

Food Processing Handbook

Edited by
James G. Brennan



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**Food Processing
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*Edited by
James G. Brennan*

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James G. Brennan
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Contents

Preface XXI

List of Contributors XXIII

1	Postharvest Handling and Preparation of Foods for Processing	1
	<i>Alistair S. Grandison</i>	
1.1	Introduction	1
1.2	Properties of Raw Food Materials and Their Susceptibility to Deterioration and Damage	2
1.2.1	Raw Material Properties	3
1.2.1.1	Geometric Properties	3
1.2.1.2	Colour	4
1.2.1.3	Texture	5
1.2.1.4	Flavour	5
1.2.1.5	Functional Properties	5
1.2.2	Raw Material Specifications	6
1.2.3	Deterioration of Raw Materials	7
1.2.4	Damage to Raw Materials	7
1.2.5	Improving Processing Characteristics Through Selective Breeding and Genetic Engineering	8
1.3	Storage and Transportation of Raw Materials	9
1.3.1	Storage	9
1.3.1.1	Temperature	11
1.3.1.2	Humidity	12
1.3.1.3	Composition of Atmosphere	12
1.3.1.4	Other Considerations	13
1.3.2	Transportation	13
1.4	Raw Material Cleaning	14
1.4.1	Dry Cleaning Methods	14
1.4.2	Wet Cleaning Methods	18
1.4.3	Peeling	20
1.5	Sorting and Grading	21
1.5.1	Criteria and Methods of Sorting	21

1.5.2	Grading	24
1.6	Blanching	26
1.6.1	Mechanisms and Purposes of Blanching	26
1.6.2	Processing Conditions	27
1.6.3	Blanching Equipment	28
1.7	Sulphiting of Fruits and Vegetables	29
	References	30

2 Thermal Processing 33

Michael J. Lewis

2.1	Introduction	33
2.1.1	Reasons for Heating Foods	33
2.1.2	Safety and Quality Issues	34
2.1.3	Product Range	35
2.2	Reaction Kinetics	36
2.2.1	Microbial Inactivation	36
2.2.2	Heat Resistance at Constant Temperature	36
2.3	Temperature Dependence	39
2.3.1	Batch and Continuous Processing	41
2.3.2	Continuous Heat Exchangers	43
2.4	Heat Processing Methods	48
2.4.1	Thermisation	48
2.4.2	Pasteurisation	48
2.4.2.1	HTST Pasteurisation	49
2.4.2.2	Tunnel (Spray) Pasteurisers	53
2.4.3	Sterilisation	53
2.4.3.1	In-Container Processing	53
2.4.3.2	UHT Processing	61
2.4.3.3	Special Problems with Viscous and Particulate Products	67
2.5	Filling Procedures	68
2.6	Storage	68
	References	69

3 Evaporation and Dehydration 71

James G. Brennan

3.1	Evaporation (Concentration, Condensing)	71
3.1.1	General Principles	71
3.1.2	Equipment Used in Vacuum Evaporation	73
3.1.2.1	Vacuum Pans	73
3.1.2.2	Short Tube Vacuum Evaporators	74
3.1.2.3	Long Tube Evaporators	75
3.1.2.4	Plate Evaporators	76
3.1.2.5	Agitated Thin Film Evaporators	77
3.1.2.6	Centrifugal Evaporators	77
3.1.2.7	Ancillary Equipment	78

3.1.3	Multiple-Effect Evaporation (MEE)	78
3.1.4	Vapour Recompression	79
3.1.5	Applications for Evaporation	80
3.1.5.1	Concentrated Liquid Products	80
3.1.5.2	Evaporation as a Preparatory Step to Further Processing	82
3.1.5.3	The Use of Evaporation to Reduce Transport, Storage and Packaging Costs	83
3.2	Dehydration (Drying)	85
3.2.1	General Principles	85
3.2.2	Drying Solid Foods in Heated Air	86
3.2.3	Equipment Used in Hot Air Drying of Solid Food Pieces	88
3.2.3.1	Cabinet (Tray) Drier	88
3.2.3.2	Tunnel Drier	89
3.2.3.3	Conveyor (Belt) Drier	89
3.2.3.4	Bin Drier	90
3.2.3.5	Fluidised Bed Drier	90
3.2.3.6	Pneumatic (Flash) Drier	93
3.2.3.7	Rotary Drier	93
3.2.4	Drying of Solid Foods by Direct Contact With a Heated Surface	94
3.2.5	Equipment Used in Drying Solid Foods by Contact With a Heated Surface	95
3.2.5.1	Vacuum Cabinet (Tray or Shelf) Drier	95
3.2.5.2	Double Cone Vacuum Drier	95
3.2.6	Freeze Drying (Sublimation Drying, Lyophilisation) of Solid Foods	96
3.2.7	Equipment Used in Freeze Drying Solid Foods	97
3.2.7.1	Cabinet (Batch) Freeze Drier	97
3.2.7.2	Tunnel (SemiContinuous) Freeze Drier	98
3.2.7.3	Continuous Freeze Driers	99
3.2.7.4	Vacuum Spray Freeze Drier	99
3.2.8	Drying by the Application of Radiant (Infrared) Heat	100
3.2.9	Drying by the Application of Dielectric Energy	100
3.2.10	Osmotic Dehydration	102
3.2.11	Sun and Solar Drying	104
3.2.12	Drying Food Liquids and Slurries in Heated Air	105
3.2.12.1	Spray Drying	105
3.2.13	Drying Liquids and Slurries by Direct Contact With a Heated Surface	110
3.2.13.1	Drum (Roller, Film) Drier	110
3.2.13.2	Vacuum Band (Belt) Drier	112
3.2.14	Other Methods Used for Drying Liquids and Slurries	113
3.2.15	Applications of Dehydration	114
3.2.15.1	Dehydrated Vegetable Products	114
3.2.15.2	Dehydrated Fruit Products	116
3.2.15.3	Dehydrated Dairy Products	117

- 3.2.15.4 Instant Coffee and Tea 118
- 3.2.15.5 Dehydrated Meat Products 118
- 3.2.15.6 Dehydrated Fish Products 119
- 3.2.16 Stability of Dehydrated Foods 119
- References 121

4 Freezing 125

Jose Mauricio Pardo and Keshavan Niranjana

- 4.1 Introduction 125
- 4.2 Refrigeration Methods and Equipment 125
 - 4.2.1 Plate Contact Systems 126
 - 4.2.3 Immersion and Liquid Contact Refrigeration 127
 - 4.2.4 Cryogenic freezing 127
- 4.3 Low Temperature Production 127
 - 4.3.1 Mechanical Refrigeration Cycle 129
 - 4.3.1.2 The Real Refrigeration Cycle (Standard Vapour Compression Cycle) 131
 - 4.3.2 Equipment for a Mechanical Refrigeration System 132
 - 4.3.2.1 Evaporators 132
 - 4.3.2.2 Condensers 133
 - 4.3.2.3 Compressors 135
 - 4.3.2.4 Expansion Valves 135
 - 4.3.2.5 Refrigerants 136
 - 4.3.3 Common Terms Used in Refrigeration System Design 137
 - 4.3.3.1 Cooling Load 137
 - 4.3.3.2 Coefficient of Performance (COP) 137
 - 4.3.3.3 Refrigerant Flow Rate 138
 - 4.3.3.4 Work Done by the Compressor 138
 - 4.3.3.5 Heat Exchanged in the Condenser and Evaporator 138
- 4.4 Freezing Kinetics 138
 - 4.4.1 Formation of the Microstructure During Solidification 140
 - 4.4.2 Mathematical Models for Freezing Kinetics 141
 - 4.4.2.1 Neumann's Model 141
 - 4.4.2.2 Plank's Model 142
 - 4.4.2.3 Cleland's Model 142
- 4.5 Effects of Refrigeration on Food Quality 143
- References 144

5 Irradiation 147

Alistair S. Grandison

- 5.1 Introduction 147
- 5.2 Principles of Irradiation 147
 - 5.2.1 Physical Effects 148
 - 5.2.2 Chemical Effects 152
 - 5.2.3 Biological Effects 153

5.3	Equipment	154
5.3.1	Isotope Sources	154
5.3.2	Machine Sources	157
5.3.3	Control and Dosimetry	159
5.4	Safety Aspects	160
5.5	Effects on the Properties of Food	160
5.6	Detection Methods for Irradiated Foods	162
5.7	Applications and Potential Applications	163
5.7.1	General Effects and Mechanisms of Irradiation	164
5.7.1.1	Inactivation of Microorganisms	164
5.7.1.2	Inhibition of Sprouting	166
5.7.1.3	Delay of Ripening and Senescence	166
5.7.1.4	Insect Disinfestation	166
5.7.1.5	Elimination of Parasites	167
5.7.1.6	Miscellaneous Effects on Food Properties and Processing	167
5.7.1.7	Combination Treatments	167
5.7.2	Applications to Particular Food Classes	167
5.7.2.1	Meat and Meat Products	167
5.7.2.2	Fish and Shellfish	169
5.7.2.3	Fruits and Vegetables	169
5.7.2.4	Bulbs and Tubers	170
5.7.2.5	Spices and Herbs	170
5.7.2.6	Cereals and Cereal Products	170
5.7.2.7	Other Miscellaneous Foods	170
	References	171

6 High Pressure Processing 173

Margaret F. Patterson, Dave A. Ledward and Nigel Rogers

6.1	Introduction	173
6.2	Effect of High Pressure on Microorganisms	176
6.2.1	Bacterial Spores	176
6.2.2	Vegetative Bacteria	177
6.2.3	Yeasts and Moulds	177
6.2.4	Viruses	178
6.2.5	Strain Variation Within a Species	178
6.2.6	Stage of Growth of Microorganisms	178
6.2.7	Magnitude and Duration of the Pressure Treatment	179
6.2.8	Effect of Temperature on Pressure Resistance	179
6.2.9	Substrate	179
6.2.10	Combination Treatments Involving Pressure	180
6.2.11	Effect of High Pressure on the Microbiological Quality of Foods	180
6.3	Ingredient Functionality	181
6.4	Enzyme Activity	183
6.5	Foaming and Emulsification	185

6.6	Gelation	187
6.7	Organoleptic Considerations	189
6.8	Equipment for HPP	190
6.8.1	'Continuous' System	190
6.8.2	'Batch' System	191
6.9	Pressure Vessel Considerations	193
6.9.1	HP Pumps	194
6.9.2	Control Systems	195
6.10	Current and Potential Applications of HPP for Foods	195
	References	197

7 Pulsed Electric Field Processing, Power Ultrasound and Other Emerging Technologies 201

Craig E. Leadley and Alan Williams

7.1	Introduction	201
7.2	Pulsed Electric Field Processing	203
7.2.1	Definition of Pulsed Electric Fields	203
7.2.2	Pulsed Electric Field Processing – A Brief History	203
7.2.3	Effects of PEF on Microorganisms	204
7.2.3.1	Electrical Breakdown	204
7.2.3.2	Electroporation	205
7.2.4	Critical Factors in the Inactivation of Microorganisms Using PEF	205
7.2.4.1	Process Factors	205
7.2.4.2	Product Factors	206
7.2.4.3	Microbial Factors	206
7.2.5	Effects of PEF on Food Enzymes	206
7.2.6	Basic Engineering Aspects of PEF	208
7.2.6.1	Pulse Shapes	208
7.2.6.2	Chamber Designs	210
7.2.7	Potential Applications for PEF	211
7.2.7.1	Preservation Applications	211
7.2.7.2	Nonpreservation Applications	212
7.2.8	The Future for PEF	213
7.3	Power Ultrasound	214
7.3.1	Definition of Power Ultrasound	214
7.3.2	Generation of Power Ultrasound	215
7.3.3	System Types	216
7.3.3.1	Ultrasonic Baths	216
7.3.3.2	Ultrasonic Probes	216
7.3.3.3	Parallel Vibrating Plates	217
7.3.3.4	Radial Vibrating Systems	217
7.3.3.5	Airborne Power Ultrasound Technology	217
7.3.4	Applications for Power Ultrasound in the Food Industry	218
7.3.4.1	Ultrasonically Enhanced Oxidation	218

7.3.4.2	Ultrasonic Stimulation of Living Cells	218
7.3.4.3	Ultrasonic Emulsification	220
7.3.4.4	Ultrasonic Extraction	220
7.3.4.5	Ultrasound and Meat Processing	220
7.3.4.6	Crystallisation	220
7.3.4.7	Degassing	221
7.3.4.8	Filtration	221
7.3.4.9	Drying	222
7.3.4.10	Effect of Ultrasound on Heat Transfer	222
7.3.5	Inactivation of Microorganisms Using Power Ultrasound	222
7.3.5.1	Mechanism of Ultrasound Action	222
7.3.5.2	Factors Affecting Cavitation	223
7.3.5.3	Factors Affecting Microbiological Sensitivity to Ultrasound	224
7.3.5.4	Effect of Treatment Medium	224
7.3.5.5	Combination Treatments	225
7.3.6	Effect of Power Ultrasound on Enzymes	227
7.3.7	Effects of Ultrasound on Food Quality	227
7.3.8	The Future for Power Ultrasound	228
7.4	Other Technologies with Potential	229
7.4.1	Pulsed Light	229
7.4.2	High Voltage Arc Discharge	230
7.4.3	Oscillating Magnetic Fields	230
7.4.4	Plasma Processing	230
7.4.5	Pasteurisation Using Carbon Dioxide	231
7.5	Conclusions	231
	References	232
8	Baking, Extrusion and Frying	237
	<i>Bogdan J. Dobraszczyk, Paul Ainsworth, Senol Ibanoglu and Pedro Bouchon</i>	
8.1	Baking Bread	237
8.1.1	General Principles	237
8.1.2	Methods of Bread Production	238
8.1.2.1	Bulk Fermentation	239
8.1.2.2	Chorleywood Bread Process	239
8.1.3	The Baking Process	242
8.1.3.1	Mixing	242
8.1.3.2	Fermentation (Proof)	242
8.1.3.3	Baking	243
8.1.4	Gluten Polymer Structure, Rheology and Baking	244
8.1.5	Baking Quality and Rheology	249
8.2	Extrusion	251
8.2.1	General Principles	251
8.2.1.1	The Extrusion Process	252
8.2.1.2	Advantages of the Extrusion Process	253

8.2.2	Extrusion Equipment	254
8.2.2.1	Single-Screw Extruders	255
8.2.2.2	Twin-Screw Extruders	256
8.2.2.3	Comparison of Single- and Twin-Screw Extruders	258
8.2.3	Effects of Extrusion on the Properties of Foods	259
8.2.3.1	Extrusion of Starch-Based Products	259
8.2.3.2	Nutritional Changes	264
8.2.3.3	Flavour Formation and Retention During Extrusion	267
8.3	Frying	269
8.3.1	General Principles	269
8.3.1.1	The Frying Process	270
8.3.1.2	Fried Products	270
8.3.2	Frying Equipment	272
8.3.2.1	Batch Frying Equipment	272
8.3.2.2	Continuous Frying Equipment	272
8.3.2.3	Oil-Reducing System	273
8.3.3	Frying Oils	274
8.3.4	Potato Chip and Potato Crisp Production	275
8.3.4.1	Potato Chip Production	276
8.3.4.2	Potato Crisp Production	277
8.3.5	Heat and Mass Transfer During Deep-Fat Frying	278
8.3.6	Modelling Deep-Fat Frying	279
8.3.7	Kinetics of Oil Uptake	280
8.3.8	Factors Affecting Oil Absorption	280
8.3.9	Microstructural Changes During Deep-Fat Frying	281
	References	283
9	Packaging	291
	<i>James G. Brennan and Brian P. F. Day</i>	
9.1	Introduction	291
9.2	Factors Affecting the Choice of a Packaging Material and/or Container for a Particular Duty	292
9.2.1	Mechanical Damage	292
9.2.2	Permeability Characteristics	292
9.2.3	Greaseproofness	294
9.2.4	Temperature	294
9.2.5	Light	295
9.2.6	Chemical Compatibility of the Packaging Material and the Contents of the Package	295
9.2.7	Protection Against Microbial Contamination	297
9.2.8	In-Package Microflora	297
9.2.9	Protection Against Insect and Rodent Infestation	297
9.2.10	Taint	298
9.2.11	Tamper-Evident/Resistant Packages	299
9.2.12	Other Factors	299

9.3	Materials and Containers Used for Packaging Foods	300
9.3.1	Papers, Paperboards and Fibreboards	300
9.3.1.1	Papers	300
9.3.1.2	Paperboards	301
9.3.1.3	Moulded Pulp	302
9.3.1.4	Fibreboards	302
9.3.1.5	Composite Containers	303
9.3.2	Wooden Containers	303
9.3.3	Textiles	303
9.3.4	Flexible Films	304
9.3.4.1	Regenerated Cellulose	305
9.3.4.2	Cellulose Acetate	306
9.3.4.3	Polyethylene	306
9.3.4.4	Polyvinyl Chloride	306
9.3.4.5	Polyvinylidene Chloride	307
9.3.4.6	Polypropylene	307
9.3.4.7	Polyester	308
9.3.4.8	Polystyrene	308
9.3.4.9	Polyamides	308
9.3.4.10	Polycarbonate	309
9.3.4.11	Polytetrafluoroethylene	309
9.3.4.12	Ionomers	309
9.3.4.13	Ethylene-vinyl Acetate Copolymers	309
9.3.5	Metallised Films	310
9.3.6	Flexible Laminates	310
9.3.7	Heat-Sealing Equipment	311
9.3.8	Packaging in Flexible Films and Laminates	312
9.3.9	Rigid and Semirigid Plastic Containers	314
9.3.9.1	Thermoforming	314
9.3.9.2	Blow Moulding	315
9.3.9.3	Injection Moulding	315
9.3.9.4	Compression Moulding	315
9.3.10	Metal Materials and Containers	315
9.3.10.1	Aluminium Foil	316
9.3.10.2	Tinplate	316
9.3.10.3	Electrolytic Chromium-Coated Steel	319
9.3.10.4	Aluminium Alloy	319
9.3.10.5	Metal Containers	320
9.3.11	Glass and Glass Containers	322
9.4	Modified Atmosphere Packaging	325
9.5	Aseptic Packaging	329
9.6	Active Packaging	331
9.6.1	Background Information	331
9.6.2	Oxygen Scavengers	334
9.6.3	Carbon Dioxide Scavengers/Emitters	337

- 9.6.4 Ethylene Scavengers 337
- 9.6.5 Ethanol Emitters 339
- 9.6.6 Preservative Releasers 340
- 9.6.7 Moisture Absorbers 341
- 9.6.8 Flavour/Odour Adsorbers 342
- 9.6.9 Temperature Control Packaging 343
- 9.6.10 Food Safety, Consumer Acceptability and Regulatory Issues 344
- 9.6.11 Conclusions 345
- References 346

10 Safety in Food Processing 351

Carol A. Wallace

- 10.1 Introduction 351
- 10.2 Safe Design 351
 - 10.2.1 Food Safety Hazards 352
 - 10.2.2 Intrinsic Factors 354
 - 10.2.3 Food Processing Technologies 355
 - 10.2.4 Food Packaging Issues 355
- 10.3 Prerequisite Good Manufacturing Practice Programmes 355
 - 10.3.1 Prerequisite Programmes – The Essentials 357
 - 10.3.2 Validation and Verification of Prerequisite Programmes 361
- 10.4 HACCP, the Hazard Analysis and Critical Control Point System 362
 - 10.4.1 Developing a HACCP System 362
 - 10.4.2 Implementing and Maintaining a HACCP System 370
 - 10.4.3 Ongoing Control of Food Safety in Processing 370
 - References 371

11 Process Control In Food Processing 373

Keshavan Niranjana, Araya Ahromrit and Ahok S. Khare

- 11.1 Introduction 373
- 11.2 Measurement of Process Parameters 373
- 11.3 Control Systems 374
 - 11.3.1 Manual Control 374
 - 11.3.2 Automatic Control 376
 - 11.3.2.1 On/Off (Two Position) Controller 376
 - 11.3.2.2 Proportional Controller 377
 - 11.3.2.3 Proportional Integral Controller 378
 - 11.3.2.4 Proportional Integral Derivative Controller 379
- 11.4 Process Control in Modern Food Processing 380
 - 11.4.1 Programmable Logic Controller 381
 - 11.4.2 Supervisory Control and Data Acquisition 381
 - 11.4.3 Manufacturing Execution Systems 382
- 11.5 Concluding Remarks 384
- References 384

12	Environmental Aspects of Food Processing	385
	<i>Niharika Mishra, Ali Abd El-Aal Bakr and Keshavan Niranjana</i>	
12.1	Introduction	385
12.2	Waste Characteristics	386
12.2.1	Solid Wastes	387
12.2.2	Liquid Wastes	387
12.2.3	Gaseous Wastes	387
12.3	Wastewater Processing Technology	387
12.4	Resource Recovery From Food Processing Wastes	388
12.5	Environmental Impact of Packaging Wastes	389
12.5.1	Packaging Minimisation	389
12.5.2	Packaging Materials Recycling	390
12.6	Refrigerents	392
12.7	Energy Issues Related to Environment	394
12.8	Life Cycle Assessment	396
	References	397
13	Water and Waste Treatment	399
	<i>R. Andrew Wilbey</i>	
13.1	Introduction	399
13.2	Fresh Water	399
13.2.1	Primary Treatment	400
13.2.2	Aeration	401
13.2.3	Coagulation, Flocculation and Clarification	401
13.2.4	Filtration	403
13.2.5	Disinfection	406
13.2.5.1	Chlorination	406
13.2.5.2	Ozone	408
13.2.6	Boiler Waters	409
13.2.7	Refrigerant Waters	410
13.3	Waste Water	410
13.3.1	Types of Waste from Food Processing Operations	411
13.3.2	Physical Treatment	412
13.3.3	Chemical Treatment	413
13.3.4	Biological Treatments	413
13.3.4.1	Aerobic Treatment – Attached Films	414
13.3.4.2	Aerobic Treatment – Suspended Biomass	417
13.3.4.3	Aerobic Treatment – Low Technology	419
13.3.4.4	Anaerobic Treatments	419
13.3.4.5	Biogas Utilisation	424
13.4	Sludge Disposal	425
13.5	Final Disposal of Waste Water	425
	References	426

14	Separations in Food Processing	429
	<i>James G. Brennan, Alistair S. Grandison and Michael J. Lewis</i>	
14.1	Introduction	429
14.1.1	Separations from Solids	430
14.1.1.1	Solid-Solid Separations	430
14.1.1.2	Separation From a Solid Matrix	430
14.1.2	Separations From Liquids	430
14.1.2.1	Liquid-Solid Separations	431
14.1.2.2	Immiscible Liquids	431
14.1.2.3	General Liquid Separations	431
14.1.3	Separations From Gases and Vapours	432
14.2	Solid-Liquid Filtration	432
14.2.1	General Principles	432
14.2.2	Filter Media	434
14.2.3	Filter Aids	434
14.2.4	Filtration Equipment	435
14.2.4.1	Pressure Filters	435
14.2.4.2	Vacuum Filters	439
14.2.4.3	Centrifugal Filters (Filtering Centrifugals, Basket Centrifuges)	440
14.2.5	Applications of Filtration in Food Processing	442
14.2.5.1	Edible Oil Refining	442
14.2.5.2	Sugar Refining	442
14.2.5.3	Beer Production	443
14.2.5.4	Wine Making	443
14.3	Centrifugation	444
14.3.1	General Principles	444
14.3.1.1	Separation of Immiscible Liquids	444
14.3.1.2	Separation of Insoluble Solids from Liquids	446
14.3.2	Centrifugal Equipment	447
14.3.2.1	Liquid-Liquid Centrifugal Separators	447
14.3.2.2	Solid-Liquid Centrifugal Separators	448
14.3.3	Applications for Centrifugation in Food Processing	450
14.3.3.1	Milk Products	450
14.3.3.2	Edible Oil Refining	451
14.3.3.3	Beer Production	451
14.3.3.4	Wine Making	451
14.3.3.5	Fruit Juice Processing	451
14.4	Solid-Liquid Extraction (Leaching)	452
14.4.1	General Principles	452
14.4.2	Extraction Equipment	455
14.4.2.1	Single-Stage Extractors	455
14.4.2.2	Multistage Static Bed Extractors	456
14.4.2.3	Multistage Moving Bed Extractors	457
14.4.3	Applications for Solid-Liquid Extraction in Food Processing	459
14.4.3.1	Edible Oil Extraction	459

14.4.3.2	Extraction of Sugar from Sugar Beet	459
14.4.3.3	Manufacture of Instant Coffee	459
14.4.3.4	Manufacture of Instant Tea	460
14.4.3.5	Fruit and Vegetable Juice Extraction	460
14.4.4	The Use of Supercritical Carbon Dioxide as a Solvent	460
14.5	Distillation	462
14.5.1	General Principles	462
14.5.2	Distillation Equipment	466
14.5.2.1	Pot Stills	466
14.5.2.2	Continuous Distillation (Fractionating) Columns	466
14.5.3	Applications of Distillation in Food Processing	467
14.5.3.1	Manufacture of Whisky	467
14.5.3.2	Manufacture of Neutral Spirits	469
14.6	Crystallisation	471
14.6.1	General Principles	471
14.6.1.1	Crystal Structure	471
14.6.1.2	The Crystallisation Process	471
14.6.2	Equipment Used in Crystallisation Operations	475
14.6.3	Food Industry Applications	476
14.6.3.1	Production of Sugar	476
14.6.3.2	Production of Salt	477
14.6.3.3	Salad Dressings and Mayonnaise	477
14.6.3.4	Margarine and Pastry Fats	477
14.6.3.5	Freeze Concentration	477
14.7	Membrane Processes	478
14.7.1	Introduction	478
14.7.2	Terminology	479
14.7.3	Membrane Characteristics	480
14.7.4	Flux Rate	481
14.7.5	Transport Phenomena and Concentration Polarisation	481
14.7.6	Membrane Equipment	483
14.7.7	Membrane Configuration	483
14.7.8	Safety and Hygiene Considerations	486
14.7.9	Applications for Reverse Osmosis	488
14.7.9.1	Milk Processing	488
14.7.9.2	Other Foods	489
14.7.10	Applications for Nanofiltration	489
14.7.11	Applications for Ultrafiltration	490
14.7.11.1	Milk Products	490
14.7.11.2	Oilseed and Vegetable Proteins	492
14.7.11.3	Animal Products	492
14.7.12	Applications for Microfiltration	493
14.8	Ion Exchange	495
14.8.1	General Principles	495
14.8.2	Ion Exchange Equipment	497

- 14.8.3 Applications of Ion Exchange in the Food Industry 500
- 14.8.3.1 Softening and Demineralisation 500
- 14.8.3.2 Decolourisation 502
- 14.8.3.3 Protein Purification 502
- 14.8.3.4 Other Separations 503
- 14.8.4 Conclusion 504
- 14.9 Electro dialysis 504
- 14.9.1 General Principles and Equipment 504
- 14.9.2 Applications for Electro dialysis 506
- References 507

- 15 Mixing, Emulsification and Size Reduction 513**
James G. Brennan
- 15.1 Mixing (Agitation, Blending) 513
- 15.1.1 Introduction 513
- 15.1.2 Mixing of Low and Moderate Viscosity Liquids 513
- 15.1.2.1 Paddle Mixer 515
- 15.1.2.2 Turbine Mixer 515
- 15.1.2.3 Propeller Mixer 516
- 15.1.3 Mixing of High Viscosity Liquids, Pastes and Plastic Solids 517
- 15.1.3.1 Paddle Mixers 519
- 15.1.3.2 Pan (Bowl, Can) Mixers 519
- 15.1.3.3 Kneaders (Dispersers, Masticators) 519
- 15.1.3.4 Continuous Mixers for Pastelike Materials 519
- 15.1.3.5 Static Inline Mixers 520
- 15.1.4 Mixing Dry, Particulate Solids 520
- 15.1.4.1 Horizontal Screw and Ribbon Mixers 521
- 15.1.4.2 Vertical Screw Mixers 522
- 15.1.4.3 Tumbling Mixers 522
- 15.1.4.4 Fluidised Bed Mixers 523
- 15.1.5 Mixing of Gases and Liquids 523
- 15.1.6 Applications for Mixing in Food Processing 524
- 15.1.6.1 Low Viscosity Liquids 524
- 15.1.6.2 Viscous Materials 524
- 15.1.6.3 Particulate Solids 524
- 15.1.6.4 Gases into Liquids 524
- 15.2 Emulsification 524
- 15.2.1 Introduction 524
- 15.2.2 Emulsifying Agents 526
- 15.2.3 Emulsifying Equipment 527
- 15.2.3.1 Mixers 527
- 15.2.3.2 Pressure Homogenisers 528
- 15.2.3.3 Hydroshear Homogenisers 530
- 15.2.3.4 Microfluidisers 530
- 15.2.3.5 Membrane Homogenisers 530

15.2.3.6	Ultrasonic Homogenisers	530
15.2.3.7	Colloid Mills	531
15.2.4	Examples of Emulsification in Food Processing	532
15.2.4.1	Milk	532
15.2.4.2	Ice Cream Mix	533
15.2.4.3	Cream Liqueurs	533
15.2.4.4	Coffee/Tea Whiteners	533
15.2.4.5	Salad Dressings	534
15.2.4.6	Meat Products	534
15.2.4.7	Cake Products	535
15.2.4.8	Butter	535
15.2.4.9	Margarine and Spreads	536
15.3	Size Reduction (Crushing, Comminution, Grinding, Milling) of Solids	537
15.3.1	Introduction	537
15.3.2	Size Reduction Equipment	540
15.3.2.1	Some Factors to Consider When Selecting Size Reduction Equipment	540
15.3.2.2	Roller Mills (Crushing Rolls)	541
15.3.2.3	Impact (Percussion) Mills	544
15.3.2.4	Attrition Mills	546
15.3.2.5	Tumbling Mills	548
15.3.3	Examples of Size Reduction of Solids in Food Processing	550
15.3.3.1	Cereals	550
15.3.3.2	Chocolate	552
15.3.3.3	Coffee Beans	554
15.3.3.4	Oil Seeds and Nuts	554
15.3.3.5	Sugar Cane	555
	References	556
	Subject Index	559

Preface

There are many excellent texts available which cover the fundamentals of food engineering, equipment design, modelling of food processing operations etc. There are also several very good works in food science and technology dealing with the chemical composition, physical properties, nutritional and microbiological status of fresh and processed foods. This work is an attempt to cover the middle ground between these two extremes. The objective is to discuss the technology behind the main methods of food preservation used in today's food industry in terms of the principles involved, the equipment used and the changes in physical, chemical, microbiological and organoleptic properties that occur during processing. In addition to the conventional preservation techniques, new and emerging technologies, such as high pressure processing and the use of pulsed electric field and power ultrasound are discussed. The materials and methods used in the packaging of food, including the relatively new field of active packaging, are covered. Concerns about the safety of processed foods and the impact of processing on the environment are addressed. Process control methods employed in food processing are outlined. Treatments applied to water to be used in food processing and the disposal of wastes from processing operations are described.

Chapter 1 covers the postharvest handling and transport of fresh foods and preparatory operations, such as cleaning, sorting, grading and blanching, applied prior to processing. Chapters 2, 3 and 4 contain up-to-date accounts of heat processing, evaporation, dehydration and freezing techniques used for food preservation. In Chapter 5, the potentially useful, but so far little used process of irradiation is discussed. The relatively new technology of high pressure processing is covered in Chapter 6, while Chapter 7 explains the current status of pulsed electric field, power ultrasound, and other new technologies. Recent developments in baking, extrusion cooking and frying are outlined in Chapter 8. Chapter 9 deals with the materials and methods used for food packaging and active packaging technology, including the use of oxygen, carbon dioxide and ethylene scavengers, preservative releasers and moisture absorbers. In Chapter 10, safety in food processing is discussed and the development, implementation and maintenance of HACCP systems outlined. Chapter 11 covers the various types of control systems applied in food processing. Chapter 12 deals with envi-

ronmental issues including the impact of packaging wastes and the disposal of refrigerants. In Chapter 13, the various treatments applied to water to be used in food processing are described and the physical, chemical and biological treatments applied to food processing wastes are outlined. To complete the picture, the various separation techniques used in food processing are discussed in Chapter 14 and Chapter 15 covers the conversion operations of mixing, emulsification and size reduction of solids.

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James G. Brennan

List of Contributors

Dr. Araya Ahromrit

Assistant Professor
Department of Food Technology
Khon Kaen University
Khon Kaen 40002
Thailand

Professor Paul Ainsworth

Department of Food and Consumer
Technology
Manchester Metropolitan University
Old Hall Lane
Manchester, M14 6HR
UK

Professor Dr. Ing. Ali Abd El-Aal Bakr

Food Science and Technology
Department
Faculty of Agriculture
Minufiya University
Shibin El-Kom
A. R. Egypt

Dr. Pedro Bouchon

Departamento de Ingeniera Química
y Bioprocesos
Pontificia Universidad Católica
de Chile
Vicuña Mackenna 4860
Macul
Santiago
Chile

Mr. James G. Brennan (Editor)

16 Benning Way
Wokingham
Berkshire, RG40 1XX
UK

Dr. Brian P.F. Day

Program Leader –
Minimal Processing & Packaging
Food Science Australia
671 Sneydes Road (Private Bag 16)
Werribee
Victoria 3030
Australia

Dr. Bogdan J. Dobraszczyk

School of Food Biosciences
The University of Reading
P.O. Box 226
Whiteknights
Reading, RG6 6AP
UK

Dr. Alistair S. Grandison

School of Food Biosciences
The University of Reading
P.O. Box 226
Whiteknights
Reading, RG6 6AP
UK

Dr. Senol Ibanoglu

Department of Food Engineering
Gaziantep University
Kilis Road
27310 Gaziantep
Turkey

Dr. Ashok Khare

School of Food Biosciences
The University of Reading
P.O. Box 226
Whiteknights
Reading, RG6 6AP
UK

Mr. Craig E. Leadley

Campden & Chorleywood
Food Research Association
Food Manufacturing Technologies
Chipping Campden
Gloucestershire, GL55 6LD
UK

Professor Dave A. Ledward

School of Food Biosciences
The University of Reading
Whiteknights
Reading, RG6 6AP
UK

Dr. Michael J. Lewis

School of Food Biosciences
The University of Reading
P.O. Box 226
Whiteknights
Reading, RG6 6AP
UK

Mrs. Niharika Mishra

School of Food Biosciences
The University of Reading
P.O. Box 226
Whiteknights
Reading, RG6 6AP
UK

Professor Keshavan Niranjan

School of Food Biosciences
The University of Reading
P.O. Box 226
Whiteknights
Reading, RG6 6AP
UK

Dr. Jose Mauricio Pardo

Director
Ingenieria de Produccion
Agroindustrial
Universidad de la Sabana
A.A. 140013
Chia
Columbia

Dr. Margaret F. Patterson

Queen's University, Belfast
Department of Agriculture and Rural
Development
Agriculture and Food Science Center
Newforge Lane
Belfast, BT9 5PX
Northern Ireland
UK

Mr. Nigel Rogers

Avure Technologies AB
Quintusvägen 2
Vasteras, SE 72166
Sweden

Mrs. Carol Anne Wallace

Principal Lecturer
Food Safety Management
Lancashire School of Health
& Postgraduate Medicine
University of Central Lancashire
Preston, PR1 2HE
UK

Mr. R. Andrew Wilbey

School of Food Biosciences
The University of Reading
P.O. Box 226
Whiteknights
Reading, RG6 6AP
UK

Dr. Alan Williams

Senior Technologist & HACCP
Specialist
Department of Food Manufacturing
Technologies
Campden & Chorleywood Food
Research Association Group
Chipping Campden
Gloucestershire, GL55 6LD
UK

1

Postharvest Handling and Preparation of Foods for Processing

Alistair S. Grandison

1.1

Introduction

Food processing is seasonal in nature, both in terms of demand for products and availability of raw materials. Most crops have well established harvest times – for example the sugar beet season lasts for only a few months of the year in the UK, so beet sugar production is confined to the autumn and winter, yet demand for sugar is continuous throughout the year. Even in the case of raw materials which are available throughout the year, such as milk, there are established peaks and troughs in volume of production, as well as variation in chemical composition. Availability may also be determined by less predictable factors, such as weather conditions, which may affect yields, or limit harvesting. In other cases demand is seasonal, for example ice cream or salads are in greater demand in the summer, whereas other foods are traditionally eaten in the winter months, or even at more specific times, such as Christmas or Easter.

In an ideal world, food processors would like a continuous supply of raw materials, whose composition and quality are constant, and whose prices are predictable. Of course this is usually impossible to achieve. In practice, processors contract ahead with growers to synchronise their needs with raw material production. The aim of this chapter is to consider the properties of raw materials in relation to food processing, and to summarise important aspects of handling, transport, storage and preparation of raw materials prior to the range of processing operations described in the remainder of this book. The bulk of the chapter will deal with solid agricultural products including fruits, vegetables, cereals and legumes; although many considerations can also be applied to animal-based materials such as meat, eggs and milk.

1.2

Properties of Raw Food Materials and Their Susceptibility to Deterioration and Damage

The selection of raw materials is a vital consideration to the quality of processed products. The quality of raw materials can rarely be improved during processing and, while sorting and grading operations can aid by removing oversize, under-size or poor quality units, it is vital to procure materials whose properties most closely match the requirements of the process. Quality is a wide-ranging concept and is determined by many factors. It is a composite of those physical and chemical properties of the material which govern its acceptability to the 'user'. The latter may be the final consumer, or more likely in this case, the food processor. Geometric properties, colour, flavour, texture, nutritive value and freedom from defects are the major properties likely to determine quality.

An initial consideration is selection of the most suitable cultivars in the case of plant foods (or breeds in the case of animal products). Other preharvest factors (such as soil conditions, climate and agricultural practices), harvesting methods and postharvest conditions, maturity, storage and postharvest handling also determine quality. These considerations, including seed supply and many aspects of crop production, are frequently controlled by the processor or even the retailer.

The timing and method of harvesting are determinants of product quality. Manual labour is expensive, therefore mechanised harvesting is introduced where possible. Cultivars most suitable for mechanised harvesting should mature evenly producing units of nearly equal size that are resistant to mechanical damage. In some instances, the growth habits of plants, e.g. pea vines, fruit trees, have been developed to meet the needs of mechanical harvesting equipment. Uniform maturity is desirable as the presence of over-mature units is associated with high waste, product damage, and high microbial loads, while under-maturity is associated with poor yield, hard texture and a lack of flavour and colour. For economic reasons, harvesting is almost always a 'once over' exercise, hence it is important that all units reach maturity at the same time. The prediction of maturity is necessary to coordinate harvesting with processors' needs as well as to extend the harvest season. It can be achieved primarily from knowledge of the growth properties of the crop combined with records and experience of local climatic conditions. The 'heat unit system', first described by Seaton [1] for peas and beans, can be applied to give a more accurate estimate of harvest date from sowing date in any year. This system is based on the premise that growth temperature is the overriding determinant of crop growth. A base temperature, below which no growth occurs, is assumed and the mean temperature of each day through the growing period is recorded. By summing the daily mean temperatures minus base temperatures on days where mean temperature exceeds base temperature, the number of 'accumulated heat units' can be calculated. By comparing this with the known growth data for the particular cultivar, an accurate prediction of harvest date can be computed. In addition, by allowing