

Foodborne pathogens

Hazards, risk analysis and control

Edited by
Clive de W. Blackburn and Peter J. McClure



CRC Press
Boca Raton Boston New York Washington, DC

WOODHEAD PUBLISHING LIMITED

Cambridge England

Contents

<i>List of contributors</i>	<i>xiii</i>
---------------------------------------	-------------

Part I Risk assessment and management in the food chain

1 Introduction	3
<i>Dr Clive Blackburn and Dr Peter McClure, Unilever R&D Colworth, UK</i>	
1.1 Trends in foodborne disease	3
1.2 Incidence of foodborne disease	4
1.3 Foodborne disease surveillance	5
1.4 Emerging foodborne disease and changing patterns in epidemiology	6
1.5 Control of foodborne disease	9
1.6 Rationale for this book	10
1.7 References	10
2 Detecting pathogens in food	13
<i>Dr Roy Betts, Campden and Chorleywood Food Research Association, UK and Dr Clive Blackburn, Unilever R and D Colworth, UK</i>	
2.1 Introduction	13
2.2 A comparison of Quality Control and Quality Assurance	14
2.3 Use of microbiology methods in a Quality Control system	14
2.4 Sampling	15
2.5 Use of microbiology methods in a Quality Assurance system	16
2.6 Conventional microbiological techniques	19

2.7	Rapid and automated methods	21
2.8	Future trends	44
2.9	References and further reading	45
3	Modelling the growth, survival and death of bacterial pathogens in food	53
	<i>Dr David Legan, and Dr Mark Vandeven, Kraft Foods North America; and Dr Cynthia Stewart and Dr Martin Cole, Food Science Australia</i>	
3.1	Introduction	53
3.2	Approaches to modelling	54
3.3	Kinetic growth models	56
3.4	Growth boundary models	72
3.5	Death models	77
3.6	Survival models	83
3.7	Applications of models: product and process design, product shelf-life	83
3.8	Applications of models: hygienic equipment design, HACCP systems	84
3.9	Applications of models: risk assessment, food safety objectives	86
3.10	Future trends	88
3.11	Sources of further information and advice	91
3.12	References	91
4	Risk assessment and pathogen management	97
	<i>Dr Tom Ross and Professor Tom McMeekin, University of Tasmania, Australia</i>	
4.1	Introduction	97
4.2	The development of risk assessment	98
4.3	Risk assessment methodology	106
4.4	Risk assessment tools	114
4.5	The role of risk assessment in pathogen management: food safety objectives and HACCP systems	117
4.6	Future trends	121
4.7	Sources of further information and advice	122
4.8	References	123
5	HACCP in farm production	127
	<i>Professor Mac Johnston, Royal Veterinary College, University of London, UK</i>	
5.1	Introduction	127
5.2	Planning the HACCP system	128

5.3	Problems with hazard and CCP identification	129
5.4	Good working practices	130
5.5	Critical Control Points	131
5.6	Documentation	133
5.7	HACCP plans: the examples of meat and dairy production	134
5.8	Summary: the effectiveness of HACCP on the farm	136
5.9	References	140
5.10	Appendix: model HACCP system for cattle	142
6	Hygienic plant design and sanitation	151
	<i>Dr John Holah and Dr Richard Thorpe, Campden and Chorleywood Food Research Association, UK</i>	
6.1	Introduction: hygienic design	151
6.2	Level 1: the factory site	152
6.3	Level 2: the factory building	153
6.4	Level 3: internal barriers separating manufacturing processes	156
6.5	Hygienic construction	166
6.6	Hygienic equipment design	173
6.7	Sanitation: introduction	176
6.8	The principles of sanitation	177
6.9	Sanitation chemicals	179
6.10	Disinfectants	181
6.11	Sanitation methodology	183
6.12	Sanitation procedures	186
6.13	Evaluating the effectiveness of sanitation programmes	188
6.14	References and further reading	190
7	Safe process design and operation	197
	<i>Professor Martyn Brown, Unilever R and D Colworth, UK</i>	
7.1	Introduction: product and process design	197
7.2	Modelling and product/process design	199
7.3	Safety management tools: good manufacturing practice (GMP), HACCP and risk assessment	200
7.4	Principles of process design	202
7.5	Process flow and equipment	206
7.6	Manufacturing areas	207
7.7	Handling and processing products	215
7.8	Control systems	221
7.9	Conclusions	225
7.10	References and further reading	226

8 The effective implementation of HACCP systems in food processing	229
<i>Ms Sara Mortimore, Pillsbury Europe, UK; and Mr Tony Mayes, Unilever R and D Colworth, UK</i>	
8.1 Introduction	229
8.2 HACCP methodology and implementation	231
8.3 Motivation	233
8.4 The knowledge required for HACCP	236
8.5 Initial training and preparation	237
8.6 Building knowledge and expertise	238
8.7 Resources and planning	244
8.8 Prerequisite programmes (PRPs)	246
8.9 HACCP teams	247
8.10 Hazard analysis	248
8.11 HACCP implementation	249
8.12 Maintenance	250
8.13 HACCP and globalised production	251
8.14 Future trends	252
8.15 References	254
9 Good practices for food handlers and consumers	257
<i>Dr Chris Griffith, University of Wales Institute, Cardiff, UK</i>	
9.1 Introduction	257
9.2 Food safety management in manufacturing: HACCP and GMP	262
9.3 Safety management in the food service sector: GCP, ASC and SAFE	263
9.4 Domestic food preparation: GDKP	263
9.5 Understanding food handlers	265
9.6 Improving food-handling practices	270
9.7 Future trends	274
9.8 References	274
Part II Bacterial hazards	
10 Pathogenic <i>Escherichia coli</i>	279
<i>Dr Chris Bell and Alec Kyriakides, Sainsbury's Supermarkets Ltd, UK</i>	
10.1 Introduction	279
10.2 Characteristics of <i>Escherichia coli</i>	280
10.3 Detecting <i>Escherichia coli</i>	286
10.4 Control of pathogenic <i>Escherichia coli</i> in foods	288
10.5 Raw material control	291
10.6 Control in processing	296
10.7 Final product control	300

10.8	Future trends	302
10.9	References and further reading	302
11	<i>Salmonella</i>	307
	<i>Dr Chris Bell and Alec Kyriakides, Sainsbury's Supermarkets Ltd, UK</i>	
11.1	Introduction	307
11.2	Characteristics of <i>Salmonella</i>	308
11.3	Detecting <i>Salmonella</i>	315
11.4	Control of <i>Salmonella</i> in foods	317
11.5	Raw material control	321
11.6	Control in processing	327
11.7	Final product control	330
11.8	General considerations	330
11.9	Future trends	331
11.10	References and further reading	331
12	<i>Listeria monocytogenes</i>	337
	<i>Dr Chris Bell, Consultant Microbiologist and Alec Kyriakides, Sainsbury's Supermarkets Ltd, UK</i>	
12.1	Introduction	337
12.2	Characteristics of <i>Listeria monocytogenes</i>	337
12.3	Detecting <i>Listeria monocytogenes</i>	345
12.4	Control of <i>Listeria monocytogenes</i> in foods	346
12.5	Raw material control	349
12.6	Control in processing	352
12.7	Final product control	356
12.8	Future trends	358
12.9	References	358
13	<i>Campylobacter</i> and <i>Arcobacter</i>	363
	<i>Dr Peter McClure and Dr Clive Blackburn, Unilever R and D Colworth, UK</i>	
13.1	Introduction	363
13.2	Characteristics of <i>Campylobacter</i> and <i>Arcobacter</i> species	364
13.3	The nature of <i>Campylobacter</i> and <i>Arcobacter</i> infections	366
13.4	Risk factors for <i>Campylobacter</i>	367
13.5	Risk factors for <i>Arcobacter</i>	370
13.6	Control procedures for <i>Campylobacter</i>	371
13.7	Control procedures for <i>Arcobacter</i>	372
13.8	Detection methods for <i>Campylobacter</i>	373
13.9	Detection methods for <i>Arcobacter</i>	376

13.10	Future trends	377
13.11	Sources of further information and advice	379
13.12	References	379
14	Enterotoxin-producing <i>Staphylococcus</i>, <i>Shigella</i>, <i>Yersinia</i>, <i>Vibrio</i>, <i>Aeromonas</i> and <i>Plesiomonas</i>	385
	<i>Dr Jane Sutherland and Dr Alan Varnam, University of North London, UK</i>	
14.1	Introduction	385
14.2	Characteristics of enterotoxin-producing staphylococci	385
14.3	Risk factors, detection methods and control procedures	387
14.4	Future trends	390
14.5	Further information	390
14.6	Characteristics of the genus <i>Yersinia</i>	390
14.7	Risk factors, detection methods and control procedures	392
14.8	Future trends	395
14.9	Further information	396
14.10	Characteristics of the genus <i>Shigella</i>	396
14.11	Risk factors, detection methods and control procedures	398
14.12	Future trends	400
14.13	Further information	400
14.14	Characteristics of the genus <i>Vibrio</i>	401
14.15	Risk factors, detection methods and control procedures	403
14.16	Future trends	407
14.17	Further information	407
14.18	Characteristics of the genera <i>Aeromonas</i> and <i>Plesiomonas</i>	407
14.19	Risk factors, detection methods and control procedures	410
14.20	Future trends	412
14.21	Further information	412
14.22	References	412
15	Characteristics of spore-forming bacteria	417
	<i>Dr Paul Gibbs, Leatherhead Food Research Association, UK</i>	
15.1	Introduction	417
15.2	<i>Clostridium botulinum</i> : general characteristics	418
15.3	<i>Clostridium perfringens</i> : general characteristics	421
15.4	<i>Bacillus</i> spp.: general characteristics	423

15.5	Methods of detection: <i>Clostridium botulinum</i>	427
15.6	Methods of detection: <i>Clostridium perfringens</i>	428
15.7	Methods of detection: <i>bacillus</i> spp.	429
15.8	Control issues: <i>Clostridium botulinum</i>	429
15.9	Control issues: <i>Clostridium perfringens</i>	430
15.10	Control issues: <i>bacillus</i> spp.	430
15.11	Sources of further information and advice	431
15.12	References	433
Part III Non-bacterial and emerging foodborne pathogens		
16	Viruses	439
	<i>Dr Marion Koopmans, National Institute of Public Health and the Environment, The Netherlands</i>	
16.1	Introduction	439
16.2	Current level of incidence	442
16.3	Conditions of growth and survival	445
16.4	Detection methods	446
16.5	Control issues	446
16.6	Sources of further information and advice	447
16.7	References	447
17	Parasites: <i>Cryptosporidium</i>, <i>Giardia</i> and <i>Cyclospora</i> as foodborne pathogens	453
	<i>Dr Rosely Nichols and Professor Huw Smith, Scottish Parasite Diagnostic Laboratory, UK</i>	
17.1	Introduction	453
17.2	Description of the organisms	453
17.3	Symptoms caused in humans	457
17.4	Infectious dose and treatment	459
17.5	Current levels of incidence	460
17.6	Conditions for growth	465
17.7	Detection methods	467
17.8	Control issues	467
17.9	The regulatory framework	470
17.10	Sources of further information and advice	472
17.11	References	472
18	Toxigenic fungi	479
	<i>Dr Maurice Moss, University of Surrey, UK</i>	
18.1	Introduction	479
18.2	Aflatoxins: occurrence and significance	480
18.3	Control measures	482
18.4	Ochratoxin A: occurrence and significance	483
18.5	Control measures	484

18.6	Patulin: occurrence and significance	484
18.7	Control measures	485
18.8	Fumonisin: occurrence and significance	485
18.9	Control measures	485
18.10	Other mycotoxins	486
18.11	Sources of further information and advice	487
18.12	References	487
19	<i>Mycobacterium paratuberculosis</i>	489
	<i>Professor Mansel Griffiths, University of Guelph, Canada</i>	
19.1	Introduction	489
19.2	<i>Mycobacterium paratuberculosis</i> and Crohn's disease	490
19.3	<i>Mycobacterium paratuberculosis</i> in foods	491
19.4	Detection methods	495
19.5	Control measures	496
19.6	Sources of further information and advice	497
19.7	References	497
20	Chronic sequelae of foodborne infections	501
	<i>Dr Yasmine Motarjemi, Nestlé, Switzerland</i>	
20.1	Introduction	501
20.2	<i>Aeromonas</i>	503
20.3	<i>Brucella</i> spp.	503
20.4	<i>Campylobacter</i> spp.	503
20.5	Enterohaemorrhagic <i>Escherichia coli</i>	504
20.6	<i>Enterobacter Sakazakii</i>	505
20.7	<i>Helicobacter pylori</i>	505
20.8	<i>Listeria monocytogenes</i>	506
20.9	<i>Mycobacterium paratuberculosis</i>	506
20.10	Nanobacteria	507
20.11	Non-Typhi <i>Salmonella</i>	508
20.12	<i>Vibrio vulnificus</i>	508
20.13	<i>Yersinia enterocolitica</i>	508
20.14	<i>Toxoplasma gondii</i>	509
20.15	Trematodes	509
20.16	<i>Taenia solium</i>	510
20.17	<i>Trichinella spiralis</i>	511
20.18	Viral hepatitis A virus	511
20.19	References	512
	Index	515