Contents

	Contributors Preface			
1 /	ejuce		xvii	
1	Dairy Protein Powders P. Schuck			
	1.1	Introduction	3	
	1.2	Extraction of Milk Proteins	5	
		1.2.1 Milk proteins	5	
		1.2.2 Separation of proteins	5 5	
		1.2.3 Pretreatment of milk	6	
	1.3	Drying Principles	10	
		1.3.1 Roller drying	10	
		1.3.2 Spray drying and fluid bed drying/cooling	11	
	1.4	Drying of Dairy Proteins	17	
		1.4.1 Heat treatment	17	
		1.4.2 Water transfer	18	
		1.4.3 Energy consumption	18	
	1.5	Powder Properties	20	
		1.5.1 Powder structure	20	
		1.5.2 Particle size distribution	20	
		1.5.3 Powder density	20	
		1.5.4 Flowability	21	
		1.5.5 Rehydration of dairy protein powders	22	
	1.6	Conclusion	25	
2		ose: Chemistry, Processing, and Utilization Hourigan, E.V. Lifran, L.T.T. Vu, Y. Listiohadi, and R.W. Sleigh	31	
	2.1	Introduction	31	
	2.2	Forms and Properties of Lactose	32	
		2.2.1 Types of lactose	33	
		2.2.2 Mutarotation	38	
		2.2.3 Solubility and supersaturation	38	
		2.2.4 Properties of lactose crystals	42	

	2.3 Manufacture of Lactose		43
		2.3.1 Industrial processes for α-lactose monohydrate	44
		2.3.2 Creation of amorphous lactose during the α -lactose	
		monohydrate manufacturing process	47
		2.3.3 Crystallization theory and research trends	48
		2.3.4 Effect of impurities on lactose crystal growth	51
	2.4	Effect of Moisture on Lactose in the Solid State	53
		2.4.1 Moisture-induced crystallization of amorphous lactose	53
		2.4.2 Effect of moisture on the crystalline forms of lactose	56
		2.4.3 Effect of moisture and amorphous lactose content in	
		lactose-rich dairy powders	57
	2.5	Lactose Applications	58
	2.6	Summary	60
3	Dairy	Ingredients Containing Milk Fat Globule Membrane:	
	Desci	ription, Composition, and Industrial Potential	71
	X. El	ías-Argote, A. Laubscher, and R. Jiménez-Flores	
	3.1	Introduction	71
	3.2	Origin and Function of the MFGM	73
	3.3	Composition and Structure of the MFGM	75
		3.3.1 Lipids of the milk fat globule membrane	76
		3.3.2 Milk fat globule membrane proteins	79
	3.4	Health Benefits of the Milk Fat Globule Membrane	83
		3.4.1 Anticancer properties of MFGM	83
		3.4.2 Antimicrobial and antiviral properties of the MFGM	84
		3.4.3 MFGM and lactic acid bacteria binding	84
	3.5	Technical Aspects and Foods Based on MFGM	85
		3.5.1 Emulsifying and stabilizing properties of MFGM	85
		3.5.2 Potential delivery systems derived from MFGM	86
		3.5.3 MFGM components as part of food systems	86
		3.5.4 Isolation of the MFGM	87 88
	3.6	MFGM: A Novel Product from Dairy Products	
	3.7	3.7 Methodology to Monitor the Biological Activity of the MFGM	
		Before and After Processing	90
		3.7.1 Atomic force microscopy	90
		3.7.2 Confocal laser scanning microscopy	90
	2.0	3.7.3 Laser tweezers and the MFGM	91
	3.8	The Future of MFGM and Its Components	92
4	Biofu	unctional Dairy Protein Fractions	99
	H. Roginski, L. Bennett, H. Korhonen, S.F. Gauthier, Y. Pouliot,		
	and I	3.W. Woonton	
	4.1	Introduction	99
	4.2	Physiologically Active Peptides from Milk	99
		4.2.1 Antihypertensive peptides	100
		4.2.2 Biological role of antithrombotic peptides	101

		4.2.3 Biological role of immunomodulatory peptides	102			
		4.2.4 Biological role of opioid receptor-binding peptides	103			
		4.2.5 Biological role of metal-binding peptides	104			
		4.2.6 Conclusions	105			
	4.3	Antimicrobial and Antiviral Effects of Milk Proteins and Peptides	105			
		4.3.1 Antimicrobial proteins	106			
		4.3.2 Antimicrobial peptides	110			
		4.3.3 Antiviral proteins and peptides from milk	114			
		4.3.4 Conclusions	116			
	4.4	Immunoglobulins	116			
		4.4.1 Structure	117			
		4.4.2 Recovery and purification	117			
		4.4.3 Biological effects	118			
	4.5	Milk Growth Factors	118			
		4.5.1 Composition and characteristics	119			
		4.5.2 Methods for extracting growth factors	119			
		4.5.3 Health benefits of milk growth factors	122			
		4.5.4 Future developments	123			
	4.6	Glycomacropeptide	123			
		4.6.1 Structure	123			
		4.6.2 Physiological effects in humans and animals	125			
		4.6.3 Future developments	126			
5	Modern Chromatographic Separation Technologies for Isolation of					
	Dairy Ingredients					
	•	Woonton, U. Kulozik, K. De Silva, and G.W. Smithers				
	5.1	Introduction				
	5.2	5.2 Isolation of Dairy Components Using				
			137			
			137 138			
		Isolation of Dairy Components Using				
		Isolation of Dairy Components Using Resin-Based Chromatography	138			
		Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware	138 138			
		Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry	138 138			
	5.3	Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC)	138 138 141 145 148			
		Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description	138 138 141 145 148 148			
		Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC	138 138 141 145 148 148 151			
		Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode	138 138 141 145 148 148 151 154			
	5.3	Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode 5.3.4 Processing scheme for the separation of CMP	138 138 141 145 148 148 151 154 156			
		Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode	138 138 141 145 148 148 151 154			
6	5.3	 Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode 5.3.4 Processing scheme for the separation of CMP Conclusions 	138 138 141 145 148 148 151 154 156			
6	5.3 5.4 Nont	Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode 5.3.4 Processing scheme for the separation of CMP	138 138 141 145 148 148 151 154 156 156			
6	5.3 5.4 Nont	Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode 5.3.4 Processing scheme for the separation of CMP Conclusions hermal Technologies in Dairy Processing	138 138 141 145 148 148 151 154 156 156			
6	5.3 5.4 Nonti	Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode 5.3.4 Processing scheme for the separation of CMP Conclusions hermal Technologies in Dairy Processing Deeth, N. Datta, and C. Versteeg	138 138 141 145 148 148 151 154 156 156			
6	5.3 5.4 Nont H.C.	Isolation of Dairy Components Using Resin-Based Chromatography 5.2.1 Chromatographic hardware 5.2.2 Chromatographic adsorbents 5.2.3 Commercial applications of resin chromatography in the dairy industry Membrane Adsorption Chromatography (MAC) 5.3.1 Principles of MAC technology and technical description 5.3.2 Separation of aCMP and gCMP by means of MAC 5.3.3 Separation of aCMP and gCMP in a direct capture mode 5.3.4 Processing scheme for the separation of CMP Conclusions hermal Technologies in Dairy Processing Deeth, N. Datta, and C. Versteeg Introduction	138 138 141 145 148 148 151 154 156 156			

		6.2.3 Effect on milk components	166
		6.2.4 Applications	172
	6.3	High Pressure Homogenization	177
		6.3.1 Principle	177
		6.3.2 Effect on milk components	178
		6.3.3 Effect on products	183
		6.3.4 Commercial developments	184
	6.4	Ultrasonication	184
		6.4.1 Principle	185
		6.4.2 Setup	185
		6.4.3 Effect on milk components	186
		6.4.4 Applications	189
		6.4.5 Commercial developments	192
	6.5	Pulsed Electric Field Technology	192
		6.5.1 Principle	193
		6.5.2 Effect on milk components	194
		6.5.3 Effects on products and processes	198
		6.5.4 Commercial developments	199
	6.6	Further Reading	200
7		y-Dried Dairy-Based Emulsions for the Delivery of Bioactives Augustin and L. Sanguansri	217
	7.1	Introduction	217
	7.2	Considerations for Delivery of Bioactives	218
	7.3	Spray-Dried Dairy-Based Emulsions	220
		7.3.1 Formulation and preparation of emulsions7.3.2 Spray drying of emulsions	221
	7.4	1 1 1 5	222
	7.4	Casein and Whey Protein-Based Spray-Dried Emulsions 7.4.1 Factors affecting physical stability	223
			223
	7.5	→	224
	7.6	Incorporation of Bioactive Ingredients into Functional Foods Conclusion	226 227
8		ing Dairy Protein Functionality in Food Microstructure Design olding	229
	8.1	Introduction	229
	8.2	Casein Functionality in Structured Foods	230
		8.2.1 Acid coagulation	231
		8.2.2 Enzymatic modification	232
		8.2.3 High pressure	236
		8.2.4 Mixed biopolymer effects	241
	8.3	Applications of Whey Protein Structuring	
		in Foods	250
	8.4	Milk Proteins as Emulsifiers	252
	8.5	Milk Proteins as Foaming Agents	258
	8.6	Conclusions	260

9	Probiotics and Prebiotics D.Y. Ying and C. Gantenbein-Demarchi			269	
	9.1	Introdu		269	
	9.2	Definit		270	
	9.3	Probio		271	
		9.3.1	Historical aspects	271	
		9.3.2	Overview of important probiotic strains	272	
		9.3.3	Health benefits	274	
		9.3.4	Safety assessments of probiotics	275	
		9.3.5	Consumer acceptance and product overview	276	
		9.3.6	Probiotic dairy products and the world market	277	
		9.3.7	Other probiotic food products and recent developments	278	
	0.4	9.3.8	Guidelines for the evaluation of probiotics for food use	278	
	9.4	Prebio		279	
	9.5		nges and Approaches for Probiotic Ingredients	281	
		9.5.1	Strain selection	282	
		9.5.2	Understanding the probiotic mechanism	283	
		9.5.3	Survival of probiotics	283	
		9.5.4	Microencapsulation of probiotics	285	
10	Dairy Ingredient Safety: The No Compromise Area D. Eddy and A. Astin				
	10.1	Introdu	action	291	
	10.2	Backg		292	
	10.3	_	Developments	292	
	10.4		sing Requirements	294	
	10.5		ds and Risks	294	
	10.6	RegulationMicrobiological EcologyFood Safety Programs and Food Safety Objectives			
	10.7				
	10.8				
	10.9				
	10.10				
	10.11	Conclu	usion	300	
11	Marko	et Accer	otance of Dairy Ingredients: What Consumers Are		
		_	Demanding	303	
	B. Davis and B. Katz				
	11.1		round: Recognition and Relevance Are Drivers of	202	
	11.2		mer Acceptance	303	
	11.2		er Interest in Select Functional Benefits	306	
		11.2.1	Cognitive performance	306	
		11.2.2		307	
		11.2.3	•	309	
	11.2	11.2.4		310	
	11.3	Concli	uding Remarks	311	

The Future of Dairy Ingredients: Critical Considerations That Will **Underpin Future Success** 313 P.S. Tong and G.W. Smithers Introduction 313 12.1 313 12.2 **Evolution of Dairy Ingredients** 314 "First-generation" dairy ingredients 315 12.2.2 "Second-generation" dairy ingredients 315 12.2.3 "Third-generation" dairy ingredients Next Generation of Dairy Ingredients 315 12.3 316 Verifiable dairy food quality and safety Optimal nutritional and functional performance 316 Sustainability, environment, and animal welfare 316 316 12.4 Conclusions

Index

319