
Contents

<i>Preface</i>	xi
<i>Contributors</i>	xiii
<i>Abbreviations</i>	xvii
1 Traditional and Emerging Feedstocks for Food and Industrial Bioproduct Manufacturing	1
Nurhan Turgut Dunford	
1.1 Introduction	1
1.2 Grain crops	2
1.2.1 Wheat	2
1.2.2 Corn	5
1.2.3 Barley	8
1.2.4 Sorghum	10
1.3 Oil and oilseeds	13
1.3.1 Rapeseed/Canola	14
1.3.2 Soybeans	15
1.3.3 Other Oilseeds	19
1.4 Lignocellulosic biomass	24
1.5 Conclusions	25
References	26
2 Recent Processing Methods for Preparing Starch-based Bioproducts	37
George F. Fanta, Frederick C. Felker and Randal L. Shogren	
2.1 Introduction	37
2.2 Annealing and heat–moisture treatment	40
2.3 High-pressure treatment	41
2.4 Microwave processing	46
2.5 Processes using ultrasound	50
2.6 Processing using supercritical fluids	56
2.7 Extrusion processing	63
2.8 Processing by steam jet cooking	67
2.9 Conclusions	71
References	72

3 Protein Processing in Food and Bioproduct Manufacturing and Techniques for Analysis	85
Joyce Irene Boye and Chockry Barbana	
3.1 Introduction	85
3.2 General properties of proteins	86
3.3 Protein separation processes in food and bioproduct manufacturing	87
3.3.1 Dry processing	88
3.3.2 Wet processing	89
3.4 Calculating protein yields and recovery	101
3.5 Processing effects on yield and protein quality	101
3.5.1 Protein characterization	102
3.6 Conclusion	108
References	108
 4 Advancements in Oil and Oilseed Processing	 115
Nurhan Turgut Dunford	
4.1 Introduction	115
4.2 Oilseed pretreatment	116
4.2.1 Handling and storage	116
4.2.2 Preparation of seeds for oil extraction	117
4.2.3 Size reduction and flaking	118
4.2.4 Cooking/Tempering	118
4.3 Oil extraction	119
4.3.1 Solvent extraction	119
4.3.2 Mechanical oil expression	122
4.3.3 Aqueous extraction	124
4.3.4 Enzyme and surfactant-aided oil extraction	124
4.3.5 Supercritical fluid technology	126
4.4 Oil refining	127
4.4.1 Degumming	127
4.4.2 Deacidification/Refining	131
4.4.3 Bleaching	135
4.4.4 Deodorization	136
4.4.5 Winterization	137
4.5 Conclusions	137
References	138
 5 Food-grade Microemulsions As Nano-scale Controlled Delivery Vehicles	 145
Natasha Berry, Rickey Yada and D��rick Rousseau	
5.1 Introduction	145
5.2 Winsor classification/phase behavior	146
5.3 Theories of microemulsion formation	147
5.3.1 Mixed film theory	147
5.3.2 Solubilization theory	147
5.3.3 Thermodynamic theory	147
5.4 What makes microemulsions thermodynamically stable?	148
5.5 Methods of microemulsion formation	148
5.6 Polydispersity	149

5.7	Composition	149
5.7.1	Organic phase	149
5.7.2	Aqueous phase	150
5.7.3	Surfactants	150
5.7.4	Co-surfactants	151
5.8	Factors affecting phase behavior	151
5.9	Parameters that modify microemulsion structure	152
5.9.1	Critical micelle concentration	152
5.9.2	Critical packing parameter	152
5.9.3	Hydrophile–lipophile balance	153
5.9.4	Ingredient compatibility	153
5.10	Characterization techniques	154
5.10.1	Ternary phase diagrams	154
5.10.2	Small angle scattering techniques	155
5.10.3	Cryo-transmission electron microscopy	156
5.10.4	Dynamic light scattering	157
5.10.5	Nuclear magnetic resonance	158
5.11	Applications	158
5.11.1	Solubilization of poorly-soluble drugs	158
5.11.2	Emulsified microemulsions	159
5.11.3	Protection against oxidation/light	159
5.11.4	Controlled release delivery systems	159
5.11.5	Microemulsions as nano-reactors	160
5.12	Conclusions	160
	References	161
6	Emulsions, Nanoemulsions and Solid Lipid Nanoparticles as Delivery Systems in Foods	167
	Umut Yucel, Ryan J. Elias and John N. Coupland	
6.1	Delivery systems in foods	167
6.2	Structure of emulsions	168
6.3	Localization of BLI in emulsions	169
6.4	Emulsions as delivery systems	172
6.5	Crystallization in emulsions	174
6.5.1	Kinetics of crystallization in fine droplets	175
6.5.2	Structure of crystalline fat droplets	177
6.6	Localization of BLI in solid lipid nanoparticles	178
6.7	Conclusions	180
	Acknowledgement	181
	References	181
7	Fermentation	185
	Mark R. Wilkins and Hasan Atiyeh	
7.1	Introduction	185
7.2	Fermentative pathways	186
7.3	Microbial growth	188
7.4	Reactor design	189
7.4.1	Types of reactors	190

7.5	Fermentation schemes	194
7.5.1	Batch fermentation	194
7.5.2	Fed-batch fermentation	194
7.5.3	Continuous fermentation	194
7.6	Fermentation Products	195
7.6.1	Acetone–Butanol–Ethanol (ABE) fermentation	195
7.6.2	Glycerol	196
7.6.3	Propionate	197
7.6.4	Succinate	197
7.6.5	1,3 Propanediol	197
7.6.6	Butanediol	198
7.7	Separation	199
7.7.1	Separation of acids	199
7.7.2	Separation of alcohols	199
7.7.3	Separation of diols and triols	200
7.8	Future application areas and emerging developments	200
	References	201
8	Fungal Cell Factories	205
	Sue A. Karagiosis and Scott E. Baker	
8.1	Fungi and fungal biotechnology	205
8.2	Historical perspective	206
8.2.1	Koji	206
8.2.2	Penicillin	207
8.2.3	Citric acid	208
8.3	Industry	208
8.3.1	Organic acids	208
8.3.2	Enzymes	211
8.3.3	Lovastatin	211
8.4	Genomics and the future	213
8.4.1	Citric acid and <i>Aspergillus niger</i>	213
8.4.2	Cellulase production	214
8.4.3	Bioactive secondary metabolites	215
8.5	Conclusions	215
	References	216
9	Microalgae: A Renewable Source of Bioproducts	221
	Susan I. Blackburn and John K. Volkman	
9.1	Introduction	221
9.2	Microalgae and their global importance	221
9.3	Cultured microalgae	223
9.4	Algal culture collections	224
9.5	Microalgal production systems	225
9.5.1	Plastic bags and tanks	225
9.5.2	Open ponds	225
9.5.3	Photobioreactors	226
9.5.4	Hybrid or combination growth systems	227
9.5.5	Fermentation systems	227

9.6	Historical natural foods	228
9.7	Live feedstocks for aquaculture	228
9.8	Bioproducts	229
9.8.1	Bioactive compounds	229
9.8.2	Lipids	230
9.8.3	Proteins and carbohydrates	233
9.8.4	Vitamins and antioxidants	233
9.8.5	Pigments	234
9.9	Pharmaceuticals	235
9.10	Microalgae in cosmetics and skin care	236
9.11	Microalgae bioproducts: Future potential	236
	References	237
10	Bioprocessing Approaches to Synthesize Bio-based Surfactants and Detergents	243
	Douglas G. Hayes	
10.1	Bio-based surfactants: Overview	243
10.2	Feedstocks for bio-based surfactants	244
10.3	Industrial bio-based surfactants	246
10.4	Advantages of bioprocessing to prepare bio-based non-ionic surfactants	248
10.5	Preparation of bio-based surfactants via enzymes in non-aqueous media	249
10.5.1	Lipase-catalyzed synthesis of monoacylglycerols (MAGs)	251
10.5.2	Lipase-catalyzed synthesis of saccharide–fatty acid esters	252
10.5.3	Lipase-catalyzed synthesis of polyglycerol polyricinoleate	254
10.5.4	Enzyme-catalyzed synthesis of alkylpolyglucosides (APGs)	254
10.5.5	Enzyme-catalyzed synthesis of amino acid derivatives	255
10.5.6	Enzymatic production of lysophospholipids and structured phospholipids	256
10.6	Preparation of biosurfactants via fermentation	258
10.7	Conclusions	261
	References	262
11	Biopolymers	267
	Oğuz Türlüç and Michael A. R. Meier	
11.1	Introduction	267
11.2	Carbohydrate-based polymers	267
11.2.1	Polymers from starch	267
11.2.2	Polymers from cellulose	270
11.2.3	Polymers from lactic acid and lactide	272
11.2.4	Polyhydroxyalkanoates	275
11.2.5	Polymers from chitin or chitosan	276
11.3	Fat- and oil-based polymers	277
11.3.1	Polymers from triglycerides	277
11.3.2	Polymers from fatty acids	282
11.4	Conclusion	286
	References	286

12	Lignocellulosic Biomass Processing	293
	Fei Yu and Jonathan Y. Chen	
12.1	Introduction	293
12.2	Availability of lignocellulosic biomass	293
12.2.1	Southern pine wood	294
12.2.2	Corn stover	295
12.2.3	Bast fiber crops	295
12.2.4	Other lignocellulosic feedstocks	296
12.3	Processing	297
12.3.1	Biological conversion	297
12.3.2	Thermochemical conversion	297
12.3.3	Bast fiber production	305
	References	308
13	Recent Developments in Non-thermal Processess	313
	Fernando Sampedro and Howard Q. Zhang	
13.1	Introduction	313
13.2	Recent advances in non-thermal technologies	314
13.2.1	High Pressure Processing (HPP)	314
13.2.2	Ultra High Pressure Homogenization (UHPH)	315
13.2.3	High Pressure Carbon Dioxide (HPCD)	317
13.2.4	Pulsed Electric Fields (PEF)	318
13.2.5	Ultraviolet Light (UV)	320
13.2.6	Irradiation	321
13.2.7	High Intensity Ultrasounds	323
13.2.8	Hurdle approach	324
13.3	Future trends	325
	Acknowledgements	325
	References	326
14	Enzymes as Biocatalysts for Lipid-based Bioproducts Processing	333
	Ling-Zhi Cheong, Zheng Guo, Sergey N. Fedosov, Bena-Marie Lue, Ram C.R. Jala, Gündüz Güzel, and Xuebing Xu	
14.1	Introduction	333
14.2	Enzyme characteristics	333
14.3	Enzyme kinetics in industrial applications	334
14.4	Enzymes in industrial applications	338
14.4.1	Enzymatic processing of partial acylglycerols	339
14.4.2	Enzymatic processing of bioactive compounds	343
14.4.3	Enzymatic processing of phospholipids	346
14.4.4	Enzymatic processing of fatty acid alkyl esters	348
14.5	Conclusions and future trends	351
	References	353