

Contents

1 Cheese: Historical Aspects	1
1.1 Introduction.....	2
1.2 Cheese Production and Consumption	7
1.3 Cheese Science and Technology	9
References.....	9
Suggested Reading.....	10
2 Overview of Cheese Manufacture	11
2.1 Selection of Milk.....	13
2.2 Standardization of Milk Composition.....	13
2.3 Heat Treatment of Milk.....	14
2.4 Cheese Colour.....	15
2.5 Conversion of Milk to Cheese Curd.....	17
2.6 Ripening.....	23
2.7 Processed Cheese Products.....	24
2.8 Whey and Whey Products.....	25
3 Principal Families of Cheese	27
3.1 Introduction.....	27
3.2 Rennet-Coagulated Cheeses.....	34
3.3 Acid-Coagulated Cheeses	60
3.4 Heat/Acid-Coagulated Cheeses	60
3.5 Concentration/Crystallization	61
3.6 Visual Appearance of Selected Cheeses	63
3.7 Ultrafiltration Technology in Cheesemaking.....	63
References.....	68
Suggested Reading.....	69
4 Chemistry of Milk Constituents	71
4.1 Introduction.....	71
4.2 Lactose and Other Carbohydrates	73
4.3 Milk Lipids.....	79

4.4	Milk Proteins.....	88
4.5	Milk Salts	99
4.6	pH of Milk.....	100
4.7	Physico-Chemical Properties of Milk.....	101
	References.....	102
5	Bacteriology of Cheese Milk	105
5.1	Introduction.....	105
5.2	Sources of Microorganisms	105
5.3	Mastitis and Other Diseases.....	107
5.4	Milking Machines and Bulk Tanks	109
5.5	Natural Inhibitors	111
5.6	Pathogens in Raw Milk	111
5.7	Raw Milk Cheeses	113
5.8	Pasteurisation	113
5.9	Alternatives to Heat Treatment	115
5.10	Standards for Raw Milk	118
	Suggested Reading.....	119
6	Starter Cultures.....	121
6.1	Introduction.....	121
6.2	Types of Starters.....	122
6.3	Adjunct Cultures	133
6.4	Measurement of Growth	134
6.5	Effect of Temperature	135
6.6	Taxonomy.....	136
6.7	Phylogeny.....	141
6.8	Metabolism of Starters.....	143
6.9	Respiration in Lactic Acid Bacteria.....	153
6.10	Citrate.....	154
6.11	Exopolysaccharide Production.....	158
6.12	Plasmids	159
6.13	Genome Sequences	159
6.14	Inhibition of Acid Production	160
6.15	Bacteriocins.....	175
6.16	Production of Bulk Cultures in Cheese Plants	178
6.17	DVS and DVI Cultures	180
	Suggested Reading.....	180
7	Enzymatic Coagulation of Milk.....	185
7.1	Introduction.....	185
7.2	Primary Phase of Rennet Coagulation	186
7.3	Rennet	189
7.4	Factors that Affect the Hydrolysis of κ -Casein and the Primary Phase of Rennet Coagulation	190

7.5	Secondary (Non-enzymatic) Phase of Coagulation and Gel Assembly	192
7.6	Factors that Affect the Non-enzymatic Phase of Rennet Coagulation	199
7.7	Measurement of Rennet Coagulation Properties	201
7.8	Factors that Affect Rennet Coagulation.....	210
7.9	Rennet Substitutes.....	220
7.10	Immobilized Rennets	225
	References.....	226
8	Post-Coagulation Treatment of the Renneted-Milk Gel.....	231
8.1	Introduction.....	231
8.2	Methods for Measuring Syneresis	232
8.3	Influence of Compositional Factors on Syneresis.....	233
8.4	Influence of Processing Variables on Syneresis.....	234
8.5	Kinetics and Mechanism of Syneresis	239
8.6	Textured Cheese.....	240
8.7	Moulding and Pressing of Cheese Curd.....	246
8.8	Packaging.....	248
	References.....	249
9	Salting of Cheese Curd	251
9.1	Introduction.....	251
9.2	Salt in Different Cheese Varieties	253
9.3	The Major Functions of Salt in Cheese.....	253
9.4	Salting Methods	256
9.5	Brine-Salting	257
9.6	Dry Salting of Cheese	263
9.7	Effect of Salt on Cheese Composition	268
9.8	Effect of NaCl on the Microbiology of Cheese	270
9.9	Influence of NaCl on Enzymes in Cheese.....	273
9.10	Effect of Salt on Cheese Quality.....	274
9.11	Nutritional Aspects of NaCl in Cheese.....	275
	References.....	275
10	Cheese Yield.....	279
10.1	Introduction.....	280
10.2	Definition and Expression of Cheese Yield	280
10.3	Measurement of Cheese Yield and Efficiency	283
10.4	Prediction of Cheese Yield.....	288
10.5	Factors That Affect Cheese Yield	295
10.6	Conclusions.....	324
	References.....	325
	Suggested Reading.....	331

11 Microbiology of Cheese Ripening.....	333
11.1 Introduction.....	333
11.2 Microbial Activity During Ripening.....	334
11.3 Water and Water Activity.....	334
11.4 Salt	336
11.5 Oxidation-Reduction Potential.....	339
11.6 pH and Organic Acids.....	340
11.7 Nitrate	340
11.8 Temperature	341
11.9 Growth of Starter Bacteria in Cheese	342
11.10 Growth of Non-Starter Lactic Acid Bacteria in Cheese	344
11.11 Spatial Development of Bacteria in Cheese.....	347
11.12 Non-Starter Lactic Acid Bacteria as Adjunct Cultures.....	348
11.13 Enterococci	349
11.14 Secondary Microorganisms in Ripening Cheese	351
11.15 Molecular Methods of Identification	351
11.16 Development of Microorganisms in Different Cheeses.....	352
11.17 Microbial Spoilage of Cheese.....	373
11.18 Probiotics	375
11.19 Non-Lactic Genera of Bacteria Found in Cheese	376
11.20 Yeast and Moulds.....	381
Suggested Reading.....	386
References.....	386
12 Biochemistry of Cheese Ripening.....	391
12.1 Introduction.....	391
12.2 Ripening Agents in Cheese.....	392
12.3 Contribution of Individual Agents to Ripening	393
12.4 Metabolism of Residual Lactose and of Lactate and Citrate	395
12.5 Citrate Metabolism.....	405
12.6 Lipolysis and Related Events.....	406
12.7 Proteolysis.....	414
12.8 Characterization of Proteolysis in Cheese	428
12.9 Catabolism of Amino Acids and Related Events.....	436
12.10 Conclusions.....	438
References.....	439
13 Cheese Flavour	443
Kieran N. Kilcawley	
13.1 Introduction.....	444
13.2 Sensory Analysis.....	444
13.3 Characteristics of Cheese Flavour.....	452
13.4 Analysis of Cheese Flavour	452
13.5 Analysis of Volatile Compounds.....	456
13.6 Aroma Compounds in Specific Cheeses	468
13.7 Conclusion	471
References.....	472

14 Cheese: Structure, Rheology and Texture	475
14.1 Introduction to Cheese Rheology.....	476
14.2 Relationship Between Cheese Rheology and Texture	477
14.3 Cheese Structure	480
14.4 Rheological Concepts	484
14.5 Model of Cheese Rheology Based on Creep and Recovery Experiments	490
14.6 Measurement of the Rheological Behaviour of Cheese.....	494
14.7 Factors That Influence the Rheological Characteristics of Cheese as Measured Using Large Strain Uniaxial Compression	507
14.8 Cheese Texture.....	522
References.....	527
Suggested Reading.....	532
15 Factors that Affect Cheese Quality.....	533
15.1 Introduction.....	533
15.2 Milk Supply	534
15.3 Coagulant (Rennet)	536
15.4 Starter.....	537
15.5 Non-starter Lactic Acid Bacteria (NSLAB)	537
15.6 Cheese Composition	538
15.7 Ripening Temperature.....	541
15.8 Conclusions.....	541
References.....	542
16 Fresh Cheese Products: Principals of Manufacture and Overview of Different Varieties	543
16.1 Introduction.....	543
16.2 Overview of the Manufacturing Process for Fresh Acid-Curd Cheese Products	546
16.3 Principles and Mechanism of Acid-Induced Gelation of Milk.....	546
16.4 Gel Syneresis	557
16.5 Factors that Influence the Rheology and Syneresis of Acid-Induced Milk Gels	560
16.6 Treatments of the Concentrated Gel after Whey Separation	568
16.7 Major Fresh Acid-Curd Cheese Varieties	571
16.8 Whey Cheeses	583
References.....	584
Suggested Reading.....	588
17 Processed Cheese and Substitute/Imitation Cheese Products.....	589
17.1 Introduction.....	590
17.2 Pasteurized Processed Cheese Products.....	590
17.3 Imitation and Substitute Cheese Products, and Tofu	614
References.....	623
Suggested Reading.....	626

18 Cheese as an Ingredient.....	629
18.1 Introduction and Definitions	630
18.2 Overview of Functional Requirements of Cheese as an Ingredient	636
18.3 Basis of Functional Properties in Cheese.....	638
18.4 Evaluation of the Rheological-Related Functional Properties of Cheese	646
18.5 Effects of Different Factors on the Functionality of Unheated Cheese	652
18.6 Effects of Different Factors on the Functionality of Heated Cheese	654
18.7 Dried Cheese Products.....	667
18.8 Conclusions.....	676
References.....	677
Suggested Reading.....	679
19 Pathogens in Cheese and Foodborne Illnesses	681
19.1 Pathogens in Cheese	688
19.2 Growth of Pathogens in Cheese During Manufacture	694
19.3 Growth of Pathogens in Cheese During Ripening	699
19.4 Raw Milk Cheeses	705
19.5 Control of Growth of Pathogens	706
19.6 Stresses and Survival of Pathogens.....	708
19.7 Biogenic Amines.....	708
References.....	709
Suggested Reading.....	712
20 Nutritional Aspects of Cheese	715
Y.C. O'Callaghan, T.P. O'Connor, and N.M. O'Brien	
20.1 Introduction.....	716
20.2 Fat and Cholesterol	716
20.3 Protein and Carbohydrate	718
20.4 Vitamins and Minerals	719
20.5 Additives in Cheese	723
20.6 Cheese and Dental Caries	723
20.7 Mycotoxins	724
20.8 Biogenic Amines in Cheese	728
References.....	729
21 Current Legislation on Cheese.....	731
Michael Hickey	
21.1 Background.....	732
21.2 International Standards for Cheese Developed by the Codex Alimentarius Commission	736
21.3 European Legislation Pertaining to Cheese	738
21.4 EU Food Additive Legislation	741

21.5	EU Food Labelling Legislation.....	742
21.6	Cheese Legislation in the United Kingdom.....	743
21.7	Ireland	745
21.8	US Legislation on Cheese.....	746
21.9	Cheese Legislation in a Selection of Other Countries	749
21.10	Summary	749
	References.....	751
22	Whey and Whey Products.....	755
22.1	Introduction.....	755
22.2	Clarification of Whey.....	757
22.3	Whey Beverages.....	758
22.4	Concentrated and Dried Whey Products.....	758
22.5	Lactose	759
22.6	Whey Proteins	765
22.7	Whey Cheese	767
22.8	Conclusions.....	767
	References and Suggested Reading	768
	Index.....	771

Fundamentals of Cheese Science

Fox, P.F.; Guinee, T.P.; Cogan, T.M.; McSweeney, P.L.H.
2017, XV, 799 p. 271 illus., 78 illus. in color., Hardcover
ISBN: 978-1-4899-7679-6