

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



CONTENTS

List of Contributors	xv
Series Foreword	xxiii
Series Preface	xxv
Volume Preface	xxvii

Chapter 1 Antimicrobial Nanocomposites for Food Packaging 1

Xiaolong Deng, Anton Yu Nikiforov, Christophe Leys

1 Introduction	1
2 Nanoantimicrobial Compounds for Food Packaging	5
3 Incorporating Antimicrobial Nanoparticles Within Packaging Materials	8
4 Grafting Antimicrobial Nanoparticles on Packaging Surface	13
5 Depositing Antimicrobial Nanocomposite Coatings by Plasma	19
6 Risk of Antimicrobial Nanocomposite Films	29
7 Conclusions	30
References	30

Chapter 2 Food Applications of Nanostructured Antimicrobials 35

Adriano Brandelli, Nathalie Almeida Lopes, Juliana Ferreira Boelter

1 Introduction	35
2 Nanoparticles	36
3 Nanofibers	46
4 Nanocomposites: Films and Coatings for Food Packaging	53
5 Nanotoxicology: General Considerations	57
6 Toxicological Evaluation of Nanomaterials	60
7 Conclusions	65
References	66

**Chapter 3 Nanostructured Antimicrobial Materials
in The Food Industry 75***Juan Rodríguez-Hernández*

1 Introduction to Antimicrobial Agents and Their Role in Food-Packaging Applications.	75
2 Traditional Antimicrobial (AM) Additives	77
3 Materials Employed in Antimicrobial Packaging	85
4 Antimicrobial Packaging Alternatives	87
5 Polymer Nanotechnology in Food Packaging.	93
6 Antimicrobial Nanostructures in Food Packaging	97
7 Conclusions.	110
References.	112

**Chapter 4 Antimicrobial Nanotechnology: Research Implications
and Prospects in Food Safety 125***Nagarajan Srividya, Manjula D. Ghoora, Pushkala R. Padmanabh*

1 Introduction.	125
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.	149
5 Nanocomposite Antimicrobial Surfaces for Prevention of Biofouling	151
6 Safety Considerations of Antimicrobial Nanoparticles	155
7 Conclusions.	156
References.	157

Chapter 5 Sanitation of Equipment. 167*Ana Meireles, Manuel Simões*

1 Introduction.	167
2 Sanitation.	168

3	Conclusions	186
	References	186

Chapter 6 Recent Advances in Gas Plasma Technology for Decontamination of Food Surfaces 197

Akikazu Sakudo

1	Current Status on Decontamination of Foods	197
2	Gas Plasma Technology	198
3	Inactivation of <i>Salmonella</i> by Nitrogen Gas Plasma	200
4	Influenza Virus Inactivation by Nitrogen Gas Plasma Treatment	207
5	Gas Plasma in Food Decontamination	220
6	Future Perspectives	222
	References	223

Chapter 7 Use of High-Intensity Ultrasound for Production of Antimicrobial and Self-Cleaning Surfaces 229

Anna Kollath, Daria V. Andreeva

1	Introduction	229
2	Chemical and Physical Effects of High-Intensity Ultrasound on Surfaces	234
3	High and Low Intensity of Sonication	236
4	Mechanisms of Surface Modification by HIUS	238
5	Kinetics of Ultrasonically Induced Modification of Metal Surface	242
6	Functionalization of Ultrasonically Modified Metal Surfaces: Formation of Hybrid Materials	249
7	Application of Ultrasonically Modified Metal Surfaces	251
8	General Aspects of Ultrasound-Assisted Modification of Polymer Surfaces and Their Application	255
9	Conclusions and Outlooks	259
	References	260

**Chapter 8 Multifunctional Antimicrobial Nanocomposites
for Food Packaging Applications. 265***Elena Fortunati, Debora Puglia, Ilaria Armentano, Arantzazu Valdés, Marina Ramos,
Nerea Juárez, Maria Carmen Garrigós, José Maria Kenny*

1 Introduction	265
2 Antimicrobial Agents	267
3 Biodegradable Polymers for Food Packaging Applications.	277
4 Nanotechnology in Food Packaging: Nanocomposite Approach.	284
5 Antimicrobial Nanocomposites in Food Packaging Market.	288
6 Conclusions.	293
References.	293

**Chapter 9 Nanostructured Materials for Prolonged
and Safe Food Preservation 305***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/Modern Techniques	310
4 Prolonged Food Preservation.	315
5 Nanomaterials in Food Preservation and Packaging	316
6 Conclusions.	330
References.	331

**Chapter 10 Nanobiotechnological Strategies
for Toxicogenic Fungi and Mycotoxin Control. 337***Kamel A. Abd-Elsalam, Ayat F. Hashim, Mousa A. Alghuthaymi, Ernest Said-Galiev*

1 Introduction	337
2 Chemical Fungicides Problems	340
3 Green and Ecofriendly Alternatives.	341
4 What Are Nanopesticides?	343

5	Nanomaterial Antitoxigenic Fungi	344
6	Chitosan	349
7	Adsorbing Nanoadditives	350
8	Nanogels	351
9	Nanomaterials Antimycotoxins	352
10	Mechanism of Action	352
11	Residue Profiles of Nanocides in Agroecosystems	354
12	Advantages of Green and/or Nanofungicides	355
13	Conclusions and Future Focus	357
	References	357

Chapter 11 Natural Products Used for Food Preservation 365

George Dan Mogoșanu, Alexandru Mihai Grumezescu, Cornelia Bejenaru, Ludovic Everard Bejenaru

1	Introduction	365
2	Aromatic Compounds	366
3	Terpenoids: Essential Oils	369
4	Organosulfur Compounds	375
5	Bacteriocins	377
6	Antimicrobial Products of Animal Origin	381
7	Other Natural Food Preservatives	384
8	Conclusions and Future Perspectives	387
	References	388

Chapter 12 Use of Nanoparticles as a Potential Antimicrobial for Food Packaging 413

Gerson 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

5	Food Packaging and Nanotechnology Applications as Antimicrobial.	421
6	Antimicrobial Polymeric Nanoparticles in Food Packaging.	425
7	Food Packaging and Silver Nanoparticles.	431
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

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
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

Ahmed A. Tayel, Noha M. Sorour, Ashraf F. El-Baz, Wael F. El-Tras

1	Introduction.	487
2	Nanometals Application as Antimicrobial Agents.	489

3	Nanometals and Foodborne Pathogens	493
4	Nanometals and Food Preservation	496
5	Applications of Nanotechnologies in Food-Related Sectors	500
6	The Antimicrobial Mode of Action of Nanometals	500
7	Potential Risks From Nanometals Application in Food-Related Sectors	509
8	Conclusions	518
	References	519

Chapter 15 Photodamage and Photoprotection: Toward Safety and Sustainability Through Nanotechnology Solutions 527

*Carlos Fernandes, Sofia Benfeito, André Fonseca, Catarina Oliveira,
Jorge Garrido, E. Manuela Garrido, Fernanda Borges*

1	Introduction	527
2	External Factors Affecting Food Quality	531
3	Nanotechnology as a Part of the Solution for Protection and Preservation	535
4	Nanoengineered Solutions for Bioactive Food Component Protection: Case Studies	544
5	Concluding Remarks	554
	References	555

Chapter 16 Nanoparticles and Their Potential Application as Antimicrobials in the Food Industry 567

Zivile Luksiene

1	Introduction	567
2	Antimicrobial Nanoparticles and their Physicochemical Properties	568
3	Mechanism of Antimicrobial Action of Nanoparticles	571
4	Antimicrobial Nanoparticles Against Foodborne Pathogens	581
5	Antimicrobial Nanoparticles Against Waterborne Pathogens	583
6	Antimicrobial Nanoparticles Against Harmful Microfungi	586

7	Toward Hurdle Antimicrobial Nanotechnologies	588
8	Possible Impact of Nanoparticles on the Environment and Human Health	589
9	Future Perspectives.	592
10	Conclusions	594
	References.	595

Chapter 17 Nanobiotechnology of Cyanobacterial UV-Protective Compounds: Innovations and Prospects 603

Richa, Jainendra Pathak, Arun S. Sonker, Vidya Singh, Rajeshwar P. Sinha

1	Introduction	603
2	Photoprotection in Cyanobacteria	606
3	Nanobiotechnology of Cyanobacterial UV-Protective Compounds	623
4	Conclusions	635
	References.	636

Chapter 18 Advances in Molecular Biology Based Assays for the Rapid Detection of Food Microbial Contaminants 645

Mariana Carmen Chifiriuc, Irina Gheorghe, Ilda Czobor, Denisa Alexandra Florea, Lorena Mateescu, Marius Eduard Caplan, Dana Magdalena Caplan, Veronica Lazar

1	Introduction	645
2	Factors That Influence the Growth and Development of Microorganisms in Foodstuffs.	646
3	Foodborne Diseases	647
4	Microorganisms Involved in the Etiology of FPs	648
5	Conventional Methods Used in Detecting Food Microbial Contaminants	650
6	Unconventional Methods Used In the Detection of Different Food Microbial Contaminants	653
7	Conclusions	665
	References.	665

Chapter 19 Antimicrobial Food Packaging with Cellulose-Copper Nanoparticles Embedded in Thermoplastic Resins 671*Tuhua Zhong, Gloria S. Oporto, Jacek Jaczynski*

1	Introduction	671
2	Background	672
3	Materials and Methods.	678
4	Results and Discussion.	681
5	Conclusions.	698
	References.	699

Chapter 20 Scientometric Overview in Food Nanopreservation 703*Ozcan Konur*

1	Overview	703
2	Food Research in General: an Overview.	705
3	The Nanomaterials and Nanoprocesses Research in General: Overview	707
4	Conclusions.	723
	References.	723

	Subject Index	731
--	-------------------------	-----