QUALITY ASPECTS OF FETA CHEESE MANUFACTURED FROM MIXTURES OF COW'S MILK AND GOAT’S MILK

BY
SEBOLELO PITSO

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE M INST AGRAR FOOD PROCESSING

IN THE
DEPARTMENT OF FOOD SCIENCE
FACULTY OF NATURAL, AGRICULTURAL AND INFORMATION SCIENCES
UNIVERSITY OF PRETORIA

OCTOBER, 1999
DECLARATION

I, the undersigned, hereby declared that this dissertation is my original work and has never been submitted at any university for a degree.

[Signature]
ACKNOWLEDGEMENTS

I wish to extend my sincere gratitude to all those who assisted in conducting this research. Special appreciation is due to:

- Prof. B. H. Bester (Department of Food Science, UP) for offering guidance with his ingenuity in the field of fermented milk products and dairy science and technology.

- The Department of Food Science for financial assistance.

- Mrs R. de Kock (Department of Food Science, UP) for assistance in planning for sensory evaluation and statistical analysis of the results.

- Mr J. Grimbeeck (Department of Statistics and Data Analysis, UP) for guidance in designing the project plan.

- Mr G. Duodu (Department of Food Science, UP) for technical assistance in the laboratory and statistical analysis of the results.

- My family, friends and husband, Abraham, for their love and support.

- God Almighty, for giving me strength and wisdom to cope, the baby girl I got while carrying out this research and for making my dreams a reality.
ABSTRACT

Title:- Quality Aspects of Feta Cheese Manufactured from Mixtures of Cow’s Milk and Goat’s Milk

By

Sebolelo Pitso

Study Leader:- Prof B. H. Bester
Department:- Food Science
Degree:- M Inst Agrar Food Processing

Pure goat’s milk and pure cow’s milk were analysed for microbial, physical and chemical quality. The milks were mixed in the proportions of 100% cow’s milk (treatment 1), 65% cow’s milk + 35% goat’s milk (treatment 2), 35% cow’s milk + 65% goat’s milk (treatment 3) and 100% goat’s milk (treatment 4). Feta cheese was made from these milks and the experiment was done three times (three batches in all).

Physical, chemical and microbial analysis were performed on the Feta cheeses on day 2, 7, 14 and 21 after manufacturing. Sensory evaluation of the cheeses was done only on batch 3 after ripening the cheeses for a period of 21 days.

Analysis of the Feta cheeses revealed that the treatments differed significantly (p < 0.05), especially in terms of fat content, total solids content, log total plate count (TPC), texture, pH, protein content and free fatty acids (FFA) content. Other quality aspects, namely soluble protein content, NaCl content and sensory evaluation scores did not differ significantly (p > 0.05) between treatments. The pH, log TPC, soluble protein content, FFA content, NaCl content and texture changed significantly (p < 0.05) during ripening.

The Feta cheeses made from high proportion of goat’s milk (treatments 3 and 4) had higher microbial counts, FFA content and soluble protein content than cheeses made from milk with higher proportions of cow’s milk. Although treatments 2 and
3 almost overlapped in soluble protein content, the values concerning these three quality aspects generally increased as the proportion of goat’s milk used for cheese manufacturing increased (the trend being treatment 1<2<3<4). Conversely, the pH values decreased systematically from treatment 1 to 4.

The mean fat content of the Feta cheeses increased systematically with increase in the proportion of cow’s milk, while the mean total protein content followed the reverse pattern. In all the cheeses, the lactose content was almost negligible from the second day after manufacturing. The texture analysis results fluctuated significantly with time and between the treatments and there was no logical trend found.

Despite the difference in composition and other characteristics, the acceptability of all the Feta cheeses was the same as they all received a sensory evaluation score of “like slightly”.
UITTREKSEL

Titel: - Kwaliteitsaspekte van Feta-kaas Vervaardig van Mengsels van Beesmelk en Bokmelk

Deur
Sebololo Pitso

Studieleier:- Prof B.H. Bester
Departement:- Voedselwetenskap
Graad:- M Inst Agrar Voedselprosesserings

Suiwer bokmelk en suiwes melk is ontled vir mikrobiologiese, fisiese en chemiese kwaliteite. Die melk is gemeng in die proporsies van 100 % beesmelk (behandeling 1), 65 % beesmelk + 35 % bokmelk (behandeling 2), 35 % beesmelk + 65 % bokmelk (behandeling 3) en 100 % bokmelk. Feta-kaas is gemaak van hierdie melk en die eksperiment is drie keer herhaal (altesaam drie lotte).

Fisiese, chemiese en mikrobiologiese ontedings is gedoen op die Feta-kaas op dag 2, 7, 14 en 21 na vervaardiging. Sensorsie evaluering van slegs lot 3 se kaas is gedoen na rypmaking vir 'n periode van 21 dae.

Analise van die Feta-kaas het getoon dat die behandelings beduidend van mekaar verskil het (p < 0.05), veral in terme van vetinhoud, totale vastestowwe-inhoud, log totale plaattelling (TPT), tekstuur, pH, proteïeninhoud en vrye vetsuur-inhoud (VVS). Ander kwaliteitsaspekte, naamlik oplosbare proteïeninhoud, NaCl-inhoud en punte vir sensorsie evaluering het nie beduidend (p > 0.05) verskil tussen behandelings nie. Die pH, log TPT, oplosbare proteïeninhoud, VVS-inhoud, NaCI-inhoud en tekstuur het beduidend (p < 0.05) verander gedurende rypmaking.

Die Feta-kaas gemaak van melk met 'n hoër proporsie bokmelk (behandelings 3 en 4) het hoër mikrobiologiese tellings, VVS-inhoud en oplosbare proteïeninhoud gehad as kase gemaak van melk met hoër proporsies beesmelk. Al het behandelings 2 en 3 omtrent oorvleul wat oplosbare proteïeninhoud betref, het die waardes vir hierdie drie
Kwaliteitsaspekte oor die algemeen toegeneem soos die proporsie bokmelk gebruik in die kaasvervaardiging toegeneem het (die neiging was $1<2<3<4$). In teenstelling hiermee het die pH-waardes sistematies verlaag van behandeling 1 na 4.

Die gemiddelde vetinhoud van die Feta-kaas het sistematies toegeneem met 'n toename in die proporsie beesmelk, terwyl die gemiddelde totale proteïeninhoud die omgekeerde patroon gevolg het. Die laktose-inhoud van al die kase was onbeduidend vanaf die tweede dag na vervaardiging. Die resultate van tekstuurmetings het beduidend gewissel met tyd en tussen behandelings, maar geen logiese neiging is gevind nie.

Ten spyte van die verskille in samestelling en ander eienskappe, was die aanvaarbaarheid van al die Feta-kase dieselfde en het almal 'n sensoriese evaluering van “hou effens van” gekry.
# TABLE OF CONTENTS

A. LIST OF TABLES ................................................................. i

B. LIST OF FIGURES .......................................................... ii

C. LIST OF APPENDICES .................................................... iii

1. INTRODUCTION ................................................................. 1

1.1 PROBLEM STATEMENT ................................................... 2

1.2 OBJECTIVES ................................................................. 3

2. LITERATURE REVIEW ......................................................... 4

2.1 BASIC INGREDIENTS USED FOR FETA CHEESE MANUFACTURING .... 4

2.1.1 Milk ................................................................................ 4

2.1.1.1 Total solids content ...................................................... 4

2.1.1.2 Fat content ..................................................................... 5

2.1.1.3 Protein content ............................................................. 5

2.1.1.4 Odour and flavour ......................................................... 6

2.1.1.5 Colour ........................................................................... 6

2.1.1.6 Health implications ...................................................... 6

2.1.2 Starter cultures ............................................................. 6

2.1.3 Rennet ........................................................................... 7

2.1.4 Salt ................................................................................ 8

2.2 CHEESEMAKING SCIENCE AND TECHNOLOGY ...................... 8

2.2.1 Heat treatment of milk .................................................... 8

2.2.1.1 Microbiological effect ................................................... 8

2.2.1.2 Physico-chemical effects ............................................. 9

2.2.1.3 Heating technique ......................................................... 9

2.2.2 Fermentation ................................................................. 10

2.2.2.1 Advantages of fermentation ........................................ 10

2.2.2.2 Lactic acid fermentation .............................................. 10

2.2.2.3 Citric acid fermentation .............................................. 11

2.2.3 Curd formation ............................................................. 13
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.3.1 Acid curd formation</td>
<td>13</td>
</tr>
<tr>
<td>2.2.3.2 Rennet coagulation</td>
<td>14</td>
</tr>
<tr>
<td>2.2.3.3 Structure of the curd</td>
<td>16</td>
</tr>
<tr>
<td>2.2.4 Cutting of the curd</td>
<td>17</td>
</tr>
<tr>
<td>2.2.4.1 Cutting technique</td>
<td>17</td>
</tr>
<tr>
<td>2.2.4.2 The impact of cutting</td>
<td>18</td>
</tr>
<tr>
<td>2.2.5 Salting</td>
<td>18</td>
</tr>
<tr>
<td>2.2.6 Ripening</td>
<td>20</td>
</tr>
<tr>
<td>2.2.6.1 Lipolysis</td>
<td>20</td>
</tr>
<tr>
<td>2.2.6.2 Proteolysis</td>
<td>21</td>
</tr>
<tr>
<td>2.2.6.3 Flavour components</td>
<td>23</td>
</tr>
<tr>
<td>2.3 DEVELOPMENTS IN FETA CHEESEMAKING</td>
<td>23</td>
</tr>
<tr>
<td>2.3.1 Ultra filtration and reverse osmosis</td>
<td>24</td>
</tr>
<tr>
<td>2.3.2 Skim Milk Retentate powder</td>
<td>24</td>
</tr>
<tr>
<td>2.3.3 Low heat skim milk powder and anhydrous milk fat</td>
<td>25</td>
</tr>
<tr>
<td>2.3.4 Bleaching of the milk fat</td>
<td>26</td>
</tr>
<tr>
<td>2.3.4.1 High temperature bleaching</td>
<td>26</td>
</tr>
<tr>
<td>2.3.4.2 Chemical Bleaching</td>
<td>26</td>
</tr>
<tr>
<td>2.3.5 Other non-dairy additives</td>
<td>26</td>
</tr>
<tr>
<td>2.3.5.1 Coagulants and coagulation catalyst</td>
<td>26</td>
</tr>
<tr>
<td>2.3.5.2 Lipolytic agents</td>
<td>27</td>
</tr>
<tr>
<td>2.3.6 Low fat version of Feta cheese</td>
<td>28</td>
</tr>
<tr>
<td>2.3.7 Rennet substitutes</td>
<td>29</td>
</tr>
<tr>
<td>3. MATERIALS AND METHODS</td>
<td>30</td>
</tr>
<tr>
<td>3.1 MILK</td>
<td>30</td>
</tr>
<tr>
<td>3.1.1 Procurement</td>
<td>30</td>
</tr>
<tr>
<td>3.1.2 Sampling</td>
<td>30</td>
</tr>
<tr>
<td>3.1.3 Fat content</td>
<td>30</td>
</tr>
<tr>
<td>3.1.4 Protein content</td>
<td>30</td>
</tr>
<tr>
<td>3.1.5 pH</td>
<td>31</td>
</tr>
<tr>
<td>3.1.6 Titratable acidity</td>
<td>31</td>
</tr>
</tbody>
</table>
4.2.10 Total plate count ................................................................. 52
4.2.11 Sensory Evaluation ............................................................. 53
4.2.12 Lactose ............................................................................... 53

5. DISCUSSION ........................................................................... 54

6. CONCLUSIONS AND RECOMMENDATIONS ......................... 64

7. REFERENCES .......................................................................... 66
A. LIST OF TABLES

Table 1.1  Chemical composition of Feta cheese .................................................. 2
Table 2.1  Proximate composition of goat’s milk and cow’s milk ............................. 4
Table 2.2  Plants giving extracts that will coagulate milk ..................................... 27
Table 4.1  Composition and properties of cow’s milk and goat’s milk used for making
three batches of Feta cheese ............................................................................. 39
Table 4.2  P-values for the Feta cheeses .................................................................. 40
Table 4.3  Soluble protein content of the Feta cheeses during ripening .................... 44
Table 4.4  Texture of the Feta cheese from treatment 1, 2, 3 and 4 during ripening ..... 46
Table 4.5  pH of the Feta cheese from treatment 1, 2, 3 and 4 during ripening .......... 48
Table 4.6  Salt content of the Feta cheese from treatment 1, 2, 3 and 4 during ripening ... 50
Table 4.7  Hedonic score of sensory evaluation of the Feta cheeses ...................... 53
B. LIST OF FIGURES

Figure 2.1 Fermentation of lactose.......................................................... 12
Figure 2.2 Ripe Feta cheese...................................................................... 12
Figure 2.3 Pathway for the metabolism of citrate................................... 13
Figure 2.4 Acid curd formation................................................................. 14
Figure 2.5 Model of casein micelles.......................................................... 14
Figure 2.6 Schematic presentation of the attack by chymosin on casein micelles 15
Figure 2.7 Structure of a cheese curd....................................................... 16
Figure 2.8 Effect of seasonal variation of casein to fat ratio on the texture of cheese 17
Figure 2.9 Cheese curd cutting operation................................................. 18
Figure 2.10 Principal factors that affect salt uptake.............................. 19
Figure 2.11 Breakdown of casien during cheese ripening.................... 22
Figure 3.1 Summary of Feta cheesemaking.......................................... 33
Figure 3.2 Evaluation sheet used for sensory evaluation...................... 36
Figure 4.1 The mean fat content of Feta cheese from treatment 1, 2, 3 and 4 41
Figure 4.2 Effect of ripening of the free fatty acids content of the Feta cheese from treatment 1, 2, 3 and 4.......................................................... 42
Figure 4.3 The mean protein content of Feta cheese from treatment 1, 2, 3 and 4 43
Figure 4.4 Change in soluble protein content of the Feta cheeses during ripening........ 44
Figure 4.5 The mean total solids content of the Feta cheese from treatment 1, 2, 3 and 4 45
Figure 4.6 Effect of ripening on the texture of Feta cheese from treatment 1, 2, 3 and 4 47
Figure 4.7 Changes in pH of the Feta cheese from treatment 1, 2, 3 and 4 during ripening 49
Figure 4.8 The mean salt content of the Feta cheeses from treatment 1, 2, 3 and 4........ 52
Figure 4.9 Effect of ripening on the microbiological loads of the Feta cheese from treatment 1, 2, 3 and 4.......................................................... 53
C. LIST OF APPENDICES

Appendix A  Quality aspects of Feta cheeses made from different proportions of cow's milk and goat's milk ................................................................. 74

Appendix B  An example of representative results produced by the texture analyser TA-XT2 ................................................................. 75