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Improving the Quality of Ras-type Cheese made from Recombined Milk Containing High Levels of Total Solids

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ABSTRACT

Ras type cheese was made from recombined milk (RM) containing normal (12·5%) or high levels of Total Solids (TS) (25%, 32% or 40%) using fresh or recombined cream. Cheese curds obtained from RM containing high TS levels were moulded directly or after washing with warm water (50°C) for 10 min before moulding. The cheeses were matured at 7°C or 15°C. Cheese made from fresh milk was better in flavour and consistency than any of the cheeses made from RM. Use of RM in which fresh cream was used gave cheeses of better quality than those made from RM containing recombined cream. Washing the curd made from all RMs resulted in cheeses with better flavour and body characteristics than those made from unwashed curd. Cheese made from RM containing 25% TS with or without washing of the curds was of better quality than those made from RM containing 32% or 40% TS.

The changes of nitrogenous fractions, degradation of α_{s1}- and β-caseins, accumulation of free amino acids and the formation of free fatty acids were reduced as the level of TS in RM was increased. All cheeses made from washed RM curd showed greater proteolysis and lipolysis compared with

those made from unwashed curd. Storage of RM cheese at 15°C accelerated its ripening and improved cheese quality compared with ripening at 7°C.

INTRODUCTION

The short supply of fresh milk production in Egypt has led to increased interest in the utilization of dried milk in cheese production. Several attempts to manufacture Ras cheese (a popular hard type in Egypt) from recombined milk were reported by a number of investigators (Ghaleb, 1979; Hofi *et al.*, 1983; El-Ghandour *et al.*, 1983). The possibility of improving the quality of Ras cheese made from recombined milk has been investigated by using various additives, e.g. trace elements, microbial rennet and lipase preparations (Hagrass *et al.*, 1983), a proteinase/lipase mixture or a slurry of ripened cheese (Rabie *et al.*, 1984).

The use of recombined milk (RM) containing normal (12–14%) total solids (TS) for cheese manufacture results in the production of large volumes of whey and an associated loss of valuable milk solids. Increasing the TS of the RM reduces the volume of whey proportionately. However, the lactose content of the cheese also increases and this results in excessive sweetness in the fresh cheese and it is generally believed that high residual lactose in cheese will result in poor quality (Davis, 1965). The use of recombined concentrate prepared by ultrafiltration avoids these problems but suitable manufacturing techniques for hard, textured varieties from concentrated milk have not yet been developed. The objective of the present study was to manufacture Ras-type cheese from RM containing normal or high TS levels using fresh or recombined cream as a source of fat. An attempt was made to improve the quality of Ras-type cheese made from recombined concentrate by washing the curd after manufacture using warm water (previously pasteurised). The effect of ripening temperature on the quality of Ras-type cheese made from RM was also investigated.

MATERIALS AND METHODS

Materials

Low-heat skim milk powder was obtained from Mitchelstown Co-op and butter oil from Ballyclough Co-op. Recombined cream containing 20% fat was prepared as follows: reconstituted skim milk (10% Total Solids) was heated to 60°C; butter oil (at 60°C) was added to the reconstituted milk with high speed mixing and the mixture at 60°C was double homogenized at

1500 psi and 500 psi. Fresh cream, 40% fat, was obtained from CMP Dairy, Cork, Ireland.

Cheesemaking

Ras-type cheese was manufactured by the protocol described by Abdel Tawab (1963). In this study, cheese was made from RM containing 12·5%, 25%, 32% or 40% TS. The fat content of the cheese milk was standardized to 3·2% for 12·5% TS, 6·4% for 25% TS, 8·2% for 32% TS and 10·24% for 40% TS, using recombined cream or fresh cream.

The cheese curd obtained from high TS RM was divided into two parts; one part was moulded and the other was washed for 10 min using good quality warm water (50°C) and then moulded. All cheeses were ripened at 7°C or 15°C for 16 weeks. The final products were as described in Table 1.

Sampling of cheese for analysis

A cheese was taken from each group at 0, 6 and 16 weeks and analyzed for pH (Aly, 1987), acidity (Ling, 1963), lactose (O'Connor, 1968), moisture (IDF, 1982), salt (Fox, 1963), total nitrogen (IDF, 1964) and fat (IS, 1955). The water-soluble N extract of cheese was prepared as described by

TABLE 1
Composition and Ingredients of Reconstituted Cheese Milk

Treatment code	*TS in cheese milk* (%)	*Fat* (%)	*Source of fat*	*Curd treatment*
1			Fresh pasteurized cow's milk, as control	
2	12·5	3·2	Butter oil	—
3	12·5	3·2	Fresh cream	—
4	25	6·4	Butter oil	Washed
5	25	6·4	Butter oil	Unwashed
6	25	6·4	Fresh cream	Washed
7	25	6·4	Fresh cream	Unwashed
8	32	8·2	Butter oil	Washed
9	32	8·2	Butter oil	Unwashed
10	32	8·2	Fresh cream	Washed
11	32	8·2	Fresh cream	Unwashed
12	40	10·2	Butter oil	Washed
13	40	10·2	Butter oil	Unwashed
14	40	10·2	Fresh cream	Washed
15	40	10·2	Fresh cream	Unwashed

Kuchroo & Fox (1982). The N content of a sample was determined and the remainder was freeze-dried for analysis by gel electrophoresis. The method of Jarrett *et al.* (1982) was adopted for the determination of 5% phosphotungstic acid-soluble N (PTA), 70% ethanol-soluble N and total free amino acids. The method described by Bynum and Barbano (1985) was used for the determination of total concentration of free fatty acids.

Stacking gel electrophoresis

Stacking gel electrophoresis was used to determine the extent of proteolysis during ripening. Electrophoresis was performed in a vertical cell (Shandon Southern Product Ltd, Runcorn, Cheshire, Great Britain) using a method essentially similar to that of Andrews (1983). Cheese sample was prepared as described by Ledford *et al.* (1966), while water-soluble N extract was prepared according to Kuchroo & Fox (1982). Composition of buffers and gels and conditions of electrophoresis are described by Aly (1987) and Abdel Baky *et al.* (1987).

Organoleptic evaluation

All cheeses were tasted by individuals experienced in sensory evaluation procedures.

RESULTS

Organoleptic assessment of cheese

Organoleptic evaluation of the cheeses after 6 and 16 week's ripening showed that all cheeses made from RM, using fresh or recombined cream, had an acid taste and lower flavour intensity and poorer body and texture than the cheese made from fresh milk. The cheeses made using fresh cream had better flavour, body and texture characteristics than those made using recombined cream. All cheeses from washed recombined curd had better flavour, body and texture than those made from unwashed curd. The cheeses made from RM containing 25% TS, with or without washing the curds, were better in flavour, body and texture than those made from RM containing 32% or 40% TS.

All cheeses ripened at 15°C were of better quality than the corresponding cheeses ripened at 7°C.

Gross chemical composition

It appears from the results in Table 2 that the cheeses made from RM with a normal TS level (12·5%), using fresh cream or butter oil, had lower moisture contents than that made from fresh milk. Similar results were reported for Ras cheese by Omar & Ashour (1982) and Rabie *et al.* (1984). The results also indicated that increasing the TS level in RM led to an increase in the moisture content of all cheeses compared to the control. It can be observed from these results that the cheeses made from washed, RM curd had higher moisture contents than those made from unwashed curd. All cheeses matured at 15°C had lower moisture contents than those ripened at 20°C, probably due to the greater evaporation of water during storage at the higher temperature.

It is apparent that the cheeses made from RM had higher salt in moisture (S/M) levels than that made from fresh milk. There were no significant differences in the % S/M between the cheeses made using recombined or fresh cream. Cheeses made from washed, RM curd showed lower levels of S/M than those made from unwashed curd. All cheeses ripened at 15°C had higher levels of S/M than those matured at 7°C.

The fat content (on a dry matter basis) of cheese made from recombined milk was slightly lower than that in the control cheese. No marked differences in fat content were observed between the cheeses made using recombined or fresh cream. The cheeses made from washed curd showed slightly higher fat contents than those made from unwashed curd. All cheeses matured at 15°C had higher fat contents than those ripened at 7°C.

The total N contents (on a dry matter basis) of all cheeses were similar. The results in Table 2 indicate that increasing the TS content of RM had no marked effects on the % S/M, fat and total N contents.

Changes in lactose, pH and titratable acidity

The results shown in Table 3 clearly indicate that the lactose content of all cheeses decreased during ripening, and that lactose breakdown was faster during the first 6 weeks of ripening than during the later period of ripening. Similar results were reported for Ras cheese by Hofi *et al.* (1970) and for Cheddar cheese by Miah *et al.* (1968), Turner & Thomas (1980) and Bynum & Barbano (1985). The results showed that the lactose content of the cheeses increased as the TS level in the RM increased and that the recombined cheeses had higher lactose contents than cheese made from fresh milk. The results also indicated that cheeses made from washed curd had lower lactose levels than the cheeses made from unwashed curd. There were no marked

TABLE 2
Chemical Composition of Ras Cheese made from Recombined Milk as Affected by Storage Temperature

Ripening temperature (°C)	*Ripening period* (weeks)	*Treatment number*														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
								Moisture (%)								
	0	44·6	43·0	42·2	44·8	43·2	44·0	43·1	44·3	42·3	47·0	44·4	46·5	42·7	46·0	43·1
7	16	38·8	37·0	36·2	39·9	38·1	40·4	39·0	40·3	39·1	43·2	41·8	40·8	38·8	41·5	39·0
15	16	36·4	35·2	35·3	38·0	37·1	39·2	38·8	39·0	36·8	41·3	39·1	40·0	37·7	40·5	38·2
								Fat in dry matter (%)								
	0	47·8	45·6	45·8	45·3	44·9	45·5	44·8	45·7	45·1	46·2	45·9	44·8	44·5	46·3	45·7
7	16	49·8	47·7	47·8	48·3	47·7	48·6	47·5	47·7	47·6	48·4	48·1	47·3	47·4	47·9	47·5
15	16	50·3	48·7	48·7	48·4	48·5	49·3	48·2	48·3	48·3	48·6	48·5	48·5	48·3	48·1	47·7
								Salt (%)								
7	16	2·8	3·3	3·2	3·0	3·3	3·0	3·2	3·1	3·2	3·2	3·3	3·3	3·3	3·2	3·4
15	16	2·9	3·3	3·2	3·1	3·4	3·2	3·4	3·4	3·4	3·4	3·5	3·5	3·5	3·5	3·6
								Salt-in-moisture (%)								
7	16	7·3	9·0	8·7	7·5	8·6	7·4	8·1	7·7	8·2	7·4	7·9	8·0	8·5	7·8	8·7
15	16	8·0	9·4	9·1	8·2	9·3	8·2	8·8	8·7	9·2	8·2	8·8	8·8	9·4	8·7	9·4
								TN in dry matter (%)								
	0	6·4	6·5	6·5	6·4	6·4	6·5	6·4	6·5	6·4	6·4	6·4	6·5	6·5	6·5	6·5
7	16	6·5	6·6	6·6	6·5	6·5	6·5	6·6	6·6	6·6	6·6	6·6	6·6	6·5	6·6	6·6
15	16	6·6	6·6	6·6	6·6	6·6	6·6	6·6	6·6	6·6	6·6	6·6	6·5	6·6	6·6	6·6

TABLE 3

Changes in pH, Titratable Acidity and Lactose of Ras Cheese made from Recombined Milk as Affected by Storage Temperature

Ripening temperature (°C)	*Ripening period* (*weeks*)	*Treatment number*														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
								Lactose (%)								
	0	0·5	1·8	1·6	1·8	2·0	1·7	1·8	1·9	2·0	1·8	2·1	2·0	2·2	1·9	2·3
7	6	0·3	0·7	0·7	0·6	0·8	0·7	0·8	0·8	0·9	0·6	1·0	0·8	1·0	0·8	1·1
	16	0·1	0·2	0·1	0·3	0·3	0·2	0·3	0·3	0·4	0·2	0·3	0·3	0·4	0·2	0·4
15	6	0·2	0·6	0·6	0·5	0·6	0·5	0·6	0·5	0·6	0·5	0·7	0·6	0·8	0·5	0·8
	16	0·0	0·1	0·1	0·2	0·2	0·1	0·1	0·1	0·2	0·1	0·2	0·2	0·3	0·1	0·4
								Titratable acidity (%)								
	0	0·7	1·0	1·0	1·4	1·5	1·4	1·5	1·0	1·2	1·1	1·2	0·7	0·9	1·2	1·0
7	6	0·9	1·2	1·3	1·7	1·8	1·6	1·8	1·3	1·5	1·4	1·5	1·2	1·1	1·5	1·1
	16	1·4	1·8	2·0	2·0	2·1	2·0	2·2	1·8	1·9	2·0	2·2	1·6	1·5	2·0	1·6
15	6	1·0	1·3	1·4	1·8	1·9	1·8	1·9	1·5	1·6	1·7	1·8	1·4	1·4	1·6	1·4
	16	1·6	1·9	2·0	2·2	2·3	2·3	2·4	1·9	2·0	2·1	2·4	1·9	1·8	2·1	2·0
								pH								
	0	5·3	5·3	5·4	5·4	5·3	5·4	5·4	5·8	5·8	5·9	5·8	6·0	6·1	5·6	6·0
7	6	5·2	5·2	5·2	5·3	5·3	5·4	5·3	5·3	5·3	5·4	5·2	5·3	5·5	5·2	5·4
	16	5·4	5·5	5·5	5·3	5·3	5·4	5·4	5·3	5·3	5·4	5·3	5·3	5·3	5·3	5·5
15	6	5·2	5·3	5·3	5·3	5·3	5·4	5·3	5·4	5·3	5·4	5·3	5·3	5·4	5·3	5·4
	16	5·5	5·6	5·6	5·3	5·3	5·4	5·4	5·5	5·4	5·5	5·4	5·4	5·5	5·4	5·5

differences in lactose content between cheeses made using recombined or fresh cream. All cheeses matured at 15°C had lower lactose levels than those ripened at 7°C. Similar results were reported for Cheddar cheese by Miah *et al.* (1968).

It can be observed from Table 3 that cheeses made from RM with normal or high TS levels showed higher acidities than that made from fresh milk; increasing TS content tended to increase the cheese acidity.

No marked difference in titratable acidity existed between the cheeses made using recombined or fresh cream. The acidities of the cheeses made from washed, RM curd were slightly lower than those made from unwashed curd. All cheeses matured at 15°C had higher acidities than those ripened at 7°C.

From Table 3, it could also be observed that, after 16 weeks of ripening, the pH values of cheeses made from recombined milk with high TS were equal to, or lower than, that of cheese made from fresh milk or from RM with normal TS content.

Rate of ripening

Proteolysis

The levels of WSN, as a percentage of TN, for all cheeses throughout ripening are shown in Table 4; the WSN in all cheeses increased as ripening progressed. The cheeses made from RM containing normal or high TS levels, using fresh or recombined cream, had lower levels of WSN at all stages of ripening than the control cheese. Increasing the TS content of the RM resulted in lower levels of WSN in the cheeses. Cheeses made using fresh cream contained higher levels of WSN than those made using recombined cream. The cheeses manufactured from washed curd showed higher levels of WSN than those made from unwashed curd. It can be observed from the results in Table 4 that all cheeses ripened at 15°C had higher levels of WSN than those matured at 7°C.

The formation of 5% PTA-soluble N and 70% ethanol-soluble N in all cheeses followed the same trends as that observed for WSN (Table 4).

Characterization of proteolysis by gel electrophoresis

Figure 1 shows the electrophoretograms of cheese samples ripened at 7°C or 15°C for 16 weeks. The following points can be observed.

(a) Degradation of α_{s1}- and β-caseins was more rapid and extensive in the cheese made from fresh milk than in the RM cheeses.
(b) Proteolysis was greater in the cheeses made using fresh cream than those made using recombined cream.

TABLE 4

Changes in Nitrogenous Fractions of Ras Cheese made from Recombined Milk as Affected by Storage Temperature

Ripening temperature (°C)	*Ripening period* (*weeks*)	*Treatment number*														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
		WSN as a % of TN														
	0	7·6	5·5	6·42	7·0	5·9	7·0	6·0	6·1	5·6	6·2	5·9	6·0	5·6	6·2	6·0
7	6	23·9	18·6	20·33	20·7	19·0	22·0	20·2	19·2	17·9	21·0	18·1	18·3	17·0	18·9	18·4
	16	26·5	21·6	22·06	24·1	21·9	25·9	22·8	21·9	19·6	24·7	19·9	20·5	19·1	21·6	20·8
15	6	27·3	21·4	21·90	23·5	19·9	26·2	21·1	20·5	19·2	26·0	20·1	19·9	18·2	20·9	19·0
	16	30·6	23·8	25·00	28·3	22·2	30·0	23·0	25·8	21·6	30·0	23·6	24·2	20·9	25·5	21·9
		5% PTA-soluble N as a % of TN														
7	6	4·2	3·2	3·68	3·5	2·9	4·0	3·1	3·0	2·1	3·6	2·6	2·8	2·0	3·0	2·1
	16	7·9	5·9	6·45	6·0	4·8	6·3	5·2	4·9	3·6	5·8	4·0	4·1	3·0	4·8	3·8
15	6	6·9	5·9	6·42	5·5	4·0	6·0	4·3	4·5	3·1	5·7	4·0	4·0	2·4	4·8	3·0
	16	11·9	10·0	10·50	9·9	7·7	10·2	8·1	9·0	6·8	9·1	7·9	7·7	5·6	8·0	6·2
		70% ethanol-soluble N as a % of TN														
7	6	9·7	8·9	9·2	9·0	8·0	9·5	7·5	8·0	7·9	9·0	7·4	7·8	7·6	8·5	7·7
	16	12·6	11·3	11·6	12·0	11·3	12·3	11·6	11·2	10·8	11·5	11·3	11·0	10·2	10·6	11·1
15	6	11·0	8·3	9·9	9·7	8·6	9·9	8·4	8·5	7·9	9·2	8·2	8·3	7·5	8·9	8·0
	16	14·7	10·8	12·0	12·6	11·7	12·8	11·9	11·5	10·9	12·3	11·8	11·3	10·0	12·0	11·5

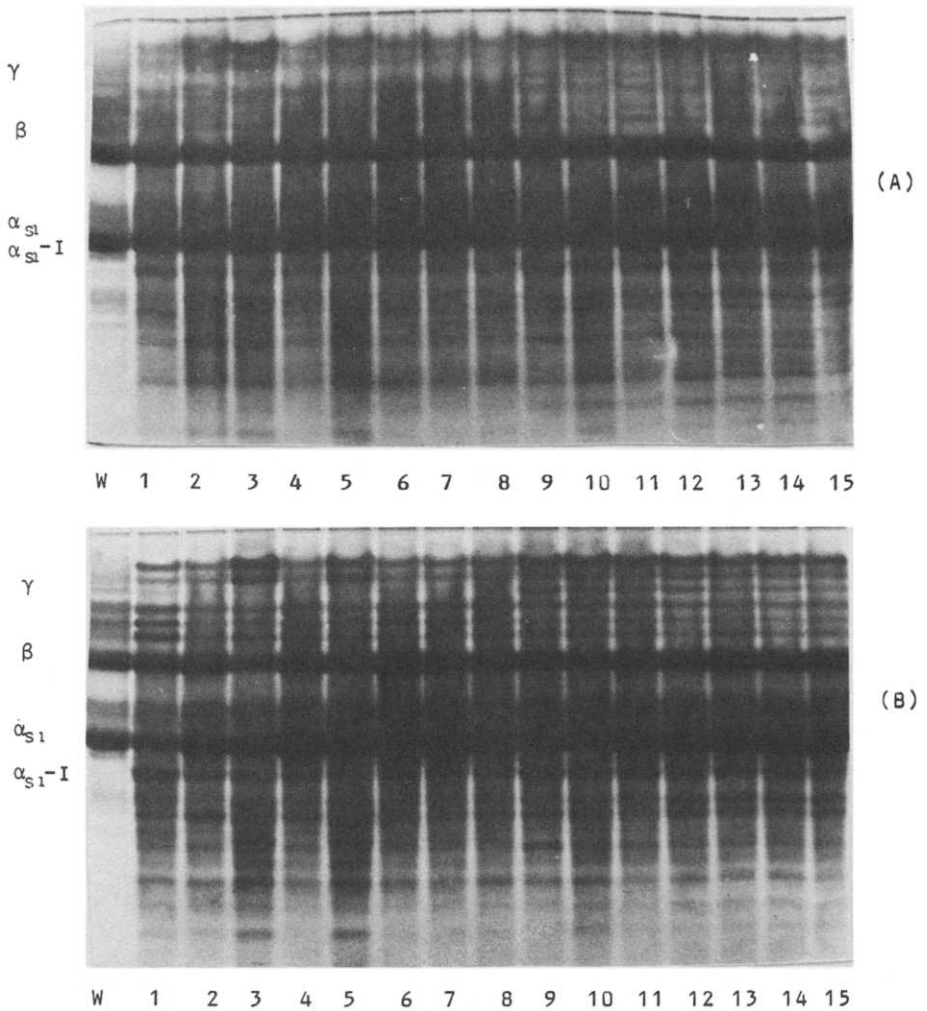

Fig. 1. Electrophoretograms of 16-weeks-old Ras cheeses made from recombined milk, ripened at 7°C (A) or at 15°C (B). Slots 1: fresh milk cheese; Slots 2–8: treatment number, 3, 6, 7, 10, 11, 14, 15, respectively; Slots 9–15: treatment number 2, 4, 5, 8, 9, 12, 13, respectively. Note: slot numbers do not correspond to treatment code.

(c) Hydrolysis of α_{s1}- and β-caseins in the cheeses was reduced as the TS level in the recombined milk was increased.

(d) More extensive breakdown of α_{s1}- and β-caseins was observed in the cheeses made from washed, RM curd compared with the same cheeses made from unwashed curd.

(e) Gel electrophoresis of all cheeses matured at 15°C showed that the degradation of α_{s1}- and β-caseins was more rapid and extensive than in the corresponding cheeses matured at 7°C.

TABLE 5

Accumulation of Free Amino Acids in Ras Cheese made from Recombined Milk as Affected by Storage Temperature

Ripening temperature (°C)	*Ripening period* (*weeks*)	*Treatment number*														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
		(*mM amino acid/g cheese*)														
7	6	0·2	0·2	0·2	0·2	0·2	0·2	0·2	0·2	0·1	0·2	0·2	0·1	0·1	0·2	0·1
	16	0·4	0·3	0·3	0·3	0·3	0·3	0·3	0·3	0·2	0·3	0·3	0·3	0·2	0·3	0·2
15	6	0·3	0·2	0·3	0·2	0·2	0·2	0·2	0·2	0·2	0·2	0·2	0·2	0·1	0·2	0·1
	16	0·6	0·5	0·6	0·5	0·4	0·6	0·5	0·4	0·3	0·5	0·4	0·3	0·2	0·4	0·3

TABLE 6

Changes in Free Fatty Acid Levels in Ras Cheese made from Recombined Milk as Affected by Storage Temperature

Ripening temperature (°C)	*Ripening period* (*weeks*)	*Treatment number*														
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
		(*mM palmitic acid/kg cheese*)														
7	6	3·0	2·4	2·3	2·9	2·0	2·5	1·9	2·6	1·8	2·4	1·5	2·1	1·4	2·0	1·4
	16	5·1	4·0	3·9	5·0	3·3	4·8	3·0	4·1	3·1	4·0	2·9	4·0	3·0	3·4	2·3
15	6	4·0	2·9	2·8	4·0	2·9	3·8	3·8	3·6	2·7	3·5	2·4	3·0	2·1	2·9	2·0
	16	6·4	5·1	5·0	6·0	4·4	5·5	4·4	5·5	4·0	4·9	3·2	5·0	4·0	3·9	3·0

The electrophoretic patterns confirmed the data for the proportion of WSN, 5% PTA-soluble and 70% ethanol-soluble N formed during ripening.

Accumulation of total free amino acids

Table 5 shows the changes in free amino acid levels, as PTA-soluble amino N, in cheese samples taken after 6 and 16 weeks' ripening. The results indicate that the levels of free amino acids increased during ripening and increased faster in all cheeses matured at 15°C than in cheeses stored at 7°C. Accumulation of free amino acids in the RM cheeses was slower than in the cheese made from fresh milk. The recombined cheeses made using fresh cream contained higher levels of free amino acids than those made using recombined cream. Increasing the TS level of the recombined milk resulted in lower concentrations of free amino acids in the resultant cheeses. The results also show that the cheeses made from washed, RM curd had higher levels of amino acids compared with unwashed curd cheeses.

Development of free fatty acids (FFA)

The concentrations of FFA in all cheeses after ripening for 6 and 16 weeks are shown in Table 6. The levels of FFA in all cheeses increased as ripening progressed and were higher in the cheeses matured at 15°C than at 7°C. Cheeses made from RM had lower levels of FFA than the control cheese. All cheeses made using recombined cream had higher levels of FFA than those made using fresh cream. Increasing the TS level in the RM gave lower levels of FFA in the resulting cheeses. Development of FFA in the recombined cheeses made from washed curd was higher than in the cheeses made from unwashed curd.

DISCUSSION

Several reports on the production of Ras cheese from RM have indicated that cheese made from fresh milk is better than RM cheese in flavour, body and texture characteristics (Ghaleb, 1979; Omar & Ashour, 1982; Hofi *et al.*, 1983; El-Ghandour *et al.*, 1983; Rabie *et al.*, 1984). In this study, Ras-type cheese made from RM had a lower quality than cheese made from fresh milk. However, cheeses made using fresh cream as a source of fat were better than those made using recombined cream. The results of this study showed that cheese made from RM of normal TS level had a lower moisture content than fresh milk cheese, while increasing the solids level in the RM led to an increase in the moisture content of the resulting cheeses.

In the present study, Ras-type cheeses made from recombined milk, having normal or higher TS levels, had lower fat contents than control

cheeses. This could be attributed to the formation of a weaker curd from the RMs which would cause an excessive loss of fat in the whey (Schormuller, 1968).

Lactose in Cheddar cheese is usually converted to other compounds, mainly lactic acid, during the first weeks of ripening (Van Slyke & Price, 1952; Turner & Thomas, 1980). In this study, lactose breakdown was fast in all cheeses during the first 6 weeks of ripening; similar results for Ras cheese were reported by Hofi *et al.* (1970). The results showed that the titratable acidity of Ras-type cheese increased throughout ripening, especially during the first half of the period. Cheeses made from RMs containing normal levels of TS had higher acidities than cheese made from fresh milk. Increasing the solids level in RM tended to increase the cheese acidity which may be attributed to the increase in moisture content of the cheese as a result of the higher solids content of the milk. The results of this study showed a continuous increase in the titratable acidity of Ras-type cheese during ripening even though cheese pH decreased initially and then increased during ripening. Similar results were reported for Cheddar cheese by Peters & Williams (1961).

The changes of nitrogenous fractions, degradation of α_{s1}- and β-caseins, accumulation of free amino acids and the formation of FFA were more pronounced in the fresh milk cheese than in the recombined cheeses. Thus, RM cheese matured more slowly than fresh milk cheese. These findings correspond to those reported by Peters & Williams (1961), Czulak & Hammond (1974), Omar & Buchheim (1983), El-Ghandour *et al.* (1983) and Rabie *et al.* (1984).

In this study, an attempt was made to improve the quality of Ras-type cheese made from concentrated recombined milk by washing the cheese curd with good quality water. This improved the flavour, as well as the body and texture, of the cheese. The results indicate that all cheeses made from washed, recombined curd showed greater proteolysis and lipolysis than those made from unwashed curd, probably due to the increase in moisture content and the decrease in salt in the aqueous phase of the cheese. Presumably, higher moisture and lower salt-in-moisture stimulated the growth of bacteria and enzyme activity in the cheese.

Temperature control during ripening had a significant effect on the flavour, body and texture quality, as well as on the extent of proteolysis and lipolysis in the recombined Ras-type cheeses. Storage of the cheeses at 15°C accelerated the ripening of Ras-type cheese and improved its quality, compared with ripening at 7°C.

In conclusion, it is evident that the cheese made from fresh milk was better than all those made from RM. This may be due to the slower degradation of the casein and fat in RM cheese, possibly due to the higher salt level in the

aqueous phase of the cheese made from RM than that in control cheese made from fresh milk. Good quality Ras-type cheese could be made from recombined milk containing 25% TS, using fresh or recombined cream and with a curd wash. The ripening of Ras-type cheese made from RM could be enhanced by storing the cheese at 15°C rather than at 7°C.

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