

Woodhead Publishing in Food Science and Technology

Food authenticity and traceability

Edited by Michèle Lees



WOODHEAD PUBLISHING LIMITED

Contents

<i>Contributor contact details</i>	xiii
<i>The Humber Institute of Fisheries & Food</i>	xviii
Part I Methods for authentication and traceability	1
1 Advanced PCR techniques in identifying food components	3
<i>N. Marmiroli, C. Peano and E. Maestri, University of Parma, Italy</i>	
1.1 Introduction	3
1.2 Qualitative and quantitative PCR techniques	6
1.3 Method validation	14
1.4 Advanced PCR techniques	15
1.5 Applying PCR techniques: identifying genetically-modified organisms in food	18
1.6 Applying PCR techniques: molecular markers and identification of cultivar or breed	22
1.7 Future trends: PCR and identity preservation of foods	29
1.8 References	30
1.9 Acknowledgements	33
2 DNA methods for identifying plant and animal species in food	34
<i>J. A. Lenstra, Utrecht University, The Netherlands</i>	
2.1 Introduction	34
2.2 Meat species identification	35
2.3 Identifying species in dairy products, feedstuffs and fish	41

2.4	Identifying plant species, cell lines and animal breeds	44
2.5	Comparison and validation of methods	45
2.6	Future trends	46
2.7	References	46
3	Enzyme immunoassays for identifying animal species in food .	54
	<i>E. Märtlebauer, University of Munich, Germany</i>	
3.1	Introduction	54
3.2	Principles of enzyme immunoassays	55
3.3	Applications: identifying animal species in meat, dairy and other foods	60
3.4	Advantages and disadvantages	64
3.5	Sources of further information and advice	65
3.6	References	66
4	Proteome and metabolome analyses for food authentication ...	71
	<i>S. Vaidyanathan and R. Goodacre, University of Manchester Institute of Science and Technology (UMIST), UK</i>	
4.1	Introduction	71
4.2	The importance of proteomics and metabolomics	72
4.3	Proteome analysis	74
4.4	Metabolome analysis	80
4.5	Fingerprinting techniques	83
4.6	Applications: rapid authentication of food components	90
4.7	Future trends	92
4.8	Sources of further information and advice	93
4.9	References	94
5	Near infra-red absorption technology for analysing food composition	101
	<i>I. B. Benson, NDC Infrared Engineering, UK</i>	
5.1	Introduction	101
5.2	Principles of measurement	103
5.3	Instrumentation	110
5.4	Multi-component analysis of food products	118
5.5	Advantages and disadvantages	120
5.6	On-line applications	124
5.7	Future trends	127
5.8	References	129
6	NMR spectroscopy in food authentication	131
	<i>G. Le Gall and I. J. Colquhoun, Institute of Food Research, UK</i>	
6.1	Introduction	131
6.2	Using NMR spectroscopy: sample preparation	132
6.3	Data recording and processing	133

6.4	Signal assignment and chemometrics	137
6.5	Advantages and disadvantages of the NMR technique	138
6.6	Applications: authenticating oils, beverages, animal and other foods	140
6.7	Future trends	149
6.8	Sources of further information and advice	149
6.9	References	150
7	Using stable isotope ratio mass spectrometry (IRMS) in food authentication and traceability	156
<i>S. D. Kelly, Institute of Food Research, UK</i>		
7.1	Introduction: stable isotopes	156
7.2	Principles of operation of IRMS	162
7.3	Current applications: adulteration of fruit juice, honey and wine	169
7.4	New applications: determining the geographical origin of foods	174
7.5	Future trends: position-specific isotope analysis (PSIA)	178
7.6	Conclusion	180
7.7	References	181
8	Spectrophotometric techniques	184
<i>M. Meurens, Université Catholique de Louvain, Belgium</i>		
8.1	Introduction	184
8.2	Ultraviolet spectroscopy: detecting fruit and vegetable oil adulteration	185
8.3	Infra-red spectroscopy for food authentication	187
8.4	Fluorescence spectroscopy for food authentication	190
8.5	Raman spectroscopy for food authentication	191
8.6	Conclusion	194
8.7	References	194
9	Gas chromatography	197
<i>E. Forgács and T. Cserháti, Hungarian Academy of Sciences</i>		
9.1	Introduction	197
9.2	Principles and technologies	198
9.3	Sample preparation	202
9.4	Applications: identifying flavour compounds	204
9.5	Advantages and disadvantages of gas chromatography	212
9.6	References	215
10	High pressure liquid chromatography (HPLC) in food authentication	218
<i>L. M. L. Nollet, Hogeschool Gent, Belgium</i>		
10.1	Introduction: principles and technologies	218
10.2	Authenticating fruit products	221

10.3	Authenticating oils	225
10.4	Authenticating other foods	228
10.5	Future trends	233
10.6	References	233
11	Enzymatic techniques for authenticating food components	239
<i>G. Henniger, University of Applied Sciences – Lemgo, Germany</i>		
11.1	Introduction	239
11.2	Analysing enzymes in sugars, acids, salts, alcohols and other compounds	241
11.3	Sample materials and equipment	243
11.4	Sample preparation	246
11.5	Performing an assay	250
11.6	Routine enzymatic methods for food analysis and authentication	256
11.7	Advantages and disadvantages	268
11.8	Future trends	272
11.9	Abbreviations	273
11.10	References and further reading	273
12	In-line sensors for food analysis	275
<i>P. D. Patel and C. Beveridge, Leatherhead Food International Ltd, UK</i>		
12.1	Introduction	275
12.2	Requirements for in-line sensors	276
12.3	Current commercial sensor systems	278
12.4	In-line sampling	284
12.5	Future trends	295
12.6	Sources of further information and advice	296
12.7	References	297
13	Chemometrics in data analysis	299
<i>R. Leardi, University of Genoa, Italy</i>		
13.1	Introduction	299
13.2	Data collection and display	300
13.3	Classification	310
13.4	Modelling	312
13.5	Calibration	313
13.6	Variable selection	315
13.7	Future trends	317
13.8	Conclusion: the advantages and disadvantages of chemometrics	318
13.9	Sources of further information and advice	319
13.10	References	320

Part II Authenticating and tracing particular foods	321
14 Species identification in processed seafoods	323
<i>C. G. Sotelo and R. I. Pérez-Martín, Instituto de Investigaciones Marinas, Spain</i>	
14.1 Introduction: the importance of species identification	323
14.2 The problem of species identification in seafood products	324
14.3 The use of biomolecules as species markers	325
14.4 The use of DNA for species identification	329
14.5 Polymerase chain reaction (PCR) techniques	329
14.6 Methods not requiring a previous knowledge of the sequence	331
14.7 Methods using sequence information	333
14.8 Future trends	338
14.9 Sources of further information and advice	340
14.10 References	341
15 Meat and meat products	347
<i>M. Lees and B. Popping, Eurofins Scientific Analytics, France</i>	
15.1 Introduction	347
15.2 Species identification	347
15.3 Meat content and adulteration	351
15.4 References	352
16 Milk and dairy products	357
<i>F. Ulberth, European Commission, Belgium</i>	
16.1 Introduction: authenticity issues for milk and dairy products	357
16.2 Detection and quantification of foreign fats	360
16.3 Identifying milk of different species	363
16.4 Other authenticity and traceability indices	367
16.5 Conclusions	371
16.6 References	372
17 Cereals	378
<i>G. Downey, TEAGASC – The National Food Centre, Ireland</i>	
17.1 Introduction	378
17.2 Wheat	378
17.3 Pasta	381
17.4 Rice	382
17.5 References	383
18 Herbs and spices	386
<i>R. S. Singhal and P. R. Kulkarni, Institute of Chemical Technology, Mumbai, India</i>	
18.1 Introduction: quality and adulteration issues	386
18.2 Whole spices and spice powders	392

18.3	Essential oils	397
18.4	Oleoresins	406
18.5	Testing for sensory quality and geographical origin	408
18.6	Future trends	411
18.7	References	411
19	Identifying genetically modified organisms (GMOs)	415
	<i>B. Popping, Eurofins Scientific Analytics, France</i>	
19.1	Introduction	415
19.2	Characteristics of transgenic crops	417
19.3	Labelling requirements	419
19.4	Detection methods and traceability systems for GMOs	421
19.5	Future trends	424
19.6	References	425
20	Wine authenticity	426
	<i>I. S. Arvanitoyannis, University of Thessaly, Greece</i>	
20.1	Introduction: traditional and novel methods for testing wine authenticity	426
20.2	Analysis of minerals and trans-resveratrol	427
20.3	Analysis of phenols, volatiles and amino acids	431
20.4	The use of NMR, FT-IR and sensory techniques	438
20.5	Data analysis	443
20.6	Conclusions	450
20.7	References	451
Part III	Traceability	457
21	Traceability in food processing: an introduction	459
	<i>C. Morrison, Youngs Bluecrest Seafoods Ltd, UK</i>	
21.1	Introduction: the key objectives of traceability	459
21.2	Traceability coding	460
21.3	Components of traceability systems	462
21.4	Using traceability systems when problems arise	467
21.5	Summary	471
21.6	References	471
22	Developing traceability systems across the supply chain	473
	<i>A. Furness and K. A. Osman, Centre for Automatic Identification and Intelligent Systems, Technology Innovation Centre, UK</i>	
22.1	Introduction	473
22.2	Accommodating multi-functional traceability requirements ..	476
22.3	Item-specific data capture	480
22.4	The EAN.UCC coding system	482
22.5	Data carrier technologies	485

22.6	Linking item-attendant data and database information	490
22.7	The FOODTRACE project	491
22.8	Conclusions	494
23	Developing and implementing an effective traceability and product recall system	496
<i>M. Dillon and M. Thompson, Humber Institute of Food and Fisheries, UK</i>		
23.1	Introduction	496
23.2	Building traceability in the supply chain: an example	498
23.3	Key elements in a traceability system	498
23.4	Verifying control	502
23.5	Conclusions	504
23.6	Sources of further information and advice	505
23.7	References	505
24	Traceability in fish processing	507
<i>E. Larsen, Danish Institute of Fisheries Research</i>		
24.1	Introduction: the fish sector	507
24.2	Recent legislation in Europe and the rest of the world regarding traceability	510
24.3	Traceability systems in use today	511
24.4	External traceability systems: how to generate data and inform other links in the chain	513
24.5	Farmed fish – the difference between conventional and organic production	514
24.6	Attitudes to traceability in the fish sector	515
24.7	References	516
25	Safety and traceability of animal feed	518
<i>S. Notermans and H. Beumer, TNO Nutrition and Food Research, The Netherlands</i>		
25.1	Introduction	518
25.2	Requirements for safe feed production	519
25.3	Risks from animal feed	523
25.4	Control systems to manage risks: GMP and HACCP	536
25.5	The role and requirements of traceability systems	542
25.6	Future trends: hazard early warning systems	547
25.7	Abbreviations	549
25.8	References	550
26	Geographic traceability of cheese	554
<i>L. Pillonel and J. O. Bosset, Federal Dairy Research Station, Switzerland</i>		
26.1	Introduction	554
26.2	Approaches to identifying geographical origin	555

xii Contents

26.3	Analytical methods: primary indicators	559
26.4	Analytical methods: secondary indicators	562
26.5	Conclusion	571
26.6	References	572
27	Advanced DNA-based detection techniques for genetically modified food	575
	<i>A. Holst-Jensen, National Veterinary Institute, Norway</i>	
27.1	Introduction	575
27.2	Issues in detecting genetically-modified organisms (GMOs) ..	577
27.3	Developing improved GMO detection methods	581
27.4	Future trends in detecting GMOs in food	586
27.5	References	592
<i>Index</i>		595