in environmental matrix standard reference materials. Journal of Chromatography A, 816(2), 213–220. doi:10.1016/S0021-9673(98)00528-7.
Schantz, M. M. , Nichols, J. J. , & Wise, S. A. (1997). Evaluation of pressurized fluid extraction for the extraction of environmental matrix reference materials. Analytical Chemistry, 69(20), 4210–4219. doi:10.1021/ac970299c.
Shu, Y. Y. , Lao, R. C. , Chiu, C. H. , & Turle, R. (2000). Analysis of polycyclic aromatic hydrocarbons in sediment reference materials by microwave-assisted extraction. Chemosphere, 41(11), 1709–1716. doi:10.1016/S0045-6535(00)00065-5.
Sporring, S. , & Björklund, E. (2004). Selective pressurized liquid extraction of polychlorinated biphenyls from fat-containing food and feed samples: Influence of cell dimensions, solvent type, temperature and flush volume. Journal of Chromatography A, 1040(2), 155–161. doi:10.1016/j.chroma.2004.04.022.
Stapleton, H. M. (2006). Instrumental methods and challenges in quantifying polybrominated diphenyl ethers in environmental extracts: A review. Analytical and Bioanalytical Chemistry, 386(4), 807–817. doi:10.1007/s00216-006-0400-y.
Stołyhwo, A. , & Sikorski, Z. E. (2005). Polycyclic aromatic hydrocarbons in smoked fish - A critical review. Food Chemistry, 91(2), 303–311. doi:10.1016/j.foodchem.2004.06.012.
Suchan, P. , Pulkrabová, J. , Hajšlová, J. , & Kocourek, V. (2004). Pressurized liquid extraction in determination of polychlorinated biphenyls and organochlorine pesticides in fish samples. Analytica Chimica Acta, 520(1–2), 193–200. doi:10.1016/j.aca.2004.02.061.
U.S. EPA . (2000). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2 Risk Assessment and Fish Consumption Limits Third Edition. Office of Science and Technology Office of Water U.S. Environmental Protection Agency, Washington, DC.
U.S. EPA . (n.d.). SW-846 Test Method 3561: Supercritical Fluid Extraction of Polynuclear Aromatic Hydrocarbons (PAHs). https://www.epa.gov/hw-sw846/sw-846-test-method-3561-supercritical-fluid-extraction-polynuclear-aromatic-hydrocarbons.
U.S. EPA . (n.d.). SW-846 Test Method 3562: Supercritical Fluid Extraction of Polychlorinated Biphenyls (PCBs) and Organochlorine Pesticides (OCPs). https://www.epa.gov/hw-sw846/sw-846-test-method-3562-

supercritical-fluid-extraction-polychlorinated-biphenyls-pcbs-and.
van Leeuwen, S. P. J. , & de Boer, J. (2008). Advances in the gas chromatographic determination of persistent organic pollutants in the aquatic environment. Journal of Chromatography A, 1186(1–2), 161–182. doi:10.1016/j.chroma.2008.01.044.
Vassilaros, D. L. , Stoker, P. W. , Booth, G. M. , & Lee, M. L. (1982). Capillary gas chromatographic determination of polycyclic aromatic compounds in vertebrate fish tissue. Analytical Chemistry, 54(1), 106–112. doi:10.1021/ac00238a031.
Verenitch, S. S. , deBruyn, A. M. H. , Ikonomou, M. G. , & Mazumder, A. (2007). Ion-trap tandem mass spectrometry- based analytical methodology for the determination of polychlorinated biphenyls in fish and shellfish. Performance comparison against electron-capture detection and high-resolution mass spectrometry detection. Journal of Chromatography A, 1142(2), 199–208. doi:10.1016/j.chroma.2006.12.068.
Vives, I. , & Grimalt, J. O. (2002). Method for integrated analysis of polycyclic aromatic hydrocarbons and organochlorine compounds in fish liver. Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences, 768(2), 247–254. doi:10.1016/S1570-0232(01)00585-2.
Wang, G. , Lee, A. S. , Lewis, M. , Kamath, B. , & Archer, R. K. (1999). Accelerated solvent extraction and gas chromatography/mass spectrometry for determination of polycyclic aromatic hydrocarbons in smoked food samples. Journal of Agricultural and Food Chemistry, 47(3), 1062–1066. doi:10.1021/jf980956h.
Wenzl, T. , Simon, R. , Anklam, E. , & Kleiner, J. (2006). Analytical methods for polycyclic aromatic hydrocarbons (PAHs) in food and the environment needed for new food legislation in the European Union. TrAC - Trends in Analytical Chemistry, 25(7), 716–725. doi:10.1016/j.trac.2006.05.010.
Wolkers, H. , Hammill, M. O. , & van Bavel, B. (2006). Tissue-specific accumulation and lactational transfer of polychlorinated biphenyls, chlorinated pesticides, and brominated flame retardants in hooded seals (Cistophora cristata) from the Gulf of St. Lawrence: Applications for monitoring. Environmental Pollution, 142(3), 476–486. doi:10.1016/j.envpol.2005.10.031.

Innovations in Seafood Packaging Technologies

Coles, R. Introduction. In Food Packaging Technology; Geo, G. A., Ed.; Blackwell Publishing Ltd.: Boca Raton, 2003; pp. 1–29.
Dobrucka, R. ; Cierpiszewski, R. Active and Intelligent Packaging Food-Research and Development-A Review. Pol. J. Food Nutr. Sci., 2014, 64(1), 7–15. doi:10.2478/v10222-012-0091-3.
Robertson, G. L. Food Packaging and Shelf Life: A Practical Guide. In Role of Food Packaging; Robertson, G. L., Ed.; CRC Press: Boca Raton, 2010; pp. 1–4.
Shin, J. ; Selke, S. E. M. Food Packaging. Food Processing. In Principles and Applications; Clark, S. , Jung, S. , Lamsal, B. , Eds.; John Wiley & Sons: Chichester, West Sussex, 2014; pp. 249–274.
Marsh, K. ; Bugusu, B. Food Packaging-Roles, Materials, and Environmental Issues. J. Food Sci., 2007, 72(3), 39–55. doi:10.1111/j.1750-3841.2007.00301.x.
Brody, A. L. ; Bugusu, B. ; Han, J. H. ; Sand, C. K. ; Mchugh, T. H. Innovative Food Packaging Solutions. J. Food Sci., 2008, 73(8), 107–116. doi:10.1111/j.1750-3841.2008.00933.x.
De Luca, P. ; Penco, P. The Role of Packaging in Marketing Communication: An Explorative Study of the Italian Wine Business. Presented at 3rd. International Wine Business Research Conference, Montpellier, July 8, 2006.
Folinas, D. ; Manikas, I. ; Manos, B. Traceability Data Management for Food Chains. Br. Food J., 2006, 108, 622–633. doi:10.1108/00070700610682319.
Sen, C. ; Das, M. Trends in Food Packaging Technology. In Food Process Engineering: Emerging Trends in Research and Their Applications; Meghwal, N. , Goyal, M. G. , Eds.; Apple Academic Press (AAP): Oawille, Canada, 2016; pp. 3–24.
Phillips, C. A. Review: Modified Atmosphere Packaging and Its Eects on the Microbiological Quality and Safety of Produce. Int. J. Food Sci. Technol., 1996, 31(6), 463–479. doi:10.1046/j.1365-2621.1996.00369.x.
De Witt, C. A. M. ; Oliveira, A. C. M. Modified Atmosphere Systems and Shelf Life Extension of Fish and Fishery Products. Foods, 2016, 5(3), 48–75. doi:10.3390/foods5030048.
Rodgers, S. Technological Innovation Supporting Dierent Food Production Philosophies in the Food Service Sectors. Int. J. Contemp. Hospitality Manage., 2008, 20(1), 19–34. doi:10.1108/09596110810848541.
Sivertsvik, M. ; Jeksrud, W. K. ; Rosnes, J. T. A. Review of Modified Atmosphere Packaging of Fish and Fishery Products-Significance of Microbial Growth, Activities and Safety. Int. J. Food Sci. Technol., 2002, 37, 107–127. doi:10.1046/j.1365-2621.2002.00548.x.
Mol, S. ; Ucok Alakavuk, D.; Ulusoy, S. Eects of Modified Atmosphere Packaging on Some Quality Attributes of a Ready-to-Eat Salmon Sushi. Iran. J. Fish. Sci., 2014, 13(2), 394–406. doi:10.18869/acadpub.ijfs.
Arashisar, S. ; Hisar, O. ; Kaya, M. ; Yanık, T. Eects of Modified Atmosphere and Vacuum Packaging on Microbiological and Chemical Properties of Rainbow Trout. (oncorynchus Mykiss) Fillets. Int. J. Food Microbiol., 2004, 97, 209–214. doi:10.1016/j.ijfoodmicro.2004.05.024.

Speranza, B. ; Corbo, M. ; Conte, A. ; Sinigaglia, M. ; Del Nobile, M. Microbiological and Sensorial Quality Assessment of Ready-to-Cook Seafood Products Packaged under Modified Atmosphere. J. Food Sci., 2009, 74, 473–478. doi:10.1111/j.1750-3841.2009.01369.x.

Soltani, M. ; Alimardani, R. ; Mobli, H. ; Mohtasebi, S. S. Modified Atmosphere Packaging: A Progressive Technology for Shelf-Life Extension of Fruits and Vegetables. J. Appl. Packag. Res., 2015, 7(3), 33–59. doi:10.13140/RG.2.1.2822.0887.

Davis, H. K. Fish and Shellfish . In Principles and Applications of Modified Atmosphere Packaging of Foods; Blackistone, B. A. , Ed.; Blackie Academic and Professional: London, 1999; pp. 194–239.

Soccol, M. C. H. ; Oetterer, M. Use of Modified Atmosphere in Seafood Preservation. Braz. Arch. Biol. Technol., 2003, 46(4), 569–580. doi:10.1590/S1516-89132003000400011.

Stammen, K. ; Gerdes, D. ; Caporaso, F. ; Martin, R. E. Modified Atmosphere Packaging of Seafood. Critical Reviews in Food Science and Nutrition, 1990, 29(5), 301–331. doi:10.1080/10408399009527530.

Sandhya . Modified Atmosphere Packaging of Fresh Produce: Current Status and Future Needs. Food Sci. Technol., 2010, 43, 381–392. doi:10.1016/j.lwt.2009.05.018.

Yesudhason, P. ; Lalitha, K. V. ; Gopal, T. K. S. ; Ravishankar, C. N. Retention of Shelf Life and Microbial Quality of Seer Fish Stored in Modified Atmosphere Packaging and Acetate Pre-treatment. J. Food Packag. Shelf Life, 2014, 1, 123–130. doi:10.1016/j.fpsl.2014.04.001.

McMillin, K. W. Where Is MAP Going? A Review and Future Potential of Modified Atmosphere Packaging for Meat. Meat Sci., 2008, 80, 43–65. doi:10.1016/j.meatsci.2008.05.028.

Amanatidou, A. ; Schluter, O. ; Lemkau, K. ; Gorris, L. G. M. ; Smid, E. J. ; Knorr, D. Eect of Combined Application of High Pressure Treatment and Modified Atmospheres on the Shelf Life of Fresh Atlantic Salmon. Innovative Food Sci. Emerg. Technol., 2000, 1, 87–98. doi:10.1016/S1466-8564(00)00007-2.

Manu-Tawiah, W. ; Myers, D. J. ; Olson, D. G. ; Molins, R. A. Survival and Growth of Listeria Monocytogenes and Yersinia Enterocolitica in Pork Chops Packaged under Modified Gas Atmospheres. J. Food Sci., 1993, 58, 475–479. doi:10.1111/j.1365-2621.1993.tb04303.x.

Rutherford, T. J. ; Marshell, D. L. ; Andrews, L. S. ; Coggins, P. C. ; Schilling, M. W. ; Gerard, P. Combined Eect of Packaging Atmosphere and Storage Temperature on Growth of Listeria Monocytogenes on Ready-to-Eat Shrimp. Food Microbiol., 2007, 24, 703–710. doi:10.1016/j.fm.2007.03.011.

Luno, M. ; Roncales, P. ; Djenane, D. ; Beltran, J. A. Beef Shelf Life in Low O2 and High CO2 Atmospheres Containing Dierent Low CO Concentrations. Meat Sci., 2000, 55, 413–419. doi:10.1016/S0309-1740(99)00170-9.

Djenane, D. ; Roncales, P. Carbon Monoxide in Meat and Fish Packaging: Advantages and Limits. Foods, 2018, 7, 12. doi:10.3390/foods7020012.

Mantilla, D. ; Kristinsson, H. G. ; Balaban, M. O. ; Otwell, W. S. ; Chapman, F. A. ; Raghavan, S. Carbon Monoxide Treatments to Impart and Retain Muscle Color in Tilapia Fillets. J. Food Sci., 2008, 73, C390–C399. doi:10.1111/j.1750-3841.2008.00757.x.

Kowalski, B. Tasteless Smoke Sources, Specifications, and Controls. In Modified Atmosphere Processing and Packaging of Fish - Filtered Smokes, Carbonmon Oxide and Reduced Oxygen Packaging; Otwell, E. S. , Kristinsson, H. G. , Balaban, M. O. , Eds.; Blackwell Publishers: Gainesville, 2006; pp. 117–126.

Kristinsson, H. G. ; Crynen, S. ; Yagiz, Y. Eect of a Filtered Wood Smoke Treatment Compared to Various Gas Treatments on Aerobic Bacteria in Yellow Fin Tuna Steaks. LWT Food Sci. Technol., 2007, 41, 746–750. doi:10.1016/j.lwt.2007.04.005.

Concollato, A. ; Bjørlykke, G. A. ; Kvamme, B. O. ; Sørheim, O.; Slinde, E. ; Olsen, R. E. The Eect of Carbon Monoxide on Slaughter and Processing of Fish. In Processing and Impact on Active Components in Food; Preedy, V. R., Ed.; Elsevier: London, UK, 2015; pp. 427–431.

Herbert, U. ; Rossaint, S. ; Khanna, M. A. ; Kreyenschmidt, J. Comparison of Argon-Based and Nitrogen-Based Modified Atmosphere Packaging on Bacterial Growth and Product Quality of Chicken Breast Fillets. Poultr. Sci., 2013, 92(5), 1348–1356. doi:10.3382/ps.2012-02590.

Giménez, B. ; Roncalés, P. ; Beltrán, J. A. Modified Atmosphere Packaging of Filleted Rainbow Trout. J. Sci. Food Agric., 2002, 82(10), 1154–1159. doi:10.1002/jsfa.1136.

Parkin, K. L. ; Wells, M. J. ; Brown, W. D. Modified Atmosphere Storage of Rockfish Fillets. J. Food Sci., 1982, 47(1), 181–184. doi:10.1111/j.1365-2621.1982.tb11054.x.

Debevere, J. ; Boskou, G. Eect of Modified Atmosphere Packaging on the TVB/TMA-Producing Microflora of Cod Fillets. Int. J. Food Microbiol., 1996, 31, 221–229. doi:10.1016/0168-1605(96)01001-X.

Ozogul, F. ; Polat, A. ; Ozogul, Y. The Eects of Modified Atmosphere Packaging and Vacuum Packaging on Chemical, Sensory and Microbiological Changes of Sardines (sardina Pilchardus). Food Chem., 2004, 84, 49–57. doi:10.1016/j.foodchem.2003.05.006.

Erkan, N. ; Özden, Ö. ; Üçok Alakavuk, Ş. ; Yildirim, Y. ; Inugur, M. Spoilage and Shelf Life of Sardines (sardina Pilchardus) Packed in Modified Atmosphere. Eur. Food Res. Technol., 2006, 222, 667–673. doi:10.1007/s00217-005-0194-8.

Arkoudelosa, J. ; Stamatisb, N. ; Samarasa, F. Quality Attributes of Farmed Eel (Anguilla Anguilla) Stored under Air, Vacuum and Modified Atmosphere Packaging at 0°C. Food Microbiol., 2007, 24, 728–735. doi:10.1016/j.fm.2007.03.008.

Erkan, N. ; Ozden, Ö. ; Inugur, M. The Eects of Modified Atmosphere and Vacuum Packaging on Quality of Chub Mackerel. Int. J. Food Sci. Technol., 2007, 42(11), 1297–1304. doi:10.1111/j.1365-2621.2006.01325.x.
Hudecová, K. ; Buchtová, H. ; Steinhauserová, I. The Eects of Modified Atmosphere Packaging on the Microbiological Properties of Fresh Common Carp (cyprinus Carpio L.). Acta Vet. Brono., 2010, 79, 93–100. doi:10.2754/avb201079S9S093.
Payap, M. ; Benama, O. ; Jaruwan, M. Eect of Modified Atmosphere and Vacuum Packaging on Quality Changes of Refrigerated Tilapia (oreochromis Niloticus) Fillets. Int. Food Res. J., 2013, 20(3), 1401–1408. doi:10.1111/j.1365-2621.2012.02944.x.
Guðjónsdóttir, M. ; Magnússon, H. ; Sveinsdóttir, K. ; Margeirsson, B. ; Lauzon, H. L. ; Reynisson, E. ; Martinsdóttir, E. Eect of Modified Atmosphere Packaging (MAP) and Super Chilling on the Shelf Life of Fresh Cod (gadus Morhua) Loins of Dierent Degrees of Freshness at Packaging; Matis Food Research, Innovation and Safety Report Summary, Vinlandsleid, reykjavik, Iceland. 2012; pp. 1–37.
Kykkidou, S. ; Giatrakou, V. ; Papavergou, A. ; Kontominas, M. G. ; Savvaidis, I. N. Eect of Thyme Essential Oil and Packaging Treatments on Fresh Mediterranean Swordfish Fillets during Storage at 4°C. Food Chem., 2009, 11, 169–175. doi:10.1016/j.foodchem.2008.11.083.
Yesudhason, P. ; Gopal, T. K. S. ; Ravi Shankar, C. N. ; Lalitha, K. V. ; Kumar, K. N. A. Eect of Potassium Sorbate and Modified Atmosphere Packaging on the Shelf-Life Extension of Seerfish (scomberomorus Commerson) Steaks during Iced Storage. J. Food Biochem., 2010, 34, 399–424. doi:10.1111/j.1745-4514.2009.00288.x.
Sharp, W. F., Jr .; Norbach, J. P. ; Stuiber, D. A. Using a New Measure to Define Shelf Life of Fresh Whitefish. J. Food Sci., 1986, 51, 936–939. doi:10.1111/j.1365-2621.1986.tb11203.x.
Fey, M. S. ; Regenstein, J. M. Extending Shelf-Life of Freshwater Hake and Salmon Using CO2-O2 Modified Atmosphere and Potassium Sorbate Ice at 1°C. J. Food Sci., 1982, 47, 1048–1054. doi:10.1111/j.1365-2621.1982.tb07619.x.
Regenstein, J. M. The Shelf-Life Extension of Haddock in CO2 Atmosphers with and without Potassium Sorbate. J. Food Qual., 1982, 5, 285–300. doi:10.1111/j.1745-4557.1982.tb00750.x.
Del Nobile, M. A. ; Corbo, M. R. ; Speranza, B. ; Sinigaglia, M. ; Cont, A. ; Caroprese, M. Combined Eect of Modified Atmosphere Packaging and Active Compounds on Fresh Blue Fishburger. Int. J. Food Microbiol., 2009, 135, 281–287. doi:10.1016/j.ijfoodmicro.2009.07.024.
Soccol, M. C. ; Otterer, M. ; Gallo, C. R. ; Spoto, M. H. F. ; Biato, D. O. Eects of Modified Atmosphere and Vacuum on the Shelf Life of Tilapia (oreochromis Niloticus) Fillets. Braz. J. Food Technol., 2005, 8(1), 7–15.
Pastoriza, L. ; Sampedro, G. ; Herrera, J. J. ; Cabo, L. M. Influence of Sodiumchloride and Modified Atmosphere Packaging on Microbiological, Chemical and Sensorial Properties in Ice Storage of Slices of Hake (merluccius Merluccius). Food Chem., 1998, 61, 23–28. doi:10.1016/S0308-8146(97)00130-1.
Jing, X. ; Xi, Y. ; Xinlin, Z. ; Aifang, L. ; Hanbo, D. High Hydrostatic Pressure Treatment Combined with Modified Atmosphere Package Keeping Quality Characteristic of Trichiurus Lepturus during Cold Storage. Trans. Chin. Soc. Agric. Eng., 2015, 31(12), 246–252. doi:10.11975/j.issn.1002-6819.2015.12.033.
Parry, R. T. Introduction. In Principles and Applications of Modified Atmosphere Packaging of Foods; Parry, R. T., Ed.; Chapman &Hall, Glasgow, UK 1993; pp. 1–17.
Rachtanapun, P. ; Rachtanapun, C. Vacuum Packaging . In Handbook of Frozen Food Processing and Packaging, 2nd ed.; Sun, D. W., Ed.; CRC Press: New York, 2011; pp. 861–874.
Ozturk, K. Packaging Applications for Ready-to-Eatfoods. Thesis, Istanbul Technıcal Unıversıty Faculty of Chemıcal and Metallurgıcal Engıneerıng Food Engıneerıng, İstanbul, 2015.
Bykowski, P. ; Dutkiewicz, D. Packaging Used in Freshwater Fish Processing. In Freshwater Fish Processing and Equipment in Small Plants. FAO Fisheries Circular. No. 905; FAO: Rome, 1996; p. 59.
Huang, Y. ; Kouadio, K. ; Gates, K. W. Microbiological , Sensory and Chemical Assessment of Pre-packaged Weak Fish during Iced Storage. J. Aquat. Food Prod. Technol., 1993, 2(1), 135–144. doi:10.1300/J030v02n01_10.
Yam, K. L. ; Takhıstov, P. T. ; Mıltz, J. Intelligent Packaging: Concepts and Applications. J. Food Sci., 2005, 70, 1–10. doi:10.1111/j.1365-2621.2005.tb09052.x.
Day, B. Active Packaging of Food. In Smart Packaging Technologies for Fast Moving Consumer Goods; Kerry, J. , Butler, P. , Eds.; John Wiley & Sons: Chichester, 2008; pp. 1–18.
Wyrwa, J. ; Barska, A. Innovations in the Food Packaging Market: Active Packaging. Eur. Food Res. Technol., 2017, 243, 1681–1692. doi:10.1007/s00217-017-2878-2.
Prasad, P. ; Kochhar, A. Active Packaging in Food Industry. J. Environ . Sci. Toxicol. Food Technol., 2014, 8, 1–7. doi:10.9790/2402-08530107.
Goncalves, A. ; Mendes, R. ; Nunes, M. L. Eect of Oxygen Absorber on the Shelf Life of Gilthead Seabream (sparus Aurata). J. Aquat. Food Prod. Technol., 2004, 13, 49–59. doi:10.1300/J030v13n03_05.
Mohan, C. ; Ravishankar, C. N. ; Srinivasagopal, T. K. Eect of O2 Scavenger on the Shelf Life of Catfish (pangasius Sutchi) Steaks during Chilled Storage. J. Sci. Food Agric., 2008, 88, 442–448. doi:10.1002/jsfa.3105.
Mohan, C. O. ; Ravishankar, C. N. ; Srinivasa Gopal, T. K. ; Ashok Kumar, K. Nucleotide Breakdown Products of Seer Fish (scomberomorus Commerson) Steaks Stored in O2 Scavenger Packs during Chilled Storage. Innovative Food Sci. Emerg. Technol., 2009, 10, 272–278. doi:10.1016/j.ifset.2008.11.012.

Mohan, C. O. ; Ravishankar, C. N. ; SrinivasaGopal, T. K. ; Ashok Kumar, K. ; Lalitha, K. V. Biogenic Amines Formation in Seer Fish (scomberomorus Commerson) Steaks Packed with O2 Scavenger during Chilled Storage. Food Res. Int., 2009, 42, 411–416. doi:10.1016/j.foodres.2009.01.015.
Erkan, N. The Eect of Actıve and Vacuum Packagıng on the Qualıty of Turkısh Tradıtıonal Salted Dried Fısh “çiroz”. J. Food Health Sci., 2017, 21(1), 29–35. doi:10.3153/JFHS17004.
Siverstik, M. Active Packaging of Seafood. Presented at 27th Annual WEFTA Meeting, Madrid, 1997, pp. 19–22.
Gomes, C. ; Castell-Perez, M. E. ; Chimbombi, E. ; Barros, F. ; Sun, D. ; Liu, J. ; Sue, H. J. ; Sherman, P. ; Dunne, P. ; Wright, A. O. Eect of Oxygen-Absorbing Packaging on the Shelf Life of a Liquid-Based Component of Military Operational Rations. J. Food Sci., 2009, 74, 167–176. doi:10.1111/j.1750-3841.2009.01120.x.
Pereira de Abreu, D. A. ; Cruz, J. M. ; PaseiroLosada, P. Active and Intelligent Packaging for the Food Industry. Food Rev. Int., 2012, 28(2), 146–187. doi:10.1080/87559129.2011.595022.
Vermeiren, L. ; Devlieghere, F. ; Van Beest, M. ; De Kruijf, N. ; Debever, J. Developments in the Active Packaging of Foods. J. Food Technolol., 2000, 5, 6–13. doi:10.1016/S0924-2244(99)00032–1.
De Jong, A. R. ; Boumans, H. ; Slaghek, T. ; Van Veen, J. ; Rijk, R. ; Zandvoort, M. V. Active and Intelligent Packaging for Food: Is It the Future? Food Addit. Contam., 2005, 22(10), 975–979. doi:10.1080/02652030500336254.
Franzetti, L. ; Martinoli, S. ; Piergiovanni, L. ; Galli, A. Influence of Active Packaging on the Shelf-Life of Minimally Processed Fish Products in a Modified Atmosphere. Packag. Technol. Sci., 2001, 14, 267–274. doi:10.1002/pts.559.
Mohan, C. O. ; Ravishankar, C. N. ; SrinivasaGopal, T. K. Active Packaging of Fishery Products: A Review. Fishery Technol., 2010, 47(1), 1–18.
Ahvenainen, R. Oxygen, Ethylene and Other Scavengers. In Novel Food Packaging Techniques; Ahvenainen, R. , Ed.; Woodhead Publishing Series in Food Science, Technology and Nutrition, Cambridge, UK, 2003; pp. 22–49.
Ozdemir, M. ; Floros, J. D. Active Food Packaging Technologies. Crit. Rev. Food Sci. Nutr., 2004, 44, 185–193. doi:10.1080/10408690490441578.
Ramos, M. ; Valdés, M. ; Mellinas, A. C. ; Garrigós, M. C. New Trends in Beverage Packaging Systems: A Review. Beverages, 2015, 1, 248–272. doi:10.3390/beverages1040248.
Edens, L. ; Farin, F. ; Ligtvoet, A. F. ; Van Der Platt, J. B. Dry Yeast Immobilized in Wax or Paran for Scavenging Oxygen. US Patent 5106633, 1992.
Day, B. P. F. Active Packaging. In Smart Packaging Technology; Coles, R. , McDowel, D. , Kirwan, M. J. , Eds.; Blackwell Publishing, CRC Press: Oxford, 2003; pp. 282–300.
Mexis, S. F. ; Chouliara, E. ; Kontominas, M. G. Combined Eect of an O2 Absorber and Oregano Essential Oil on Shelf-Life Extension of Greek Cod Roe Paste (tarama Salad) Stored at 4°C. Innovative Food Sci. Emerging Technol., 2009, 10, 572–579. doi:10.1016/j.ifset.2009.04.005.
Gaikwad, K. K. ; Singh, S. ; Ajji, A. Moisture Absorbers for Food Packaging Applications. Environ. Chem. Lett., 2019, 17, 609–628. doi:10.1007/s10311-018-0810-z.
Bleoanca, I. ; Turtoi, M. Innovative Fish Packaging Solutions. In Trends in Fish Processing Technologies; Bordo, D. , Nicolau, A. I. , Raspor, P. , Eds.; Taylor and Francis Group: Boca Raton, FL, 2017; pp. 187–216.
Singh, P. ; Wani, A. B. ; Saengerlaub, S. Active Packaging of Food Products: Recent Trends. Nutr. Food Sci., 2011, 41(4), 249–260. doi:10.1108/00346651111151384.
Hansen, A. A. ; Morkore, T. ; Rudi, K. ; Rodbotten, M. ; Bjerke, F. ; Eie, T. Quality Changes of Pre-rigor Filleted Atlantic Salmon (salmo Salar L.) Packaged in Modified Atmosphere Using CO2 Emitter, Traditional MAP. J. Food Sci., 2009, 74, 242–249. doi:10.1111/j.1750-3841.2009.01233.x.
Cha, D. S. ; Choi, J. H. ; Chinnan, M. S. ; Park, H. J. Antimicrobial Films Based on Na-Alginate and K-Carrageenan. LWT Food Sci. Technol., 2002, 35, 715–719. doi:10.1006/fstl.2002.0928.
Han, J. H. Antimicrobial Food Packaging. Food Technol., 2000, 54, 56–65. doi:10.1533/9781855737020.1.50.
Coma, V. Bioactive Packaging Technologies for Extended Shelf Life of Meat-Based Products. Meat Sci., 2008, 78, 90–103. doi:10.1080/10.1016/j.meatsci.2007.07.035.
Appendini, P. ; Hotchkiss, J. H. Review of Antimicrobial Food Packaging. Innovative Food Sci. Emerg. Technol., 2002, 3, 113–126. doi:10.1016/S1466-8564(02)00012-7.
Biji, K. B. ; Ravishankar, C. N. ; Mohan, C. O. ; Srinivasa Gopal, T. K. Smart Packaging Systems for Food Applications: A Review. J. Food Sci. Technol., 2015, 52(10), 6125–6135. doi:10.1016/S1466-8564(02)00012-7.
Brody, A. L. ; Strupinsky, E. R. ; Kline, L. R. Active Packaging for Food Applications; Technomic Publishing Inc.: Boca Raton, 2001.
García-Soto, B. ; Miranda, J. M. ; Rodríguez-Bernaldo de Quirós, A.; Sendón, R.; Rodr íguez-Martínez, A. V.; Barros-Velázquez, J.; Aubourg, S. P. Eect of Biodegradable Film (Lyophilised Alga Fucus spiralis and Sorbic Acid) on Quality Properties of Refrigerated Megrim (Lepidorhombus whiagonis). Int. J. Food Sci. Technol., 2015, 50(8), 1891–1900. doi:10.1111/ijfs.12821.
Galotto, M. ; Ulloa, P. Eect of High-Pressure Food Processing on the Mass Transfer Properties of Selected Packaging Materials. Packag. Technol. Sci., 2010, 23, 253–266. doi:10.1002/pts.893.

Fernández-Saiz, P. ; Sánchez, G. ; Soler, C. ; Lagaron, J. M. ; Ocio, M. J. Chitosan Films for the Microbiological Preservation of Refrigerated Sole and Hake Fillets. Food Control, 2013, 34, 61–68. doi:10.1016/j.foodcont.2013.03.047.
Shakila, R. J. ; Jeevithan, E. ; Varatharajakumar, A. ; Jeyasekaran, G. Suitability of Antimicrobial Grouper Bone Gelatin Films as Edible Coatings for Vacuum Packaged Fish Steaks. J. Aquat. Food Prod. Technol., 2015, 25(5), 724–734. doi:10.1080/10498850.2014.921658.
Neetoo, H. ; Mahomoodally, F. Use of Antimicrobial Films and Edible Coatings Incorporating Chemical and Biological Preservatives to Control Growth of Listeria Monocytogenes on Cold Smoked Salmon. Biomed Res. Int., 2014, 2014, 1–10. doi:10.1155/2014/534915.
Pereira de Abreu, D. A. ; Paseiro Losada, P. ; Maroto, J. ; Cruz, J. M. Evaluation of the Eectiveness of a New Active Packaging Film Containing Natural Antioxidants (from Barley Husks) that Retard Lipid Damage in Frozen Atlantic Salmon (Salmo salar L.). Food Res. Int., 2010, 43, 1277–1282. doi:10.1016/j.foodres.2010.03.019.
Pereira de Abreu, D. A. ; PaseiroLosada, P. ; Maroto, J. ; Cruz, J. M. Lipid Damage During Frozen Storage of Atlantic Halibut (Hippoglossus hippoglossus) in Active Packaging Film Containing Antioxidants. Food Chem., 2011, 126, 315–320. doi:10.1016/j.foodchem.2010.10.048.
Pereira de Abreu, D. A. ; PaseiroLosada, P. ; Maroto, J. ; Cruz, J. M. Lipid Damage Inhibition in Hake by Active Packaging Film with Natural Antioxidants. Packag. Technol. Sci., 2011, 4, 353–360. doi:10.1002/pts.944.
Pereira de Abreu, D. A. ; Paseiro Losada, P. ; Maroto, J. ; Cruz, J. M. Natural Antioxidant Active Packaging Film and Its Eect on Lipid Damage in Frozen Blue Shark (Prionace glauca). Innovative Food Sci. Emerging Technol., 2011, 12, 50–55. doi:10.1016/j.ifset.2010.12.006.
Torres-Arreola, W. ; Soto-Valdez, H. ; Peralta, E. ; Cárdenas-López, J. L. ; Ezquerra-Brauer, J. M. Eect of a Low-Density Polyethylene Film Containing Butylatedhydroxytoluene on Lipid Oxidation and Protein Quality of Sierra Fish (scomberomorus Sierra) Muscle during Frozen Storage. J. Agric. Food Chem., 2007, 55(15), 6140–6146. doi:10.1021/jf070418h.
Almenar, E. ; Catala, R. ; Hernandez-Munoz, P. ; Gavara, R. Optimization of an Active Package for Wild Strawberries Based on the Release of 2-Nonanone. LWT Food Sci. Technol., 2009, 42, 587–593. doi:10.1016/j.lwt.2008.09.009.
Hoshino, A. ; Osanai, T. Inventors. Packaging Films for Deodorization. Japanese Patent 86209612, 1986.
Hu, K. Active and Intelligent Packaging: Innovations for the Future. Department of Food Science and Technology. Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, Virginia. 2008; pp. 1–13.
Giannakouroua, M. C. ; Koutsoumanis, K. ; Nychasc Taoukisa, P. S. Field Evaluation of the Application of Time Temperature Integrators Form Monitoring Fish Quality in the Chill Chain. Int. J. Food Microbiol., 2005, 102, 323–336. doi:10.1016/j.ijfoodmicro.2004.11.037.
Kuswandi, B. ; Jayus Larasati, T. S. ; Abdullah, A. ; Heng, L. Y. Real-Time Monitoring of Shrimp Spoilage Using On-package Sticker Sensor Based on Natural Dye of Curcumin. Food Anal. Methods, 2012, 5(4), 881–889. doi:10.1007/s12161-011-9326-x.
Pavelkova, A. Intelligent Packaging as Device for Monitoring of Risk Factors in Food. J. Microbiol. Biotechnol. Food Sci., 2012, 2(1), 282–292.
Fanga, Z. ; Zhaob, Y. ; Warnera, R. D. ; Johnson, S. K. Active and Intelligent Packaging in Meat Industry. Trends Food Sci. Technol., 2017, 61, 60–71. doi:10.1016/j.tifs.2017.01.002.
Kerry, J. P. ; O'Grady, M. N. ; Hogan, S. A. Past, Current and Potentialutilization of Active and Intelligent Packaging Systems for Meat and Muscle-Based Products: A Review. Meat Sci., 2006, 74, 113–130. doi:10.1016/j.meatsci.2006.04.024.
Wolfbeis, O. S. ; List, H. Method for Quality Control of Packaged Organic Substances and Packaging Material for Use with This Method. US Patent 5407829, 1995.
Heising, J. ; Dekker, M. Intelligent Packaging for Fresh Fish: Prototyping and Assessing Its Application for Waste Reduction Using Quality Controlled Logistics. Presented at 6th International Symposium on Food Packaging-Scientific Developments Supporting Safety and Innovation, Barcelona, Spain. November 16, 2016.
Pacquit, A. ; Lau, K. T. ; Mclaughlin, H. ; Frisby, J. ; Quilty, B. ; Diamond, D. Development of a Volatile Amine Sensor for the Monitoring of Fish Spoilage. Talanta, 2006, 69, 515–520. doi:10.1016/j.talanta.2005.10.046.
Pacquit, A. ; Frisby, J. ; Diamond, D. ; Lau, K. T. ; Farrell, A. Development of a Smart Packaging for the Monitoring of Fish Spoilage. Food Chem., 2007, 102, 466–470. doi:10.1016/j.foodchem.2006.05.052.
Byrne, L. ; Lau, K. ; Diamond, D. Monitoring of Headspace Total Volatile Basic Nitrogen from Selected Fish Species Using Reflectance Spectroscopic Measurements of Ph Sensitive Films. Analyst, 2002, 127, 1338–1341. doi:10.1039/B206149J.
Cierpiszewski, R. ; Tichoniuk, M. ; Radomska, N. Application of Freshness Indicator for Monitoring of Fish Spoilage in Model and Commercial Packaging. Waroznawcze Problemy Jakości, 2017, 4, 103–118. doi:10.19202/j.cs.2017.04.10.
Watanabe, E. ; Ando, K. ; Karube, I. ; Matsuoka, H. ; Suzuki, S. Determination of Hypoxanthine in Fish Meat with an Enzyme Sensor. J. Food Sci., 1983, 48, 496–500. doi:10.1111/j.1365-2621.1983.tb10775.x.
Kuswandi, B. ; Jayus, R. A. ; Abdullah, A. ; Heng, L. Y. ; Ahmad, M. A Novel Colorimetric Food Package Label for Fish Spoilage Based on Polyaniline Film. Food Control, 2012, 25(1), 184–189. doi:10.1016/j.foodcont.2011.10.008.

Bodenhamer, W. T. Method and Apparatus for Selective Biological Material Detection. (Toxin Alert, Inc., Canada). US Patent 6051388, 2000.
Goldsmıth, R. M. Detection of Contaminants in Food. US Patent 5306466, 1994. doi:10.3168/jds.S0022-0302(94)77044-2.

Residues of Food Contact Materials

Bradley, E. L. (2008). Determination of phthalates in foods and establishing methodology to distinguish their source. Available at https://webarchive.nationalarchives.gov.uk/ukgwa/20141207175755/https://www.food.gov.uk/node/6716 (accessed 31/10/2022).
Bradley, E. L. , J. S. Stratton , J. Leak , L. Lister and L. Castle (2013a). Printing ink compounds in foods: UK survey results. Food Additives & Contaminants: Part B, 6(2):73–83, doi:10.1080/19393210.2012.725774. Available at https://www.tandfonline.com/doi/full/10.1080/19393210.2012.725774 (accessed 31/10/2022).
Bradley, E. L. , R. A. Burden , I. Leon , D. N. Mortimer , D. R. Speck and L. Castle (2013b). Determination of phthalate diesters in foods. Food Additives & Contaminants: Part A, 30(4):722–734, doi:10.1080/19440049.2013.781683. Avaiable at https://www.tandfonline.com/doi/full/10.1080/19440049.2013.781683 (accessed 31/10/2022).
Bratinova, S. , B. Raffael and C. Simoneau (2009). Guidelines for Performance Criteria and Validation Procedures of Analytical Methods Used in Controls of Food Contact Materials. 1st edition. Publication Office of the European Union, Luxembourg, JRC Scientific and Technical Report, EUR 24105 EN. Available at https://publications.jrc.ec.europa.eu/repository/handle/JRC5303 (accessed 31/10/2022).
EC (2019). Summary of discussions of the Expert Working Group on Food Contact Materials on the use and placing on the market of plastic food contact materials and articles containing ground bamboo or other similar constituents. Brussels, 23 June 2019. Available from https://food.ec.europa.eu/system/files/2021-06/cs_fcm_meeting-ind_20200623_en.pdf (europa.eu) (accessed 31/10/2022).
EDQM (2021). New Multi-analyte Methods for the Determination of Substances Migrating from Printing Inks to Dry Food or Food Simulants. European Directorate for the Quality of Medicines & HealthCare of the Council of Europe (EDQM). European Committee for Food Contact Materials and Articles (CD-P-MCA); S. Keitel (ed.). Available from https://freepub.edqm.eu/publications (accessed 31/10/2022).
EFSA (2019). Safety assessment of the substance, titanium dioxide surface treated with fluoridemodified alumina, for use in food contact materials. The EFSA Journal, 17(6):5737, 11 pp. Available at https://www.efsa.europa.eu/en/efsajournal/pub/5737 (accessed 31/10/2022).
EFSA (2022). The efficacy and safety of high-pressure processing of food. EFSA Journal, 20(3):7128. Available at https://www.efsa.europa.eu/en/efsajournal/pub/7128 (accessed 31/10/2022).
Schilter, B. , K. Burnett , C. Eskes , L. Geurts , M. Jacquet , C. Kirchnawy , P. Oldring , G. Pieper , E. Pinter , M. Tacker , H. Traussnig , P. van Herwijnen and A. Boobis (2019). Value and limitation of in vitro bioassays to support the application of the threshold of toxicological concern to prioritise unidentified chemicals in food contact materials. Food Additives & Contaminants: Part A, 36(12):1903–1936. Available at https://www.tandfonline.com/doi/full/10.1080/19440049.2019.1664772 (accessed 31/10/2022).
Song, Y. S. , J. L. Koontz , R. O. Juskelis , E. Patazca , W. Limm and K. Zhao (2021). Effect of high pressure processing on migration characteristics of polypropylene used in food contact materials. Food Additives and Contaminants Part A-Chemistry Analysis Control Exposure & Risk Assessment, 38:513–531, doi:10.1080/19440049.2020.1861341 (accessed 31/10/2022).
van den Houwe, K. , S. van de Velde , C. Evrard , E. van Hoeck , J. van Loco and F. Bolle (2014). Evaluation of the migration of 15 photo-initiators from cardboard packaging into Tenax(r) using ultra-performance liquid chromatography-tandem mass spectrometry (UPLC-MS/MS). Food Additives & Contaminants, Part A, 31:767–775.
Barnes, K. A. , R. Sinclair and D. Watson , (eds.). (2007). Chemical Migration and Food Contact Materials. Woodhead Publishing. ISBN-13: 978-1-84569-029-8.
European Union Reference Laboratory for Food Contact Materials, website , https://ec.europa.eu/jrc/en/eurl/food-contact-materials (accessed 31/10/2022).
Kerry, J. P. (ed.). (2012). Advances in Meat, Poultry and Seafood Packaging. Woodhead Publishing Series in Food Science, Technology and Nutrition: Number 220. Woodhead Publishing Limited. ISBN 978-1-84569-751-8 (print). ISBN 978-0-85709-571-8 (online).
Koster, S. , M. H. Bani-Estivals , M. Bonuomo , E. Bradley , M. C. Chagnon , M. L. Garcia , F. Godts , T. Gude , R. Helling , P. Paseiro-Losada , G. Pieper , M. Rennen , T. Simat and L. Spack (2015). Guidance on Best Practices on the Risk Assessment of Non Intentionally Added Substances (NIAS) in Food Contact Materials and Articles. ILSI Europe Report Series. pp. 1–70. Available at https://ilsi.eu/publication/guidance-on-best-practices-on-the-risk-assessment-of-non-intentionally-added-substances-nias-in-food-contact-materials-and-articles/ (accessed 31/10/2022).

Piringer, O. G. and A. L. Baner (2007). Plastic Packaging: Interactions with Food and Pharmaceuticals. Wiley-VCH Verlag GmbH. ISBN 9783527314553.
Rijk, R. and R. Veraart (eds.). (2010). Global Legislation for Food Packaging Materials. Wiley-VCH Verlag GmbH & Co. KGaA. ISBN 978-3-527-31912-1.
United States Food and Drug Administration, Packaging and Food Contact Substances , website, https://www.fda.gov/food/food-ingredients-packaging/packaging-food-contact-substances-fcs, (accessed 31/10/2022).

Microplastics and Nanoplastics in Food

Vitali C , Peters RJB , Janssen H-G , Nielen MWF . Microplastics and Nanoplastics in Food, Water, and Beverages; Part I. Occurrence. TrAC Trends in Analytical Chemistry. 2023;159:116670. doi: 10.1016/j.trac.2022.116670.
Ivleva NP . Chemical Analysis of Microplastics and Nanoplastics: Challenges, Advanced Methods, and Perspectives. Chemical Reviews. 2021;121:11886–11936. doi:10.1021/acs.chemrev.1c00178.
Amobonye A , Bhagwat P , Singh S , Pillai S. Plastic Biodegradation: Frontline Microbes and Their Enzymes. Science of the Total Environment. 2021;759:143536. doi:10.1016/j.scitotenv.2020.143536.
Amobonye A , Bhagwat P , Raveendran S , Singh S , Pillai S. Environmental Impacts of Microplastics and Nanoplastics: A Current Overview. Frontiers in Microbiology. 2021;12. doi:10.3389/fmicb.2021.768297.
Wright SL , Ulke J , Font A , Chan KLA , Kelly FJ . Atmospheric Microplastic Deposition in an Urban Environment and an Evaluation of Transport. Environment International. 2020;136:105411. doi:10.1016/j.envint.2019.105411.
Hartmann NB , Hüffer T , Thompson RC , Hassellöv M , Verschoor A , Daugaard AE , Rist S , Karlsson T , Brennholt N , Cole M , et al . Are We Speaking the Same Language? Recommendations for a Definition and Categorization Framework for Plastic Debris. Environmental Science & Technology. 2019;53:1039–1047. doi:10.1021/acs.est.8b05297.
Thompson RC , Olsen Y , Mitchell RP , Davis A , Rowland SJ , John AWG , McGonigle D , Russell AE . Lost at Sea: Where Is All the Plastic? Science. 2004;304:838–838. doi:10.1126/science.1094559.
Ng E-L , Huerta Lwanga E , Eldridge SM , Johnston P , Hu H-W , Geissen V , Chen D. An Overview of Microplastic and Nanoplastic Pollution in Agroecosystems. Science of the Total Environment. 2018;627:1377–1388. doi:10.1016/j.scitotenv.2018.01.341.
Lai H , Liu X , Qu M. Nanoplastics and Human Health: Hazard Identification and Biointerface. Nanomaterials. 2022;12:1298. doi:10.3390/nano12081298.
Karkanorachaki K , Tsiota P , Dasenakis G , Syranidou E , Kalogerakis N. Nanoplastic Generation from Secondary PE Microplastics: Microorganism-Induced Fragmentation. Microplastics. 2022;1:85–101. doi:10.3390/microplastics1010006.
Allen S , Allen D , Karbalaei S , Maselli V , Walker TR . Micro(Nano)Plastics Sources, Fate, and Effects: What We Know after Ten Years of Research. Journal of Hazardous Materials Advances. 2022;6:100057. doi:10.1016/j.hazadv.2022.100057.
An L , Liu Q , Deng Y , Wu W , Gao Y , Ling W. Sources of Microplastic in the Environment. In: Damià Barceló and Andrey G. Kostianoy (eds.) The Handbook of Environmental Chemistry. 2020;143–159. Springer Nature: Switzerland AG. doi:10.1007/698_2020_449.
Hu J-L , Duan Y , Zhong H-N , Lin Q-B , Zhang T , Zhao C-C , Chen S , Dong B , Li D , Wang J , et al . Analysis of Microplastics Released from Plastic Take-Out Food Containers Based on Thermal Properties and Morphology Study. Food Additives & Contaminants: Part A. 2023;40:305–318. doi:10.1080/19440049.2022.2157894.
Li Q , Feng Z , Zhang T , Ma C , Shi H. Microplastics in the Commercial Seaweed Nori. Journal of Hazardous Materials. 2020;388:122060. doi:10.1016/j.jhazmat.2020.122060.
Huerta Lwanga E , Gertsen H , Gooren H , Peters P , Salánki T , van der Ploeg M , Besseling E , Koelmans AA , Geissen V. Incorporation of Microplastics from Litter into Burrows of Lumbricus Terrestris. Environmental Pollution. 2017;220:523–531. doi:10.1016/j.envpol.2016.09.096.
Rillig MC , Ingraffia R , de Souza Machado AA. Microplastic Incorporation into Soil in Agroecosystems. Frontiers in Plant Science. 2017;8. doi:10.3389/fpls.2017.01805.
Rillig MC , Ziersch L , Hempel S. Microplastic Transport in Soil by Earthworms. Scientific Reports. 2017;7. doi:10.1038/s41598-017-01594-7.
Kutralam-Muniasamy G , Pérez-Guevara F , Elizalde-Martínez I , Shruti VC . Branded Milks - Are They Immune from Microplastics Contamination? Science of the Total Environment. 2020;714:136823. doi:10.1016/j.scitotenv.2020.136823.
Wang J , Chen G , Christie P , Zhang M , Luo Y , Teng Y. Occurrence and Risk Assessment of Phthalate Esters (PAEs) in Vegetables and Soils of Suburban Plastic Film Greenhouses. Science of the Total Environment. 2015;523:129–137. doi:10.1016/j.scitotenv.2015.02.101.

Mintenig SM , Löder MGJ , Primpke S , Gerdts G. Low Numbers of Microplastics Detected in Drinking Water from Ground Water Sources. Science of the Total Environment. 2019;648:631–635. doi:10.1016/j.scitotenv.2018.08.178.
Yang D , Shi H , Li L , Li J , Jabeen K , Kolandhasamy P. Microplastic Pollution in Table Salts from China. Environmental Science & Technology. 2015;49:13622–13627. doi:10.1021/acs.est.5b03163.
Garrido Gamarro E , Ryder J , Elvevoll EO , Olsen RL . Microplastics in Fish and Shellfish - A Threat to Seafood Safety? Journal of Aquatic Food Product Technology. 2020;29:417–425. doi:10.1080/10498850.2020.1739793.
Rajendran K , Rajendiran R , Pasupathi MS , Ahamed SBN , Kalyanasundaram P , Velu RK . Authentication of Microplastic Accumulation in Customary Fruits and Vegetables. 2022; doi:10.21203/rs.3.rs-1314420/v1. https://www.researchsquare.com/article/rs-1314420/v1.
Oliveri Conti G , Ferrante M , Banni M , Favara C , Nicolosi I , Cristaldi A , Fiore M , Zuccarello P. Micro- and Nano-plastics in Edible Fruit and Vegetables. The First Diet Risks Assessment for the General Population. Environmental Research. 2020;187:109677. doi:10.1016/j.envres.2020.109677.
Roy T , Dey TK , Jamal M. Microplastic/Nanoplastic Toxicity in Plants: An Imminent Concern. Environmental Monitoring and Assessment. 2022;195:27. doi:10.1007/s10661-022-10654-z.
Oßmann BE , Sarau G , Holtmannspötter H , Pischetsrieder M , Christiansen SH , Dicke W. Small-sized Microplastics and Pigmented Particles in Bottled Mineral Water. Water Research. 2018;141:307–316. doi:10.1016/j.watres.2018.05.027.
Mason SA , Welch VG , Neratko J. Synthetic Polymer Contamination in Bottled Water. Frontiers in Chemistry. 2018;6:407. doi:10.3389/fchem.2018.00407.
Gambino I , Bagordo F , Grassi T , Panico A , De Donno A. Occurrence of Microplastics in Tap and Bottled Water: Current Knowledge. International Journal of Environmental Research and Public Health. 2022;19:5283. doi:10.3390/ijerph19095283.
Gambino I , Bagordo F , Grassi T , Panico A , De Donno A. Occurrence of Microplastics in Tap and Bottled Water: Current Knowledge. International Journal of Environmental Research and Public Health. 2022;19:5283. doi:10.3390/ijerph19095283.
Jin M , Wang X , Ren T , Wang J , Shan J. Microplastics Contamination in Food and Beverages: Direct Exposure to Humans. Journal of Food Science. 2021;86:2816–2837. doi:10.1111/1750-3841.15802.
Diaz-Basantes MF , Conesa JA , Fullana A. Microplastics in Honey, Beer, Milk and Refreshments in Ecuador as Emerging Contaminants. Sustainability. 2020;12:5514. doi:10.3390/su12145514.
Smith M , Love DC , Rochman CM , Neff RA . Microplastics in Seafood and the Implications for Human Health. Current Environmental Health Reports. 2018;5:375–386. doi:10.1007/s40572-018-0206-z.
Soares J , Miguel I , Venâncio C , Lopes I , Oliveira M. Perspectives on Micro(Nano)Plastics in the Marine Environment: Biological and Societal Considerations. Water. 2020;12:3208. doi:10.3390/w12113208.
EFSA Panel on Contaminants in the food chain (CONTAM) . Presence of Microplastics and Nanoplastics in Food, with Particular Focus on Seafood. EFSA Journal. 2016;14(6): e04501. doi:10.2903/j.efsa.2016.4501.
Valsesia A , Parot J , Ponti J , Mehn D , Marino R , Melillo D , Muramoto S , Verkouteren M , Hackley VA , Colpo P. Detection , Counting and Characterization of Nanoplastics in Marine Bioindicators: A Proof of Principle Study. Microplastics and Nanoplastics. 2021;1:5. doi:10.1186/s43591- 021-00005-z.
Kiran BR , Kopperi H , Venkata Mohan S. Micro/Nano-Plastics Occurrence, Identification, Risk Analysis and Mitigation: Challenges and Perspectives. Reviews in Environmental Science and Bio/Technology. 2022;21:169–203. doi:10.1007/s11157-021-09609-6.
Mariano S , Tacconi S , Fidaleo M , Rossi M , Dini L. Micro and Nanoplastics Identification: Classic Methods and Innovative Detection Techniques. Frontiers in Toxicology. 2021;3:636640. doi:10.3389/ftox.2021.636640.
Picó Y , Barceló D. Analysis of Microplastics and Nanoplastics: How Green Are the Methodologies Used? Current Opinion in Green and Sustainable Chemistry. 2021;31:100503. doi:10.1016/j.cogsc.2021.100503.
Song YK , Hong SH , Jang M , Han GM , Rani M , Lee J , Shim WJ . A Comparison of Microscopic and Spectroscopic Identification Methods for Analysis of Microplastics in Environmental Samples. Marine Pollution Bulletin. 2015;93:202–209. doi:10.1016/j.marpolbul.2015.01.015.
Kalaronis D , Ainali NM , Evgenidou E , Kyzas GZ , Yang X , Bikiaris DN , Lambropoulou DA . Microscopic Techniques as Means for the Determination of Microplastics and Nanoplastics in the Aquatic Environment: A Concise Review. Green Analytical Chemistry. 2022;3:100036. doi:10.1016/j.greeac.2022.100036.
Capolungo C , Genovese D , Montalti M , Rampazzo E , Zaccheroni N , Prodi L. Frontispiece: PhotoluminescenceBased Techniques for the Detection of Micro and Nanoplastics. Chemistry - A European Journal. 2021;27:17529–17541. doi:10.1002/chem.202187062.
Noren F. Small Plastic Particles in Coastal Swedish Waters. Technical Report. KIMO. 2008.
Oleshko VP , Gijbels R , Amelinckx S. Electron Microscopy, Nanoscopy, and Scanning Micro- and Nanoanalysis. In: R.A. Meyers (Ed.) Encyclopedia of Analytical Chemistry. 2013; Wiley: Hoboken NJ USA. doi:10.1002/9780470027318.a2506.pub2.
Vitali C , Peters RJB , Janssen H-G , Nielen MWF , Ruggeri FS . Microplastics and Nanoplastics in Food, Water, and Beverages, Part II. Methods. TrAC Trends in Analytical Chemistry. 2022;157:116819. doi:10.1016/j.trac.2022.116819.

Adhikari S , Kelkar V , Kumar R , Halden RU . Methods and Challenges in the Detection of Microplastics and Nanoplastics: A MiniReview. Polymer International. 2022;71:543–551. doi:10.1002/pi.6348.

Huang Z , Hu B , Wang H. Analytical Methods for Microplastics in the Environment: A Review. Environmental Chemistry Letters. 2022;21:383–401. doi:10.1007/s10311-022-01525-7.

Woo H , Seo K , Choi Y , Kim J , Tanaka M , Lee K , Choi J. Methods of Analyzing Microsized Plastics in the Environment. Applied Sciences. 2021;11:10640. doi:10.3390/app112210640.

Picó Y , Barceló D. Analysis of Microplastics and Nanoplastics: How Green Are the Methodologies Used? Current Opinion in Green and Sustainable Chemistry. 2021;31:100503. doi:10.1016/j.cogsc.2021.100503.

Faltynkova A , Johnsen G , Wagner M. Hyperspectral Imaging as an Emerging Tool to Analyze Microplastics: A Systematic Review and Recommendations for Future Development. Microplastics and Nanoplastics. 2021;1:13. doi:10.1186/s43591-021-00014-y.

Nguyen B , Claveau-Mallet D , Hernandez LM , Xu EG , Farner JM , Tufenkji N. Separation and Analysis of Microplastics and Nanoplastics in Complex Environmental Samples. Accounts of Chemical Research. 2019;52:858–866. doi:10.1021/acs.accounts.8b00602.

Mansa R , Zou S. Thermogravimetric Analysis of Microplastics: A Mini Review. Environmental Advances. 2021;5:100117. doi:10.1016/j.envadv.2021.100117.

Liu Y , Li R , Yu J , Ni F , Sheng Y , Scircle A , Cizdziel JV , Zhou Y. Separation and Identification of Microplastics in Marine Organisms by TGA-FTIR-GC/MS: A Case Study of Mussels from Coastal China. Environmental Pollution. 2021;272:115946. doi:10.1016/j.envpol.2020.115946.

Picó Y , Barceló D. Micro(Nano)Plastic Analysis: A Green and Sustainable Perspective. Journal of Hazardous Materials Advances. 2022;6:100058. doi:10.1016/j.hazadv.2022.100058.

Kung H-C , Wu C-H , Cheruiyot NK , Mutuku JK , Huang B-W , Chang-Chien G-P. The Current Status of Atmospheric Micro/Nanoplastics Research: Characterization, Analytical Methods, Fate, and Human Health Risk. Aerosol and Air Quality Research. 2023;23:220362. doi:10.4209/aaqr.220362.