# Contents

List of Contributors  xxvii  
Preface  xxxvii  

## Part 1  Introduction  1

1  **Shared Responsibility of Food Safety**  3  
   *Joseph J. Jen*
   1.1 Introduction  3  
   1.2 History  5  
   1.3 The Food Chain and Food Safety Laws  6  
   1.4 Current Status  8  
   1.5 The Future  11  
   References  13  

2  **Overview of Food Safety Situation in China**  15  
   *Junshi Chen and Zhiqiang Zhang*
   2.1 Introduction  15  
   2.2 The Past (1995–2009)  16  
   2.2.1 National Food Control System  16  
   2.2.2 Food Standards  17  
   2.2.3 Application of the Risk Analysis Framework  18  
   2.3 Present (2009–2015)  19  
   2.3.1 National Food Control System  19  
   2.3.2 Food Standards  20  
   2.3.3 Application of the Risk Analysis Framework  21  
   2.4 Major Food Safety Issues at Present  22  
   2.5 Looking Forward  26  
   2.6 Summary  27  
   References  27  

3  **Food Safety Education and Training Programs in China**  29  
   *Yao-wen Huang*
   3.1 Introduction  29  
   3.2 Definitions of Food Safety Problems  30  
   3.3 Food Poisoning Incidents  31  
   3.3.1 Subjective Factors  31  

---

*Due to the nature of the content, the full text is not included here.*
3.3.1.1 Changes in Eating Habits 31
3.3.1.2 Changes in Family Structure 31
3.3.1.3 Lack of Food Safety Knowledge 31
3.3.2 Objective Factors 32
3.3.2.2 Complexity of Supply Chain 32
3.3.2.3 Drug Resistance of Bacteria 32
3.3.2.4 Correct Identification of Food Poisoning Cases 32
3.4 Food Safety Education and Training 32
3.4.1 Food Safety Education 33
3.4.1.1 Current Food Safety Programs in China 34
3.4.1.2 Current Food Safety Education Programs in the US 35
3.4.2 Food Safety Training 37
3.4.2.1 Current Food Safety Training Programs in China 37
3.4.2.2 Current Food Safety Training Programs in the US 39
3.5 Summary 41
References 41

4 Development of the Food Industry in China 43
Suhe Meng and Joseph J. Jen
4.1 Introduction 43
4.2 Background Information 43
4.3 Current Status 45
4.3.1 Internal Structure Changes in the Food Industry 45
4.3.2 Food Safety Concerns Damaged “Made in China” Products 47
4.3.3 Moderate Speed Development of the Chinese Food Industry 47
4.4 Major Adjustment in Progress 47
4.5 Challenges 48
4.6 Future Development 50
References 51

Part 2 Food Microbiology 53

5 Food-borne Diseases and Surveillance 55
Yunchang Guo, Shuyu Wu and Jianghui Zhu
5.1 Introduction 55
5.2 The Past (–2010) 56
5.2.1 Reporting System of Food Poisoning and Infectious Diarrhea 56
5.2.2 Analysis of the Previous Results of Food Poisoning Reports 56
5.3 Present (2010~) 57
5.3.1 Building a New Food-borne Disease Surveillance System 57
5.3.2 Outcomes of Current Food-borne Disease Surveillance 59
5.4 The Future 60
5.5 Brief Summary 61
Disclaimer 62
References 62
6 Food-borne Pathogenic Bacteria 65
Xianming Shi, Yanping Xie and Xiujuan Zhou
6.1 Introduction to Bacterial Food Poisoning 65
6.2 Important Food-borne Pathogenic Bacteria 66
6.2.1 Salmonella 66
6.2.2 Vibrio parahaemolyticus 67
6.2.3 Staphylococcus aureus 67
6.2.4 Listeria monocytogenes 68
6.2.5 Escherichia coli O157:H7 68
6.2.6 Clostridium botulinum 69
6.3 Frequent Vehicles of Food-borne Pathogens 70
6.3.1 Food Category 70
6.3.1.1 Vegetables and Fruits 70
6.3.1.2 Egg products 71
6.3.1.3 Meat and Poultry 71
6.3.1.4 Fish and Shellfish 72
6.3.1.5 Milk and Dairy Products 72
6.3.2 Processing Methods 72
6.4 Prevention and Control of Bacterial Food Poisoning 73
6.4.1 Rapid Detection and Molecular Typing Methods 73
6.5 Principles of Prevention and Control 74
6.5.1 Novel Physical Control Technologies 74
6.5.2 Essential Oils as Antimicrobials 75
6.5.3 Bacteriophages for Biocontrol of Food-borne Pathogens 75
6.5.4 Bacterial Biofilm Control in Food Environments 75
6.5.5 Education of the Public to Reduce Food-borne Illness 76
6.6 Future Aspects 76
6.6.1 Viable but Non-Culturable (VBNC) Bacteria 76
6.6.2 Horizontal Transfer of Antibiotic-Resistance by Mobile Genetic Elements 76
6.6.3 Applications of High-Throughput Omics Technology 77
6.7 Risk Assessment of Food-borne Pathogens 77
6.7.1 Microbiological Quantitative Risk Assessment 77
6.7.2 Examples of Modelling Exercises 78
6.7.2.1 A Shiga-Toxin-Producing Escherichia coli O157 in Steak Tartare Patties [43] 78
6.7.2.2 Bacillus cereus in broccoli puree [44] 78
6.7.2.3 Pathways to be Included in Risk Assessment of Campylobacter in Chickens [45] 79
6.7.3 Assessment of the Microbiological Quality of Fresh Produce 79
References 79

7 Mycotoxins in China: Occurrence and Exposure 83
Yunyun Gong, Fengqin Li and Michael N. Routledge
7.1 Introduction to Mycotoxins 83
7.2 Aflatoxin 84
7.2.1 Introduction 84
7.2.2 Methods for Detection of Aflatoxin 84
7.2.3 Measurement of Exposure to Aflatoxin 85
7.2.4 Toxicity of Aflatoxins 85
7.2.5 Occurrence of Aflatoxins in China 87
7.3 Fumonisins 87
7.3.1 Introduction 87
7.3.2 Methods of Detection of Fumonisins 88
7.3.3 Measurement of Exposure to Fumonisins 88
7.3.4 Toxicity of Fumonisins 89
7.3.5 Occurrence of Fumonisins in China 89
7.4 DON 89
7.4.1 Introduction 89
7.4.2 Methods of Detection of DON 90
7.4.3 Measurement of DON Exposure 90
7.4.4 Toxicity of DON 90
7.4.5 Occurrence of DON in China 91
7.5 T-2 Toxin 92
7.6 ZEN 92
7.6.1 Introduction 92
7.6.2 Methods for Detection of ZEN 92
7.6.3 Toxicity of ZEN 93
7.6.4 Occurrence of ZEN in China 93
7.7 Combined Exposures 94
7.8 Regulations, Control and Surveillance 95
7.8.1 Aflatoxins 95
7.8.2 Fumonisins 95
7.8.3 DON 95
7.8.4 T-2 Toxin 95
7.8.5 ZEN 96
7.9 Challenges 96
References 97

8 Viruses 103
Jennifer L. Cannon, Lingling Liu and Wei Kang
8.1 Introduction 103
8.2 Overview of Specific Food-borne Viruses Important in China and Globally 104
8.2.1 Norovirus 106
8.2.2 Sapovirus 107
8.2.3 Rotavirus 107
8.2.4 Astrovirus 108
8.2.5 Aichivirus 109
8.2.6 Hepatitis A Virus 109
8.2.7 Hepatitis E Virus 110
8.3 The Current Status of Food-borne Viruses in China 111
8.3.1 Food-borne Virus Surveillance in China 111
8.3.2 The Role of Food Handlers in Food-borne Virus Outbreaks in China 113
8.3.3 Foods Contaminated by Food-borne Viruses During Production, Processing or Transport 114
8.3.3.1 Shellfish 114
8.3.3.2 Fresh Produce 115
8.3.3.3 International Efforts for Food-borne Virus Detection, Prevention and Control 116
8.4 Future Perspectives for Food-borne Viruses in China 117
References 119

9 Food-borne Parasitic Diseases in China 127
Xue Bai, Xiaolei Liu, Xiaonong Zhou, Jiaxu Chen, Xiuping Wu,
Pascal Boireau and Mingyuan Liu
9.1 Epidemic Features of Major Food-borne Parasitic Diseases in China 129
9.1.1 Various Food-borne Parasitic Diseases 129
9.1.2 Food Safety Incidents Occur Frequently 129
9.1.3 Number of Latent Infections is Increasing 130
9.1.4 Epidemic Areas are Expanding 131
9.1.5 Intermediate Hosts are Widespread, and Infection Rates Remain High 132
9.1.6 Great Economic Losses 133
9.1.7 Severe Threats to Human Health 133
9.2 Diagnostic Technologies for Food-borne Parasitic Diseases in China 134
9.2.1 Chinese Standards 135
9.2.2 Morphological Identification 135
9.2.3 Immunoassays 135
9.2.4 Molecular Biology Detection 136
9.2.4.1 Polymerase Chain Reaction (PCR) 136
9.2.4.2 Quantitative PCR (qPCR) 136
9.2.4.3 Loop-Mediated Isothermal Amplification (LAMP) 137
9.2.4.4 DNA Chips 137
9.3 Management and Regulation of Food-borne Parasitic Diseases in China 138
9.3.1 Formulation of Laws and Regulations 138
9.3.2 Establishment of the Disease Reporting and Surveillance Systems 139
9.3.3 Establishment of the International and National Veterinary Reference Laboratories or Collaboration Centres 139
9.3.4 Implementation of Special Projects and Increasing the Investment in Important Food-borne Parasites 140
9.3.5 Development of a Food-borne Parasitic Disease Vaccine and New Drugs 140
9.3.6 Surveillance of Exotic Diseases 141
9.3.7 Emphasis on Interdisciplinary and International Cooperation 141
9.3.8 Health Education 141
References 142

10 Natural Antimicrobials from Herbs and Spices 147
P. Michael Davidson
10.1 Food Preservation 147
10.2 Antimicrobial Food Preservatives 147
10.3 Spices and Herbs as Natural Antimicrobials 148
12.3.4.3 Inaccurate Reports from Individual Media Mislead the Public About Food Additives 196
12.3.4.4 The Public Scientific Popularization of Food Additives and Food Safety in China is Still Weak 196
12.4 The Status and Development of Food Additives in Foreign Countries 196
12.4.1 The Regulation and Development of Food Additives in the US 196
12.4.2 The Regulation and Development of Food Additives in the EU 197
12.4.3 The Regulation and Development of Food Additives in the UK 198
12.5 The Development Trend of Food Additives in the Future 198
12.5.1 Natural Green Food Additives Have Become the Main Development Direction for the Future 198
12.5.2 The Exploitation and Application of Functional Food Additives Has Become an Important Research Direction 198
12.5.3 Biotechnology Promotes the Development of the Food Additive Industry in China 199
12.5.4 A Singular Food Additive Develops in the Direction of Compound Food Additives 199

References 200

13 Pesticide Residues 201
Xiongwu Qiao
13.1 Introduction 201
13.2 The Impact of Pesticide Residues on Food Safety 201
13.3 Past Events and Evolution of Pesticide Residue Issues: Changing Across the Centuries 202
13.3.1 The Main Direction of Scientific Research 208
13.4 The Current Status of Pesticide Residues in Food Safety and Management Measures 210
13.4.1 Revision of the Food Safety Law 210
13.4.2 Amendment of the Pesticide Management Regulations 211
13.4.3 The Pesticide Reduction Plan 211
13.4.4 National Standards System Has Gradually Improved the Basis for Management of Pesticide Residues in Food 213
13.5 The Future of Risk Management for Pesticide Residues in Foods 213

References 216

14 Veterinary Drug Residues in China 219
Zhenling Zeng, Fan Yang and Liqi Wang
14.1 Introduction 219
14.1.1 Definition of Veterinary Drug Residues 219
14.1.2 Hazards of Drug Residues to Public Health 220
14.1.3 Reasons for Drug Residues 220
14.2 The Regulations Used in China to Prevent and Control Veterinary Drug Residues 221
14.2.1 Regulation on Administration of Veterinary Drugs 221
14.2.2 Veterinary Pharmacopoeia of the People's Republic of China and the Guidelines on the Use of Veterinary Drugs 221

14.3 The Measures Used in China to Prevent and Control Veterinary Drug Residues 222

14.3.1 Regulation of Veterinary Drug Application 222
14.3.1.1 Development of the Standards for Rational Use of Veterinary Drugs 222
14.3.1.2 Rational Use of Veterinary Drugs Under the Guidance of Veterinarians 222
14.3.1.3 Regulations Regarding Prescribed Veterinary Drugs and OTC Veterinary Drugs 223

14.3.2 Implementing the Monitoring and Control Plan for Veterinary Drug Residues 223

14.3.3 Determination and Amendment of the Maximum Residue Limits for Veterinary Drugs Used in Food Animals 224

14.3.4 Establishment of the National Expert Committee on Veterinary Drug Residues 225

14.3.5 Establishment of Standards for the Detection of Veterinary Drug Residues in Animal-Derived Food 226

14.3.6 Databank of the Application of Domestic and Foreign Veterinary Drugs and Drug Residues in Animal-Derived Food 226

14.3.7 Strengthening the Construction of Veterinary Drug Residues Detection Laboratories 226

14.4 Measures and Policies that Should be Applied in Future to Monitor and Control Veterinary Drug Residues in China 227

14.4.1 Perfection of Animal-Derived Food Safety Regulation System 227
14.4.1.1 Improving the Veterinary Drug Residue Database 227
14.4.1.2 Application of Hazard Analysis and Critical Control Points (HACCP) System in Animal Husbandry 227
14.4.1.3 Promoting a Market Access System, and a Tracking and Traceability System for Animal-Derived Food 228

14.4.2 Strengthening Residue Supervision and Regulation Enforcement 228

14.4.2.1 Strengthening the Construction of the Veterinary Drug Administration System 228

14.4.2.2 Strengthening the Legal Framework of Veterinary Drug Administration 228

14.4.2.3 Implementing a Certified Veterinarian and Veterinary Officer System 228

14.4.3 Strengthening Construction of Veterinary Drug Residue Standards 228

14.4.3.1 Strengthening the Construction of Standards for Veterinary Drug Residue Limits 228

14.4.3.2 Establishing Withdrawal Periods 229

14.4.3.3 Standards for Veterinary Drug Residue Analysis 229

14.4.4 Strengthening Scientific and Technological Support for Veterinary Drug Residues 229

14.4.4.1 Strengthening Fundamental Research on Veterinary Drug Residues and Food Safety 229

14.4.4.2 Developing and Improving Analytical Methods for Screening and Confirmation 229

14.4.4.3 Strengthening the Development and Promotion of the Use of Natural Animal Medicines and their Formulations 230

14.4.4.4 Strengthening International Cooperation and Communication 230
14.4.4.5 Strengthening Talent Cultivation and Training 231
14.4.5 Strengthening Publicity, Education and Mass Supervision 231
References 231

15 Heavy Metal Contamination 237
Dajin Yang, Kai Zhao, Fabrizis Suarez, Lawrence Pacquette and Daniel Schmitz
15.1 Food Safety Concerns in the Past 238
15.1.1 Contamination of Soil 238
15.1.2 Lead in Century Eggs 241
15.1.3 Cadmium in the Kidneys of Livestock and Poultry 241
15.1.4 Mercury in Special Kinds of Fish 243
15.1.5 Arsenic in Rice 243
15.2 Heavy Metal Contamination at Present 244
15.2.1 Lead 244
15.2.2 Cadmium 244
15.2.2.1 Infant Food 245
15.2.2.2 Rice 245
15.2.2.3 Aquatic Animals 246
15.2.3 Arsenic 247
15.3 Prospects for Heavy Metal Contamination Control 247
References 248

16 Food Fraud 253
Yongning Wu, Hong Miao, Bing Shao, Jing Zhang, John W. Spink and Douglas C. Moyer
16.1 Introduction 253
16.2 Overview of Food Fraud in China 255
16.2.1 Fuyang Counterfeit Milk Powder Incident 255
16.2.2 Melamine Milk Powder Incident 256
16.2.3 Gutter Oil Incident 256
16.2.4 Functional Food Fraud 256
16.3 Influential Factors and Characteristics of Food Fraud in China 257
16.3.1 Food Authenticity 257
16.3.2 The Complex Chinese Food Chain 257
16.3.3 Urbanization 258
16.4 China's Management of Food Fraud 258
16.4.1 Legal Regulations 258
16.4.2 The Black List System 259
16.4.3 Food Fraud Detection System 262
16.5 The Future of Combating Food Fraud 262
16.5.1 International Developments in Food Fraud Prevention and China's Strategy 262
16.5.2 Vulnerability Assessment of the Food Chain for Food Fraud Prevention 263
16.5.3 Detection Technology Buildup 264
16.5.4 Establishment of a System-Wide Traceability and Early Warning System 265
16.5.5 Establishment of a Credit System for Food Based on Strengthened Regulation and Publicity 265
18.2.1 Determining a Risk Assessment Project 292
18.2.2 Setting up an Assessment Project Group 292
18.2.3 Determining Assessment Key Factors 292
18.2.4 Developing an Assessment Implementation Scheme 292
18.2.5 Collecting Data [27] 293
18.2.6 Hazard Identification and Hazard Characterization 293
18.2.6.1 Hazard Identification 293
18.2.6.2 Hazard Characterization 294
18.2.7 Exposure Assessment 294
18.2.8 Risk Characterization 295
18.2.9 Report Drafting and Review 295
18.2.10 Recording 295
18.3 Achievements and Shortcomings of Food Quantitative Microbiological Risk Assessment 295
18.3.1 Achievements of Food Microbiological Risk Assessment 295
18.3.1.1 Completion of a Number of Food–Microorganism Combination Quantitative Risk Assessments 295
18.3.1.2 Construction of a Basic Paradigm of Food Quantitative Microbiological Risk Assessment 296
18.3.1.3 Exercising a Professional Team for Food Microbiological Risk Assessment 296
18.3.1.4 Opening up a Research Field of Food Quantitative Microbiological Risk Assessment 296
18.3.1.5 Carrying Out Effective International Cooperation and Exchange 296
18.3.2 Shortcomings of Food Microbiological Risk Assessment 297
18.3.3 Main Problems of Food Microbiological Risk Assessment 297
18.3.3.1 The Problem of Making a Clear Assessment Plan and Scope 297
18.3.3.2 The Problem of Hazard Identification 298
18.3.3.3 The Problem of Cost-Effectiveness 298
18.3.3.4 The Problem of Selecting a Qualitative or a Quantitative Method 298
18.3.3.5 The Problem of Risk Modeling Research 299
18.4 Future Outlook for Food Microbiological Risk Assessment 299
18.4.1 Strengthening the Interaction between Risk Assessment and Risk Management 300
18.4.2 Improving Risk Surveillance 300
18.4.3 Improving Legal Limits 301
18.4.4 Strengthening International Cooperation 301
References 302

19 Food Safety Risk Communication Practices and Exploration in China 307
Kai Zhong and Yue Zheng
19.1 The Importance of Food Safety Risk Communication 307
19.2 Genetically Modified Organisms (GMOs) and Consciousness of Public Rights 309
19.3 The Rise of the New Media Era and Opinion Leaders 310
19.4 The Proposal of Social Participation and the Concept of Cooperated and Joint Efforts 311
19.5 The Germination Stage of Government Agencies Risk Communication System 312
19.6 The Food Division of the Health and Family Planning Commission has Set Up a Risk Communication Position 313
19.7 The Current Situation of Food Safety Risk Communication in China 314
19.7.1 The Government Risk Communication System is Gradually Developing 314
19.7.2 Government Food Safety Risk Communication has Intensified 315
19.7.3 The Participation of Various Society Segments Continues to Improve 317
19.8 Future Perspectives for Risk Communication 318
19.8.1 Official Organization Communication Shifts from Reactive Responding to Proactive Communication 318
19.8.2 Companies and Industry Will Become the Driving Force in Risk Communication 319
19.8.3 Public Opinion Will Return to Scientific Rationality 319
19.8.4 The Consumer Food Safety Concept Has Gradually Been Shaped 320

References 320

20 Consumer Knowledge, Attitude and Behavior Toward Food Safety 323
Li Bai and Shunlong Gong
20.1 Introduction 323
20.2 Materials and Methods 324
20.3 Consumer Perception and Confidence in Food Safety 324
20.4 Consumer Knowledge, Attitude and Behavior Toward Safe Food Purchase 327
20.4.1 Consumer Willingness to Pay for Food Safety 328
20.4.2 Consumer Knowledge, Attitude and Purchase Behavior Toward Organic Food 329
20.4.3 Recovery of Food Purchase After Food Scandals 331
20.5 Home Food Safety and Consumer Knowledge, Attitude and Behavior 331
20.5.1 Food-Borne Illnesses and Consumer Home Food Handling Behavior 331
20.5.2 Consumer Knowledge, Attitude, and Behavior Regarding Home Food Handling 332
20.5.3 Factors Influencing Home Food Handling Knowledge, Attitude, and Behavior 333
20.5.4 “High-Risk” Groups with the Poorest Home Food Handling Knowledge and Behavior 334
20.6 Discussion and Future Research 335
20.7 Conclusions 337
Acknowledgements 338
References 338

Part 5 Risk Management 345

21 Food Safety Laws and Regulations 347
Yunbo Luo and Guangfeng Wu
21.1 Overview: The Importance of Laws and Regulations for Food Safety 347
21.1.1 They are Necessary to Protect Citizens’ Right to Health 347
21.1.2 They are Necessary for the Healthy Development and Operation of the Market Economy 348
21.1.3 They are Needed for Social Order and Political Stability 348
21.1.4 The Composition of Chinese Law and its Regulatory System 348
21.2 History 349
21.3 Current Situation (January 2014 to June 2015) 353
21.4 The Future 358
References 361

22 Food Safety Standards 363
Zhutian Wang, Yongxiang Fan, Zhe Zhang and Samuel Godefroy

22.1 China’s Food Standards before Promulgation of the Food Safety Law 363
22.1.1 Chinese Food Standardization History 363
22.1.2 Development of Food Hygiene Standards 364
22.1.3 The Food Hygiene Standard System Forms the Predecessor of Food Safety Standards 365
22.1.3.1 Formulation of Food Hygiene Standards 365
22.1.3.2 Composition of the Food Hygiene Standards System 366
22.1.4 Problems Related to the Parallel Existence of Various Food Standards 367
22.1.4.1 Ambiguous Boundaries Between Food Quality and Food Safety Standards 367
22.1.4.2 Managing the Interface and Possible Overlap Between Industry Standards 368
22.1.4.3 The Scientific Foundation of Food Hygienic Standards was Deemed to be Weak 369

22.2 Setup and Development of the Food Safety Standard System 370
22.2.1 Setup of the Food Safety Standard System 370
22.2.2 The National Food Safety Standard Formulation Process 371
22.2.2.1 Engagement on Food Safety Standards Programming and Planning 371
22.2.2.2 Planning for Standards Elaboration and Revision 371
22.2.2.3 Drafting the Standards 372
22.2.2.4 Soliciting Opinions from the Public 372
22.2.2.5 Reviewing the Standards 373
22.2.2.6 Approval and Issuance of the Standards 373
22.2.2.7 Tracking and Re-Evaluating Standards 373
22.2.2.8 Amending and Reviewing the Standards 373
22.2.3 Gradual Development of the National Food Safety Standard System 373
22.2.4 China Strengthens its Contribution to the Formulation of International Food Standards 374
22.2.5 Challenges to Continuing to Enhance China’s Food Safety Standards 375

22.3 Future Directions and Trends in Food Safety Standards Development 376
22.3.1 Future Directions of Food Safety Standards Development 376
22.3.1.1 Departmental Coordination of Food Safety Standards will be Further Strengthened 376
22.3.1.2 The Scientific Foundation for Food Safety Standards will be Further Strengthened 377
22.3.1.3 Tracking Assessment, Promotion and Training on Developed and Adopted Standards will be Enhanced 377
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.3.1.4</td>
<td>The Standard Formulation Process will be More Open and Transparent and Embody the “Shared Governance by all Stakeholders” Approach</td>
<td>377</td>
</tr>
<tr>
<td>22.3.2</td>
<td>Challenges Faced by Food Safety Standards Formulation</td>
<td>378</td>
</tr>
<tr>
<td>22.4</td>
<td>Conclusion</td>
<td>379</td>
</tr>
<tr>
<td>References</td>
<td></td>
<td>379</td>
</tr>
</tbody>
</table>

### 23 Lessons for China from US Food Safety History

*Fred Gale and Sandra Hoffmann*

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.1</td>
<td>Introduction</td>
<td>381</td>
</tr>
<tr>
<td>23.2</td>
<td>Food Safety Then and Now</td>
<td>382</td>
</tr>
<tr>
<td>23.3</td>
<td>Urbanization and Food Safety</td>
<td>383</td>
</tr>
<tr>
<td>23.4</td>
<td>Development of US Food Safety Regulation</td>
<td>384</td>
</tr>
<tr>
<td>23.5</td>
<td>Lessons from History</td>
<td>386</td>
</tr>
<tr>
<td>23.5.1</td>
<td>An Informed Public Propels Food Safety Reforms</td>
<td>386</td>
</tr>
<tr>
<td>23.5.2</td>
<td>National Rules are Needed to Assure Food Safety in a National Market</td>
<td>388</td>
</tr>
<tr>
<td>23.5.3</td>
<td>Food Safety Measures must be Practical to Ensure they can be Enforced</td>
<td>389</td>
</tr>
<tr>
<td>23.5.4</td>
<td>International Trade Considerations Can Drive Positive Domestic Change</td>
<td>390</td>
</tr>
<tr>
<td>23.5.5</td>
<td>Food Safety Regulation Requires Coordination Across Government</td>
<td>391</td>
</tr>
<tr>
<td>23.6</td>
<td>Concluding Remarks</td>
<td>391</td>
</tr>
<tr>
<td>References</td>
<td></td>
<td>392</td>
</tr>
</tbody>
</table>

### 24 Food Safety Regulatory Inspection in China

*Zhenhua Gu, Congqian Qiu and Zhinong Yan*

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.1</td>
<td>Overview of Food Safety Regulatory Inspection</td>
<td>397</td>
</tr>
<tr>
<td>24.1.1</td>
<td>The Definition of Food Safety Regulatory Inspection</td>
<td>397</td>
</tr>
<tr>
<td>24.1.2</td>
<td>The Importance of Food Safety Regulatory Inspection</td>
<td>397</td>
</tr>
<tr>
<td>24.1.3</td>
<td>Basic Principles and Tasks of Food Safety Regulatory Inspection</td>
<td>398</td>
</tr>
<tr>
<td>24.1.3.1</td>
<td>Primary Principles</td>
<td>398</td>
</tr>
<tr>
<td>24.1.3.2</td>
<td>Enforcement</td>
<td>398</td>
</tr>
<tr>
<td>24.2</td>
<td>The History of Chinese Food Safety Regulatory Inspection</td>
<td>399</td>
</tr>
<tr>
<td>24.2.1</td>
<td>The Development of Food Safety Regulatory Inspection</td>
<td>399</td>
</tr>
<tr>
<td>24.2.1.1</td>
<td>Technical Supportive Management (Disease Prevention and Quarantine)</td>
<td>399</td>
</tr>
<tr>
<td>24.2.1.2</td>
<td>Administrative Regulation (Health Agency)</td>
<td>400</td>
</tr>
<tr>
<td>24.2.1.3</td>
<td>Regulation by Multiple Ministries (Multiple Agency System)</td>
<td>400</td>
</tr>
<tr>
<td>24.2.1.4</td>
<td>A Single Agency System (CFDA)</td>
<td>400</td>
</tr>
<tr>
<td>24.2.2</td>
<td>The Dynamics of Food Safety Regulation Mechanisms</td>
<td>401</td>
</tr>
<tr>
<td>24.2.2.1</td>
<td>The Regulatory System of Food Hygiene Focusing on Prevention of Food Poisoning</td>
<td>401</td>
</tr>
<tr>
<td>24.2.2.2</td>
<td>The Regulatory System Coexisting between Food Poisoning and Contamination Prevention</td>
<td>401</td>
</tr>
<tr>
<td>24.2.2.3</td>
<td>Food Regulatory Systems Focusing on Risk-Based Prevention and Management</td>
<td>401</td>
</tr>
<tr>
<td>24.2.3</td>
<td>The Outcome and Results of Food Safety Regulations</td>
<td>402</td>
</tr>
<tr>
<td>24.2.3.1</td>
<td>Continuous Improvement of Food Safety Legal Systems</td>
<td>402</td>
</tr>
</tbody>
</table>
24.2.3.2 The Increasing Trend in the Pass Rate of Products by Randomized Testing 402
24.2.3.3 The Decreasing Trend for Food Poisoning 402
24.2.3.4 Significant Results of Specific Food Safety Campaigns 403
24.2.4 Investigation and Prosecution of Major Food Safety Incidents 403
24.2.4.1 Counterfeit Baby Formula in 2004 [20] 403
24.2.4.2 Sudan I Red Dye in 2005 [21] 404
24.2.4.3 Melamine in Infant Milk Powder in 2008 [23] 404
24.2.4.4 Lean Meat Powder in 2011 [24] 404
24.2.4.5 Gutter Oil in 2011 [25] 404
24.2.4.6 Shanghai OSI Incident in 2014 [26] 405
24.3 The Current Status of Food Safety Regulatory Inspection 405
24.3.1 Basic Information 405
24.3.2 The Status of Food Safety Regulatory Inspection 405
24.3.2.1 The Coordination Department and its Duties 405
24.3.2.2 The Administration of Food Safety Inspection and its Duties 405
24.3.3 The Current Status of the Food Safety Regulatory Inspection Mechanism 406
24.3.3.1 The Comprehensive Coordination Mechanism 406
24.3.3.2 The Holistic Regulatory Mechanism 406
24.3.3.3 Regulatory Mechanisms with Categories at Different Levels 406
24.3.3.4 Emergence Management and Response Mechanisms 406
24.3.3.5 Rewarded Reporting System 406
24.3.3.6 Primary Responsibility System 406
24.3.3.7 Food Recall System 407
24.3.3.8 Social Governance System 407
24.3.4 Food Safety Regulatory Focus and Innovative Approaches 407
24.3.4.1 Edible Agriculture Sector 407
24.3.4.2 Food Processing Sector 407
24.3.4.3 Food Trade and Service Sectors 407
24.3.4.4 Import Sector 408
24.3.5 Challenges of Food Safety Regulatory Inspection 408
24.3.5.1 Food Safety Problems are Subtle 408
24.3.5.2 The Food Company is not Able to Shoulder the Main Responsibility 408
24.3.5.3 The Problem of Food Safety Regulatory Inspection 408
24.4 The Future of Food Safety Regulatory Inspection 408
24.4.1 Trends in Regulatory System Development 408
24.4.2 Trends in Regulatory Inspection Mechanisms 409
24.4.3 Trends in What is Regulated and Inspected 409
24.5 Global Food Safety Regulatory Systems and their Relevance to China 409
24.5.1 The Food Safety Regulatory System in the US [28–31] 410
24.5.1.1 The Role of the USDA 410
24.5.1.2 The Role of the FDA 411
24.5.1.3 The Role of the CDC 412
24.5.1.4 The Environmental Protection Agency (EPA) 412
24.5.1.5 Food Defense against Bioterrorism 413
24.5.2 European Food Safety Regulatory Systems [32] 413
24.5.2.1 Food Safety Legislation 413
24.5.2.2 The European Food Safety Authority (EFSA) 414
24.5.2.3 Enforcement and Control 414
24.5.3 The Relevance to China's Food Safety Regulatory Inspection Systems 414
References 415

25 Food Safety in Restaurants and Catering 419
Zhaohui Ma and Duncan Lap-Yan Tung

25.1 Introduction 419
25.2 Changes in Food Safety in Catering in the Past 10 Years 422
25.2.1 Changes in the Catering Industry 422
25.2.2 Changes in Monitoring of Food Safety in Catering 423
25.2.2.1 Changes in monitoring laws 423
25.2.2.2 Change in the Monitoring Framework 424
25.2.2.3 Changes in monitoring methods 424
25.2.2.4 Changes in monitoring methods 425
25.2.3 Important Catering Food Safety Incidents 427
25.3 Current Food Safety in Catering 427
25.3.1 The Revised Version of “The Food Safety Law” was Promulgated 427
25.3.2 Construction of the Monitoring System was Pushed Forward 427
25.3.3 The Use of Innovative Monitoring Methods 428
25.3.4 Continuous Strengthening in Monitoring 429
25.3.5 Improvements in Monitoring Capacity 429
25.4 The Future of Food Safety in Catering 430
25.4.1 The Legal System will be More Comprehensive 430
25.4.2 Improvements in Risk Management 430
25.4.3 Whole-Process Monitoring will be Strengthened 430
25.4.4 The System of Food Traceability will be more Mature 431
25.4.5 Penalties for Illegal Practices will be More Severe 431
25.4.6 Improvements in Technological Support 432
25.4.7 Monitoring Capacity will be Continuously Improved 432
25.4.8 Social Co-Governance will be Reinforced 433
25.5 Food Safety Regulatory Systems in Other Countries 433
25.5.1 Australia 433
25.5.2 The European Union (EU) 434
25.5.3 The United States of America (US) 435
References 436

26 Food Safety and International Trade: Regulatory Challenges 439
Shawn S. Arita, Fred Gale and Xuedan Mao

26.1 Introduction 439
26.2 Overview of China's SPS regime 440
26.2.1 Authority Organizations of WTO/SPS in China 440
26.2.2 WTO/SPS Notification and Comments 441
26.2.3 Overview of the Participation of China in WTO-SPS Discussions 441
26.2.4 Challenges for China in Accordance with WTO Rules 442
26.3 Case Study: China's Experience Regulating Beta Agonists at Home and at the Border 443
Part 6  Commodities  453

27  Meat Safety in China  455

Guanghong Zhou, Keping Ye and Ronald Keith Tume

27.1  Introduction  455
27.1.1  The Present Status of China’s Development of the Meat Industry  455
27.1.2  The Importance of Meat Safety  455
27.2  Hazards Associated with Meat Safety in China  456
27.2.1  Chemical Contamination  457
27.2.1.1  Residues from Veterinary Pharmaceuticals  457
27.2.1.2  Additives Used in Meat Processing  458
27.2.1.3  Formation of Pollutants During the Manufacture of Processed Meats  459
27.2.1.4  Environment Pollutants  460
27.2.1.5  Heavy Metals  460
27.2.2  Biological Contamination  460
27.2.2.1  Bacteria  460
27.2.2.2  Viruses  462
27.2.2.3  Parasites  463
27.2.3  Physical Contamination  463
27.3  Control Technologies for Meat Safety  464
27.3.1  Non-Thermal Processing Technologies  464
27.3.1.1  High Hydrostatic Pressure (HHP) Processing  464
27.3.1.2  Ionizing Radiation  465
27.3.1.3  Other Technologies  466
27.3.2  Chemical and Natural Preservatives  466
27.3.3  Packaging  467
27.3.3.1  Vacuum Packaging  467
27.3.3.2  Modified Atmosphere Packaging (MAP)  467
27.3.3.3  Active Packaging (AP)  468
27.4  Ensuring Meat is Safe to Eat  468
27.4.1  Safe Production Technology Systems  468
27.4.2  Trace-Back Processes and Technologies  469
27.4.3  The Regulatory System in China  470
27.5  Summary  470

References  471

28  A New Epoch of Dairy Product Safety in China  477

Yujun Jiang and Jin Yue

28.1  Food Safety is the Top Priority for Dairy Products  477
28.2  Crises Create Concerns: The History of China’s Dairy Product Safety  478
28.2.1 DP Safety Incidents Caused by Raw Milk 478
28.2.2 DP Safety Incidents Caused by Lack of Processing Control 479
28.2.3 DP Safety Disturbances 481
28.2.4 DP Safety Supervision 481
28.3 Reinforcing Management and Pursuing Safety: The Present Status of China’s Dairy Products 483
28.4 Metamorphosis in a New Epoch: The Future of DP Safety in China 485
References 486

29 The Importance of Food Safety for Fruits and Vegetables 489
Xiaosong Hu, Fang Chen, Pan Wang and Zhao Chen
29.1 The Present Situation for Fruit and Vegetable Safety, Domestic and Abroad 489
29.2 Pre-Harvest Routes for Fresh Produce Contamination in Soils 490
29.2.1 Environmental Contaminants 492
29.2.2 Chemical Inputs in Agricultural Production 493
29.2.2.1 Fertilizers 493
29.2.2.2 Pesticides 494
29.3 Post-Harvest Routes for Fresh Produce Contamination 495
29.3.1 Pathogens Associated with Fruits and Vegetables 495
29.3.2 Survival and Growth of Pathogens on Fresh Produce During Storage 496
29.3.3 Packaging Technology 496
29.3.4 Transportation 498
29.4 Global Perspective 498
References 499

30 Safety of Fats and Oils 503
Yu Wang, Bo-Yang Hsu, Chi-Tang Ho and Lucy Sun Hwang
30.1 Introduction to Lipids 503
30.2 Safety of Saturated Fat 503
30.3 Safety of Trans Fat 504
30.3.1 Formation of Trans Fat 504
30.3.1.1 Exogenously Produced Trans Fat 504
30.3.1.2 Endogenously Produced Trans Fat 505
30.3.1.3 Exogenously vs Endogenously Produced Trans Fat 505
30.3.2 Safety Issues of Trans Fat 505
30.3.2.1 Trans Fat and Cardiovascular Disease 506
30.3.2.2 Trans Fat and Systemic Inflammation 506
30.3.2.3 Trans Fat and Alzheimer’s Disease 506
30.3.2.4 Trans Fat and Type 2 Diabetes 507
30.3.2.5 Trans Fat and Cancer 507
30.3.2.6 Trans Fat and Other Diseases 507
30.3.3 Regulation of Trans Fats Worldwide 507
30.3.3.1 Trans Fat Regulation in the United States 507
30.3.3.2 Trans Fat Regulation in China 508
30.3.3.3 Trans Fat Regulation in Taiwan 509
30.3.4 The Effectiveness of Policies for Reducing Dietary Trans Fat 509
30.4 3-Chloro-1,2-Propanediol and Glycidol Fatty Acid Esters 509
30.4.1 Formation of 3-MCPD Fatty Acid Esters 510
30.4.2 Formation of Glycidol Fatty Acid Esters 510
30.4.3 Safety Issues 510
30.4.3.1 Toxicity of 3-MCPD 510
30.4.3.2 Toxicity of Glycidol 511
30.5 Safety Issues of Fat-Soluble Components and Contaminants 511
30.5.1 Cholesterol and Cholesterol Oxides 511
30.5.2 Polychlorinated Biphenyls (PCBs) 512
30.5.3 Polycyclic Aromatic Hydrocarbons (PAHs) 513
30.5.4 Heterocyclic Amines (HCAs) 514
References 515

31 Grain and Grain Products Safety 521
Xiaonan Sui, Yan Zhang, Zhongjiang Wang, Baokun Qi, Yang Li and Lianzhou Jiang
31.1 Introduction 521
31.2 Past Grain Safety Problems in China 521
31.2.1 Contamination of Food Products During Grain Processing 522
31.2.2 Formation of Toxic By-Products During Grain Processing 523
31.2.3 Grain Safety Problems Arising from Misuse of Food Additives 523
31.3 Current Grain Safety Problems in China 524
31.3.1 Grain Safety Challenges Due to Biotoxins 524
31.3.2 Grain Safety Challenges Due to Chemical Contaminants 525
31.3.2.1 Residual Pesticide Contamination 525
31.3.2.2 Heavy Metal Contamination 525
31.3.3 Grain Safety Challenges Due to the Misuse of Grain Additives 526
31.3.4 Grain Safety Challenges Due to Overprocessing of Food 526
31.3.5 Genetically Modified (GM) Grain Safety Challenges 526
31.3.5.1 Overview of GM Rice 527
31.3.5.2 Chinese Government’s Attitude Toward GM Rice 527
31.3.5.3 Safety Assessment of GM Rice 528
31.4 Potential Future Grain Safety Problems in China 529
31.4.1 Increasing Demand for Grain 529
31.4.2 Grain Safety and Technology 530
31.4.3 New Technologies for Grain Storage 530
31.4.4 Implementation of Public Policies to Safeguard Grain Safety 530
31.4.5 The Promotion of New Advanced Technologies to Ensure Grain Safety 531
31.5 Conclusion 531
References 532

32 Food Safety Aspects of Aquatic Products in China 537
Felicia Kow and Junrong Liu
32.1 Chinese Aquatic Products: Supply and Consumption 537
32.1.1 The Development of Chinese Fishery Production 537
32.1.2 Chinese Seafood Consumption Characteristics 538
32.2 Development of Chinese Aquatic Product Quality 540
32.2.1 Incidence of Aquatic Food-Borne Illness 540
32.2.1.1 Food Poisoning 540
32.2.1.2 Infection 541
32.2.2 Aquatic Food Safety Incident Review 542
32.2.2.1 Chloramphenicol Event 542
32.2.2.2 Turbot Event 543
32.2.2.3 Other Residue Events 543
32.2.3 Aquatic Product Quality and Safety System Development 543
32.2.3.1 Growth Amidst the Export Barrier Storm 543
32.2.3.2 Development of the Primary Production Management System 544
32.3 Current Status 547
32.3.1 The Food Safety Law 547
32.3.2 The Twelfth Five-Year Plan 2010–2015 548
32.3.3 Food Safety Focus Work Arrangements 549
32.3.4 Veterinary Drug Standards and Quarantine Inspection Control of Imported Seafood 549
32.4 Gaining Consumer Confidence on Food Safety 549
32.4.1 International Food Code and Standards (Codex Alimentarius) 551
32.4.2 Inspection and Certification, Basis of Food Safety Management: FSSC 22000 551
References 552

Part 7 New Technology 559

33 Food Safety Traceability 561
Yimin Wei, Boli Guo, Hongyan Liu, Shuai Wei and Jianrong Zhang
33.1 Introduction 561
33.2 Legal Regulations 562
33.3 Food Safety Traceability System 564
33.4 Food Traceability and Verification Technology 565
33.4.1 Plant and Animal Species Identification Technology 565
33.4.1.1 Proteomics Analysis 565
33.4.1.2 Chromatography/Spectrometry Methods 565
33.4.1.3 DNA Fingerprinting Methods 565
33.4.2 Food Origin Identification Technology 566
33.4.2.1 Traceability Technology Principles and Applications for Food Origin 566
33.4.2.2 Trends in Food Origin Traceability Technology 569
33.5 Problems and Recommendations 569
33.5.1 Problems 569
33.5.2 Recommendations 571
33.5.2.1 Establish and Improve Food Safety Traceability Regulations and Standards 571
33.5.2.2 Strengthen Top-Level Design and Build a Unified Information Platform 571
33.5.2.3 Promote the Standardization and Intensification of Agricultural and Food Industries 571
33.5.2.4 Establish a Scientific Supervision and Management System and Promote an Enterprise Credit System to Guarantee the Authenticity of Traceability Information 571
33.5.2.5 Enhance the Information Level of Agricultural Infrastructure 571
33.5.2.6 Strengthen the Convergence of Networking Technology and Traceability System Development 572
33.5.2.7 Intensify Publicity Efforts to increase Consumer Awareness 572
References 572

34 New Techniques for Genetically Engineered Organism Analysis 575
Litao Yang, Dabing Zhang and Sheng Quan
34.1 Status of GEO Commercialization 575
34.2 The Worldwide Regulations for GEO Labeling 576
34.2.1 Mandatory Labeling Regulations 576
34.2.2 Voluntary Labeling Regulation 577
34.2.3 Low Level Presence 577
34.3 Currently Used Methods and Technologies for GEO Analysis 578
34.3.1 Detection Methods and Technologies Based on Protein Analysis 578
34.3.2 PCR Technologies and Strategies for GEO Detection 580
34.3.3 New Nucleic Acid-Based Analytical Technologies for GEO Analysis 580
34.3.3.1 Multiplex Target Analysis Based on PCR 580
34.3.3.2 DNA Microarrays 580
34.3.3.3 Next-Generation Sequencing (NGS) 583
34.3.3.4 Loop-Mediated Isothermal Amplification (LAMP) 584
34.3.3.5 Digital PCR 584
34.3.4 Biosensors for GEO Analysis 585
34.3.5 Spectrum Detection Method 586
34.4 Standardization of GEO Detection Methods 586
34.5 Database for GEO Analysis 587
34.6 Prospects 587
References 589

35 Safety of Food Contact Materials and Articles in China 593
Rongfang Chen and Yanyun Zhao
35.1 Introduction 593
35.2 Legislation on Food Contact Materials in China 594
35.2.1 Historical Evolution 594
35.2.2 Current Regulation Systems 595
35.2.2.1 Basis of Laws and Regulations 595
35.2.2.2 Mandatory Technical Standards 595
35.2.2.3 Regulations for New Food-Related Products 596
35.2.3 Improvement of the Regulations and Standards Profile 598
35.3 Safety of Some Food Contact Substances 600
35.3.1 Bisphenol A (BPA) 601
35.3.2 Styrene 602
35.3.3 Plasticizers 603
35.4 Food Safety in the Use of Emerging Packaging Technologies and Materials 604
35.4.1 Active and Intelligent Packaging 604
35.4.2 Edible Packaging 604
References 609
35.4.3 Biodegradable Packaging 605
35.4.4 Nanomaterials Used in Food Packaging 605
35.5 Challenges and Strategies for Ensuring the Safety of Food Packaging 606
References 607

36 Nanotechnology Applications to Improve Food Safety 609
Boce Zhang, Yaguang Luo and Hongda Chen
36.1 Introduction 609
36.2 Recent Advances in Nanotechnology Applications for Improving Food Safety 610
36.2.1 Identification and Detection of Pathogens and Hazardous Substances in Food 610
36.2.1.1 Advances in Electrochemical Nanosensors 610
36.2.1.2 Advanced Optical Nanosensors 615
36.2.2 Preventive Control and Intervention Strategies 620
36.2.2.1 Nanoscale Antimicrobial Systems 620
36.2.2.2 Surface Treatment and Nanoscale Coating 624
36.3 Current Efforts and Future Directions 627
References 628

Index 637