

Contents

Preface	xi
Mohamed GHOUL	
Introduction	xiii
Mohamed GHOUL	
Part 1. Enzymatic Processes in the Food Industry	1
Introduction to Part 1.	3
Isabelle CHEVALOT	
Chapter 1. General Characteristics of Enzymes	5
Isabelle CHEVALOT, Mohamed GHOUL and Seraphim PAPANIKOLAOU	
1.1. Notion of catalysis.	5
1.2. Notion of specificity	7
1.3. Nomenclature	7
1.4. Mechanism of enzyme catalysis.	9
1.5. Single-substrate enzyme kinetics	11
1.6. Effects of the environment on activity	13
1.6.1. Effect of pH on enzyme activity	13
1.6.2. Effect of temperature on enzyme activity.	14
1.6.3. Effect of inhibitors on enzyme activity	14

1.7. Multi-substrate enzyme kinetics	18
1.7.1. Ordered sequential mechanism	18
1.7.2. Random sequential mechanism	18
1.7.3. Ping-pong mechanism	19
Chapter 2. Classification of Enzymes Used in the Food Industry	21
Latifa CHEBIL and Mohamed GHOUL	
2.1. Oxidoreductases (CE1)	22
2.2. Transferases (CE2)	22
2.3. Hydrolases (CE3)	23
2.4. Lyases (CE4)	24
2.5. Isomerases (CE5)	24
2.6. Ligases (CE6)	25
Chapter 3. Mode of Action of the Main Enzymes Used in the Food Industry	27
Catherine HUMEAU, Mohamed GHOUL and Seraphim PAPANIKOLAOU	
3.1. Enzymes involved in the starch degradation reaction	27
3.2. Enzymes involved in the degradation of lignocellulosic substrates	29
3.3. Enzymes involved in the degradation of pectin-type substrates	33
3.4. Enzymes involved in the degradation of lipid substrates	36
3.5. Enzymes involved in protein degradation	37
Chapter 4. Enzyme Production for Food Applications.	41
Mohamed GHOUL and Seraphim PAPANIKOLAOU	
4.1. Amylases	42
4.2. Pullulases	44
4.3. Lignocellulases.	44
4.4. Pectinases	49
4.5. Lipases	52
4.6. Proteases	54
4.7. Conclusion	58

Chapter 5. Ways to Improve Enzymatic Processes	59
Isabelle CHEVALOT and Catherine HUMEAU	
5.1. Enzyme engineering.	59
5.1.1. Enzyme engineering methods.	60
5.1.2. Improving enzyme stability	67
5.1.3. Improving enzyme specificity and selectivity	78
5.1.4. Improving catalytic performance.	83
5.2. Process engineering	89
5.2.1. Introduction	89
5.2.2. Enzyme immobilization technology	89
5.2.3. Microwave and ultrasound-assisted enzyme processes.	100
5.2.4. Process intensification	104
Chapter 6. Main Enzymatic Processes in the Food Industry	107
Latifa CHEBIL and Mohamed GHOUL	
6.1. Baking and pastry	107
6.2. Malting and brewing	110
6.2.1. Malting	111
6.2.2. Brewing.	112
6.3. Starch and its by-products	114
6.4. Milk	116
6.5. Fat	120
6.6. Meat and seafood products.	124
6.6.1. Meat products	124
6.6.2. Seafood products	125
6.7. Flavors and additives	127
6.8. Fruit juices and wines.	130
6.8.1. Fruit juices	130
6.8.2. Wines	134
Part 1 References	137
Part 2. Lactic Acid Bacteria and Bifidobacteria: A Fermented Food Source	163
Introduction to Part 2.	165
Marie-Bénédicte ROMOND	

Chapter 7. Lactic Acid Bacteria and Bifidobacteria	167
Jennifer BURGAIN and Marie-Bénédicte ROMOND	
7.1. Taxonomic notions and the definition of “probiotic”	167
7.2. The probiotics market and health claims.	170
7.3. Prebiotics	172
7.3.1. Definition.	172
7.3.2. Prebiotics, synbiotics and health claims.	173
Chapter 8. Bifidobacteria: From Commensal Bacteria to Probiotics and Metabiotics/Postbiotics	175
Frank PIVA and Marie-Bénédicte ROMOND	
8.1. Taxonomy and ecological aspects of commensal bifidobacteria: discovery and identification criteria	175
8.1.1. Distribution of bifid species in humans and animals	185
8.1.2. Topographical and kinetic distribution in humans.	186
8.1.3. Safety and health activity	188
8.2. Production of probiotics and metabiotics/postbiotics	191
8.2.1. Nutritional requirements of bifidobacteria: use of complex oligosaccharides and production of exopolysaccharides	191
8.2.2. Concentration and preservation technology for live probiotics (strain selection, encapsulation)	194
8.3. Industrial applications.	196
8.3.1. Fermentation manufacturers and characteristics of marketed products	196
8.3.2. Live biotechnology products and European Pharmacopoeia constraints	198
8.4. Prospects for development and innovation: metabiotics/postbiotics (bifidobacterial lipoproteins), therapeutic targets	199
8.4.1. Bifidobacterial bacteriocins and food preservation	208
Chapter 9. Lactobacilli: Strain Selection and Probiotic Effects	211
Jennifer BURGAIN and Marie-Bénédicte ROMOND	
9.1. Species, strain identity and origin.	211
9.2. Physiology of probiotic strains	213
9.3. Impact of lactobacilli on digestive health	215
9.3.1. General health effects	215
9.3.2. Mechanisms of action on the digestive system.	216
9.3.3. <i>Lactocaseibacillus rhamnosus</i> GG (new nomenclature)	220

9.3.4. <i>Lacticaseibacillus casei</i> and <i>Lacticaseibacillus paracasei</i> (new nomenclature)	221
9.3.5. <i>Lactobacillus acidophilus</i>	222
Chapter 10. Encapsulation Processes	225
Jennifer BURGAIN, Joël SCHER and Claire GAIANI	
10.1. Definition and aims of encapsulation	225
10.2. Atomization	227
10.3. Extrusion	230
10.4. Emulsification	232
10.5. Coating.	233
Chapter 11. Encapsulation Matrices	237
Jennifer BURGAIN, Joël SCHER and Claire GAIANI	
11.1. Polysaccharides.	237
11.2. Proteins	239
11.3. Bacterial adhesion to encapsulation materials.	240
11.4. Conclusion	243
Chapter 12. Fermented Foods	245
Frank PIVA and Marie-Bénédicte ROMOND	
12.1. Traditional fermented foods	246
12.2. New approaches to fermentation	254
Part 2 References	257
Conclusion	291
Mohamed GHOUL	
List of Authors	293
Index	295