

Food preservation techniques

**Edited by
Peter Zeuthen and Leif Bøgh-Sørensen**



**CRC Press
Boca Raton Boston New York Washington, DC**

WOODHEAD PUBLISHING LIMITED

Cambridge England

Contents

<i>Contributor contact details</i>	xiii
1 Introduction	1
Part I Ingredients	3
2 The use of natural antimicrobials	5
<i>P. M. Davidson and S. Zivanovic, University of Tennessee, USA</i>	
2.1 Introduction	5
2.2 Natural antimicrobials from animal sources	7
2.3 Natural antimicrobials from plant sources	10
2.4 Natural antimicrobials from microbial sources	15
2.5 Evaluating the effectiveness of antimicrobials	18
2.6 Key issues in using natural antimicrobials	19
2.7 Future trends	23
2.8 Sources of further information and advice	23
2.9 References	23
3 Natural antioxidants	31
<i>J. Pokorný, Prague Institute of Chemical Technology, Czech Republic</i>	
3.1 Introduction	31
3.2 Classifying natural antioxidants	32
3.3 Antioxidants from oilseeds, cereals and grain legumes	34
3.4 Antioxidants from fruits, vegetables, herbs and spices	35

3.5	Using natural antioxidants in food	37
3.6	Improving antioxidant functionality	41
3.7	Combining antioxidants with other preservation techniques ..	43
3.8	Future trends	44
3.9	Sources of further information and advice	45
3.10	References	45
4	Antimicrobial enzymes	49
	<i>A. S. Meyer, Technical University of Denmark</i>	
4.1	Introduction	49
4.2	Lysozymes and other lytic enzyme systems	51
4.3	Lactoperoxidase	56
4.4	Glucose oxidase and other enzyme systems	59
4.5	Combining antimicrobial enzymes with other preservation techniques	61
4.6	Future trends	64
4.7	Sources of further information and advice	66
4.8	References	66
5	Combining natural antimicrobial systems with other preservation techniques: the case of meat	71
	<i>P. Paulsen and F. J. M. Smulders, University of Veterinary Medicine Vienna, Austria</i>	
5.1	Introduction	71
5.2	Microbial contamination of meat	72
5.3	Using organic acids to control microbial contamination	75
5.4	Regulatory and safety issues	80
5.5	Combining organic acids with other preservation techniques	82
5.6	Conclusion	84
5.7	References	85
6	Edible coatings	90
	<i>H. J. Park, Korea University</i>	
6.1	Introduction: the development of edible coatings	90
6.2	How edible coatings work: controlling internal gas composition	92
6.3	Selecting edible coatings	92
6.4	Gas permeation properties of edible coatings	92
6.5	Wettability and coating effectiveness	95
6.6	Determining diffusivities of fruits	97
6.7	Measuring internal gas composition of fruits	100
6.8	Future trends	100
6.9	References	102

Part II Traditional preservation technologies	107
7 The control of pH	109
<i>F.-K. Lücke, University of Applied Sciences (Fulda), Germany</i>	
7.1 Introduction	109
7.2 The effect of pH on cellular processes	110
7.3 Combining pH control with other preservation techniques ...	112
7.4 The effect of pH on the growth and survival of foodborne pathogens	113
7.5 The use of pH control to preserve dairy, meat and fish products	114
7.6 The use of pH control to preserve vegetable, fruits, sauces and cereal products	118
7.7 Future trends	121
7.8 References	122
8 The control of water activity	126
<i>S.M. Alzamora, Universidad de Buenos Aires, Argentina, M.S. Tapia, Universidad Central de Venezuela, A. López-Malo and J. Welti-Chanes, Universidad de Los Américas, México</i>	
8.1 Introduction	126
8.2 The concept of water activity	127
8.3 Water activity, microbial growth, death and survival	129
8.4 Combining control of water activity with other preservation techniques	134
8.5 Applications: fully hydrated, intermediate and high moisture foods	135
8.6 Measurement and prediction of water activity in foods	142
8.7 Future trends	148
8.8 Sources of further information and advice	149
8.9 References	149
9 Developments in conventional heat treatment	154
<i>G. Bown, Alcan Packaging, UK</i>	
9.1 Introduction	154
9.2 Thermal technologies: cookers	154
9.3 Thermal technologies: retorts	157
9.4 Using plastic packaging in retort operations	162
9.5 Dealing with variables during processing	167
9.6 The strengths and weaknesses of batch retorts	173
9.7 Future trends	175
9.8 Sources of further information and advice	176
9.9 References	178

10 Combining heat treatment, control of water activity and pressure to preserve foods	179
<i>L. Beney, J.M. Perrier-Cornet, F. Fine and P. Gervais, ENSBANA (Université de Bourgogne), France</i>	
10.1 Introduction	179
10.2 The thermal destruction of microorganisms	179
10.3 The effects of dehydration and hydrostatic pressure on microbial thermotolerance	182
10.4 Temperature variation and microbial viability	187
10.5 Combining heat treatment, hydrostatic pressure and water activity	191
10.6 Conclusions	197
10.7 References	198
11 Combining traditional and new preservation techniques to control pathogens: the case of <i>E. coli</i>	204
<i>V. K. Juneja, US Department of Agriculture</i>	
11.1 Introduction	204
11.2 Pathogen growth conditions: the case of <i>E. coli</i>	205
11.3 The heat resistance of <i>E. coli</i>	209
11.4 Problems in combining traditional preservation techniques ..	212
11.5 Combining traditional and new preservation techniques	216
11.6 Conclusions and future trends	219
11.7 References	221
12 Developments in freezing	228
<i>C. Kennedy, NutriFreeze Ltd, UK</i>	
12.1 Introduction	228
12.2 Pre-treatments	229
12.3 Developments in conventional freezer technology	232
12.4 The use of pressure in freezing	233
12.5 Developments in packaging	234
12.6 Cryoprotectants	235
12.7 References	236
Part III Emerging preservation techniques	241
13 Biotechnology and reduced spoilage	243
<i>J. R. Botella, University of Queensland, Australia</i>	
13.1 Introduction: mechanisms of post-harvest spoilage in plants ..	243
13.2 Methods for reducing spoilage in fruits	244
13.3 Methods for reducing spoilage in vegetables	249
13.4 Enhancing plant resistance to diseases and pests	251
13.5 Future trends	255

13.6	Sources of further information and advice	256
13.7	References	257
14	Membrane filtration techniques in food preservation	263
	<i>A. S. Grandison, The University of Reading, UK</i>	
14.1	Introduction	263
14.2	General principles of membrane processing	264
14.3	Filtration equipment	271
14.4	Using membranes in food preservation	276
14.5	Future trends	281
14.6	Sources of further information and advice	282
14.7	References	282
14.8	Acknowledgement	283
15	High-intensity light	284
	<i>S. Green, N. Basaran and B. G. Swanson, Washington State University, USA</i>	
15.1	Introduction	284
15.2	Process and equipment	287
15.3	Microbial inactivation	289
15.4	Inactivation of pathogens and spoilage bacteria	292
15.5	Applications, strengths and weaknesses	296
15.6	Sources of further information and advice	299
15.7	References	301
16	Ultrasound as a preservation technology	303
	<i>T. J. Mason and L. Paniwnyk, University of Coventry, UK and F. Chemat, University of Réunion, France</i>	
16.1	Introduction	303
16.2	Principles: acoustic cavitation	305
16.3	Ultrasound as a preservation technology	311
16.4	Ultrasonic inactivation of microorganisms, spores and enzymes	317
16.5	Ultrasound in combination with other preservation techniques	323
16.6	Ultrasonic equipment	328
16.7	Conclusions	332
16.8	References	333
17	Modified atmosphere packaging (MAP)	338
	<i>B. Ooraikul, University of Alberta, Canada</i>	
17.1	Introduction	338
17.2	The use of MAP to preserve foods	339
17.3	MAP gases	344
17.4	Packaging materials	347

17.5	Quality assurance	348
17.6	Using MAP and other techniques to preserve fresh and minimally processed produce	349
17.7	Using MAP and other techniques to preserve processed meat, bakery and other products	351
17.8	Future trends	354
17.9	References	355
18	Pulsed electric fields	360
	<i>L. Picart and J-C. Cheftel, Université des Sciences et Techniques du Languedoc, France</i>	
18.1	Introduction	360
18.2	Principles and technology	361
18.3	Mechanisms of microbial inactivation	370
18.4	Critical factors determining microbial inactivation	377
18.5	Combinations with other preservation techniques	388
18.6	Effects on enzymes	394
18.7	Effects on food proteins	401
18.8	Effects on vitamins and other quality attributes of foods	403
18.9	Strengths and weaknesses as a preservation technology	406
18.10	Applications	411
18.11	Acknowledgements	415
18.12	References	416
18.13	Patents	425
19	High hydrostatic pressure technology in food preservation	428
	<i>Indrawati, A. Van Loey, C. Smout and M. Hendrickx, Katholieke Universiteit Leuven, Belgium</i>	
19.1	Introduction	428
19.2	Principles and technologies	429
19.3	Effects of high pressure on microorganisms	433
19.4	Effects of high pressure on quality-related enzymes	434
19.5	Effects of high pressure on nutritional and colour quality	437
19.6	Effects of high pressure on water-ice transition of foods	438
19.7	Future trends	440
19.8	Sources of further information and advice	441
19.9	Acknowledgements	441
19.10	References	441
Part IV	Assessing preservation requirements	449
20	Modelling food spoilage	451
	<i>J. Sutherland, London Metropolitan University, UK</i>	
20.1	Introduction: spoilage mechanisms	451

20.2	Approaches to spoilage modelling	452
20.3	Developing spoilage models	454
20.4	Measurement techniques	458
20.5	Constructing models	463
20.6	Applications of spoilage models	464
20.7	Limitations of models	465
20.8	Future trends	467
20.9	Sources of further information and advice	469
20.10	References	470
21	Modelling applied to foods: predictive microbiology for solid food systems	475
	<i>E.J. Dens and J.F. Van Impe, Katholieke Universiteit Leuven, Belgium</i>	
21.1	Introduction	475
21.2	Microbial growth in solid food systems: colony dynamics ...	476
21.3	Factors affecting microbial growth	478
21.4	Microbial growth dynamics: cell level	482
21.5	Microbial growth dynamics: colony level	486
21.6	Evaluating types of model	489
21.7	Selecting the right modelling approach	496
21.8	Conclusions and future trends	499
21.9	Sources of further information and advice	501
21.10	References	502
22	Modelling applied to processes: the case of thermal preservation	507
	<i>M. Peleg, University of Massachusetts, USA</i>	
22.1	Introduction	507
22.2	Understanding thermal inactivation	509
22.3	Modelling microbial death and survival	510
22.4	Simulating thermal processes	513
22.5	Using models to improve food safety and quality	517
22.6	Conclusions	521
22.7	References	522
23	Food preservation and the development of microbial resistance	524
	<i>S. Brul and F.M. Klis, University of Amsterdam, The Netherlands, D. Knorr, Berlin University of Technology, Germany, T. Abee, Wageningen University, The Netherlands and S. Notermans, TNO Nutrition and Food Research, The Netherlands</i>	
23.1	Introduction	524
23.2	Methods of food preservation	527
23.3	Preservation techniques and food safety	531
23.4	Understanding microbial adaptation to stress	534
23.5	Future trends	540

23.6	Sources of further information and advice	543
23.7	Acknowledgements	544
23.8	References	544
24	Monitoring the effectiveness of food preservation	552
	<i>P. Zeuthen, Consultant, Denmark and L. Bøgh-Sørensen, Danish Veterinary and Food Administration</i>	
24.1	Introduction	552
24.2	HACCP and other monitoring systems	553
24.3	Instrumentation for monitoring the effectiveness of food preservation during processing	556
24.4	Monitoring the effectiveness of food preservation during storage and distribution	559
24.5	Future trends	565
24.6	References	565
	<i>Index</i>	567