4. RESULTS

4.1 THE MILK USED IN THE EXPERIMENTS

Table 4.1 shows the composition and properties of cow's milk and goat's milk used for making the Feta cheeses. The cow's milk had higher percentanges of protein, fat, lactose and total solids, and also had better microbiological quality than the goat's milk. The two milks had almost the same pH and titratable acidity.

Statistically, the two milks differed significantly ($p \leq 0.05$) in fat content, total solids content, lactose content and log total plate count; but there was no marked difference in protein content, pH and titratable acidity.

Table 4.1: Composition and properties of cow's milk and goat's milk used for making three batches of Feta cheese

Milk Type	Batch	Proteins (%)	Fats (%)	Total solids (%)	pH	Titratable Acidity (%)	Lactose (%)	Log Total Plate Count
Cow's milk	1	3.44	3.93	14.36	6.74	.0.21	4.53	3.51
	2	3.32	3.77	12.39	6.72	0.14	4.80	2.66
	3	3.39	4.17	13.30	6.72	0.14	4.67	2.49
	*Means	3.38	3.96	13.35	6.73	0.17	4.67	2.89
	**SD.	0.07	0.19	1.01	0.05	0.04	0.12	0.61
Goat's milk	1	2.88	3.40	10.13	6.73	0.19	4.27	2.31
	2	3.57	3.07	11.34	6.66	0.15	4.60	4.86
	3	3.37	3.00	10.77	6.70	0.16	4.37	2.64
	*Means	3.27	3.16	10.75	6.70	0.17	4.41	3.27
	**SD	0.32	0.20	0.54	0.05	0.02	0.15	1.59
	***P-value	0.3397	0.0000	0.0000	0.1764	0.9357	0.0013	0.04911

*Means = Mean values for milk used in June (Batch 1), September (Batch 2) and November (Batch 3).

**SD = Standard deviation

***(P-values) = Differences were significant where $p \leq 0.05$

4.2 FETA CHEESES

4.2.1 Chemical, physical and microbiological aspects of the Feta cheeses

Table 4.2 summarises the degree of difference (p-values) between cheese treatments (cheese made from different proportions of cow's milk and goat's milk) as well as the impact of ripening on the cheeses. The four Feta cheese treatments differed significantly ($p \leq 0.05$) in all aspects except soluble protein content, salt content and sensory properties. Moreover, pH, log total plate count, soluble protein content, free fatty acids, salt content and texture of the cheeses changed significantly during ripening.

Table 4.2 P-values for the Feta cheeses

Variables	Treatment effect*	Day effect**
pH	0.0000	0.0000
Log Total plate count	0.0402	0.0004
Fat content	0.0000	0.3213
Soluble protein content	0.0902	0.0000
Total solids content	0.0000	0.0617
Free fatty acids content	0.0002	0.0000
Protein content	0.0000	0.5527
NaCl content	0.8487	0.0018
Texture	0.0081	0.0000
Sensory score	0.5106	N/A***

Treatment effect * = Effect of using different portions of cow's milk and goat's milk

Day effect** = Changes in the composition of Feta cheese during ripening (10°C for 21 days).

N/A***= Not applicable

4.2.2 Fat content

The fat content of all the treatments (Table 4.2) fluctuated only slightly during ripening, but the fluctuations were not statistically significant ($p = 0.3213$). However, the fat content differed significantly ($p = 0.0000$) between the treatments. This is clearly illustrasted in Figure 4.1, where fat content decreased systematically from treatments 1 through to 4 ($1 > 2 > 3 > 4$). The raw data is given in appendix A.

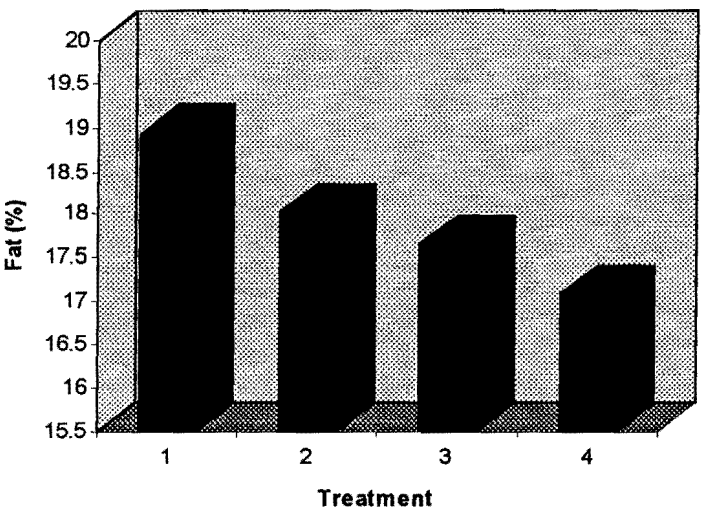

Figure 4.1: The mean fat content of Feta cheese from treatments 1, 2, 3 and 4 (Treatment 1 = 100% cow's milk; Treatment 2 = 65% cow's milk + 35% goat's milk; Treatment 3 = 35% cow's milk + 65% goat's milk; Treatment 4 = 100% goat's milk)

4.2.3 Free fatty acids

The free fatty acids (FFA) content of the Feta cheese from all the four treatments increased significantly ($p = 0.0000$) from day 2 to day 21 of the ripening period (Table 4.2). The values of FFA content also differed significantly ($p = 0.0002$) between the treatments. Treatment 4 had highest values, treatment 1 had the lowest and those for treatment 2 and 3 almost overlapped (Figure 4.2). The raw data is shown in appendix A.

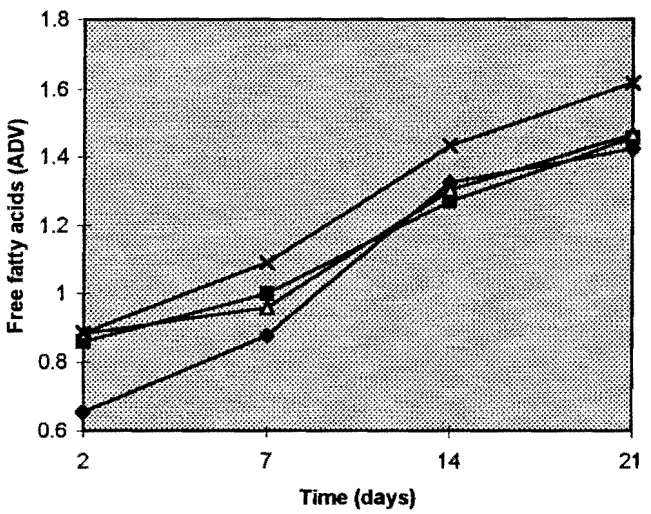

Figure 4.2: Effect on ripening on the free fatty acids content of the Feta cheeses from Treatment 1 (◆:100% cow's milk); Treatment 2 (■:65% cow's milk + 35% goat's milk); Treatment 3 (Δ:35% cow's milk + 65% goat's milk) and Treatment 4 (✖: 100% goat's milk).

4.2.4 Total Proteins

The protein content of the Feta cheeses did not change significantly ($p = 0.5527$) during ripening (Table 4.2), but there was a significant difference ($p = 0.0000$) between treatments. Figure 4.3 indicates that treatment 4 had the highest protein content, followed by treatment 3, whilst treatment 1 and 2 had almost equal values for protein content. The raw data is shown in appendix A.

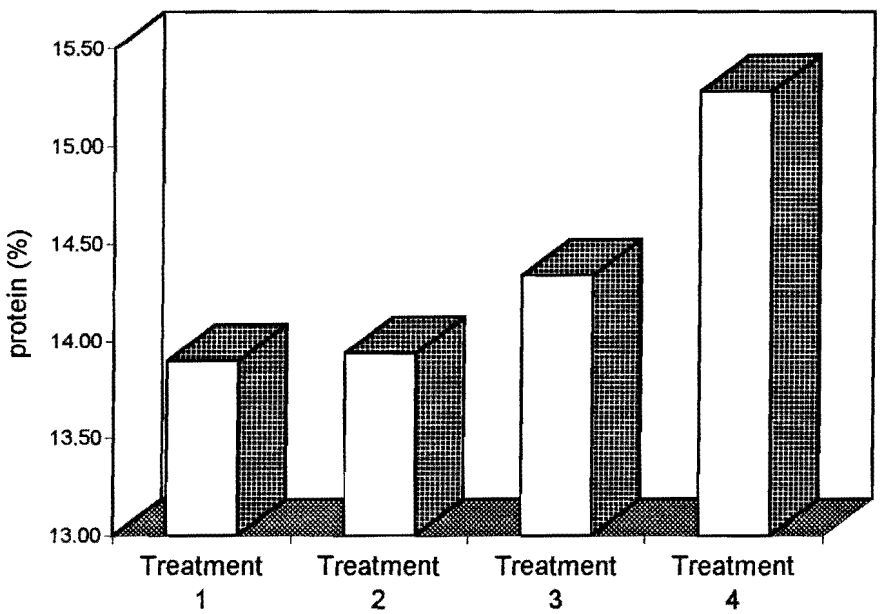

Figure 4.3: The mean protein content of Feta cheeses from treatment 1, 2, 3 and 4 (Treatment 1 = 100% cow's milk; Treatment 2 = 65% cow's milk + 35% goat's milk; Treatment 3 = 35% cow's milk + 65% goat's milk; Treatment 4 = 100% goat's milk)

4.2.5 Soluble proteins

According to Table 4.3 the soluble protein content of the Feta cheeses ranged between 1.50% and 1.85% on day 2, and between 2.89% and 3.08% on day 21. Statistically, there was no significant difference ($p = 0.0907$) between the treatments (Table 4.2), but the values increased significantly ($p = 0.0000$) during ripening (Figure 4.5).

Table 4.3: Soluble protein content of the Feta cheeses during ripening

Treatments*	Day 2	Day 7	Day 14	Day 21
1	1.82% (0.27)**	1.76% (0.48)	2.40% (0.34)	2.94% (0.48)
2	1.73% (0.18)	1.70% (0.21)	2.57% (0.52)	2.98% (0.22)
3	1.85% (0.12)	2.08% (0.46)	2.72% (0.47)	2.89% (0.25)
4	1.50% (0.44)	2.19% (0.47)	2.94% (0.41)	3.08% (0.38)

Treatments*: 1 (100% cow's milk), 2 (65% cow's milk + 35% goat's milk), 3 (35% cow's milk + 65% goat's milk) and 4 (100% goat's milk).

** = Figures in brackets are standard deviations

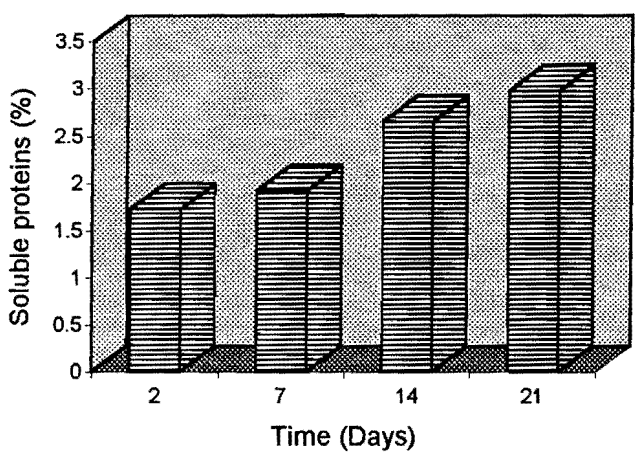

Figure 4.4: Change in soluble protein content of the Feta cheeses during ripening

4.2.6 Total solids

From Table 4.2 it can be seen that the total solids content of the Feta cheeses did not change significantly (p = 0.0617) during ripening. However, there was a significant difference (p = 0000) between the treatments (Figure 4.5). Although the values differed significantly between the treatments, the degree of difference between treatments 1, 3 and 4 was slightly smaller than that between treatment 2 and the other three (raw data is shown in appendix A).

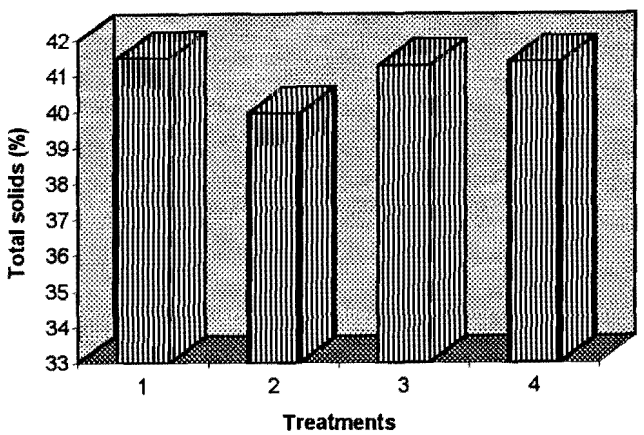

Figure 4.5: The mean total solids content of Feta cheese from treatment 1 (100% cow's milk), treatment 2 (65% cow's milk + 35% goat's milk), treatment 3 (35% cow's milk + 65% goat's milk) and treatment 4 (100% goat's)

4.2.7 Texture

Table 4.4 shows the measure of ease with which the cheese could be penetrated or the force (in N) which the cheese could withstand before breaking. The values ranged between 0.85 N and 1.66 N, and fluctuated with time. According to Figure 4.6, the results did not show any particular trend regarding the different Feta cheese treatments. An example of representative results produced by the texture analyser TA-XT2 is shown in appendix B.

Table 4.4: Texture of the Feta cheese from treatments 1, 2, 3 and 4 during ripening

Treatments*	**Day 2**	**Day 7**	**Day 14**	**Day 21**
1	1.57 N (0.44)**	1.24 N (0.56)	1.66 N (0.41)	1.55 N (0.88)
2	1.40 N (0.51)	1.46 N (0.46)	0.85 N (0.65)	1.22 N (0.43)
3	1.35 N (0.45)	1.48 N (0.87)	0.96 N (0.39)	1.07 N (0.56)
4	1.16 N (0.88)	1.35 N (0.48)	1.24 N (0.43)	0.95 N (0.90)

Treatments*: 1 (100% cow's milk), 2 (65% cow's milk + 35% goat's milk), 3 (35% cow's milk + 65% goat's milk) and 4 (100% goat's milk).

** = Figures in brackets are standard deviations

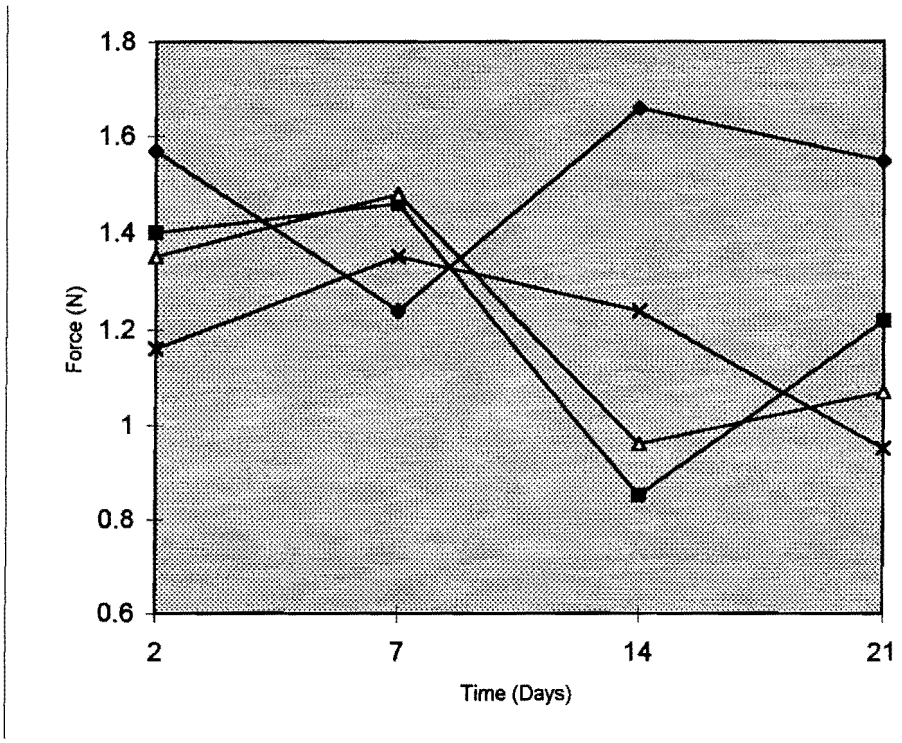

Figure 4.6: Effect of ripening on the texture of Feta cheese from treatment 1 (◆: 100% cow's milk); treatment 2 (■: 65% cow's milk + 35% goat's milk); treatment 3 (△: 35% cow's milk + 65% goat's milk) and treatment 4 (✖: 100% goat's milk)

4.2.8 pH

The pH values of the Feta cheeses are given in Table 4.5. Generally the pH decreased significantly ($p = 0.0000$) from day 2 to day 21 (Table 4.2), although the pattern of change differed with treatments (Figure 4.7). A significant difference ($p = 0.0000$) was observed between the treatments (Table 4.2), where treatment 4 had significantly lower pH values than treatment 1, 2 and 3 (Figure 4.7).

Table 4.5: pH of Feta cheese treatments 1, 2, 3 and 4 during ripening

Treatments*	Day 2	Day 7	Day 14	Day 21
1	4.68 (0.07)**	4.67 (0.08)	4.66 (0.09)	4.62 (0.08)
2	4.64 (0.07)	4.67 (0.08)	4.66 (0.09)	4.58 (0.09)
3	4.67 (0.11)	4.68 (0.09)	4.66 (0.08)	4.61 (0.08)
4	4.62 (0.07)	4.63 (0.06)	4.64 (0.07)	4.63 (0.07)

Treatments*: 1 (100% cow's milk), 2 (65% cow's milk + 35% goat's milk), 3 (35% cow's milk + 65% goat's milk) and 4 (100% goat's milk).

** = Figures in brackets are standard deviations

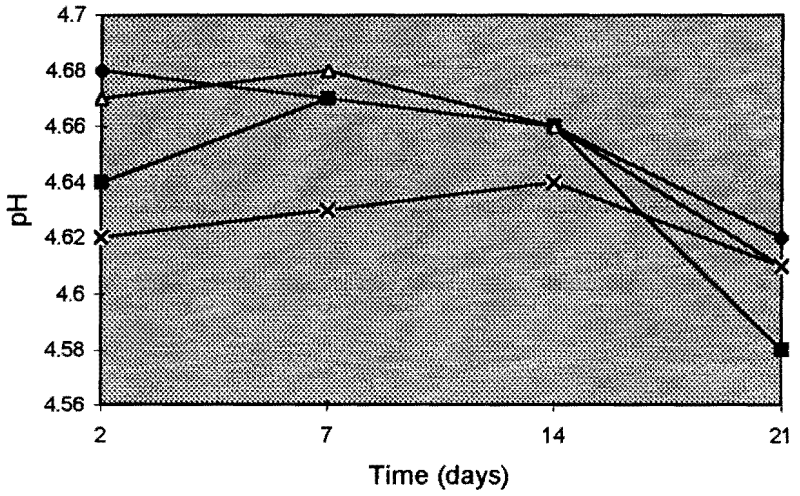

Figure 4.7: Changes in pH of Feta cheese from treatment 1 (◆: 100% cow's milk); treatment 2 (■: 65% cow's milk + 35% goat's milk); treatment 3 (△: 35% cow's milk + 65% goat's milk) and treatment 4 (✖: 100% goat's milk) during ripening

4.2.9 Salt content

The salt content of the Feta cheeses was significantly (p = 0.0018) affected by ripening time (Table 4.2). Generally, the values increased substantially from day 2 to day 14, and remained almost constant between day 14 and day 21. However, the magnitude of change was much greater between day 2 and 7 than between day 7 and 14 (Table 4.6). The p-value of 0.8784 (Table 4.2) indicates that there was no significant difference between the treatments (Figure 4.8). The average salt content ranged between 3.93% and 4. 01%.

Table 4.6: Salt content of Feta cheese from treatment 1, 2, 3 and 4 during ripening

Treatments*	**Day 2**	**Day 7**	**Day 14**	**Day 21**
1	3.88% (0.50)**	4.00% (0.48)	4.09% (0.77)	4.11% (0.40)
2	3.84% (0.87)	3.93% (1.12)	3.96% (1.11)	4.00% (0.29)
3	3.70% (0.85	4.04% (0.34)	4.10% (0.67)	4.08% (0.33)
4	3.71% (1.06)	3.98% (0.43	4.04% (0.52)	4.07% (0.80)

Treatments*: 1 (100% cow's milk), 2 (65% cow's milk + 35% goat's milk), 3 (35% cow's milk + 65% goat's milk) and 4 (100% goat's milk).

** = Figures in brackets are standard deviations.

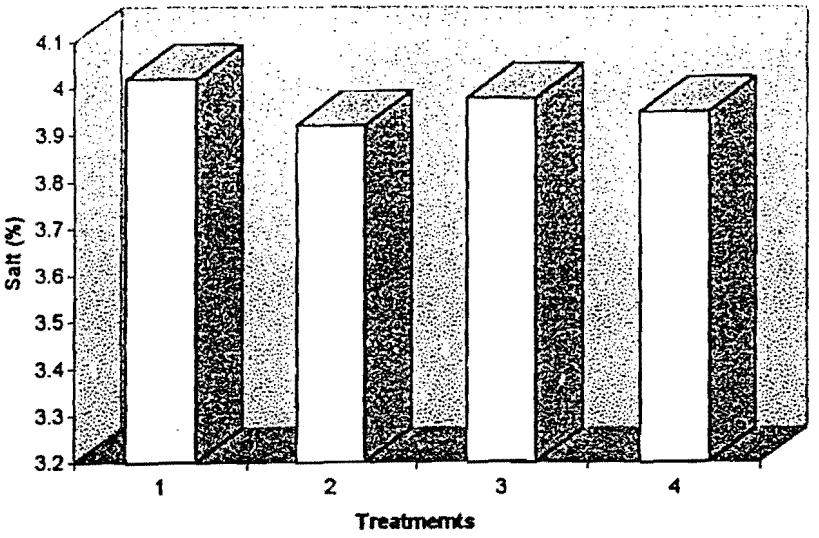

Figure 4.8: The mean salt content of the Feta cheeses from treatment 1 (100% cow milk), treatment 2 (65% cow's milk + 35% goat's milk), treatment 3 (35% cow's milk + 65% goat's milk) and treatment 4 (100% goat's)

4.2.10 Total plate count

The results of the microbial load of the Feta cheeses are given in log total plate count (log TPC). All the cheeses showed a significant ($p = 0.0004$) increase in log TPC values with time. Treatment 4 had the smallest magnitude of change compared to the other three treatments (Figure 4.9). There was also a marked difference ($p = 0.0402$) in log TPC between the treatments, the values having increased systematically from treatment 1 to 4. The raw data is given in appendix A.

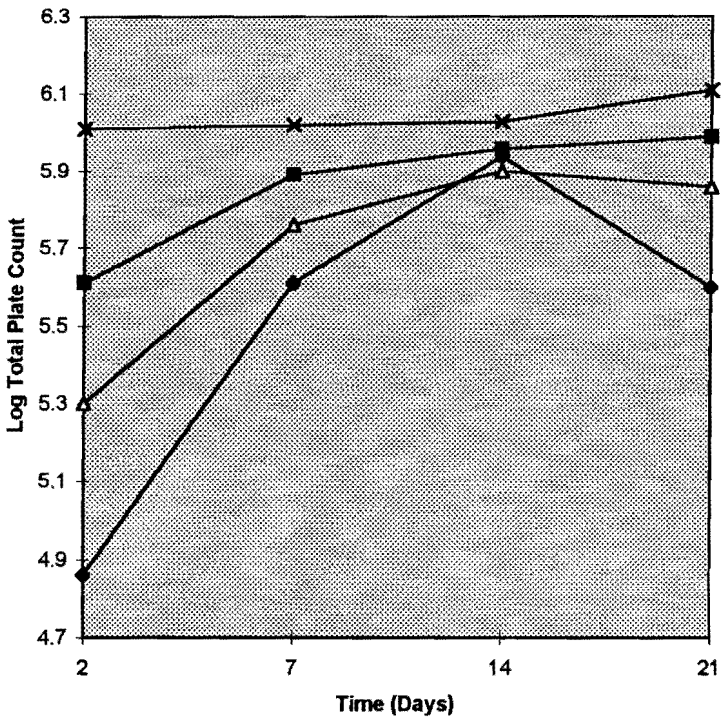

Figure 4.9: Effect of ripening on the microbial load of Feta cheese from Treatment 1 (◆: 100% cow's milk), Treatment 2 (Δ: 65% cow's milk + 35% goat's milk), Treatment 3 (■: 35% cow's milk + 65% goat's milk) and Treatment 4 (×: 100% goat's milk)

4.2.11 Sensory Evaluation

According to Table 4.7, the sensory evaluation score of the four Feta cheeses did not differ significantly as the mean score of all of them corresponded to a Hedonic score of approximately 6 (like slightly).

Table 4.7: Hedonic* score of sensory evaluation of Feta cheeses

Sample	Mean score	Std Deviation
Treatment 1	6.11	1.89
Treatment 2	5.98	1.95
Treatment 3	5.77	2.10
Treatment 4	5.76	2.11

*Hedonic score ranges between 1 and 9, where 1 is the minimum score (dislike extremely) and 9 is the maximum score (like extremely)

4.2.12 Lactose

The lactose content of all the Feta cheeses was found to be almost negligible from the second day after renneting.