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EXUDATION OF WHEY FROM CHEESE DURING STORAGE

**A thesis presented
in partial fulfilment
of the requirements for the
degree of Doctor of Philosophy
in Food Technology at Massey University**

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1991

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15

ABSTRACT

Cheeses of low pH, such as Feta, Blue, Cream and Cheshire, often exude whey after manufacture. This exudation lowers the yield and reduces product acceptability. Virtually no scientific study has been undertaken on this subject. Investigations were therefore undertaken to determine the factors affecting exudation and to elucidate the underlying mechanism. Cream cheese made by the hot-pack method and recombined Feta cheese made by the traditional method, representing unripened and ripened varieties of cheese respectively, were studied.

In Cream cheese the amount of exudate increased with decreased protein to fat (P/F) ratio, decreased homogenisation pressure, decreased pasteurisation temperature, decreased pH at cooking, decreased cooking temperature, increased storage temperature and increased storage time. Within the selected limits of variation of P/F ratio, fat did not affect exudation. However, an increase of moisture in non-fat substance resulted in an increased amount of exudate. The effect of homogenisation pressure appears to be due to the increase in the fat globule surface area and the increase in the coating of fat globule with casein. The partial heat-denaturation of the whey proteins in the cheesemilk was effective in reducing the rate of exudation, possibly due to the complex formation between β -lactoglobulin and κ -casein that prevented fusion of casein micelles.

Residual lactose and pH did not change, and proteolysis was not detected up to 16 weeks in Cream cheese stored at 5°C. It is concluded that exudation from Cream cheese does not occur due to any gross chemical changes during storage.

Manufacture of Feta cheese involved the use of recombined cow's milk and vacuum packaging of cheese after brining. A storage study of Feta cheese up to 6 months showed steady proteolysis, slow metabolism of residual lactose and a gradual decrease of pH. The water activity of the cheese depended on the salt-in-moisture concentration.

In Feta cheese the amount of exudate increased with increased P/F ratio, increased pH at draining, increased residual rennet, packaging cheese without vacuum, increased storage temperature and increased storage time. Variation of priming time, with a constant curd pH at draining, did not affect exudation. Unlike Cream cheese, an increase in protein and a decrease in fat content in Feta correlated with increase in the amount of exudate. The effects of change in pH and calcium (within a range expected in normal Feta) on exudation were minor.

Homogenisation was effective in reducing the rate of exudation in Feta cheese. However, a variation in the homogenisation pressure had no effect. The type of material adsorbed to the fat globule surface influences syneresis during manufacture as well as subsequent exudation during storage. The effect of a reduction in the size of fat globules on exudation appears to be less important.

In Feta cheese the incorporation of heat-denatured whey proteins did not affect exudation. However, there was a substantial increase in yield.

Proteolysis is the dominant factor affecting exudation. Its influence is apparently due to the disintegration of the casein network and the release of water physically held in the capillaries. Exudation is also substantially influenced by the gradient in NaCl concentration in Feta cheese following brining.

Denaturation of whey proteins in Cream cheese; and homogenisation, controlled proteolysis, decreased salt gradient, use of vacuum packaging in Feta cheese appear to be the main factors available for reducing the extent of exudation. Based on the findings of the investigation a hypothesis is proposed to explain the exudation from cheeses.

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TABLE OF CONTENTS

	Page
ABSTRACT	ii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTENTS	vi
LIST OF FIGURES	xii
LIST OF TABLES	xiv
LIST OF APPENDICES	xix
ABBREVIATIONS	xxiii
CHAPTER 1 INTRODUCTION	1
CHAPTER 2 REVIEW OF LITERATURE	3
2.1 Introduction	3
2.2 Gels	3
2.2.1 Introduction	3
2.2.2 Rennet-induced gels in milk and cheese	4
2.2.3 Acid-induced gels in yoghurt	12
2.3 Emulsions	16
2.3.1 Introduction	16
2.3.2 Emulsification of fat in milk and cheese	17
2.3.3 Influence of materials at the fat-serum interface on the emulsion stability	18
2.4 Incorporation of whey protein in cheese	21
2.4.1 Introduction	21
2.4.2 Incorporation of native whey protein in cheese by ultrafiltration	22
2.4.3 Incorporation of denatured whey protein in cheese by heat treatment of cheesemilk	23
2.4.4 Incorporation of whey protein in cheese by addition of heat-denatured whey protein to cheesemilk	25
2.4.5 Role of whey proteins in proteolysis of cheese	27
2.5 Cream Cheese	28
2.5.1 Introduction	28
2.5.2 Composition	28

2.5.3 Manufacturing technique	28
2.5.4 Modified methods	30
2.6 Feta cheese	32
2.6.1 Introduction	32
2.6.2 Flavour	32
2.6.3 Texture	32
2.6.4 Colour	33
2.6.5 Composition	33
2.6.6 Manufacturing techniques	33
2.6.7 Changes in brine-stored Feta cheese during storage	34
2.7 Salt diffusion	37
2.7.1 Introduction	37
2.7.2 Theories on salt diffusion	37
2.7.3 Factors affecting salt diffusion	38
2.7.4 Influence of salt on ripening of cheese	40
2.8 Changes in cheese during storage	40
2.8.1 Residual lactose, acidity and pH of cheese	40
2.8.2 Residual enzymes in cheese	41
2.8.3 Calcium in cheese	41
2.8.4 Proteolysis in cheese	42
2.8.5 Water activity (A_w) of cheese	44
2.8.6 Water-binding properties of proteins	45
CHAPTER 3 SCOPE AND OBJECTIVES OF THE PRESENT INVESTIGATION	47
CHAPTER 4 ANALYTICAL METHODS AND SENSORY EVALUATION	48
4.1 Introduction	48
4.2 Section One: Specific methods	48
4.2.1 Sample preparation	48
4.2.2 Measurement of amount of exudate	48
4.2.3 Electrophoresis of cheese	52
4.2.4 Proteins adsorbed to fat globule surface	53
4.2.5 Whey protein nitrogen index	54
4.2.6 Hardness of Cream cheese	54

4.2.7	Curd-fines lost in whey	55
4.2.8	Test for emulsion stability of <i>manufactured cream</i>	55
4.2.9	Gel strength	56
4.2.10	Differential Scanning Calorimetry	56
4.2.11	Microbiological tests	57
4.3	Section Two: Sensory evaluation	57
4.3.1	Introduction	57
4.3.2	Feta cheese	57
4.3.3	Cream cheese	58
CHAPTER 5 EXUDATION OF WHEY FROM CREAM CHEESE		
DURING STORAGE		59
5.1	Introduction	59
5.2	Section One: Effect of selected manufacturing variables on exudation from cheeses of constant moisture	60
5.2.1	Introduction	60
5.2.2	Experimental approach	60
5.2.3	Experimental plan	61
5.2.4	Experimental	63
5.2.5	Analytical methods	64
5.2.6	Sensory evaluation	64
5.2.7	Results and discussion	67
5.3	Section Two: Effect of manufacturing variables on exudation from cheeses of constant MNFS	80
5.3.1	Introduction	80
5.3.2	Experimental approach	81
5.3.3	Experimental	82
5.3.4	Analytical methods	82
5.3.5	Sensory evaluation	83
5.3.6	Results and discussion	83
5.4	Overall summary and conclusion to Chapter 5	102
CHAPTER 6 EXUDATION OF WHEY FROM FETA CHEESE		
DURING STORAGE		104
6.1	Introduction	104

6.2 Section One: Preliminary studies	104
6.2.1 Experimental	105
6.2.2 Results and discussion	106
6.3 Section Two: Chemical, biochemical and microbiological changes in Feta cheese and exudate during storage at 10°C	115
6.3.1 Experimental	115
6.3.2 Results and discussion	115
6.4 Section Three: Effect of selected manufacturing variables on exudation from Feta cheese	136
6.4.1 Experimental plan	136
6.4.2 Experimental	138
6.4.3 Analytical methods	138
6.4.4 Sensory evaluation	139
6.4.5 Results and discussion	139
6.5 Summary and conclusion to Chapter 6	154
CHAPTER 7 EFFECT OF INCORPORATION OF HEAT-DENATURED WHEY PROTEIN ON THE YIELD AND EXUDATION OF WHEY FROM FETA CHEESE	156
7.1 Introduction	156
7.2 Experimental plan	157
7.3 Experimental	160
7.4 Methods of analysis	162
7.5 Sensory evaluation	162
7.6 Results and discussion	163
7.6.1 Composition of slurry, milk, whey, cheese and exudate	163
7.6.2 Manufacturing aspects and quality of cheese	164
7.6.3 Mass balance and cheese yield	166
7.6.4 Proteolysis in cheese	171
7.6.5 Exudation of whey from Feta cheese during storage	176
7.7 Summary	180
CHAPTER 8 EFFECT OF HOMOGENISATION, SOURCE OF MILK SOLIDS AND FAT EMULSIFICATION ON THE EXUDATION OF WHEY FROM FETA CHEESE DURING STORAGE	181

8.1 Introduction	181
8.2 Section One: Effect of homogenisation and source of milk solids on the exudation of whey from Feta cheese during storage	183
8.2.1 Experimental	183
8.2.2 Analytical methods	183
8.2.3 Sensory evaluation	184
8.2.4 Results and discussion	185
8.2.5 Summary and conclusion	192
8.3 Section Two: Effect of fat emulsification on the exudation of whey from Feta cheese during storage	193
8.3.1 Introduction	193
8.3.2 Preliminary studies	193
8.3.2.1 Experimental design	194
8.3.2.2 Experimental	195
8.3.2.3 Analytical methods	196
8.3.2.4 Results and discussion	196
8.3.3 Effect of material adsorbed to surface of fat globule in Feta cheese on the exudation	202
8.3.3.1 Experimental	202
8.3.3.2 Analytical methods	202
8.3.3.3 Sensory evaluation	203
8.3.3.4 Results	203
8.3.3.5 Discussion	214
8.3.3.5 Conclusion	220
8.4 Overall conclusion to Chapter 8	220

CHAPTER 9 INFLUENCE OF PROTEOLYSIS ON THE EXUDATION OF WHEY FROM FETA CHEESE DURING STORAGE	221
9.1 Introduction	221
9.2 Experimental plan	222
9.3 Experimental	223
9.4 Analytical methods	223
9.5 Sensory evaluation	224
9.6 Results and discussion	224
9.6.1 Cheese manufacture; and composition of milk, whey, cheese and exudate	224

9.6.2 Sensory evaluation of cheese	225
9.6.3 Distribution and mass balance of rennet	225
9.6.4 Proteolysis in cheese	227
9.6.5 Exudation from cheese	232
9.7 Summary and conclusion	235
CHAPTER 10 OSMOSIS AND DIFFUSION IN FETA CHEESE	237
10.1 Introduction	237
10.2 Experimental plan	238
10.3 Experimental	239
10.4 Results	241
10.4.1 Optimisation of assay procedure	241
10.4.2 Influence of selected factors on mass transfer	244
Influence of proteolysis	244
Influence of protein breakdown material	245
Influence of NaCl	246
Influence of pH	246
Effect of calcium	248
10.5 Discussion	249
10.6 Summary and conclusion	251
CHAPTER 11 SALT DIFFUSION IN FETA CHEESE AND ITS EFFECT ON EXUDATION	252
11.1 Introduction	252
11.2 Experimental	253
11.3 Results and discussion	253
11.4 Conclusion	259
CHAPTER 12 OVERALL DISCUSSION	260
APPENDICES	266 - 334
BIBLIOGRAPHY	335 - 350

LIST OF FIGURES

	Page	
Fig. 4.1	A sample of Cream cheese showing exudate on the surface	49
Fig. 4.2	Feta cheese samples at various stages after manufacture	51
Fig. 5.1	Manufacturing process of Cream cheese	65
Fig. 5.2	Selected stages in manufacture of Cream cheese	66
Fig. 5.3	Exudation of whey from Cream cheese during storage	78
Fig. 5.4	Urea-PAGE of Cream cheese during storage at 5°C	96
Fig. 6.1	Flow diagram for manufacture of Feta cheese	107
Fig. 6.2	Selected stages in Feta cheese manufacture	108
Fig. 6.3	Casein proteolysis in Feta cheese during storage at 10°C (Urea-PAGE)	116
Fig. 6.4	Casein protein degradation during storage of Feta cheese	117
Fig. 6.5	SDS-PAGE on exudates from Feta cheeses of different age	119
Fig. 6.6	Pattern of distribution of peptides in exudates from Feta cheeses of different ages (HPLC technique)	120
Fig. 6.7	Changes in pH of Feta cheese (after brining) with addition of lactic acid	123
Fig. 6.8	Relationship between water activity and salt-in-moisture concentration in Feta	128
Fig. 6.9	DSC thermogram showing a typical heating phase (220 K - 285 K) of Feta cheese	131
Fig. 6.10	Unfreezable water in Feta cheese and exudate during storage (estimated using DSC technique)	135
Fig. 6.11	Exudation of whey from Feta cheese during storage	152
Fig. 6.12	Effect of protein to fat ratio on the exudation of whey from Feta cheese during storage	153
Fig. 6.13	Effect of 'curd pH at draining' on the exudation of whey from Feta cheese during storage	153
Fig. 7.1	SDS-PAGE on six month old Feta cheeses incorporated with heat-denatured whey protein	174
Fig. 8.1	Process for preparation of <i>manufactured cream</i>	196

Fig. 8.2	Formagraph curves showing the starting time of gel formation and the subsequent firming of gels in renneted milks prepared with different emulsifying agents	201
Fig. 8.3	Urea-PAGE showing proteins adsorbed to surface of fat globules in fourteen month old Feta cheeses made using different emulsifying agents	211
Fig. 8.4	Effect of emulsifying agents on the exudation of whey from Feta cheese during storage	215
Fig. 9.1	Effect of residual rennet on casein proteolysis in Feta cheese during storage (Urea-PAGE)	228
Fig. 9.2	Effect of residual rennet on the hydrolysis of α_{s1} -casein during storage of Feta cheese	229
Fig. 9.3	Effect of residual rennet on the hydrolysis of β -casein during storage of Feta cheese	229
Fig. 9.4	HPLC plots showing the effect of residual rennet concentration on the peptides formed in three week old Feta	231
Fig. 9.5	Effect of residual rennet on the exudation of whey from Feta cheese during storage	236
Fig. 10.1	Loss of total nitrogen from Feta cheeses of different age during dialysis	243
Fig. 11.1	Cutting a block of Feta cheese into different layers	254
Fig. 11.2	Pattern of NaCl distribution in various layers of Feta cheese during storage	256
Fig. 11.3	Pattern of moisture distribution in various layers of Feta cheese during storage	256
Fig. 11.4	Pattern of distribution of salt-in-moisture in various layers of Feta cheese during storage	257

LIST OF TABLES

	Page	
Table 5.1	Selected manufacturing variables and their respective levels of variation for studying the effects on exudation of whey from Cream cheese during storage	61
Table 5.2	P/F ratio of standardised milk	67
Table 5.3	Effect of manufacturing variables on the composition of curd	68
Table 5.4	Composition of Cream cheese with relation to the manufacturing variables	69
Table 5.5	Effect of manufacturing variables on the pH of curd and Cream cheese (1 day and 16 weeks old)	70
Table 5.6	Effect of manufacturing variables on the mean scores of sensory parameters of cheeses	72
Table 5.7	Effect of manufacturing variables on the exudation of whey from Cream cheese during storage	73
Table 5.8	Effect of manufacturing variables on the exudation of whey from Cream cheese during storage (g exudate per kg moisture in cheese): based on X^2 test of significance	74
Table 5.9	Effect of storage temperature on the exudation	79
Table 5.10	Effect of manufacturing variables on the protein to fat ratio of raw standardised milk	84
Table 5.11	Composition of Cream cheese with respect to the manufacturing variables	85
Table 5.12	Effect of manufacturing variables on the mean diameter of fat globules in raw standardised milk and processed (homogenised and pasteurised) milk	88
Table 5.13	Effect of manufacturing variables on the WPNI [mg undenatured whey protein/g milk (or whey)]	90
Table 5.14	Effect of homogenisation of milk on the concentration of proteins (casein and whey protein) adsorbed to fat globule surface, and the mean diameter of fat globules	91

Table 5.15	Effect of manufacturing variables on the protein adsorbed to fat globules (casein to whey protein ratio) extracted from Cream cheese	92
Table 5.16	Effect of manufacturing variables on the hardness of Cream cheese	94
Table 5.17	Lactose level and corresponding pH of Cream cheeses of varying age	95
Table 5.18	Effect of storage time on the casein fractions in Cream cheese (urea-PAGE results)	97
Table 5.19	Effect of storage time on the casein fractions in exudate from Cream cheese (urea-PAGE results)	98
Table 5.20	Effect of manufacturing variables on the exudation of whey from Cream cheeses of constant MNFS	99
Table 6.1	Effect of brining time on the salt content and exudation of Feta cheese	110
Table 6.2	Effect of variation in size of cheese block on the exudation of whey from Feta cheese	110
Table 6.3	Effect of block to block variation in cheese manufactured from the same vat on the exudation	111
Table 6.4	Effect of vacuum packaging on the exudation of whey from Feta cheese	112
Table 6.5	Effect of miscellaneous factors on the exudation of whey from Feta cheese	113
Table 6.6	Effect of fat content in cheese on exudation	113
Table 6.7	Effect of storage temperature and storage time on exudation of whey from Feta cheese	114
Table 6.8	Concentration of major proteins in Feta cheese and exudate during storage at 10 °C	121
Table 6.9	Residual lactose in Feta cheese and exudate at different storage intervals	122

Table 6.10	Quantity of lactates present (mM/kg) in Feta cheese and exudate at varying storage intervals	124
Table 6.11	Quantities of acetates and citrates present (mM/kg) in Feta cheese and exudate during various storage intervals	125
Table 6.12	Microbial counts in cheesemilk and Feta cheese (during storage)	127
Table 6.13	Reproducibility of DSC analysis of Feta cheese	130
Table 6.14	Results from the DSC thermograms on the study of effect of major components in exudate - heating phase	132
Table 6.15	Results from the DSC thermograms on the study of exudates from Feta cheese of varying ages - heating phase	134
Table 6.16	Results from the DSC thermograms on the study of Feta cheese of varying ages	134
Table 6.17	Selective manufacturing variables and their respective levels of variation chosen for studying the effects on exudation of whey from Feta cheese during storage	136
Table 6.18	Composition of milks for Feta cheeses manufactured (with respect to manufacturing variables)	140
Table 6.19	Effect of variation in homogenisation pressure on the mean diameter of fat globules in 'manufactured cream'	141
Table 6.20	Effect of manufacturing variables on the composition of four week old Feta cheeses	142
Table 6.21	Effect of manufacturing variables on the composition of exudate from Feta cheese after 4 weeks of storage	145
Table 6.22	Effect of manufacturing variables on the exudation of whey from Feta cheeses during storage at 10 °C	148
Table 7.1	Treatment variables, and their respective levels of variation, chosen for study of the effects of incorporation of heat-denatured whey protein on yield, product characteristic and exudation of whey from Feta cheese during storage	159
Table 7.2	Effect of process treatments on yield of cheese	167
Table 7.3	Effect of process treatments on the recovery of milk constituents in cheese	169

Table 7.4	Effect of process treatments on the proteolysis in four week old Feta cheese	174
Table 7.5	Effect of process treatments on the proteolysis in six month old cheese	175
Table 7.6	Effect of process treatments on the exudation of whey from Feta cheeses (incorporated with heat-denatured whey proteins) during storage at 10 °C	177
Table 8.1	Variables used in cheese manufacture - combinations of creams and skim milks from different sources used for preparation of cheesemilk	184
Table 8.2	Results from Urea-PAGE on four week old cheeses to assess the rate of proteolysis (Densitometer readings)	187
Table 8.3	Effect of homogenisation and milk solids source on the amount of casein proteins adsorbed to surface of fat globules in cheese (densitometer readings of SDS-gel)	189
Table 8.4	Effect of homogenisation of cream and selected sources of milk solids in cheesemilk on the exudation of whey from Feta cheese during storage	191
Table 8.5	Effect of use of selected emulsifying agents on the properties of 'manufactured cream' and recombined milk	197
Table 8.6	Proportion of emulsifying agents	199
Table 8.7	Effect of emulsifying agents on the rennet coagulation properties of skim milk	200
Table 8.8	Effect of emulsifying agents on the mean diameter of fat globules in cheesemilk	205
Table 8.9	Effect of emulsifying agents on the composition of cheese (four weeks)	206
Table 8.10	Effect of emulsifying agents on casein proteolysis of Feta cheese	208
Table 8.11	Effect of emulsifying agents on the low molecular weight peptides in exudate from four week old Feta cheese (HPLC technique)	209

Table 8.12	Effect of emulsification of fat with different emulsifying agents on the protein adsorbed to surface of fat globules in Feta cheese	210
Table 8.13	Effect of emulsifying agents on exudation of whey from Feta cheese during storage	213
Table 9.1	Quantity of calf-rennet used for manufacture of cheese	222
Table 9.2	Variation in priming and setting time for different amounts of calf-rennet added to milk	223
Table 9.3	Effect of variation in the amount of rennet used during cheesemaking on the rennet retained in cheese and whey	226
Table 9.4	Effect of variation in the quantity of rennet used in cheesemaking on the exudation of whey from Feta cheeses during storage at 10°C	233
Table 10.1	Effect of temperature on mass transfer from cheese (16 wk old) during dialysis	244
Table 10.2	Effect of age of cheese on the mass transfer from Feta cheese during dialysis	244
Table 10.3	Effect of low molecular weight protein breakdown material on mass transfer from cheese and exudate	245
Table 10.4	Effect of variation in the concentration of PEG in SES on the mass transfer from Feta cheese during dialysis	246
Table 10.5	Effect of variation in the NaCl content in SES on the mass transfer from cheese (12 wk old) during dialysis	246
Table 10.6	Effect of variation in pH of SES on the mass transfer from cheese (15 wk old) during dialysis	247
Table 10.7	Effect of variation in pH of cheeses on the mass transfer from cheeses (15 wk) during dialysis in SES of constant pH	247
Table 10.8	Effect of variation in calcium of SES on the mass transfer from cheese (16 wk old) during dialysis	248
Table 10.9	Effect of variation in Ca ²⁺ of cheese on the mass transfer from cheeses during dialysis in SES of constant Ca ²⁺	249
Table 11.1	NaCl and moisture distribution in various layers of Feta cheese at selected periods of storage	255

LIST OF APPENDICES

		Page
Appendix 4.1	Standard analytical (chemical) methods	
	(a) Chemical methods for analysis of milk, cream, whey and exudate	266
	(b) Chemical methods for analysis of curd and cheese	269
Appendix 4.2	Equations used to express the exudation of whey from Feta cheese	274
Appendix 4.3	Questionnaire used to evaluate Feta cheese	275
Appendix 4.4	Questionnaire used to evaluate Cream cheese	276
Appendix 5.1	(a) Brief description of equipment and accessories used during manufacture of Cream cheese	277
	(b) Procedure for homogenising and pasteurising standardised milk	278
Appendix 5.2	Manufacturing process for Cream cheese	279
Appendix 5.3	Calculations for the amount of water to be added to or removed from curd for adjustment of moisture prior to processing	281
Appendix 5.4	Composition of standardised milks used for cheese manufacture with respect to the selected manufacturing variables	282
Appendix 5.5	(a) Statistical technique used for the test of significance of the manufacturing variables	283
	(b) Example showing application of Chi-squared test of significance	284
Appendix 5.6	Calculations for adjustment of curd to a constant MNFS	285
Appendix 5.7	Composition of standardised milk with respect to the manufacturing variables	286
Appendix 5.8	Effect of manufacturing variables on the composition of whey and fines lost in whey	287
Appendix 5.9	Effect of manufacturing variables on the composition of curd	288
Appendix 5.10	Effect of manufacturing variables on the mean scores of sensory parameters of cheeses	289

Appendix 6.1	Equipment and accessories used for manufacture of Feta cheese	290
Appendix 6.2	Manufacturing process for Feta cheese	291
Appendix 6.3	Effect of manufacturing variables on the composition of whey	292
Appendix 6.4	Effect of selected manufacturing variables on composition of Feta cheese after six months of storage at 10 °C	293
Appendix 6.5	Effect of manufacturing variables on the mean scores of sensory parameters of cheese	294
Appendix 7.1	An example showing calculations for the preparation of cheesemilk	295
Appendix 7.2	Composition of cheesemilk with respect to the process treatments	296
Appendix 7.3	Effect of process treatments on the composition of whey	297
Appendix 7.4	Effect of process treatments on the composition of cheese before brining	298
Appendix 7.5	Effect of process treatments on the composition of cheese at four weeks	299
Appendix 7.6	Effect of process treatments on the composition of exudate from four week old cheese	300
Appendix 7.7	Effect of process treatments on the mean scores of sensory parameters of cheeses	301
Appendix 7.8	(a) Data on quantities of input and output material, the calculated values of mass balance, yields and recoveries of the milk solids for all the trials	303
	(b) An example of mass balance calculation : mass balance of protein in trial no 2	305
	(c) Effect of process treatments on the mass balance of selected milk constituents for each trial	306
	(d) Justification for the variations in the mass balances of milk components	307

Appendix 7.9	Comparison of theoretical estimates of ratio of β -lactoglobulin to para- κ -casein (approximate estimates) with the observed ratios in cheeses incorporated with denatured whey protein	310
Appendix 8.1	Effect of homogenisation and source of milk solids on the mean scores of sensory parameters of eight week old Feta cheeses	312
Appendix 8.2	Composition of cheesemilks with respect to the experimental variations	313
Appendix 8.3	Effect of homogenisation and source of milk solids on the composition of whey	314
Appendix 8.4	Effect of homogenisation and source of milk solids on the composition of Feta cheese (before brining)	315
Appendix 8.5	Effect of homogenisation and source of milk solids on the composition of Feta cheese (after brining)	315
Appendix 8.6	Effect of homogenisation and source of milk solids on the composition of Feta cheese at three weeks	316
Appendix 8.7	Effect of homogenisation and source of milk solids on the composition of exudate from three weeks old Feta cheese	318
Appendix 8.8	Calculations for preparation of cheesemilk	319
Appendix 8.9	(a) Effect of use of emulsifying agents on the mass balance of fat during cheesemaking (b) Effect of use of emulsifying agents on the fat recovery based on input (milk) or output (cheese & whey)	320
Appendix 8.10	Effect of use of emulsifying agents on the mean sensory scores of eight week old Feta cheese	321
Appendix 8.11	Composition of cheesemilks for cheeses made with different emulsifying agents	322
Appendix 8.12	Effect of emulsifying agents on the composition of whey	323
Appendix 8.13	Effect of emulsifying agents on the composition of cheese (before brining)	324

Appendix 8.14	Effect of emulsifying agents on composition of exudate from four week old Feta cheese	325
Appendix 8.15	Proteins adsorbed to surface of fat globules in Feta cheeses made using different emulsifying agents (SDS-PAGE)	326
Appendix 8.16	Calculations to determine the distance between the fat globules in Feta cheese	327
Appendix 9.1	Composition of milk for cheeses made with varying amounts of rennet	328
Appendix 9.2	Composition of whey as affected by the variation in the amount of rennet used	329
Appendix 9.3	Composition of Feta cheese (before brining) as affected by the variation in the amount of rennet used during cheesemaking	330
Appendix 9.4	Composition of Feta cheese (after brining) as affected by the variation in the amount of rennet used during cheesemaking	330
Appendix 9.5	Composition of Feta cheese (three weeks old) as affected by the variation in the amount of rennet used during cheesemaking	331
Appendix 9.6	Composition of exudate from Feta cheese (three weeks old) as affected by the variation in the amount of rennet used during cheesemaking	332
Appendix 9.7	Effect of variation in the quantity of rennet used in cheesemaking on the sensory parameters of eight weeks old cheese	333
Appendix 9.8	Approximate estimates for mass balance of rennet used in manufacture of Feta cheeses with variations in the quantity of rennet	334

ABBREVIATIONS

ANOVA	Analysis of variance
A_w	Water activity
BSA	Bovine serum albumin
cm	Centimetre
d	Day
DDM	Dairy division manual
DM	Dry matter
DTE	Dithioerythritol
EDTA	Ethylene diamine tetra-acetic acid
F	F ratio
FDM	Fat in dry matter
FFMR	Fresh frozen milkfat for recombining
FGS	Fat globule size
f.p.	Freezing point
g	Gram
GMS	Glycero mono stearate
h	Hour
HPLC	High performance liquid chromatography
HTST	High temperature short time
IDF	International Dairy Federation
kg	Kilogram
kPa	Kilopascal
L	Litre
LHSMP	Low heat skim milk powder
LSM	Least square mean
m	Metre
M	Molar concentration
MFGM	Milk fat globule membrane
mg	Milligram
min	Minute (time)
ml	Millilitre
mm	Millimetre
mMol	Millimole
MNFS	Moisture in non-fat substance
mo	Month
m.p.	Melting point
nm	Nanometre

ns	Not significant
NSLAB	Non starter lactic acid bacteria
NZDRI	New Zealand Dairy Research Institute
PAGE	Poly acrylamide gel electrophoresis
P/F	Protein/fat
ppm	Parts per million
psi	Pounds per square inch
rpm	Revolutions per minute
RSM	Reconstituted skim milk
RU	Rennet unit
s	Second (time)
S.D.	Standard deviation
SDS	Sodium dodecyl sulphate
SES	Simulated external solution
S/M	Salt/moisture
SMP	Skim milk powder
SNF	Solids-not-fat
TN	Total nitrogen
TS	Total solids
UF	Ultrafiltration
UHT	Ultra-high temperature
wk	Week
WPC	Whey protein concentrate
WPNI	Whey protein nitrogen index
wt	Weight
w/v	Weight/volume
v/v	Volume/volume
w/w	Weight/weight
α -	Alpha-
β -	Beta-
κ -	Kappa-
°C	Degree Celsius (Centigrade)
μ m	Micrometre
%	Per centum
>	Greater than
\geq	Greater than or equal to; not less than
<	Less than
\leq	Less than or equal to; not greater than