VOLUME 6

Food Preservation

Editor Alexandru Mihai Grumezescu



FOOD PRESERVATION

Page left intentionally blank

FOOD PRESERVATION Nanotechnology in the Agri-Food Industry, Volume 6

Edited by

ALEXANDRU MIHAI GRUMEZESCU

Department of Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Applied Chemistry and Materials Science, University Politehnica of Bucharest, Bucharest, Romania



AMSTERDAM • BOSTON • HEIDELBERG • LONDON • NEW YORK • OXFORD PARIS • SAN DIEGO • SAN FRANCISCO • SINGAPORE • SYDNEY • TOKYO Academic Press is an imprint of Elsevier



Academic Press is an imprint of Elsevier 125 London Wall, London EC2Y 5AS, United Kingdom 525 B Street, Suite 1800, San Diego, CA 92101-4495, United States 50 Hampshire Street, 5th Floor, Cambridge, MA 02139, United States The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, United Kingdom

Copyright © 2017 Elsevier Inc. All rights reserved.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying, recording, or any information storage and retrieval system, without permission in writing from the publisher. Details on how to seek permission, further information about the Publisher's permissions policies and our arrangements with organizations such as the Copyright Clearance Center and the Copyright Licensing Agency, can be found at our website: www.elsevier.com/permissions.

This book and the individual contributions contained in it are protected under copyright by the Publisher (other than as may be noted herein).

Notices

Knowledge and best practice in this field are constantly changing. As new research and experience broaden our understanding, changes in research methods, professional practices, or medical treatment may become necessary.

Practitioners and researchers must always rely on their own experience and knowledge in evaluating and using any information, methods, compounds, or experiments described herein. In using such information or methods they should be mindful of their own safety and the safety of others, including parties for whom they have a professional responsibility.

To the fullest extent of the law, neither the Publisher nor the authors, contributors, or editors, assume any liability for any injury and/or damage to persons or property as a matter of products liability, negligence or otherwise, or from any use or operation of any methods, products, instructions, or ideas contained in the material herein.

Library of Congress Cataloging-in-Publication Data

A catalog record for this book is available from the Library of Congress

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library

ISBN: 978-0-12-804303-5

For information on all Academic Press publications visit our website at https://www.elsevier.com/



www.elsevier.com • www.bookaid.org

Publisher: Nikki Levy Acquisition Editor: Patricia Osborn Editorial Project Manager: Jaclyn Truesdell Production Project Manager: Caroline Johnson Designer: Mark Rogers

Typeset by Thomson Digital

CONTENTS

List	of Contributorsxv
Seri	es Foreword
Seri	es Preface
	ıme Preface
	pter 1 Antimicrobial Nanocomposites for Food Packaging 1
Xiao	long Deng, Anton Yu Nikiforov, Christophe Leys
1	Introduction
2	Nanoantimicrobial Compounds for Food Packaging5
3	Incorporating Antimicrobial Nanoparticles
	Within Packaging Materials8
4	Grafting Antimicrobial Nanoparticles on Packaging Surface13
5	Depositing Antimicrobial Nanocomposite Coatings by Plasma 19
6	Risk of Antimicrobial Nanocomposite Films
7	Conclusions
Re	ferences
Cha	pter 2 Food Applications of Nanostructured Antimicrobials 35
Adria	ano Brandelli, Nathalie Almeida Lopes, Juliana Ferreira Boelter
1	Introduction
2	Nanoparticles
3	Nanofibers
4	Nanocomposites: Films and Coatings for Food Packaging 53
5	Nanotoxicology: General Considerations
6	Toxicological Evaluation of Nanomaterials60
7	Conclusions
Re	eferences

Chapter 3 Nanostructured Antimicrobial Materials in The Food Industry	
	n Rodríguez-Hernández
1	Introduction to Antimicrobial Agents and Their Role
-	in Food-Packaging Applications
2	Traditional Antimicrobial (AM) Additives
3	Materials Employed in Antimicrobial Packaging
4	Antimicrobial Packaging Alternatives
5	Polymer Nanotechnology in Food Packaging
6	Antimicrobial Nanostructures in Food Packaging
7	Conclusions
Re	eferences
Cha	pter 4 Antimicrobial Nanotechnology: Research Implications
	Prospects in Food Safety
	arajan Srividya, Manjula D. Ghoora, Pushkala R. Padmanabh
1	Introduction
2	Antimicrobial Activities of Nanoparticles and Nanomaterials 126
3	Nano-Based Antimicrobial Packaging Systems
	for Shelf Life Extension and Safety Against Food Pathogens 136
4	Nanosensors for Microbial Detection and Other Food
_	Safety Applications
5	Nanocomposite Antimicrobial Surfaces for Prevention of Biofouling
6	Safety Considerations of Antimicrobial Nanoparticles
7	Conclusions
	eferences
	pter 5 Sanitation of Equipment
1	Introduction
2	Sanitation

3 Re	Conclusions
for	pter 6 Recent Advances in Gas Plasma Technology Decontamination of Food Surfaces
1 2 3 4 5 6 Re	Current Status on Decontamination of Foods197Gas Plasma Technology198Inactivation of Salmonella by Nitrogen Gas Plasma200Influenza Virus Inactivation by Nitrogen Gas207Gas Plasma Treatment207Gas Plasma in Food Decontamination220Future Perspectives222eferences223
of A	pter 7 Use of High-Intensity Ultrasound for Production Antimicrobial and Self-Cleaning Surfaces
1	Introduction
2	Chemical and Physical Effects of High-Intensity Ultrasound on Surfaces
3	High and Low Intensity of Sonication
4	Mechanisms of Surface Modification by HIUS
5	Kinetics of Ultrasonically Induced Modification of Metal Surface
6	Functionalization of Ultrasonically Modified Metal Surfaces: Formation of Hybrid Materials
7	Application of Ultrasonically Modified Metal Surfaces
8	General Aspects of Ultrasound-Assisted Modification of Polymer Surfaces and Their Application
9	Conclusions and Outlooks
Re	eferences

Elena Fortunati, Debora Puglia, Ilaria Armentano, Arantzazu Valdés, Marina Ramos, Nerea Juárez, Maria Carmen Garrigós, Josè Maria Kenny

1	Introduction
2	Antimicrobial Agents
3	Biodegradable Polymers for Food Packaging Applications277
4	Nanotechnology in Food Packaging: Nanocomposite Approach 284
5	Antimicrobial Nanocomposites in Food Packaging Market288
6	Conclusions
Re	ferences

Florin Iordache, Irina Gheorghe, Veronica Lazar, Carmen Curutiu, Lia Mara Ditu, Alexandru Mihai Grumezescu, Alina Maria Holban

1	Introduction	305
2	Current Food Preservation Methods	306
3	Industrial/ModernTechniques	310
4	Prolonged Food Preservation	315
5	Nanomaterials in Food Preservation and Packaging	316
6	Conclusions	30
Re	ferences	31

	oter 10 Nanobiotechnological Strategies oxigenic Fungi and Mycotoxin Control	337
Kame	el A. Abd-Elsalam, Ayat F. Hashim, Mousa A. Alghuthaymi, Ernest Said-Galiev	
1	Introduction	337
2	Chemical Fungicides Problems	340
З	Green and Ecofriendly Alternatives	341

0		τı
4	What Are Nanopesticides?	43

5	Nanomaterial Antitoxigenic Fungi
6	Chitosan
7	Adsorbing Nanoadditives
8	Nanogels
9	Nanomaterials Antimycotoxins
10	Mechanism of Action352
11	Residue Profiles of Nanocides in Agroecosystems
12	Advantages of Green and/or Nanofungicides
13	Conclusions and Future Focus
Ref	erences

Ludovic Everard Bejenaru

1	Introduction
2	Aromatic Compounds
3	Terpenoids: Essential Oils
4	Organosulfur Compounds
5	Bacteriocins
6	Antimicrobial Products of Animal Origin
7	Other Natural Food Preservatives
8	Conclusions and Future Perspectives
Ref	erences

Chapter 12Use of Nanoparticles as a Potential Antimicrobialfor Food Packaging413Gerson Nakazato, Renata K.T. Kobayashi, Amedea B. Seabra, Nelson Duran

1	Introduction	413
2	Foodborne Pathogens	414
3	Antimicrobials Used in Food and Packaging	416
4	Antibacterial Resistance as Problem in Food Contamination	420

6 Antimicrobial Polymeric Nanoparticles in Food Packaging		Food Packaging and Nanotechnology Applications as Antimicrobial
8 Commercial Silver Nanoparticles as Antimicrobial in Food Packaging 434 9 Food Packaging and Silver Nanoparticle Migration to the Food 437 10 New Approach of Nanoparticles Combined with Other Compounds for use as Antimicrobials 439 11 Conclusions 440 References 440 References 440 Chapter 13 Recent Advances in the Direct and Nanomaterials-Based Matrix-Assisted Laser Desorption/Ionization Mass Spectrometric Approaches for Rapid Characterization and Identification of Foodborne Pathogens 449 2 Foodborne Pathogens 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples by Direct MALDI-MS 455 5 Identification of Foodborne Pathogens in Food Samples by Nanomaterials-Based MALDI-MS 467 6 Summary 479 References 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities 487 1 Introduction 487	6	
in Food Packaging 434 9 Food Packaging and Silver Nanoparticle Migration to the Food 437 10 New Approach of Nanoparticles Combined with Other Compounds for use as Antimicrobials 439 11 Conclusions 440 References 440 Chapter 13 Recent Advances in the Direct and Nanomaterials-Based Matrix-Assisted Laser Desorption/Ionization Mass Spectrometric Approaches for Rapid Characterization and Identification of Foodborne Pathogens 449 Suresh Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu 1 Introduction 449 2 Foodborne Pathogens 453 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples by Direct MALDI-MS 455 5 Identification of Foodborne Pathogens in Food Samples by Nanomaterials-Based MALDI-MS 467 6 Summary 479 References 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities 487 1 Introduction 487	7	Food Packaging and Silver Nanoparticles
to the Food. 437 10 New Approach of Nanoparticles Combined with Other Compounds for use as Antimicrobials. 439 11 Conclusions 440 References. 440 Chapter 13 Recent Advances in the Direct and Nanomaterials-Based Matrix-Assisted Laser Desorption/Ionization Mass Spectrometric Approaches for Rapid Characterization and Identification of Foodborne Pathogens 449 Suresh Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu 1 Introduction 449 2 Foodborne Pathogens 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples by Direct MALDI-MS 455 455 5 Identification of Foodborne Pathogens in Food Samples by Nanomaterials-Based MALDI-MS 467 6 Summary 479 References 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities 487 1 Introduction 487	8	•
with Other Compounds for use as Antimicrobials 439 11 Conclusions 440 References 440 Chapter 13 Recent Advances in the Direct and Nanomaterials-Based Matrix-Assisted Laser Desorption/Ionization Mass Spectrometric Approaches for Rapid Characterization and Identification of Foodborne Pathogens 449 Suresh Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu 449 1 Introduction 449 2 Foodborne Pathogens 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples 455 5 Identification of Foodborne Pathogens in Food Samples 467 6 Summary 479 References 480 Chapter 14 Nanomaterials-Based MALDI-MS 467 6 Summary 479 References 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities 487 Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras 1 1 Introduction 487	9	
References.	10	
Chapter 13 Recent Advances in the Direct and Nanomaterials-Based Matrix-Assisted Laser Desorption/Ionization Mass Spectrometric Approaches for Rapid Characterization and Identification of Foodborne Pathogens 449 Suresh Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu 1 Introduction 449 2 Foodborne Pathogens 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples 455 5 Identification of Foodborne Pathogens in Food Samples 467 6 Summary 479 References 480 Chapter 14 Nanometals Appraisal in Food Preservation 487 Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras 487	11	Conclusions
Matrix-Assisted Laser Desorption/Ionization Mass Spectrometric Approaches for Rapid Characterization and Identification of Foodborne Pathogens 449 Suresh Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu 1 Introduction 449 2 Foodborne Pathogens 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples 455 5 Identification of Foodborne Pathogens in Food Samples 455 5 Identification of Foodborne Pathogens in Food Samples 479 8 Matrix 479 9 References 480 Chapter 14 Nanometals Appraisal in Food Preservation 487 Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras 487	Re	erences
2 Foodborne Pathogens. 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples 455 5 Identification of Foodborne Pathogens in Food Samples 467 6 Summary 467 6 Summary 479 References. 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities 487 Ahmed A. Tayel, Noha M. Sorour, Ashraf F. EI-Baz, Wael F. EI-Tras 487		•
2 Foodborne Pathogens. 453 3 Sample Preparation for Bacteria Analysis by MALDI-MS 454 4 Identification of Foodborne Pathogens in Food Samples 455 5 Identification of Foodborne Pathogens in Food Samples 467 6 Summary 467 6 Summary 479 References. 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities 487 Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras 487		
 3 Sample Preparation for Bacteria Analysis by MALDI-MS	Sures	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu
4 Identification of Foodborne Pathogens in Food Samples by Direct MALDI-MS .455 5 Identification of Foodborne Pathogens in Food Samples by Nanomaterials-Based MALDI-MS .467 6 Summary .479 References .480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras .487 1 Introduction .487	Sures 1	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
5 Identification of Foodborne Pathogens in Food Samples by Nanomaterials-Based MALDI-MS. 467 6 Summary 479 References. 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras 487 1 Introduction 487	Sures 1 2	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
by Nanomaterials-Based MALDI-MS	Sures 1 2 3	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
6 Summary 479 References 480 Chapter 14 Nanometals Appraisal in Food Preservation and Food-Related Activities Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras 1 Introduction 487	Sures 1 2 3 4	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
Chapter 14Nanometals Appraisal in Food Preservation and Food-Related Activities487Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras1Introduction487	Sures 1 2 3 4	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
and Food-Related Activities487Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras11Introduction487	Sures 1 2 3 4 5	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras 1 Introduction	Sures 1 2 3 4 5	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
1 Introduction	Sures 1 2 3 4 5 6 Re ⁻	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
	Sures 1 2 3 4 5 6 Re ⁻¹ Chap and	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction
	Sures 1 2 3 4 5 6 Re ⁻ Chap and 1 Ahme	h Kumar Kailasa, Vaibhavkumar N. Mehta, Hui-Fen Wu Introduction

3	Nanometals and Foodborne Pathogens
4	Nanometals and Food Preservation
5	Applications of Nanotechnologies in Food-Related Sectors 500
6	The Antimicrobial Mode of Action of Nanometals
7	Potential Risks From Nanometals Application
	in Food-Related Sectors
8	Conclusions
Re	eferences
Cha	pter 15 Photodamage and Photoprotection: Toward Safety
	Sustainability Through Nanotechnology Solutions
	os Fernandes, Sofia Benfeito, André Fonseca, Catarina Oliveira,
Jorg	e Garrido, E. Manuela Garrido, Fernanda Borges
1	Introduction
2	External Factors Affecting Food Quality
3	Nanotechnology as a Part of the Solution for Protection
	and Preservation
4	Nanoengineered Solutions for Bioactive Food Component
	Protection: Case Studies
5	Concluding Remarks554
Re	eferences
	pter 16 Nanoparticles and Their Potential Application
as A	Antimicrobials in the Food Industry
Zivil	e Luksiene
1	Introduction
2	Antimicrobial Nanoparticles and their Physicochemical
	Properties
3	Mechanism of Antimicrobial Action of Nanoparticles
4	Antimicrobial Nanoparticles Against Foodborne Pathogens 581
5	Antimicrobial Nanoparticles Against Waterborne Pathogens 583
6	Antimicrobial Nanoparticles Against Harmful Microfungi 586
	1 0 0

7 8	Toward Hurdle Antimicrobial Nanotechnologies
	on the Environment and Human Health
9	Future Perspectives
10	Conclusions
Ref	erences
Chap	ter 17 Nanobiotechnology of Cyanobacterial UV-Protective
-	oounds: Innovations and Prospects
Richa,	Jainendra Pathak, Arun S. Sonker, Vidya Singh, Rajeshwar P. Sinha
1	Introduction
2	Photoprotection in Cyanobacteria
3	Nanobiotechnology of Cyanobacterial
	UV-Protective Compounds
4	Conclusions
Ref	erences
Chan	ter 18 Advances in Molecular Biology Based Assays
	e Rapid Detection of Food Microbial Contaminants
Maria	na Carmen Chifiriuc, Irina Gheorghe, Ilda Czobor, Denisa Alexandra Florea, a Mateescu, Marius Eduard Caplan, Dana Magdalena Caplan, Veronica Lazar
1	Introduction
2	FactorsThat Influence the Growth and Development
	of Microorganisms in Foodstuffs646
3	Foodborne Diseases647
4	Microorganisms Involved in the Etiology of FPs648
5	Conventional Methods Used in Detecting Food
	Microbial Contaminants
6	Unconventional Methods Used In the Detection of Different Food Microbial Contaminants
7	Conclusions
Ref	erences

1 1	<i>Ja Zhong, Gloria S. Oporto, Jacek Jaczynski</i> Introduction
2	Background
3	Materials and Methods
4	Results and Discussion
5	Conclusions
Re	eferences
Cha	pter 20 Scientometric Overview in Food Nanopreservation 703
Ozca	an Konur
Ozca 1	
	an Konur
1	n Konur Overview
1 2 3	Overview
1 2 3 4	overview
1 2 3 4	Overview

Page left intentionally blank

LIST OF CONTRIBUTORS

Kamel A. Abd-Elsalam

Agricultural Research Center (ARC), Plant Pathology Research Institute, Unit of Excellence in Nano-Molecular Plant Pathology Research, Giza, Egypt

Mousa A. Alghuthaymi

Shaqra University, Science and Humanities College, Biology Department, Alquwayiyah, Saudi Arabia

Daria V. Andreeva

University of Bayreuth, Physical Chemistry II, Bayreuth, Germany

Ilaria Armentano

University of Perugia, Civil and Environmental Engineering Department, Perugia, Italy

Cornelia Bejenaru

University of Medicine and Pharmacy of Craiova, Department of Vegetal & Animal Biology, Faculty of Pharmacy, Craiova, Romania

Ludovic Everard Bejenaru

University of Medicine and Pharmacy of Craiova, Department of Pharmacognosy & Phytotherapy, Faculty of Pharmacy, Craiova, Romania

Sofia Benfeito

University of Porto, Faculty of Sciences, CIQUP/Department of Chemistry and Biochemistry, Porto, Portugal

Juliana Ferreira Boelter

Laboratory of Biochemistry and Applied Microbiology, Institute of Food Science and Technology, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

Fernanda Borges

University of Porto, Faculty of Sciences, CIQUP/Department of Chemistry and Biochemistry, Porto, Portugal

Adriano Brandelli

Laboratory of Biochemistry and Applied Microbiology, Institute of Food Science and Technology, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

Dana Magdalena Caplan

National Research Institute Cantacuzino, Bucharest, Romania

Marius Eduard Caplan

University of Agronomic Sciences and Veterinary Medicine Bucharest, Faculty of Veterinary Medicine, Bucharest, Romania

Mariana Carmen Chifiriuc

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB), Bucharest, Romania

Carmen Curutiu

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB), Bucharest, Romania

Ilda Czobor

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB), Bucharest, Romania

Xiaolong Deng

Ghent University, Department of Applied Physics, Ghent, Belgium

Lia Mara Ditu

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB), Bucharest, Romania

Nelson Duran

Campinas State University, Institute of Chemistry, São Paulo, Campinas, Brazil

Ashraf F. El-Baz

University of Sadat City, Genetic Engineering and Biotechnology Research Institute, Egypt

Wael F. El-Tras

Kafrelsheikh University, Faculty of Aquatic and Fisheries Sciences, Kafr El-Sheikh, Egypt

Carlos Fernandes

University of Porto, Faculty of Sciences, CIQUP/Department of Chemistry and Biochemistry, Porto, Portugal

Denisa Alexandra Florea

Politehnica University of Bucharest, Faculty of Medical Engineering, Department of Biomaterials and Medical Devices, Bucharest, Romania

André Fonseca

University of Porto, Faculty of Sciences, CIQUP/Department of Chemistry and Biochemistry, Porto, Portugal

Elena Fortunati

University of Perugia, Civil and Environmental Engineering Department, Perugia, Italy

E. Manuela Garrido

University of Porto, Faculty of Sciences, CIQUP/Department of Chemistry and Biochemistry; Polytechnic of Porto, School of Engineering (ISEP), Department of Chemical Engineering, Porto, Portugal

Jorge Garrido

University of Porto, Faculty of Sciences, CIQUP/Department of Chemistry and Biochemistry; Polytechnic of Porto, School of Engineering (ISEP), Department of Chemical Engineering, Porto, Portugal

Maria Carmen Garrigós

University of Alicante, Department of Analytical Chemistry, Nutrition & Food Sciences, Alicante, Spain

Irina Gheorghe

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB), Bucharest, Romania

Manjula D. Ghoora

Sri Sathya Institute of Higher Learning, Department of Food and Nutritional Sciences, Anantapur, Andhra Pradesh, India

Alexandru Mihai Grumezescu

Politehnica University of Bucharest, Department of Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Applied Chemistry and Materials Science, Bucharest, Romania

Ayat F. Hashim

Agricultural Research Center (ARC), Plant Pathology Research Institute, Unit of Excellence in Nano-Molecular Plant Pathology Research, Giza, Egypt

Alina Maria Holban

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB); Politehnica University of Bucharest, Department of Science and Engineering of Oxide Materials and Nanomaterials, Faculty of Applied Chemistry and Materials Science, Bucharest, Romania

Florin lordache

Institute of Cellular Biology and Pathology "Nicolae Simionescu" (ICBP), Flow Cytometry and Cell Therapy Laboratory, Bucharest, Romania

Jacek Jaczynski

West Virginia University, Davis College, School of Agriculture and Food, Morgantown, WV, United States

Nerea Juárez

University of Alicante, Department of Analytical Chemistry, Nutrition & Food Sciences, Alicante, Spain

Suresh Kumar Kailasa

Department of Applied Chemistry, S. V. National Institute of Technology, Surat, Gujarat, India

Josè Maria Kenny

University of Perugia, Civil and Environmental Engineering Department, Perugia, Italy

Renata K.T. Kobayashi

State University of Londrina, Department of Microbiology, Paraná, Londrina, Brazil

Anna Kollath

University of Bayreuth, Physical Chemistry II, Bayreuth, Germany

Ozcan Konur

Yildirim Beyazit University, Ankara, Turkey

Veronica Lazar

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB), Bucharest, Romania

Christophe Leys

Ghent University, Department of Applied Physics, Ghent, Belgium

Nathalie Almeida Lopes

Laboratory of Biochemistry and Applied Microbiology, Institute of Food Science and Technology, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

Zivile Luksiene

Vilnius University, Institute of Applied Research, Vilnius, Lithuania

Lorena Mateescu

University of Bucharest, Faculty of Biology, Microbiology Department, Research Institute of the University of Bucharest (ICUB), Bucharest, Romania

Vaibhavkumar N. Mehta

Department of Applied Chemistry, S. V. National Institute of Technology, Surat, Gujarat, India

Ana Meireles

University of Porto, Faculty of Engineering, LEPABE-Department of Chemical Engineering, Porto, Portugal

George Dan Mogoşanu

University of Medicine and Pharmacy of Craiova, Department of Pharmacognosy & Phytotherapy, Faculty of Pharmacy, Craiova, Romania

Gerson Nakazato

State University of Londrina, Department of Microbiology, Paraná, Londrina, Brazil

Anton Yu Nikiforov

Ghent University, Department of Applied Physics, Ghent, Belgium

Catarina Oliveira

University of Porto, Faculty of Sciences, CIQUP/Department of Chemistry and Biochemistry, Porto, Portugal

Gloria S. Oporto

West Virginia University, Davis College, School of Natural Resources, Morgantown, WV, United States

Pushkala R. Padmanabh

Sri Sathya Institute of Higher Learning, Department of Food and Nutritional Sciences, Anantapur, Andhra Pradesh, India

Jainendra Pathak

Banaras Hindu University, Institute of Science, Laboratory of Photobiology and Molecular Microbiology, Centre of Advanced Study in Botany, Varanasi, India