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THE EFFECT OF pH SHIFT
ON EARLY CHEESE MATURATION

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ABSTRACT

During the first few weeks of maturation, the texture of Cheddar-like cheeses changes substantially from an elastic material, often containing strongly oriented protein fibres from which some moisture can be expelled readily, to a uniform smooth-bodied cheese. In the past, proteolysis, particularly the cleavage of α_{s1} -casein, has been invoked as an important factor in the early changes in cheese texture. However, some of the textural changes that occur early in cheese maturation may be related to the redistribution of water within the cheese matrix. To examine this, a model cheese curd system was devised and explored.

Initially, cheese curd was prepared using starter and chymosin and the curd pH was controlled by varying the draining and salting pH values. The changes in water distribution, as measured by the quantity of centrifugal serum, seemed to be influenced by the cheese pH, but this could not be confirmed because of the continuing changes in cheese pH. Substitution of starter by dilute lactic acid to alter the pH value at setting provided a means of controlling the cheese pH during the 2-week periods of study. In some trials, glucono- δ -lactone (GDL) was used to reduce the pH of the cheese to the desired level after curd manufacture. This simulated the time-dependent pH change in a normal cheese such that the effects on the water-holding capacity, microstructure and rheological properties of the cheese could be studied. This model system of cheesemaking proved to be very effective in adjusting the pH of the cheese to the desired level. In the protocol finally adopted, milk was acidified with lactic acid and coagulated with Rennilase 46L[®]. After cheddaring, salting and light pressing, the curd was finely diced and mixed with GDL to give curd samples with comparable moisture contents and similar minimal casein proteolysis rates but different pH values.

The quantity of centrifugal serum decreased with a decrease in the set pH of cheese curds between pH 6.30 and pH 5.30. The maximum quantity was obtained from cheese curd set at pH 6.30 whereas no serum could be centrifuged from cheese curds set at pH 5.70 or lower. The quantity of centrifugal serum was essentially constant with time for

cheese curds of all set pH values. Lowering of the pH of cheese curds from the set pH by the addition of GDL also affected the quantity of centrifugal serum which decreased with a decrease in the adjusted pH value of the samples. The quantity of serum also decreased with time for all samples with adjusted pH values, the decrease being more rapid for samples with lower pH values.

The set pH was also found to influence the rheological characteristics of the cheese curds. Both the maximum force, from the large strain method developed for this project (Instron), and G' (stiffness), from the small strain method (Bohlin), showed a maximum for cheese curd with a pH of 5.90. The values for maximum force of cheese curds adjusted to lower pH values using GDL were in the same range as those of cheese curds of a similar set pH value. This suggested that the samples tended to attain a new rheological equilibrium with time that was consistent with the conditions of the lower pH value.

The microstructure of the cheese curds seemed to be determined by the pH at setting as changes in structure were apparent when cheese curds were made at different set pH values but not when the pH was altered from the set pH value using GDL. The changes resulting from the alteration in pH may have been too subtle for detection by the confocal microscopy technique used. Micrographs of cheese curds from which a serum phase could be centrifuged appeared to be less compact and had open spaces in the structure where water may have been present. Such areas were absent from the micrographs of cheese curd samples from which no centrifugal serum was obtained.

Overall, the present study showed that changes with time in the quantity of centrifugal serum, microstructure and some of the rheological properties in cheese curds took place even when proteolysis was at a minimum and when the pH was essentially constant. This suggests that physical changes in the cheese curd, such as redistribution of water within the cheese curd, are also important during the initial stages of ripening and probably contribute to the differences in rheological properties observed in young cheese.

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CONTENTS

Abstract	i
Acknowledgements	iii
List of tables	xii
List of figures	xv
List of abbreviations	xviii
1.0 INTRODUCTION	1
2.0 REVIEW OF LITERATURE	5
2.1 THE PROCESS OF CHEESE MANUFACTURE	5
2.1.1 Cheddar cheese manufacture	6
2.1.2 Cheshire cheese manufacture	11
2.1.3 Mozzarella cheese manufacture	11
2.2 MILK COAGULATION AND CURD SYNERESIS	14
2.2.1 The mechanism of gel formation	14
2.2.2 Effect of pH on coagulum composition	15
2.2.3 Cheesemaking by chemical acidification	16
2.2.4 Syneresis of cheese curd	18
2.2.4.1 Factors affecting the rate of syneresis	20
2.3 CHEDDARING AND SALTING	22
2.3.1 Changes during cheddaring of cheese curd	22
2.3.2 Heating and stretching of Mozzarella curd	23
2.3.3 Salting of cheese curd	24

2.3.3.1	Salting of Cheddar cheese curd	25
2.3.3.2	Factors affecting dry salting of cheese curd	25
2.3.3.3	Effect of salt on moisture content of Cheddar cheese curd	27
2.3.3.4	Brine salting of cheese curd	28
2.3.3.5	Factors affecting brine salting of cheese curd	30
2.3.3.6	Effect of brining on moisture content of Mozzarella curd	32
2.4	CHEESE RIPENING	32
2.4.1	Proteolysis during cheese ripening	33
2.4.1.1	Proteolysis due to action of chymosin	33
2.4.1.2	Proteolysis due to action of plasmin	35
2.4.1.3	Factors affecting the rate of proteolysis	37
2.4.1.4	Evaluation of proteolysis in cheese	39
2.4.2	Cheese rheology	41
2.4.2.1	Rheological changes during cheese ripening	42
2.4.2.2	Effect of pH on cheese texture	43
2.4.2.3	Rheological techniques	44
2.4.2.3.1	Static measurements	44
2.4.2.3.2	Dynamic measurements	46
2.5	DEVELOPMENT OF MICROSTRUCTURE IN CHEESE	47
2.5.1	Microscopic examination of cheese	50
2.5.2	Microscopy techniques	51
2.5.2.1	Light microscopy	51
2.5.2.2	Confocal microscopy	52
2.5.2.3	Electron microscopy	53
2.5.2.3.1	Scanning electron microscopy	53
2.5.2.3.2	Transmission electron microscopy	54
2.6	WATER IN CHEESE	54
2.6.1	Water-holding capacity of milk protein structures	56

2.6.2	Factors influencing the water content of cheese curd	58
2.6.3	Measurement of the water held in cheese curd	58
3.0	OBJECTIVES	60
4.0	MATERIALS AND METHODS	61
4.1	MATERIALS	61
4.2	METHODS	61
4.2.1	Cheesemaking	61
4.2.1.1	Cheesemaking with starter and chymosin	62
4.2.1.2	Cheesemaking by chemical acidification	62
4.2.1.3	Cheesemaking by chemical acidification and addition of GDL	63
4.2.2	Chemical analyses of cheese curd and centrifugal serum	63
4.2.3	Polyacrylamide gel electrophoresis (PAGE)	65
4.2.4	Centrifugation of cheese curd	66
4.2.5	Rheological analyses of cheese samples	67
4.2.5.1	Large strain deformation testing of cheese curd	67
4.2.5.1.1	Rheological measurements using the TAHD texture analyser	67
4.2.5.1.2	Rheological measurements using the Instron Universal Testing Machine	68
4.2.5.2	Small strain deformation testing of cheese curd using a Bohlin constant stress rheometer	68
4.2.6	Confocal microscopic examination of cheese	70
4.2.6.1	Confocal microscopic examination of the water phase in cheese	71

5.0	RESULTS	73
5.1	AN EXPLORATORY STUDY OF CHEDDAR, MOZZARELLA AND CHESHIRE CHEESES MADE USING STANDARD MANUFACTURING PROTOCOLS	73
5.1.1	Introduction	73
5.1.2	Composition of cheeses	73
5.1.3	Centrifugation of cheese	75
5.1.4	Changes in composition of centrifugal sera	75
5.1.5	Conclusions	78
5.2	STUDY OF CHEDDAR-LIKE CHEESES MADE AT DIFFERENT DRAINING AND SALTING pH VALUES	79
5.2.1	Introduction	79
5.2.2	Composition of cheeses	79
5.2.3	Centrifugation of cheese	80
5.2.4	Changes in composition of centrifugal pellet and centrifugal serum	81
5.2.5	Conclusions	84
5.3	STUDY OF CHEESE CURDS MADE WITH DIFFERENT SET pH VALUES	85
5.3.1	Introduction	85
5.3.2	Composition of cheese curds	85
5.3.3	Changes in composition of cheese curds, centrifugal pellet and centrifugal serum	86
5.3.4	Microscopic examination of cheese structure	89
5.3.5	Conclusions	90
5.4	STUDY OF CHEESE CURDS ADJUSTED TO DIFFERENT pH VALUES BY THE ADDITION OF GDL	93
5.4.1	Introduction	93

5.4.2	Composition of cheese curds	93
5.4.3	Changes in composition of cheese curds, centrifugal pellet and centrifugal serum	94
5.4.4	Microscopic examination of cheese structure	97
5.4.5	Conclusions	99
5.5	EVALUATION BY VARIOUS TECHNIQUES OF CHEESE CURDS MADE WITH DIFFERENT SET pH VALUES	100
5.5.1	Introduction	100
5.5.2	Composition of cheese curds	100
5.5.3	Changes in composition of cheese curds and centrifugal sera	100
5.5.4	Rheological properties of cheese curds	103
5.5.4.1	Large strain deformation studies	103
5.5.4.1.1	Evaluation using the TAHD texture analyser	103
5.5.4.1.2	Evaluation using the Instron Universal Testing Machine	105
5.5.4.2	Small strain deformation studies	105
5.5.5	Conclusions	107
5.6	EVALUATION BY VARIOUS TECHNIQUES OF CHEESE CURDS ADJUSTED TO DIFFERENT pH VALUES USING GDL	108
5.6.1	Introduction	108
5.6.2	Composition of cheese curds	108
5.6.3	Changes in composition of cheese curds and centrifugal sera	108
5.6.4	Rheological properties of cheese curds	111
5.6.4.1	Large strain deformation studies	111
5.6.4.2	Small strain deformation studies	112
5.6.5	Conclusions	114
5.7	SUMMARY OF RESULTS AND THE PLAN FOR THE FINAL TRIAL	115

5.8	STUDY OF CHEESE CURDS MADE WITH DIFFERENT SET pH VALUES AND ADJUSTED TO DIFFERENT pH VALUES BY THE ADDITION OF GDL	117
5.8.1	Introduction	117
5.8.2	Composition of cheese curds	118
5.8.3	Changes in composition of cheese curds and centrifugal sera	122
5.8.4	Large strain deformation studies of the rheological properties of cheese curds	126
5.8.5	Microscopic examination of cheese curds	127
5.8.6	Conclusions	134
5.9	STAINING AND OBSERVATION OF THE WATER PHASE IN CHEESE	136
5.9.1	Introduction	136
5.9.2	Microscopic examination of cheese curd	136
5.9.3	Conclusions	138
6.0	DISCUSSION	139
6.1	INTRODUCTION	139
6.2	CHANGES IN THE QUANTITY OF CENTRIFUGAL SERUM	143
6.3	CHANGES IN RHEOLOGICAL PROPERTIES OF CHEESE CURDS .	146
6.4	CHANGES IN CHEESE MICROSTRUCTURE	150
6.5	GENERAL DISCUSSION	151

6.6	CONCLUSIONS	153
6.7	SCOPE FOR FUTURE WORK	154
7.0	REFERENCES	156
8.0	PUBLICATION	179

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page No.</u>
5.1.1	Compositions on day 1 of the standard Cheddar, Mozzarella and Cheshire cheeses	74
5.1.2	Changes in composition of Mozzarella cheese and its centrifugal serum with time	76
5.1.3	Changes in composition of Cheshire cheese and its centrifugal serum with time	77
5.2.1	Changes in composition of the cheese made with a draining pH of 5.9 and a salting pH of 5.6 and its centrifugal pellet and serum	80
5.2.2	Changes in composition of the cheese made with a draining pH of 5.9 and a salting pH of 5.3 and its centrifugal pellet and serum	81
5.2.3	Composition of the cheeses made with a draining pH of 5.6 and salting pH values of 5.3 and 5.0 and their centrifugal sera	82
5.3.1	Compositions of the standard Cheddar cheese and the cheese curds made with different set pH values	86
5.3.2	Changes in composition of the cheese curd made with a set pH of 6.00 and its centrifugal pellet and serum	87
5.3.3	Changes in composition of the cheese curd made with a set pH of 5.70 and its centrifugal pellet and serum	88
5.4.1	Composition on day 1 of the cheese curd of set pH 5.90 to which GDL was added to alter the pH	94

<u>Table No.</u>	<u>Title</u>	<u>Page No.</u>
5.4.2	Composition of cheese curds and centrifugal sera of the curd samples adjusted from pH 5.90 to different pH values with GDL	95
5.5.1	Composition on day 1 of the cheese curds made with different set pH values	101
5.5.2	Changes in composition of the cheese curd made with a set pH of 6.05 and its centrifugal serum	101
5.5.3	Changes in composition of the cheese curd made with a set pH of 5.90 and its centrifugal serum	102
5.5.4	Changes in composition of the cheese curd made with a set pH of 5.75 and its centrifugal serum	102
5.5.5	Rheological evaluation of the cheese curd samples of set pH 5.90 using the TAHD texture analyser	104
5.6.1	Compositions on day 3 of the cheese curd of set pH 5.90 and of the cheese curds with altered pH values obtained from it by the addition of GDL	109
5.6.2	Composition of cheese curds and centrifugal sera of the curd samples adjusted to different pH values with GDL	110
5.8.1	Set and adjusted pH values of the cheese curds made in the final trial	118
5.8.2	Composition on day 3 of the cheese curd set at pH 6.60 and of those with added GDL	119
5.8.3	Composition on day 3 of the cheese curd set at pH 6.30 and of those with added GDL	119
5.8.4	Composition on day 3 of the cheese curd set at pH 5.90 and of those with added GDL	120
5.8.5	Composition on day 3 of the cheese curd set at pH 5.70 and of those with added GDL	120

<u>Table No.</u>	<u>Title</u>	<u>Page No.</u>
5.8.6	Composition on day 3 of the cheese curd set at pH 5.50 and of that with added GDL	121
5.8.7	Composition on day 3 of the cheese curd set at pH 5.30	121

LIST OF FIGURES

<u>Fig. No.</u>	<u>Title</u>	<u>Page No.</u>
2.1.1	Flow chart for the manufacture of standard Cheddar cheese at the NZDRI pilot plant	7
2.1.2	Flow chart for the manufacture of standard Cheshire cheese at the NZDRI pilot plant	12
2.1.3	Flow chart for the manufacture of standard Mozzarella cheese at the NZDRI pilot plant	13
4.2.1	Extrusion attachment used for the rheological evaluation of grated cheese	69
4.2.2	A typical plot of G' versus strain for the small strain deformation testing of cheese	70
5.1.1	Analyses of Cheshire cheese and its centrifugal serum using mini alkaline urea-PAGE	75
5.2.1	Changing concentrations of α_{s1} -, α_{s1} -I- and β -caseins with maturation time of centrifugal pellet and centrifugal serum from the cheese curds of different draining and salting pH values	83
5.3.1	Changing concentrations of α_{s1} -, α_{s1} -I- and β -caseins with maturation time of centrifugal pellet and centrifugal serum from the cheese curds with different set pH values	89
5.3.2	Distribution of protein in cheese as a function of the set pH	91
5.4.1	Changing concentrations of α_{s1} -, α_{s1} -I- and β -caseins with maturation time of centrifugal pellets from the cheese curds adjusted to different pH values using GDL	96

<u>Fig. No.</u>	<u>Title</u>	<u>Page No.</u>
5.4.2	Changing concentrations of α_{s1} -, α_{s1} -I- and β -caseins with maturation time of centrifugal sera from the cheese curds adjusted to different pH values using GDL	97
5.4.3	Distribution of protein in cheese as a function of the pH obtained with the addition of GDL	98
5.5.1	Effect of set pH and time on the quantity of centrifugal serum	103
5.5.2	Effect of set pH and time on the rheological properties of cheese, as determined using the Instron	105
5.5.3	Effect of set pH and time on the rheological properties of cheese, as determined using the Bohlin	106
5.6.1	Effect of pH and time on the quantity of centrifugal serum from the cheese curds adjusted to different pH values using GDL	111
5.6.2	Effect of pH and time on the rheological properties of cheese curds adjusted to different pH values using GDL, as determined using the Instron	112
5.6.3	Effect of pH and time on the rheological properties of cheese curds adjusted to different pH values using GDL, as determined using the Bohlin	113
5.8.1	Effect of pH and time on the quantity of centrifugal serum from the cheese curds made with different set pH values and also adjusted to lower pH values using GDL	123
5.8.2	Effect of pH on the quantity of centrifugal serum on days 3 and 13 after manufacture from the cheese curds made with different set pH values and also adjusted to lower pH values using GDL	124

<u>Fig. No.</u>	<u>Title</u>	<u>Page No.</u>
5.8.3	Effect of pH and time on the calcium and sodium contents of the centrifugal serum from cheese curds made with different set pH values and also adjusted to lower pH values using GDL	125
5.8.4	Effect of set pH and time on the rheological properties of cheese, as determined using the Instron	126
5.8.5	Effect of pH and time on the rheological properties of cheese curds made with different set pH values and also adjusted to lower pH values using GDL, as determined using the Instron	128
5.8.6	Changes in the distribution of fat and protein in cheese upon centrifugation	129
5.8.7	Distribution of protein in cheese as a function of the set pH	131
5.8.8	Distribution of protein in cheese as a function of the pH obtained with the addition of GDL	132
5.8.9	Distribution of fat and protein in cheese as a function of the set pH	133
5.9.1	Distribution of water in cheese	137
6.1.1	Comparison of the model systems of cheesemaking with the standard Cheddar cheesemaking process	142

LIST OF ABBREVIATIONS

a.u.	Arbitrary units
A_w	Water activity
°C	Degree Celsius
cm	Centimetre
CLSM	Confocal laser scanning microscopy
CS	Curd system
EDTA	Ethylene diamine tetra-acetic acid
FDM	Fat in dry matter
Fig.	Figure
GDL	Glucono- δ -lactone
g	Gram
Hz	Hertz
h	Hours
HPLC	High performance liquid chromatography
kg	Kilogram
l	Litre
m	Metre
μ g	Microgram
μ l	Microlitre
μ m	Micrometre
ml	Millilitre
mm	Millimetre
mmol	Millimoles
M	Molar concentration
mM	Millimolar concentration
min	minutes
MNFS	Moisture in non-fat substance
nm	Nanometre
NZDRI	New Zealand Dairy Research Institute

PAGE	Polyacrylamide gel electrophoresis
Pa	Pascals
P/F	Protein/fat
RU	Rennet units
rev/min	Revolutions per minute
s	Seconds
S/M	Salt/moisture
SEM	Scanning electron microscopy
SDS	Sodium dodecyl sulphate
TAHD	Texture analyser, heavy duty
TEM	Transmission electron microscopy
w/v	Weight/volume
w/w	Weight/weight
α	Alpha
β	Beta
γ	Gamma
δ	Delta
κ	Kappa
λ	Lambda