

Woodhead Publishing in Food Science and Technology

Novel food packaging techniques

Edited by Raija Ahvenainen



WOODHEAD PUBLISHING LIMITED

Contents

<i>Contributor contact details</i>	xiii
1 Introduction	1
<i>R. Ahvenainen, VTT Biotechnology, Finland</i>	
Part I Types and roles of active and intelligent packaging	3
2 Active and intelligent packaging: an introduction	5
<i>R. Ahvenainen, VTT Biotechnology, Finland</i>	
2.1 Introduction: the role of packaging in the food chain	5
2.2 Active packaging techniques	6
2.3 Intelligent packaging techniques	11
2.4 Current use of novel packaging techniques	12
2.5 Current research	13
2.6 The legislative context	13
2.7 Consumers and novel packaging	15
2.8 Future trends	16
2.9 Sources of further information and advice	18
2.10 References	19
3 Oxygen, ethylene and other scavengers	22
<i>L. Vermeiren, L. Heirlings, F. Devlieghere and J. Debevere,</i> <i>Ghent University, Belgium</i>	
3.1 Introduction	22
3.2 Oxygen scavenging technology	22
3.3 Selecting the right type of oxygen scavenger	25

3.4	Ethylene scavenging technology	34
3.5	Carbon dioxide and other scavengers	41
3.6	Future trends	44
3.7	References	45
4	Antimicrobial food packaging	50
	<i>J.H. Han, The University of Manitoba, Canada</i>	
4.1	Introduction	50
4.2	Antimicrobial agents	52
4.3	Constructing an antimicrobial packaging system	58
4.4	Factors affecting the effectiveness of antimicrobial packaging	60
4.5	Conclusion	65
4.6	References	65
5	Non-migratory bioactive polymers (NMBP) in food packaging ..	71
	<i>M. D. Steven and J. H. Hotchkiss, Cornell University, USA</i>	
5.1	Introduction	71
5.2	Advantages of NMBP	72
5.3	Current limitations	77
5.4	Inherently bioactive synthetic polymers: types and applications	79
5.5	Polymers with immobilised bioactive compounds	84
5.6	Applications of polymers with immobilised bioactive compounds	90
5.7	Future trends	95
5.8	References	95
6	Time-temperature indicators (TTIs)	103
	<i>P. S. Taoukis, National Technical University of Athens, Greece and T. P. Labuza, University of Minnesota, USA</i>	
6.1	Introduction	103
6.2	Defining and classifying TTIs	104
6.3	Requirements for TTIs	106
6.4	The development of TTIs	106
6.5	Current TTI systems	108
6.6	Maximising the effectiveness of TTIs	111
6.7	Using TTIs to monitor shelf-life during distribution	112
6.8	Using TTIs to optimise distribution and stock rotation	116
6.9	Future trends	121
6.10	References	122
7	The use of freshness indicators in packaging	127
	<i>M. Smolander, VTT Biotechnology, Finland</i>	
7.1	Introduction	127

7.2	Compounds indicating the quality of packaged food products	128
7.3	Freshness indicators	132
7.4	Pathogen indicators	136
7.5	Other methods for spoilage detection	137
7.6	Future trends	138
7.7	References	139
8	Packaging-flavour interactions	144
	<i>J. P. H. Linssen, R. W. G. van Willige and M. Dekker,</i> <i>Wageningen University, The Netherlands</i>	
8.1	Introduction	144
8.2	Factors affecting flavour absorption	145
8.3	The role of the food matrix	149
8.4	The role of differing packaging materials	153
8.5	Flavour modification and sensory quality	156
8.6	Case study: packaging and lipid oxidation	159
8.7	Modelling flavour absorption	160
8.8	Packaging-flavour interactions and active packaging	164
8.9	References	166
9	Moisture regulation	172
	<i>T. Powers and W. J. Calvo, Multisorb Technologies, USA</i>	
9.1	Introduction	172
9.2	Silica gel	173
9.3	Clay	174
9.4	Molecular sieve	176
9.5	Humectant salts	178
9.6	Irreversible adsorption	179
9.7	Planning a moisture defense	180
9.8	Future trends	185
Part II	Developments in modified atmosphere packaging (MAP) ..	187
10	Novel MAP applications for fresh-prepared produce	189
	<i>B. P. F. Day, Food Science Australia</i>	
10.1	Introduction	189
10.2	Novel MAP gases	191
10.3	Testing novel MAP applications	193
10.4	Applying high O ₂ MAP	196
10.5	Future trends	202
10.6	References	204
10.7	Acknowledgements	207

11 MAP, product safety and nutritional quality	208
<i>F. Devlieghere and J. Debevere, Ghent University, Belgium and</i>	
<i>M. Gil CEBAS-CSIC, Spain</i>	
11.1 Introduction	208
11.2 Carbon dioxide as an antimicrobial gas	208
11.3 The microbial safety of MAP: <i>Clostridium botulinum</i> and <i>Listeria monocytogenes</i>	210
11.4 The microbial safety of MAP: <i>Yersinia enterocolitica</i> and <i>Aeromonas spp</i>	212
11.5 The effect of MAP on the nutritional quality of non-respiring food products	215
11.6 The effect of MAP on the nutritional quality of fresh fruits and vegetables: vitamin C and carotenoids	215
11.7 The effect of MAP on the nutritional quality of fresh fruits and vegetables: phenolic compounds and glucosinolates	219
11.8 References	222
12 Reducing pathogen risks in MAP-prepared produce	231
<i>D. O'Beirne and G. A. Francis, University of Limerick, Ireland</i>	
12.1 Introduction	231
12.2 Measuring pathogen risks	232
12.3 Factors affecting pathogen survival	242
12.4 Improving MAP to reduce pathogen risks	251
12.5 Future trends	254
12.6 Sources of further information and advice	256
12.7 References	257
13 Detecting leaks in modified atmosphere packaging	276
<i>E. Hurme, VTT Biotechnology, Finland</i>	
13.1 Introduction	276
13.2 Leakage, product safety and quality	276
13.3 Package leak detection during processing	277
13.4 Package leak indicators during distribution	279
13.5 Future trends	282
13.6 References	283
14 Combining MAP with other preservation techniques	287
<i>J. T. Rosnes, M. Sivertsvik and T. Skåra, NORCONSERV, Norway</i>	
14.1 Introduction	287
14.2 Combining MAP with other preservative techniques	288
14.3 Heat treatment and irradiation	293
14.4 Preservatives	297
14.5 Other techniques	299
14.6 Consumer attitudes	301

14.7	Future trends	302
14.8	Sources of further information and advice	303
14.9	References	304
15	Integrating MAP with new germicidal techniques	312
	<i>J. Lucas, University of Liverpool, UK</i>	
15.1	Introduction	312
15.2	Ultra violet radiation	315
15.3	Ozone	321
15.4	Integration with MAP	325
15.5	Future trends	332
15.6	References	336
16	Improving MAP through conceptual models	337
	<i>M. L. A. T. M. Hertog, Katholieke Universiteit Leuven, Belgium</i> <i>and N. H. Banks, Zespri Innovation Ltd, New Zealand</i>	
16.1	Introduction	337
16.2	Conceptual models	338
16.3	Mathematical models	346
16.4	Dedicated MAP models	351
16.5	Applying models to improve MAP	352
16.6	The risks and benefits of applying models	354
16.7	Future trends	356
16.8	Sources of further information and advice	356
16.9	References	357
Part III	Novel packaging and particular products	363
17	Active packaging in practice: meat	365
	<i>C. O. Gill, Agriculture and Agri-Food Canada</i>	
17.1	Introduction	365
17.2	Control of product appearance	366
17.3	Control of flavour, texture and other characteristics	368
17.4	Delaying microbial spoilage	369
17.5	The effects of temperature on storage life	371
17.6	MAP technology for meat products	372
17.7	Controlled atmosphere packaging for meat products	376
17.8	Future trends in active packaging for raw meats	377
17.9	References	379
18	Active packaging in practice: fish	384
	<i>M. Sivertsvik, NORCONSERV, Norway</i>	
18.1	Introduction	384
18.2	The microbiology of fish products	385

18.3	Active packaging: atmosphere modifiers	387
18.4	Active packaging: water control	390
18.5	Active packaging: antimicrobial and antioxidant applications	391
18.6	Active packaging: edible coatings and films	392
18.7	Active packaging: taint removal	393
18.8	Intelligent packaging applications	394
18.9	Future trends	395
18.10	References	396
19	Active packaging and colour control: the case of meat	401
	<i>M. Jakobsen and G. Bertelsen, The Royal Veterinary and Agricultural University, Denmark</i>	
19.1	Introduction	401
19.2	Packaging and storage factors affecting colour stability	402
19.3	Modelling the impact of MAP	403
19.4	Pre- and post-slaughter factors	410
19.5	Future trends	412
19.6	References	414
20	Active packaging and colour control: the case of fruit and vegetables	416
	<i>F. Artes Calero, Technical University of Cartagena, Spain and P. A. Gomez, National Institute for Agricultural Technology, Argentina</i>	
20.1	Introduction	416
20.2	Colour changes and stability in fruit and vegetables	417
20.3	Colour measurement	418
20.4	Processes of colour change	419
20.5	Colour stability and MAP	424
20.6	Combining low oxygen, high carbon dioxide and other gases	429
20.7	Future trends	432
20.8	References	432
Part IV	General issues	439
21	Optimizing packaging	441
	<i>T. Lyijynen, E. Hurme and R. Ahvenainen, VTT Biotechnology, Finland</i>	
21.1	Introduction	441
21.2	Issues in optimizing packaging	442
21.3	The VTT Precision Packaging Concept	444
21.4	Examples of food packaging optimization	449
21.5	Conclusion: improving decision-making	458

22	Legislative issues relating to active and intelligent packaging ..	459
	<i>N. de Kruijf and R. Rijk, TNO Nutrition and Food Research, The Netherlands</i>	
22.1	Introduction	459
22.2	Initiatives to amend EU legislation: European project	461
22.3	Initiatives to amend EU legislation: Nordic report	468
22.4	Current EU legislation and recommendations for change	468
22.5	Food contact materials	470
22.6	Food additives	478
22.7	Food flavouring	482
22.8	Biocides and pesticides	483
22.9	Food hygiene	485
22.10	Food labelling, weight and volume control	487
22.11	Product safety and waste	489
22.12	References	492
23	Recycling packaging materials	497
	<i>R. Franz and F. Welle, Fraunhofer Institute for Process Engineering and Packaging, Germany</i>	
23.1	Introduction	497
23.2	The recyclability of packaging plastics	498
23.3	Improving the recyclability of plastics packaging	500
23.4	Testing the safety and quality of recycled material	504
23.5	Using recycled plastics in packaging	509
23.6	Future trends	513
23.7	Sources of further information and advice	514
23.8	References	515
24	Green plastics for food packaging	519
	<i>J. J. de Vlieger, TNO Industrial Technology, The Netherlands</i>	
24.1	Introduction: the problem of plastic packaging waste	519
24.2	The range of biopolymers	520
24.3	Developing novel biodegradable materials	524
24.4	Legislative issues	526
24.5	Current applications	529
24.6	Future trends	533
24.7	References	533
25	Integrating intelligent packaging, storage and distribution	535
	<i>T. Järvi-Kääriäinen, Association of Packaging Technology and Research, Finland</i>	
25.1	Introduction: the supply chain for perishable foods	535
25.2	The role of packaging in the supply chain	538
25.3	Creating integrated packaging, storage and distribution: alarm systems and TTIs	540

25.4	Traceability: radio frequency identification	542
25.5	Future trends	545
25.6	Sources of further information and advice	547
25.7	References	548
26	Testing consumer responses to new packaging concepts	550
	<i>L. Lähteenmäki and A. Arvola, VTT Biotechnology, Finland</i>	
26.1	Introduction: new packaging techniques and the consumer ..	550
26.2	Special problems in testing responses to new packaging	551
26.3	Methods for testing consumer responses	552
26.4	Consumer attitudes towards active and intelligent packaging ..	555
26.5	Consumers and the future of active and intelligent packaging ..	559
26.6	References	562
27	MAP performance under dynamic conditions	563
	<i>M. L. A. T. M. Hertog, Katholieke Universiteit Leuven, Belgium</i>	
27.1	Introduction	563
27.2	MAP performance	564
27.3	Temperature control and risks of MAP	566
27.4	The impact of dynamic temperature conditions on MAP performance	568
27.5	Maximising MAP performance	572
27.6	Future trends	573
27.7	References	574
	<i>Index</i>	<i>576</i>