

Contents

Preface to Technical Series	xi
Preface	xii
Contributors	xiii
1 Microbiota of the Human Gut	
B. O'GRADY AND G.R. GIBSON	
1.1 Background	1
1.2 The human gastrointestinal tract and its microbiota	1
1.3 Functions of the gastrointestinal microbiota	3
1.4 Influences on the GI tract and its microbiota	5
1.5 Beneficial microbiota: probiotics and health aspects	6
1.5.1 Enzymatic activity and improved digestion	7
1.5.2 <i>Clostridium difficile</i> -associated intestinal disease	7
1.5.3 Antibiotic-associated diarrhoea	8
1.5.4 Acute diarrhoea and gastroenteritis	8
1.5.5 Extra-intestinal applications	8
1.5.6 Other potential applications	9
1.5.7 Product considerations	9
1.5.8 Prebiotics	10
1.6 Conclusions	12
References	12
2 Genomic Characterisation of Starter Cultures	16
F. DELLAGLIO, G.E. FELIS, S. TORRIANI, K. SØRENSEN AND E. JOHANSEN	
2.1 Introduction	16
2.2 The 'Omic' approaches	17
2.2.1 Background	17
2.2.2 Exploration of genomic sequences	18
2.2.3 Tools for converting genomic sequences to biologically relevant information	19
2.2.4 What can genomics be used for?	20
Comparative genomics	20
Tracking of strains	20
Strain characterisation	21
Strain improvement	22
Safety assessment	22

3.5	Viability of probiotic micro-organisms	56
3.5.1	Composition of the fermentation medium	57
3.5.2	Viability as affected by oxygen	57
3.6	Methods to improve the viability of probiotic micro-organisms in the product	58
3.6.1	Selection of bacterial strain(s)	58
3.6.2	Type of packaging container	58
3.6.3	Rate of inoculation	59
3.6.4	Two-stage fermentation	59
3.6.5	Microencapsulation technique	60
3.6.6	Supplementation of the milk with nutrients	61
3.6.7	The use of oxygen scavengers	62
3.6.8	The addition of cysteine	62
3.7	Future developments	62
	References	63

4 Current Legislation of Probiotic Products

M. HICKEY

4.1	Introduction	73
4.2	The situation in the European Union (EU)	74
4.2.1	Relevant food safety legislation	74
4.2.2	The EU novel food application procedure	75
4.2.3	Simplified procedure/notification	76
4.2.4	Genetic modification	76
	Approval of GMOs	77
	Claims and labelling	77
4.2.5	Proposed health claim application procedure	78
4.2.6	EU Commission proposal for a regulation on yoghurt and yoghurt-like products	79
4.2.7	Use of the term 'Bio'	80
4.2.8	The UK market	80
4.3	The US situation	82
4.3.1	Food safety	83
4.3.2	Claims and labelling	83
4.4	The Japanese model	85
4.4.1	The process for obtaining FOSHU approval	86
4.4.2	Costs of approval	89
4.5	Codex Alimentarius	89
4.5.1	Background	89
4.5.2	Acceptance of Codex Standards and their role in the WTO	91
4.5.3	Codex and the issue of claims	92
4.5.4	Codex Standard for fermented milks	94
4.6	Conclusions and pointers to the future	94
	References	95

5 Enumeration and Identification of Mixed Probiotic and Lactic Acid Bacteria Starter Cultures	98
A.L. MCCARTNEY	
5.1 Introduction	98
5.2 Classic approaches to LAB enumeration and differentiation	98
5.3 Current approaches to LAB enumeration	100
5.3.1 Differential plating methods	100
5.3.2 Probing strategies	101
5.3.3 Quantitative PCR	102
5.4 Modern genetic approaches to LAB differentiation	103
5.4.1 Background	103
5.4.2 Pulsed-field gel electrophoresis (PFGE)	104
5.4.3 Ribotyping and amplified rDNA restriction analysis (ARDRA)	105
5.4.4 Amplified fragment length polymorphism (AFLP) analysis	107
5.4.5 Randomly amplified polymorphic DNA (RAPD)	108
5.4.6 PCR-typing	110
5.4.7 Gene sequencing	112
5.4.8 Denaturing gradient gel electrophoresis-PCR (DGGE-PCR)	112
5.4.9 Probing strategies	114
5.5 Discussion	115
References	115
6 Prebiotic Ingredients with Emphasis on Galacto-oligosaccharides and Fructo-oligosaccharides	120
F. ANGUS, S. SMART AND C. SHORTT	
6.1 Introduction	120
6.2 Classification of prebiotics	121
6.3 Prominence of prebiotics in FOSHU	122
6.4 Galacto-oligosaccharides as prebiotics	122
6.4.1 Technical aspects of GOS	122
6.4.2 Production of GOS	123
6.4.3 Characteristics of GOS	124
6.4.4 Health effects of GOS	125
6.5 Focus on FOS	128
6.5.1 Background	128
6.5.2 Technological production of FOS	129
6.5.3 Characteristics of FOS	129
6.5.4 Health effects of FOS	131
6.6 Conclusions	133
References	133
7 Health Claims Associated with Probiotics	138
G.A. O'MAY AND G.T. MACFARLANE	
7.1 Introduction	138
7.2 Probiotic use in GI tract conditions	139

7.2.1	Inflammatory bowel disease	139
	Crohn's disease	139
	Ulcerative colitis	141
7.2.2	Pouchitis	143
7.2.3	Irritable bowel syndrome	144
7.2.4	Antibiotic-associated diarrhoea and <i>Clostridium difficile</i>	146
7.2.5	Antibiotic-associated diarrhoea	148
7.2.6	<i>Clostridium difficile</i> -associated disease (CDAD)	150
7.2.7	Traveller's diarrhoea	151
7.2.8	Infant diarrhoea	153
7.3	Probiotic use in extra-gastrointestinal conditions	156
	7.3.1 Atopic dermatitis	156
	7.3.2 Bacterial vaginosis	158
7.4	Conclusion	159
	References	159
8	Production of Vitamins, Exopolysaccharides and Bacteriocins by Probiotic Bacteria	167
	E.B. O'CONNOR, E. BARRETT, G. FITZGERALD, C. HILL, C. STANTON AND R.P. ROSS	
8.1	Introduction	167
8.2	Vitamin production by lactic acid bacteria (LAB) and <i>Bifidobacterium</i> spp.	167
	8.2.1 Introduction	167
	8.2.2 Folate	168
	8.2.3 Vitamin B ₁₂ production	170
	8.2.4 Vitamin K production	170
	8.2.5 Riboflavin and thiamine	171
8.3	Exopolysaccharides (EPS) production by LAB and <i>Bifidobacterium</i> spp.	171
	8.3.1 Introduction	171
	8.3.2 Classification of EPS	172
	8.3.3 Health benefits of EPS	172
	Prebiotic effect of EPS	172
	Immunostimulatory activity of EPS	173
	Anti-tumoral activity of EPS	175
	EPS and blood cholesterol-lowering effects	176
	8.3.4 Genetic engineering for microbial production of EPS	176
8.4	Production of bacteriocins by probiotic cultures	176
	8.4.1 Introduction	176
	8.4.2 Production of antimicrobials as a probiotic trait	177
	8.4.3 Classification of bacteriocins	178
	Class I: Lantibiotics	178
	Class II: Bacteriocins	180
	Class III: Bacteriocins	181
	8.4.4 Antimicrobial potential of <i>Lactobacillus</i> spp.	181
	8.4.5 Antimicrobial potential of <i>Bifidobacterium</i> spp.	183
	8.4.6 Heterologous expression	184