

Contemporary Food  
Engineering Series

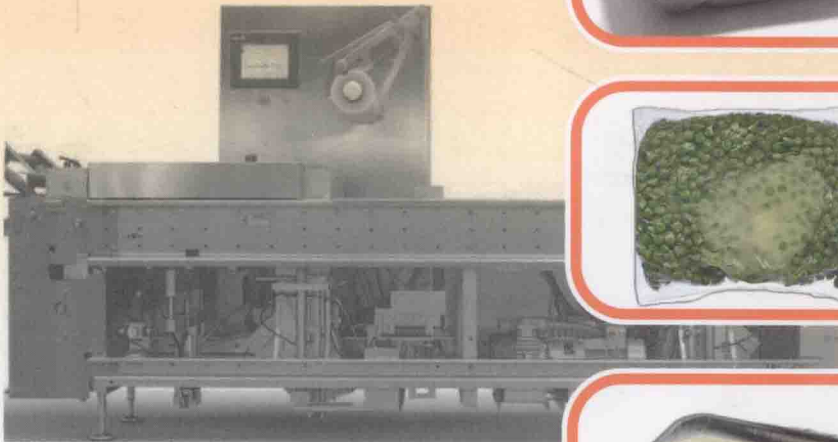
Da-Wen Sun, Series Editor



# Modified Atmosphere and Active Packaging Technologies

Edited by

**Ioannis S. Arvanitoyannis**



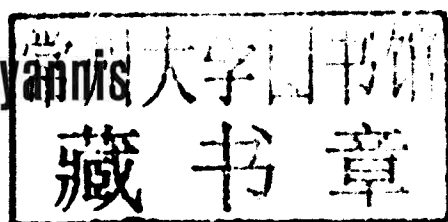
**CRC Press**

Taylor & Francis Group

# Modified Atmosphere and **Active Packaging Technologies**

Edited by

Ioannis S. Arvanitoyannis



CRC Press  
Taylor & Francis Group  
6000 Broken Sound Parkway NW, Suite 300  
Boca Raton, FL 33487-2742

© 2012 by Taylor & Francis Group, LLC  
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works

Printed and bound in Great Britain by TJ International, Padstow, Cornwall  
Version Date: 20120327

International Standard Book Number: 978-1-4398-0044-7 (Hardback)

This book contains information obtained from authentic and highly regarded sources. Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, micro-filming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access [www.copyright.com](http://www.copyright.com) (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

**Trademark Notice:** Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

---

#### Library of Congress Cataloging-in-Publication Data

---

Modified atmosphere and active packaging technologies / editor, Ioannis Arvanitoyannis.  
p. cm. -- (Contemporary food engineering)

Summary: "While other packaging books focus on individual types of packaging, this volume takes an applied engineering approach by matching packaging types to specific food types. The material provides unique insight into Modified/Controlled Atmosphere Packaging/Storage (MAP/CAS) and Active Packaging (AP). Depending on the kind of food, packaging material and the corresponding technique employed can both vary considerably. In appreciation of consumer focus on shelf life and safety, the book addresses a range of aseptic, smart, and modified atmosphere packaging. With the increased expense of active packaging, this resource will help product developers make cost-effective decisions early in product development"-- Provided by publisher.

Includes bibliographical references and index.

ISBN 978-1-4398-0044-7 (hardback)

1. Food--Packaging. 2. Protective atmospheres. I. Arvanitoyannis, Ioannis.

TP374.M59 2012  
664--dc23

2012006572

---

Visit the Taylor & Francis Web site at  
<http://www.taylorandfrancis.com>

and the CRC Press Web site at  
<http://www.crcpress.com>

# Contemporary Food Engineering

**Series Editor**

**Professor Da-Wen Sun, Director**

*Food Refrigeration & Computerized Food Technology*

*National University of Ireland, Dublin*

*(University College Dublin)*

*Dublin, Ireland*

*<http://www.ucd.ie/sun/>*

- Modified Atmosphere and Active Packaging Technologies, *edited by Ioannis Arvanitoyannis* (2012)
- Engineering Aspects of Membrane Separation and Application in Food Processing, *edited by Gyula Vatai, Erika Bekassy-Molnar, Robert W. Field, and Frank Lipnizki* (2012)
- Advances in Fruit Processing Technologies, *edited by Sueli Rodrigues and Fabiano Andre Narciso Fernandes* (2012)
- Biopolymer Engineering in Food Processing, *edited by Vânia Regina Nicoletti Telis* (2012)
- Operations in Food Refrigeration, *edited by Rodolfo H. Mascheroni* (2012)
- Thermal Food Processing: New Technologies and Quality Issues, Second Edition, *edited by Da-Wen Sun* (2012)
- Physical Properties of Foods: Novel Measurement Techniques and Applications, *edited by Ignacio Arana* (2012)
- Handbook of Frozen Food Processing and Packaging, Second Edition, *edited by Da-Wen Sun* (2011)
- Advances in Food Extrusion Technology, *edited by Medeni Maskan and Aylin Altan* (2011)
- Enhancing Extraction Processes in the Food Industry, *edited by Nikolai Lebovka, Eugene Vorobiev, and Farid Chemat* (2011)
- Emerging Technologies for Food Quality and Food Safety Evaluation, *edited by Yong-Jin Cho and Sukwon Kang* (2011)
- Food Process Engineering Operations, *edited by George D. Saravacos and Zacharias B. Maroulis* (2011)
- Biosensors in Food Processing, Safety, and Quality Control, *edited by Mehmet Mutlu* (2011)
- Physicochemical Aspects of Food Engineering and Processing, *edited by Sakamon Devahastin* (2010)
- Infrared Heating for Food and Agricultural Processing, *edited by Zhongli Pan and Griffiths Gregory Atungulu* (2010)
- Mathematical Modeling of Food Processing, *edited by Mohammed M. Farid* (2009)
- Engineering Aspects of Milk and Dairy Products, *edited by Jane Sélia dos Reis Coimbra and José A. Teixeira* (2009)
- Innovation in Food Engineering: New Techniques and Products, *edited by Maria Laura Passos and Claudio P. Ribeiro* (2009)
- Processing Effects on Safety and Quality of Foods, *edited by Enrique Ortega-Rivas* (2009)
- Engineering Aspects of Thermal Food Processing, *edited by Ricardo Simpson* (2009)
- Ultraviolet Light in Food Technology: Principles and Applications, *Tatiana N. Koutchma, Larry J. Forney, and Carmen I. Moraru* (2009)
- Advances in Deep-Fat Frying of Foods, *edited by Serpil Sahin and Servet Güllüm Sumnu* (2009)
- Extracting Bioactive Compounds for Food Products: Theory and Applications, *edited by M. Angela A. Meireles* (2009)
- Advances in Food Dehydration, *edited by Cristina Ratti* (2009)
- Optimization in Food Engineering, *edited by Ferruh Erdoğan* (2009)
- Optical Monitoring of Fresh and Processed Agricultural Crops, *edited by Manuela Zude* (2009)
- Food Engineering Aspects of Baking Sweet Goods, *edited by Servet Güllüm Sumnu and Serpil Sahin* (2008)
- Computational Fluid Dynamics in Food Processing, *edited by Da-Wen Sun* (2007)

Contemporary Food  
Engineering Series

Da-Wen Sun, Series Editor



# **Modified Atmosphere and Active Packaging Technologies**

Edited by

**Ioannis S. Arvanitoyannis**



**CRC Press**

Taylor & Francis Group

Boca Raton London New York

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

*To*

*my beloved and patient wife Nicole for her continuous and  
unfailing support over the last 13 years and to our three children*

- *Nefelli-Kallisti (the youngest and most communicative)*
- *Artemis-Eleni (the thoughtful)*
- *Iasson (the most sentimental with the fighting spirit)*

*who work hard toward conveying to us a new, more  
interesting and promising perspective of life.*

*And*

*to the memory of my grandparents (Dimitrios and  
Evangelia) for their love and support in my first steps.*

---

# Series Preface

## CONTEMPORARY FOOD ENGINEERING

Food engineering is the multidisciplinary field of applied physical sciences combined with the knowledge of product properties. Food engineers provide the technological knowledge transfer essential to the cost-effective production and commercialization of food products and services. In particular, food engineers develop and design processes and equipment to convert raw agricultural materials and ingredients into safe, convenient, and nutritious consumer food products. However, food engineering topics are continuously undergoing changes to meet diverse consumer demands, and the subject is being rapidly developed to reflect market needs.

In the development of food engineering, one of the many challenges is to employ modern tools and knowledge, such as computational materials science and nanotechnology, to develop new products and processes. Simultaneously, improving food quality, safety, and security continues to be a critical issue in food engineering study. New packaging materials and techniques are being developed to provide more protection to foods, and novel preservation technologies are emerging to enhance food security and defense. Additionally, process control and automation regularly appear among the top priorities identified in food engineering. Advanced monitoring and control systems are developed to facilitate automation and flexible food manufacturing. Furthermore, energy saving and minimization of environmental problems continue to be important food engineering issues, and significant progress is being made in waste management, efficient utilization of energy, and reduction of effluents and emissions in food production.

The Contemporary Food Engineering series, consisting of edited books, attempts to address some of the recent developments in food engineering. The series covers advances in classical unit operations in engineering applied to food manufacturing as well as such topics as progress in the transport and storage of liquid and solid foods; heating, chilling, and freezing of foods; mass transfer in foods; chemical and biochemical aspects of food engineering and the use of kinetic analysis; dehydration, thermal processing, nonthermal processing, extrusion, liquid food concentration, membrane processes, and applications of membranes in food processing; shelf life and electronic indicators in inventory management; sustainable technologies in food processing; and packaging, cleaning, and sanitation. These books are aimed at professional food scientists, academics researching food engineering problems, and graduate-level students.

The editors of these books are leading engineers and scientists from many parts of the world. All the editors were asked to present their books to address market needs and pinpoint cutting-edge technologies in food engineering.

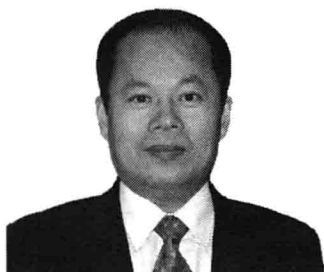
All contributions have been written by internationally renowned experts who have both academic and professional credentials. All the authors have attempted to provide critical, comprehensive, and readily accessible information on the art and science of a relevant topic in each chapter, with reference lists for further information. Therefore, each book can serve as an essential reference source to students and researchers in universities and research institutions.

**Da-Wen Sun**  
*Series Editor*



---

# Series Editor



**Professor Da-Wen Sun, PhD**, is a world authority on food engineering research and education. He is a member of the Royal Irish Academy, which is the highest academic honor in Ireland; he is also a member of Academia Europaea. His main research activities include cooling, drying, and refrigeration processes and systems; quality and safety of food products; bioprocess simulation and optimization; and computer vision technology. His innovative studies on vacuum cooling of cooked meat, pizza quality

inspection using computer vision, and edible films for shelf life extension of fruits and vegetables, in particular, have been widely reported in the national and international media. Results of his work have been published in about 600 papers, including about 250 peer-reviewed journal papers ( $h$ -index = 36). He has also edited 13 authoritative books. According to Thomson Scientific's *Essential Science Indicators*<sup>SM</sup> updated as of July 1, 2010, based on data derived over a period of 10 years and 4 months (January 1, 2000–April 30, 2010) from ISI Web of Science, a total of 2554 scientists are among the top 1% of the most-cited scientists in the category of agriculture sciences, and Professor Sun is listed at the top with a ranking of 31.

Dr. Sun received first class BSc honors and his MSc in mechanical engineering and PhD in chemical engineering from China before working at various universities in Europe. He became the first Chinese national to be permanently employed in an Irish university, when he was appointed as a college lecturer at University College Dublin (UCD)—National University of Ireland, Dublin, in 1995. He was then continuously promoted in the shortest possible time to the position of senior lecturer, associate professor, and full professor. Dr. Sun is now professor of food and biosystems engineering and director of the Food Refrigeration and Computerized Food Technology Research Group at UCD.

As a leading educator in food engineering, Dr. Sun has contributed significantly to the field of food engineering. He has guided many PhD students who have made their own contributions to the industry and academia. He has also, on a regular basis, given lectures on the advances in food engineering at international academic institutions and delivered keynote speeches at international conferences. As a recognized authority in food engineering, he has been conferred adjunct/visiting/consulting professorships by over 10 top universities in China, including Zhejiang University, Shanghai Jiaotong University, Harbin Institute of Technology, China Agricultural University, South China University of Technology, and Jiangnan University. In recognition of his significant contribution to food engineering worldwide and for his outstanding leadership in the field, the International Commission of Agricultural and Biosystems Engineering (CIGR) awarded him the CIGR Merit Award in 2000 and again in 2006; the U.K.-based Institution of Mechanical Engineers named him Food

Engineer of the Year 2004; in 2008, he was awarded the CIGR Recognition Award in recognition of his distinguished achievements as the top 1% of agricultural engineering scientists in the world; in 2007, he was presented the only AFST(I) Fellow Award in that year by the Association of Food Scientists and Technologists (India); and in 2010, he was presented the CIGR Fellow Award (the title of “Fellow” is the highest honor in CIGR and is conferred upon individuals who have made sustained, outstanding contributions worldwide).

Dr. Sun is a fellow of the Institution of Agricultural Engineers and a fellow of Engineers Ireland (the Institution of Engineers of Ireland). He has also received numerous awards for teaching and research excellence, including the President’s Research Fellowship, and has received the President’s Research Award from the UCD on two occasions. He is the editor in chief of *Food and Bioprocess Technology—An International Journal* (Springer) (2010 Impact Factor=3.576, ranked at the fourth position among 126 ISI-listed food science and technology journals); series editor of Contemporary Food Engineering series (CRC Press/Taylor & Francis); former editor of *Journal of Food Engineering* (Elsevier); and an editorial board member of *Journal of Food Engineering* (Elsevier), *Journal of Food Process Engineering* (Blackwell), *Sensing and Instrumentation for Food Quality and Safety* (Springer), and *Czech Journal of Food Sciences*. Dr. Sun is also a chartered engineer.

On May 28, 2010, Dr. Sun was awarded membership to the Royal Irish Academy (RIA), which is the highest honor that can be attained by scholars and scientists working in Ireland. At the 51st CIGR General Assembly held during the CIGR World Congress in Quebec City, Canada, in June 2010, he was elected as incoming president of the CIGR. He will become the president of the CIGR in 2013–2014. The term of the presidency is six years, two years each for serving as incoming president, president, and past president.

On September 20, 2011, he was elected to Academia Europaea, which is functioning as European Academy of Humanities, Letters and Sciences and is one of the most prestigious academies in the world; election to the Academia Europaea represents the highest academic distinction.

---

# Preface

The first human beings survived mainly by hunting wild animals, and only later did they learn to harvest vegetables, fruits, and cereals. Once they had gathered surplus food, they tried to find ways of preserving this. Apart from heating, drying, smoking, and freezing food, they used packaging materials abundant in nature such as leaves, wood, and bamboo. Later on, animal skin and woven baskets were also used for transporting water and food respectively. The canning process was introduced in 1810 by N. Appert (the method was initially known as Appertization) as a promising technique for preserving food.

Over the last two centuries, there have been lots of advances in the process of packaging. To make the proper choice of the packaging material, several parameters have to be taken into account, such as imparting the protective properties for the anticipated shelf life and availability of proper size and weight.

Although “food packaging” has been defined in several ways, some of the most representative ones are as follows: “a system for (i) preparing goods for transport, distribution, storage, (ii) ensuring safe delivery to consumer, and (iii) minimizing costs in conjunction with maximizing profits.” Another factor that has recently been introduced is the biodegradability of the packaging material, or its being environment friendly.

Apart from the so-called classical or traditional preservation techniques such as heating, drying, smoking, cooling, and freezing, there is a plethora of novel processing and preservation techniques that have gradually gained ground. Some of these techniques are the application of high pressure, microwave technology, irradiation (X-rays,  $\gamma$ -rays, e-beam), and ohmic heating, on the one hand, and the packaging-based techniques such as aseptic packaging, smart/intelligent packaging, active packaging (AP), packaging under vacuum, and modified atmosphere packaging (MAP) and controlled atmosphere packaging, on the other. Although MAP first appeared in the 1960s, its application at the commercial level was rather restricted. It is only in the last 10–15 years that this technique has seen increased usage. The same was valid for active packaging where the inclusion of a small bag (containing the active component due to be released or react with a non-desirable one) on several occasions was not highly appreciated by the consumers. Another factor limiting the extensive usage of MAP and AP was their higher cost compared to conventional packages. However, recently there has been an increasing demand for large amounts of fresh food (in view of globalization), which has favored the upgradation of MAP and AP. Since both techniques can be applied to fresh food stored in the fridge, their application has been enhanced considerably.

This book consists of 19 chapters and has been divided into seven parts: Part I (Principles, Materials, Gases, and Machinery for MAP) consists of Chapters 1 and 2. Part II (Safety and Quality Control of MAP Produces) consists of Chapter 3. Part III (Applications of MAP in Foods of Animal Origin) consists of Chapters 4 through 7, which cover fish, meat, poultry, and dairy products. Part IV (Applications of MAP

in Foods of Plant Origin) consists of Chapters 8 through 11, which deal with cereals, minimally processed vegetables, fruits, and bakery products. Part V (Other Applications of MAP) consists of Chapters 12 and 13, which describe RTE food and other miscellaneous types of foods. Part VI (Active Packaging and Its New Trends) consists of Chapters 14 through 16, which deal with active packaging, nanotechnology, and bioactive packaging. Part VII (Consumer Behavior/Sensory Analysis and Legislation) consists of Chapters 17 through 19, which cover the issues of sensory analysis and consumer search; EU, U.S., and Canadian legislation; and, finally, conclusions and new trends.

The aim of this book is to convey, both to the average and specialized reader, an overview of the current status quo of MA and AP in terms of applied techniques and methodologies in conjunction with a large number of applications on food of animal and plant (both raw and processed) origin and updated legislation for packaging coming in contact with foods. Emphasis was also given to novel technologies such as nanotechnology and bioactive packaging (chitosan).

The uniqueness of this book is that it covers practically all issues related to packaging under modified atmosphere and vacuum, controlled atmosphere, and active packaging, starting with the very basics (films, gases, techniques and applications, legislation) up to the latest advances (nanotechnology and bioactive compounds), and it is supported in this endeavor by a large number of sources (more than 2000), which will be of use to the reader.

It is anticipated that this book will be of interest and use to scientists and technologists coming from different backgrounds (veterinary doctors, agriculturists, chemists, chemical engineers, food scientists, and technologists) and levels, that is, from undergraduate students up to graduates, postgraduates, instructors, professors (research institutes and universities or polytechnics), and professionals well versed in this topic.

**Dr. Ioannis S. Arvanitoyannis PhD**

*Associate Professor  
University of Thessaly  
Volos, Greece*

---

# Editor

**Ioannis S. Arvanitoyannis** graduated from the Department of Chemistry at Aristotle University of Thessaloniki (AUTH), Hellas. He did his first PhD in polymer science, Department of Chemistry, AUTH, Hellas, and his second PhD in physical chemistry of foods, Department of Food Science and Applied Microbiology. He has worked as a postdoctoral researcher at the Research Center of Plastic Materials of Ciba-Geigy, Marly, Fribourg, Switzerland; in the Department of Chemistry at Loughborough University of Technology, United Kingdom, for two years; and in Osaka National Research Institute of Japan for two and a half years.

Since 2005, Dr. Arvanitoyannis has been serving as associate professor in the Department of Agriculture, Ichthyology and Aquatic Environment in the School of Agricultural Sciences at the University of Thessaly. He has published more than 180 research and review articles in well-known peer review journals and is the author of 35 invited chapters (32 in English). He is also author and coauthor of 16 books on topics related to food technology; food packaging (MAP, AP); food safety (HACCP), ISO 22000:2005; genetically modified foods; implementation of TQM, ISO 9001 to the food industry; quality assurance and safety guide for the food and drink industry; irradiation of food commodities; waste management for the food industries; and ISO 14000 and a laboratory guide on food quality control. He has been invited to give lectures in Kyoto University, Japan, the University of Bangkok, Thailand, the University of Chester, United Kingdom, the University of Helsinki, Finland, Mediterranean Agronomic Institute of Chania (MAICH), Greece, and Mediterranean Agronomic Institute of Bari, Italy.

Dr. Arvanitoyannis enjoys international recognition, with more than 3000 citations (cross-references) to his credit, is associate editor of the *International Journal of Food Science and Technology*, and is a member of the editorial board of six journals. He has also served as reviewer for more than 25 international journals.

---

# Contributors

**Maria Andreou**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Ioannis S. Arvanitoyannis**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Konstantinos Bosinas**

Department of Dietetics  
Technological Institute of Larissa  
Larissa, Greece

**Achilleas Bouletis**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Stéphane Desobry**

Laboratory of Biomolecules  
Engineering  
Engineering School in Food and  
Agricultural Sciences  
University of Lorraine  
Vandoeuvre, France

**Nikoletta K. Dionisopoulou**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Vasiliki I. Giatrakou**

Department of Chemistry  
University of Ioannina  
Ioannina, Greece

**Muhammad Imran**

Laboratory of Biomolecules  
Engineering  
Engineering School in Food and  
Agricultural Sciences  
University of Lorraine  
Vandoeuvre, France

**Konstantinos Kotsanopoulos**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Nikoletta Manti**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Georgios Oikonomou**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Anne-Marie Revol-Junelles**

Laboratory of Biomolecules  
Engineering  
Engineering School in Food and  
Agricultural Sciences  
University of Lorraine  
Vandoeuvre, France

**Maria Savva**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Ioannis N. Savvaidis**

Department of Chemistry  
University of Ioannina  
Ioannina, Greece

**Alexandros Ch. Stratakis**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Persephoni Tserkezou**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

**Georgios Tziatzios**

Department of Ichthyology & Aquatic  
Resources  
University of Thessaly  
Volos, Greece

---

# Contents

Series Preface.....	xi
Series Editor.....	xiii
Preface.....	xv
Editor .....	xvii
Contributors .....	xix

## ***PART I Principles, Materials, Gases, and Machinery for MAP***

<b>Chapter 1</b>	Principles of MAP and Definitions of MAP, CA, and AP.....	3
	<i>Ioannis S. Arvanitoyannis</i>	
<b>Chapter 2</b>	Materials (Films), Gases, and Machinery (Techniques) for MAP .....	9
	<i>Ioannis S. Arvanitoyannis and Achilleas Bouletis</i>	

## ***PART II Safety and Quality Control of MAP Produces***

<b>Chapter 3</b>	Safety and Quality Control of Modified Atmosphere Packaging Products .....	59
	<i>Ioannis S. Arvanitoyannis and Konstantinos Kotsanopoulos</i>	

## ***PART III Applications of MAP in Foods of Animal Origin***

<b>Chapter 4</b>	Fish and Seafood .....	147
	<i>Ioannis S. Arvanitoyannis and Alexandros Ch. Stratakis</i>	
<b>Chapter 5</b>	Fresh and Processed Meat and Meat Products.....	223
	<i>Ioannis S. Arvanitoyannis and Alexandros Ch. Stratakis</i>	



<b>Chapter 6</b>	Poultry .....	261
	<i>Ioannis S. Arvanitoyannis and Alexandros Ch. Stratakos</i>	

<b>Chapter 7</b>	Milk and Dairy Products.....	281
	<i>Ioannis S. Arvanitoyannis and Georgios Tziatzios</i>	

## ***PART IV Applications of MAP in Foods of Plant Origin***

<b>Chapter 8</b>	Cereals.....	323
	<i>Ioannis S. Arvanitoyannis and Konstantinos Kotsanopoulos</i>	

<b>Chapter 9</b>	Minimally Processed Vegetables .....	337
	<i>Ioannis S. Arvanitoyannis and Achilleas Bouletis</i>	

<b>Chapter 10</b>	Fruits .....	471
	<i>Ioannis S. Arvanitoyannis, Maria Savva, and Nikoletta K. Dionisopoulou</i>	

<b>Chapter 11</b>	Bakery Products .....	501
	<i>Ioannis S. Arvanitoyannis and Konstantinos Bosinas</i>	

## ***PART V Other Applications of MAP***

<b>Chapter 12</b>	Ready-to-Eat Foods.....	555
	<i>Ioannis S. Arvanitoyannis and Maria Andreou</i>	

<b>Chapter 13</b>	Miscellaneous Foods (Coffee, Tea, Beer, Snacks) .....	599
	<i>Ioannis S. Arvanitoyannis</i>	

## ***PART VI Active Packaging and Its New Trends***

<b>Chapter 14</b>	Active and Intelligent Packaging.....	627
	<i>Ioannis S. Arvanitoyannis and Georgios Oikonomou</i>	