

Food Safety and Preservation

Modern Biological Approaches to
Improving Consumer Health

Edited by

Alexandru Mihai Grumezescu

Alina Maria Holban



ACADEMIC PRESS

An imprint of Elsevier

Contents

Contributors	xvii
Preface	xxi
Chapter 1: A Critical Appraisal of Different Food Safety and Quality Management Tools to Accomplish Food Safety	1
1.1 Introduction.....	1
1.2 The Emerging Scenario of Contaminants and Residues Related to Food Safety	2
1.3 Different Food Safety Certification Schemes, Quality Systems, and Other Popular Standards	4
1.4 Prerequisite Programs.....	4
1.4.1 Hazard Analysis Critical Control Point (HACCP).....	4
1.4.2 Quality Management Systems (QMS): ISO 9001.....	6
1.4.3 Food Safety Management Systems (FSMS): ISO 22000.....	6
1.4.4 Laboratory Management System: ISO/IEC 17025:2005	6
1.5 Retail Standards	8
1.5.1 British Retail Consortium	8
1.5.2 The Safe Quality Food (SQF) Code.....	9
1.5.3 International Featured Standard (IFS).....	9
1.5.4 Food Safety System Certification (FSSC 22000)	9
1.5.5 Global GAP.....	10
1.6 Technical Barriers for Exporting	11
1.7 Conclusions.....	11
References.....	11
Chapter 2: Food Safety: Benefits of Contamination Control on Consumers' Health ...	13
2.1 Introduction.....	13
2.2 Sources of Contamination.....	15
2.2.1 Harvesting and Handling.....	15
2.2.2 Contamination During Packaging	21
2.2.3 Contamination During Storage and Transport	23
2.3 Type of Contaminants.....	26
2.3.1 Microorganisms.....	26
2.3.2 Pesticide Residues.....	28

Contents

2.3.3 Antibiotic Residues	29
2.3.4 Mycotoxins.....	30
2.4 Contamination and Health	31
2.4.1 Nervous System	31
2.4.2 Immune System.....	32
2.4.3 Reproductive System.....	33
2.4.4 Carcinogen	34
2.5 Conclusion	34
References.....	35
Further Reading	38
Chapter 3: Preemptive and Proactive Strategies for Food Control and Biosecurity.....	39
3.1 Introduction	39
3.2 Basic Concepts	40
3.3 Food Biosecurity.....	41
3.4 Food Terrorism (or Food Bioterrorism).....	41
3.5 Biological Weapons Threats to Food and Agriculture: A Brief History	42
3.6 Lack of Food Security and Safety Measures	43
3.7 Food Safety Management and Control.....	45
3.7.1 Food Control: A Shared Responsibility	46
3.8 Strategic Plans for Protecting Food Supplies	51
3.9 Responding to the Food-Related Health Crises.....	51
3.10 Food Safety Management.....	51
3.11 Improved Organizational Structures Can Enhance Food Control	52
3.12 Funding Food Control Systems	53
3.13 Food Security Challenges for Pakistan.....	54
3.14 Future Concerns.....	55
3.15 Preventive Measures and Readiness	56
3.16 Evaluating Weakness	56
3.17 Conclusion	57
Acknowledgments	57
References.....	57
Chapter 4: Validation of Analytical Methods for the Assessment of Hazards in Food.....	59
4.1 Introduction.....	59
4.2 Analytical Quality Control Related to Different Committee and Guidelines	60
4.3 Validation Criteria and Its Parameters	65
4.3.1 Selectivity.....	67
4.3.2 Linearity and Range	70
4.3.3 Limit of Detection	74
4.3.4 Limit of Quantification	75
4.3.5 Accuracy (Trueness)	77

4.3.6 Precision.....	80
4.3.7 Robustness.....	82
4.3.8 System Suitability Tests	83
4.4 Conclusion	85
References.....	86
Further Reading	90
Chapter 5: The Detection of Pesticide in Foods Using Electrochemical Sensors	91
5.1 Introduction.....	93
5.2 Pesticides	94
5.2.1 Pesticides Classification Related to Usage and Chemical Structure.....	95
5.2.2 Pesticides and Human Health.....	98
5.2.3 Pesticides and the Environment	98
5.2.4 Maximum Levels of Pesticide Residues in Food	99
5.2.5 Who Monitors Pesticides?	100
5.3 Overview to Electroanalytical Studies on Pesticides.....	100
5.3.1 Electrochemical Behaviors of Pesticides	100
5.3.2 The Electroanalytical Methods for Assay of Pesticides on Foods	104
5.3.3 Electrode Types in Pesticide Analysis.....	110
5.4 Applications of Electrochemical Pesticide Analysis on Foods.....	117
5.5 0.1–1000 ng/L linear Range and 52 pg/L Limit of Detection Were Obtained by Impedance Spectroscopy	119
5.6 Conclusion	128
References.....	131
Further Reading	141
Chapter 6: Multiway Calibration Approaches for Quality Control of Food Samples	143
6.1 Scope of the Chapter.....	143
6.2 Second- and Higher-Order Data Generation	144
6.3 Multiway Calibration Algorithms.....	146
6.3.1 PARAFAC	146
6.3.2 MCR-ALS	148
6.3.3 U-PLS/RBL.....	149
6.3.4 ATLD	150
6.3.5 Software	151
6.4 Analytical Applications	152
6.4.1 PARAFAC	152
6.4.2 MCR-ALS.....	156
6.4.3 U-PLS/RBL.....	159
6.4.4 ATLD, SWATLD, and APTLD	159
6.5 Concluding Remarks	162
Acknowledgments	162
References.....	162

Chapter 7: Biocontrol as an Efficient Tool for Food Control and Biosecurity	167
7.1 Introduction.....	167
7.2 Food Control.....	168
7.2.1 Generalities and Definition	168
7.2.2 Food Risks.....	169
7.2.3 Regulation and Food Control	169
7.3 Food Safety	171
7.4 Chemical Substances	173
7.4.1 Naturally Occurring Toxins.....	173
7.4.2 Biological Control of Chemicals.....	173
7.4.3 Heavy Metals	173
7.4.4 Regulatory and Socioeconomic Aspects	174
7.5 Biosecurity of Biocontrol Agents	174
7.5.1 Regulations on Biosecurity of BCA.....	175
7.5.2 Hazard Identification and Risk Assessment to Human Health and the Environment.....	176
7.5.3 Personal Protection in the Food Industry: An Overview.....	177
7.6 Agriculture and Biological Control	178
7.6.1 Opportunities.....	179
7.6.2 Drawbacks.....	183
7.6.3 Regulation	183
7.6.4 Trends.....	184
7.7 Perspectives	187
7.8 Conclusions.....	188
References.....	188
Further Reading	193
Chapter 8: Foodborne Diseases and Responsible Agents.....	195
8.1 Introduction.....	195
8.2 Food Contamination and Infection	197
8.2.1 Bacterial Infections	197
8.2.2 Viral Infections.....	199
8.2.3 Parasite	201
8.2.4 Unconventional Agents	204
8.3 Food Poisoning	204
8.3.1 Bacterial Food Poisoning	206
8.3.2 Fungal Food Poisonings.....	207
8.4 Chemical Contaminants in Food	211
8.4.1 Pesticide Residues.....	211
8.4.2 Veterinary Drug Residues	211
8.4.3 Environmental Contaminants	212
8.4.4 Heavy Metals as Contaminants.....	213
8.4.5 Food Processing-Induced Contaminants.....	215
8.4.6 Migrants From Contact Materials	217

8.4.7	Food Additives and Adulterants	218
8.4.8	Intentional Contaminants	221
8.4.9	Food Biotechnology	222
8.4.10	Food Allergies	222
8.4.11	Food Intolerances	222
8.5	The Future of Foodborne Diseases	223
8.6	Conclusion	224
	References.....	224
	Further Reading	229
Chapter 9: Challenges in Emerging Food-Borne Diseases.....		231
9.1	Introduction	231
9.2	Epidemiology.....	232
9.3	Etiology	233
9.3.1	Food-Borne Bacterial Agents.....	235
9.3.2	Food-Borne Parasitic Agents	236
9.3.3	Food-Borne Viral Agents	238
9.3.4	Molds, Toxins, and Contaminants.....	239
9.3.5	Allergens	239
9.4	Food-Borne Antimicrobial Resistance.....	239
9.5	Clinical Presentations	241
9.5.1	Acute Effects.....	241
9.5.2	Chronic Effects	242
9.6	Diagnosis of Food-Borne Diseases.....	243
9.7	General Management.....	244
9.8	Bacterial Agents.....	245
9.9	Viral Agents	248
9.10	Parasitic Agents	249
9.11	Noninfectious Agents	250
9.12	Emerging Challenges and Technologies.....	253
9.12.1	Resistance of Food-Borne Viruses and Systems for Counteractive Action.....	257
9.13	Preventive Measures	258
9.13.1	Preventive Measures in Distribution and Preparation of Food	260
9.14	Conclusion	262
	References.....	263
	Further Reading	268
Chapter 10: Opportunistic Food-Borne Pathogens.....		269
10.1	Introduction	269
10.2	Gram-Positive Opportunistic Pathogens.....	271
10.2.1	<i>Enterococcus faecalis</i> and <i>Enterococcus faecium</i>	271
10.2.2	<i>Weissella</i> Species.....	276
10.2.3	<i>Lactobacillus</i> Species.....	279

10.3 Gram-Negative Opportunistic Pathogens	282
10.3.1 <i>Klebsiella pneumoniae</i>	282
10.3.2 <i>Enterobacter</i> Species.....	285
10.3.3 <i>Serratia marcescens</i>	287
10.3.4 <i>Citrobacter freundii</i>	288
10.3.5 <i>Acinetobacter baumannii</i>	290
10.4 Conclusions	291
References.....	291
Further Reading	305

**Chapter 11: Food Poisoning and Intoxication: A Global Leading Concern
for Human Health307**

11.1 Overview.....	307
11.2 Foodborne Diseases	308
11.3 Types of Foodborne Diseases	308
11.4 Foodborne Infections.....	308
11.4.1 Bacterial Foodborne Infections	308
11.4.2 Viruses in Foodborne Infections.....	311
11.4.3 Parasitic Foodborne Infections	311
11.4.4 Prions—Transmissible Spongiform Encephalopathies (TSEs).....	314
11.5 Leading Factors of Microbial Growth in Food.....	314
11.5.1 Intrinsic Factors	315
11.5.2 Hydrogen Ion Concentration (pH).....	315
11.5.3 Water Activity (a_w)	316
11.5.4 Redox Potential (Eh)	317
11.5.5 Nutrient Contents.....	319
11.5.6 Biological Structures of Food.....	320
11.5.7 Antimicrobial Contents in Food	321
11.5.8 Extrinsic factors.....	321
11.5.9 Temperature Versus Microbial Growth.....	321
11.5.10 Impact of Time.....	323
11.5.11 Quorum Sensing and Bacterial Growth.....	324
11.5.12 Storage Conditions	324
11.6 Foodborne Intoxications	324
11.6.1 Toxicants From Plants	325
11.6.2 Toxicants From Animals.....	327
11.6.3 Bacterial Foodborne Intoxications.....	328
11.6.4 Fungal Intoxications	330
11.6.5 Chemical Intoxications	330
11.7 Additional Sources of Contamination	341
11.7.1 Unhealthy Cooking Process.....	341
11.7.2 Intake of Reheating Food.....	342
11.7.3 Retail, Restaurant, and Travel Foods	342

11.8 Outbreaks.....	343
11.8.1 Notable Incidents From 2011 to 2017	343
11.9 Conclusion	345
References.....	347
Further Reading	351
Disease Outbreak News References	352
Chapter 12: Staphylococcal Food Poisoning	353
12.1 Staphylococcal Food Poisoning: Definition and Clinical Symptoms.....	353
12.2 Staphylococcal Enterotoxins	354
12.3 Epidemiology of SFP.....	356
12.4 Detection of Staphylococcal Enterotoxins in CPS	358
12.5 Enterotoxin Detection in Coagulase Negative Staphylococci	366
12.6 Expression of Enterotoxin Genes	370
12.7 Conclusion	372
References.....	372
Further Reading	389
Chapter 13: Campylobacter: An Important Food Safety Issue	391
13.1 Introduction	391
13.2 The Genus <i>Campylobacter</i>	392
13.3 Virulence and Survival Factors	397
13.4 Antimicrobial Resistance.....	400
13.5 Aspects and Epidemiology of Campylobacteriosis	404
13.6 Reservoirs and Sources of Contamination.....	408
13.7 Intervention and Control Strategies	411
13.8 Overview of Analytical Methods for Identification.....	412
13.8.1 Culture-Based Methods.....	413
13.8.2 DNA-Based Molecular Methods	416
13.8.3 Immunological Methods	416
13.8.4 Typing Methods.....	417
13.9 Concluding remarks.....	418
References.....	418
Further Reading	430
Chapter 14: Food Contamination: From Food Degradation to Food-Borne Diseases	431
14.1 Introduction	431
14.2 Food Contamination	432
14.2.1 Vegetables and Fruit	433
14.2.2 Fish.....	440
14.2.3 Bread	442
14.2.4 Meat.....	443
14.2.5 Milk	447

14.3 Disease Induced by Contaminated Food	449
14.3.1 Stomach	449
14.3.2 Colon	452
14.3.3 Rectum	453
14.4 Conclusions	455
References.....	455

Chapter 15: A Review on the Implications of Interaction Between Human Pathogenic Bacteria and the Host on Food Quality and Disease 457

15.1 Human Pathogenic Enteric Bacteria and Their Association With Fresh Agricultural Products.....	457
15.1.1 <i>Escherichia coli</i>	457
15.1.2 <i>Salmonella enterica</i>	458
15.1.3 <i>Clostridium difficile</i>	459
15.1.4 <i>Bacillus cereus</i>	460
15.1.5 <i>Campylobacter</i> spp.....	460
15.1.6 <i>Listeria monocytogenes</i>	461
15.1.7 <i>Cronobacter</i> spp.	461
15.2 Entry of Human Pathogenic Bacteria into the Food Chain: Tracking the Point of Origin	462
15.2.1 The Potential Role of Water in the Contamination of Fresh Agricultural Produce.....	462
15.2.2 The Potential Role of Noncomposted or Improperly Composted Manure in the Contamination of Agricultural Fresh Produce	463
15.2.3 Enteric Pathogen Can Enter the Food Chain During Postharvest Processing.....	465
15.3 Interaction Between Enteric Pathogens and Plant Hosts.....	465
15.3.1 Enteric Pathogens in Plant Habitats	465
15.3.2 Survival and Growth of Enteric Bacterial Pathogens on Fresh Produce	469
15.3.3 Molecular Capabilities of Enteric Pathogens That Allow Them to Use Plants as Vehicles for the Transmission	471
15.4 Future Research Prospects and Conclusion.....	472
References.....	472
Further Reading	479

Chapter 16: Novel Strategies for the Reduction of Microbial Degradation of Foods..... 481

16.1 Introduction	481
16.2 Different Ways of Contamination and Spoilage	483
16.3 Microorganismal Species Causing Deterioration	485
16.4 The Contaminants Causing Poisoning in Humans	491

16.5	Chemical and Natural Ways to Prevent Contamination of Food and Agricultural Products	494
16.5.1	Chemical Ways to Prevent Contamination of Food and Agricultural Products	497
16.5.2	Natural Ways to Prevent Contamination of Food and Agricultural Products: Novel Methods and Approaches	498
16.6	Novel Strategies for the Reduction in Microbial Degradation of Foods and Agricultural Products	502
16.7	Conclusions	513
	References.....	514
Chapter 17: Relevance and Legal Frame in Novel Food Preservation Approaches for Improving Food Safety and Risks Assessment.....		521
17.1	Introduction	521
17.2	Legal Frame and Food Preservation Agents in EU.....	524
17.3	Preservation Agents and Health.....	525
17.4	Preservation Agents’ Residues in Edible Oils and Oil Seeds	526
17.5	Olives, Olive Oil, and Preservation Agents	532
17.5.1	Olives and Preservation Agents.....	532
17.5.2	Pest Control.....	533
17.5.3	Olive Oil Production.....	535
17.5.4	Preservation Agents in Olive Oil.....	537
17.5.5	Effect of Olive Oil Extraction Process in Preservation Agents’ Residues Level.....	539
17.5.6	Impact of Washing on Olive Oil Production	545
17.5.7	Elimination of Preservation Agents’ Residues Present in VOO.....	546
17.6	Importance of Preservation Agents for Improving Food Safety	553
17.7	Conclusions	554
	Acknowledgment	555
	References.....	555
	Further Reading	563
Chapter 18: The Current Approaches and Challenges of Biopreservation		565
18.1	Introduction	565
18.2	Bacteria Used for Biopreservation.....	566
18.2.1	Possible Usage.....	575
18.3	Bacteriophages Used Biopreservation.....	577
18.3.1	Possible Usage.....	579
18.4	Lysozyme.....	581
18.5	Natural Compounds in Food Preservation.....	582
18.5.1	Essential Oils (EOs)	582
18.5.2	Organic Acids	583
18.5.3	Chitosan.....	584
18.5.4	Green Tea Extract (GTE)	584

18.5.5 Grape Seed Extract (GSE).....	585
18.5.6 Thyme.....	585
18.6 Legal Practices.....	587
18.7 Conclusion.....	588
References.....	589
Further Reading.....	596

Chapter 19: Modern Preservation Tools Through Packaging for High Hydrostatic Pressure Processing.....599

19.1 Introduction.....	599
19.2 Food Packaging.....	600
19.3 Food Processing.....	601
19.3.1 Ultraviolet Light/Pulsed Light Processing.....	602
19.3.2 Ultrasound Processing.....	602
19.3.3 Oscillating Magnetic Field.....	603
19.3.4 Irradiation by Ionizing Radiation.....	603
19.3.5 Pulsed Electric Field.....	603
19.3.6 High Hydrostatic Pressure Processing.....	604
19.4 Requirements of Food Packaging for Nonthermal Processing.....	605
19.5 HHP for Food Processing.....	605
19.6 HHP Food Packages.....	606
19.7 Packaging—Fabrication and Their Diverse Roles.....	608
19.7.1 Moisture Control.....	609
19.7.2 Oxygen Control.....	610
19.7.3 Carbon Dioxide Control.....	610
19.8 Influence of HHP on Various Properties of Packages.....	610
19.9 Active and Intelligent Packaging.....	613
19.9.1 Oxygen Scavenging.....	614
19.9.2 Carbon Dioxide Scavenging or Release.....	614
19.10 Conclusion.....	615
References.....	616
Further Reading.....	619

Chapter 20: Natural Food Preservatives Against Microorganisms621

20.1 Introduction.....	621
20.2 Antimicrobials of Plant Origin.....	623
20.3 Antimicrobials From Plant By-Products.....	625
20.4 Antimicrobials of Animal Origin.....	626
20.4.1 Lactoferrin.....	626
20.4.2 Chitosan.....	626
20.4.3 Lysozyme.....	627
20.4.4 Lactoperoxidase.....	627
20.4.5 Milk-Derivated Peptides.....	628

20.5	Antimicrobials From Microbial Origin	629
	20.5.1 Natamycin.....	629
	20.5.2 Nisin.....	629
	20.5.3 Protective Cultures.....	630
	20.5.4 Reuterin.....	631
20.6	Antimicrobials From Algae and Mushroom Origin	631
20.7	Emerging Biotechnologies for Natural Food Preservation.....	632
	20.7.1 Nanoparticles	632
	20.7.2 Bacteriophages and Endolysins	634
	20.7.3 Bacterial Quorum-Sensing Inhibitors and Antagonists	636
	20.7.4 Phytoteases	638
20.8	Incorporation of Antimicrobials in Food Systems.....	641
20.9	Direct Applications	642
	20.9.1 Edible Films and Coatings.....	643
20.10	Regulatory Status of Natural Food Preservatives	644
20.11	Toxicological and Allergenic Effects.....	645
20.12	Cost.....	645
20.13	Antimicrobials: Food Component Interactions	645
20.14	Activity Validation Method.....	647
20.15	Conclusions	647
	References.....	649
	Further Reading	658
	<i>Index</i>	659