Journal of Brewing and Distilling Vol. 3(2), pp. 15-22, March 2012
Available online at http://www.academicjournals.org/JBD
DOI: 10.5897/JBD11.010
ISSN 2141-2197 ©2012 Academic Journals

Full Length Research Paper

Effect of pasteurization and season on milk composition and ripening of Ras cheese

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Accepted 22 February, 2012

The objective of this study was to compare between the raw and pasteurized Ras cheese from cow's milk through the season. The chemical composition of cheese was also demonstrated as the ripening period progressed. High solids in winter milk and low solids in summer milk were observed and were attributed to the hot weather and the poorer quality pastures. Casein as a percentage of true protein and the casein to fat ratio were higher in spring and summer milk. Fat in the cheese made from winter milk was higher and the total protein was lower than that in spring and summer cheeses. The chemical changes during ripening period of six months were examined for composition, flavour intensity, acidity, pH, soluble protein and total volatile fatty acids. Raw or pasteurized cheese in each period of winter, spring and summer were evaluated for flavour, body and texture and appearance at the end of ripening. Fat and protein recovery in the cheese were not affected by season. Cheese yield from winter milk was higher than from spring and summer milk and was a result of the higher casein and fat in the milk. Raw milk cheese in winter and spring scored higher values for flavour compared to summer cheese. There was a close relationship between the good flavour and the high total volatile fatty acid. Milder flavour was associated with moderate soluble protein and low volatile fatty acid. On the other hand, pasteurized milk cheese in winter, spring and summer with adding yoghurt starter had a more compact body and smoother texture and more holes and cracks. In general, Ras cheese made from pasteurized milk achieved higher score in body and texture and lower score in flavour in comparison to Ras cheese made from raw milk through the season.

Kay words: Cow's milk, Ras cheese, chemical composition.

INTRODUCTION

Ras cheese is one of the popular hard cheeses in the Mediterranean countries, particularly in the Middle and Near East.

The sensory quality of ripened cheese is determined by the technological parameters and initial characteristics of the raw material. The influence of the indigenous microflora of milk on the sensory properties of raw milk cheese compared with those of cheese made from pasteurized or microfiltered milk has been recently reviewed by Grappin and Beuvier (1997).

Diet modifies the chemical composition of milk and thus, influences the sensory quality of milk products (Forss, 1993; Keen and Wilson, 1993). In particular, milk produced from cows, fed on pasture, has different fatty acid composition and volatile compounds than milk produced from cows fed on hay or grain (Forss, 1993; Keen and Wilson, 1993). Martin and Buchin (1997) found that the flavour and texture of Abondance cheese changed with the change in the floral composition of pastures. Terpenes were also found preferentially in Comte cheese produced during the summer compared with Comte produced during the winter (Guichard et al., 1987). Recently, Coulon et al. (2004) and Verdier et al. (2000) have shown that forage type floral composition and type of preservation can influence the composition of volatile compounds in Saint Nectaire cheese.

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Barron et al. (2001) has reported on seasonal or lactation changes in milk composition of dairy sheep. The composition of ovine milk during the milking season in particular reflects the lactation and nutritional differences. In ovine milk, fat concentration increases at a higher rate than casein in late lactation so that the casein to fat ratio in the milk decreases throughout lactation (Pellegrini et al., 1997). Wendorff (2002) is a recommended reference for the cheese yields from ovine milk. More recent studies were given in the literature regarding the same direction of production of Cantal cheese (Agabriel et al., 2004), Cantal and Saint-Nectaire cheese (Verdier-Metz et al., 2005) and Cheddar cheese (Amenu et al., 2006).

Jaeggi et al. (2005) found that the seasonal changes had a significant impact on milk composition, cheese composition and cheese yield.

They found that as the season progressed, milk fat and casein decreased owing to the increased solids in early-lactation milk and the decreased solids during hot summer milk and poorer quality pastures. On the other hand, fat and protein recoveries in the cheese were not significantly affected over the season. Fekadu et al. (2005) studied the effect of composition change in goat milk, during lactation, on the sensory quality characteristic and yield of hard and semi-hard cheeses. He found that no significant differences in flavour, body and texture, and total sensory of both cheeses between 8, 16 and 24 weeks of ripening, which indicate that the cheeses should be marketed and consumed after 8 weeks of ripening. San Martin-Gonzalez et al. (2007) reported that the pasteurization increases the protein content and moisture retention, which may lead to an increase in cheese yield. Toso and Stephanon (2001) compared the Montasio cheese obtained from farms that used maize silage with that obtained from farms that didn't use maize silage. They found that after two months of ripening, the cheese came from the farms that didn't use maize silage was better than the other, while the differences were less after 6 and 12 months of ripening. Regarding goat cheese, recent results have shown that alfalfa hay led to cheeses with much more intense flavour than maize silage (Gabori et al., 2002). On the other hand, Houssin et al. (2000) found that the maize led to much white cheeses, because of the low carotene content, slightly firmer and globally rate lower by tasters in comparison with hay or grass regardless of its conservation mode. Rong et al. (2010) found significant increase in the linoleic acid content in milk when corn silage was replaced by alfalfa silage. Even higher conjugated linolic acid content in milk was obtained by using both full fat extruded soybeans and corn silage in the diets.

In the current paper, the influence of milk composition and cow diet on the sensory of Ras cheese was studied. A comparison of cheese made from raw and pasteurized milk was demonstrated. The influence of feeding cows with maize silage or hay and pasture, was investigated on the quality of cheese.

MATERIALS AND METHODS

The work was conducted in Animal Production Research Institute (APRI), Giza, Egypt. Fresh cow's milk was obtained from Animal Production Research Station dairy farms Sakha, Kafr El-Sheikh, Egypt. The feeding systems were applied according to APRI as follows:

Winter (berssem and concentrate feed), Spring (berssem, concentrate feed and rice straw) and Summer (hay or maize silage, concentrate feed and rice straw).

Ras cheese making

Calf rennet, calcium chloride, yoghurt starter (a mixed strain of *Streptococcus Salivarus* ssp*., Thermohpillus* and *Lactobacillus delbrueckii* ssp*. bulgaricus*) was obtained from Chr. Hansen's Lab. ALS (Copenhagen, Denmark). Salt was obtained from a local market in Egypt.

Fresh cow's milk was transported immediately to laboratory and divided into two parts. The first part was raw milk warmed at 30°C, calf rennet and calcium chloride (0.02% w/w) were added. The second part was a thermally treated milk (at 7°C for 15 s and then warmed to 30°C); calf rennet, calcium chloride (0.02%w/w) and starter cultured were added.

The method of Hofi et al. (1970) was followed for making Ras cheese, whereas dry salting was applied by coating the surfaces of the green cheese wheels with a small amount of dry salt for 15 days at 12 to 15°C before starting the ripening period of six months at the same temperature.

Milk and cheese analyses

Cheese samples were taken when fresh (zero ripening time) on a two-monthly basis during the ripening period and analyses for moisture, titratable acidity (TA) and pH according to Association of Official Analytical Chemists (AOAC, 2000). The pH meter used was Jenway model 3020 (Jenway Ltd. Gransmore Green, Felsted, and Dunmow, England). Salt, fat and TS contents were determined according to Ling (1963), whereas total volatile fatty acid (TVFA, ml 0.1N NaOH/100 g cheese) was measured by the direct distillation method of Kosikowski (1982). Total nitrogen (TN), soluble nitrogen (SN) and non-protein nitrogen (NPN) were determined using semi-micro Kjeldahl method as given by Ling (1963).

Recovery of fat (RF) and recovery of protein (RP) were calculated by measuring the component in cheese milk and in the resultant fresh cheese. Yield of fresh or mature cheese was calculated using the following equation:

$$\text{Yield (\%)} = \text{Weight of cheese (kg)} / \text{Weight of milk used (kg)} \times 100$$

Sensory evaluation

This was carried out by at least 10 panelists according to the scheme recommended by Hofi et al. (1970), taking into consideration the maximum attainable scores were 60 points out of 100 for flavour, 30 points out of 100 for body and texture and 10 points out of 100 for the general appearance.

Statistical analysis

The obtained data were statistically analyzed for variance, averages and Duncan's test according to SPSS computer program (SPSS, 1998.

Table 1. Influence of season on the composition (Average ± SD) of cow's milk used for manufacture of Ras cheese.

Property (%)	Milk		
	Winter	Spring	Summer
Total solids	13.68 ± 0.068[a]	12.98 ± 0.057[b]	11.56 ± 0.067[c]
Fat	3.30 ± 0.053[a]	3.20 ± 0.064[b]	3.00 ± 0.058[c]
Total protein	3.38 ± 0.042[a]	3.31 ± 0.025[b]	3.04 ± 0.036[c]
True protein	3.01 ± 0.026[a]	2.60 ± 0.035[b]	2.50 ± 0.028[c]
Casein	2.66 ± 0.016[a]	2.62 ± 0.014[b]	2.50 ± 0.013[c]
Casein/True protein	88.10 ± 1.065[c]	89.66 ± 1.152[b]	91.58 ± 1.045[a]
Casein/ Fat ratio	0.81 ± 0.012[c]	0.82 ± 0.025[b]	0.083 ± 0.012[a]

*Means within the same row (a, b and c) with different superscripts differed significantly ($P < 0.05$).

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of cow's milk as affected by seasonal feeding in winter, spring, and summer. Total solids, milk fat and total protein decreased as the season progressed. The higher milk protein in winter could be attributed to the diet containing high digestible protein content from berssem and concentrate feed, whereas the feeding in summer gave the lowest milk protein when the diet contained low supplier for protein such as maize silage and rice straw. In this respect, Colombari et al. (1999) attributed the decrease in milk protein to inadequate intestinal absorbed protein, which in turn could be ascribed to very limited rumen undegradable protein content in the diet and to an excess of soluble nitrogen. The changes in milk fat were possible due to the explanation given by Colombari et al. (1999) who correlated milk fat content to the rate of fiber digestion with consequent ruminal synthesis of fat precursors such as butyrate. Impact and importance of containing cow's diet fodder crops (like berssem in the present study) on increasing TS, fat and protein of milk could be concluded from the studies given by Hegazi (2004). They attributed the effect of the seasonal variations on milk composition to the type of feeding and correlated the highest values for the pre-mentioned constituents with the staring of green feeding.

El-Shewy et al. (2010) recorded insignificant differences in cow's milk protein (3.06 to 3.18) and significant differences in buffalo's milk protein (2.67 to 3.96) as affected by feeding the cattle a diet consisting of concentrate, fodder (berssem or rayana corn) and rice straw as 2:1 in order. Casein concentration was similar in winter and spring, but lower in summer. Cheese made in winter contained a higher percentage of whey protein, as indicated by the lower casein to true protein (Jaeggi et al. 2005). On the other hand, in summer the higher casein to fat ratio was comparable to that obtained in winter and spring.

Table 2 shows the chemical composition of different cheeses as affected by season through 6 months of ripening. Moisture content was significantly affected by the season and the recorded values during ripening period were significantly higher ($p < 0.05$) in winter cheese made from pasteurized milk compared to spring and summer (32.69 ± 0.025, 32.56 ± 0.023 and 32.19 ± 0.025%) at the end of ripening period. On the other hand, moisture content ($p > 0.05$) were insignificantly lower in winter cheese made from raw milk compared to spring and summer which had average values ± SD of 30.69 ± 0.021, 31.43 ± 0.022 and 31.26 ± 0.023%, respectively at the end of ripening period. Hofi et al. (1991) reported that the decrease of Ras cheese moisture content was sharp during first month, followed by gradual decrease during the end of ripening period.

Concerning fat/dry matter (F/DM) content, the recorded average values ± SD of cheese were the highest ($p < 0.05$) in the spring cheese made from pasteurized milk compared with the winter and summer cheese, thought to be due to the different feedings which were almost significant. Whereas F/DM in the summer cheese made from raw milk were significantly higher compared with the winter and spring cheese. However F/DM gradually increased during ripening period in all cases. The measured average values of F/DM ± SD were 43.86 ± 0.052, 44.65 ± 0.072, and 45.96 ± 0.075% in fresh cheese made from pasteurized milk from winter, spring and summer, increased to be 55.23 ± 0.034, 55.34 ± 0.074 and 54.06 ± 0.045%, respectively at the end of ripening period, as summarized in Table 2. On the other hand, the average values of F/DM ± SD were 46.67 ± 0.056, 43.97 ± 0.061 and 44.12 ± 0.061 in the fresh cheese made from raw milk in winter, spring and summer and increased to 55.18 ± 0.046, 55.21 ± 0.054 and 54.86 ± 0.046%, respectively at the end of ripening period. Ayad (2004) and Awad (2006) found that the value for fat/protein of raw milk cheese was slightly lower than those of pasteurized milk cheese.

Protein/dry matter (P/DM) content in fresh cheese was found to be affected by the feeding system during the season, as shown in Table 2. As can be seen from the table, the P/DM content significantly changes, and its highest average value ± SD is in the cheese made from pasteurized milk in summer (41.12 ± 0.052%), followed

Table 2. Chemical composition (%) of Ras cheese during ripening as affected by pasteurization and season*

Property	Ripening (mon.)	Winter		Spring		Summer	
		Raw	Past.	Raw	Past.	Raw	Past.
Moisture	Zero	39.86 ± 0.034^{b}	40.68 ± 0.045^{B}	39.52 ± 0.043^{c}	40.25 ± 0.049^{C}	40.28 ± 0.047^{a}	42.13 ± 0.052^{A}
	2	33.79 ± 0.026^{b}	37.18 ± 0.035^{B}	34.51 ± 0.028^{c}	36.62 ± 0.034^{C}	34.67 ± 0.026^{a}	37.69 ± 0.033^{A}
	4	31.92 ± 0.024^{b}	34.45 ± 0.026^{B}	32.14 ± 0.024^{a}	34.83 ± 0.027^{A}	32.63 ± 0.024^{c}	33.35 ± 0.029^{C}
	6	30.69 ± 0.021^{b}	32.69 ± 0.025^{B}	31.43 ± 0.022^{a}	32.56 ± 0.023^{A}	31.26 ± 0.023^{c}	32.19 ± 0.025^{C}
Fat/DM	Zero	46.67 ± 0.056^{a}	43.86 ± 0.052^{A}	43.97 ± 0.061^{b}	44.65 ± 0.072^{B}	44.12 ± 0.061^{c}	45.96 ± 0.075^{C}
	2	53.76 ± 0.048	52.73 ± 0.046^{A}	53.07 ± 0.051^{b}	53.12 ± 0.068^{B}	52.26 ± 0.065^{c}	52.65 ± 0.067^{C}
	4	54.65 ± 0.049^{a}	53.87 ± 0.039^{A}	54.76 ± 0.053^{b}	54.26 ± 0.072^{B}	53.17 ± 0.065 ^{c}	53.12 ± 0.062^{C}
	6	55.18 ± 0.046^{a}	55.23 ± 0.034^{A}	55.21 ± 0.054^{b}	55.34 ± 0.074^{B}	54.86 ± 0.046 ^{c}	54.06 ± 0.045^{C}
Protein /DM	Zero	36.07 ± 0.031^{c}	40.68 ± 0.054^{C}	36.49 ± 0.036^{b}	40.85 ± 0.063^{B}	36.67 ± 0.058 ^{a}	41.12 ± 0.052^{A}
	2	37.69 ± 0.042^{c}	42.56 ± 0.056^{C}	37.95 ± 0.045^{b}	42.95 ± 0.054^{B}	38.24 ± 0.062^{a}	43.02 ± 0.064^{A}
	4	38.92 ± 0.045^{c}	43.29 ± 0.058^{C}	40.21 ± 0.053^{b}	43.56 ± 0.058^{B}	39.95 ± 0.059^{a}	43.68 ± 0.069^{A}
	6	40.01 ± 0.052^{c}	44.12 ± 0.062^{C}	40.29 ± 0.059^{b}	44.26 ± 0.065^{B}	40.26 ± 0.072^{a}	44.08 ± 0.075^{A}
Salt/DM	Zero	4.96 ± 0.009^{c}	5.79 ± 0.016^{C}	5.65 ± 0.023^{b}	6.26 ± 0.025^{B}	6.32 ± 0.026^{a}	6.45 ± 0.032^{A}
	2	6.57 ± 0.012^{c}	7.07 ± 0.018^{C}	6.86 ± 0.025^{b}	7.13 ±0.026^{B}	6.95 ± 0.034^{a}	7.26 ± 0.035^{A}
	4	6.98 ± 0.014^{c}	7.26 ± 0.019^{C}	7.08 ± 0.028^{b}	7.58 ± 0.028^{B}	7.32 ± 0.035^{a}	7.69 ± 0.039^{A}
	6	7.05 ± 0.018^{c}	7.32 ± 0.024^{C}	7.12 ± 0.029^{b}	7.72 ± 0.027^{B}	7.41 ± 0.036^{a}	7.89 ± 0.041^{A}

*Means within the same row (a, b and c) with different superscripts differed significantly (P<0.05), whereas averages with different superscripts (a, b and c) and (A, B and C) for the same age of cheese differed significantly (P< 0.05).

by those from spring (40.85 ± 0.063%) and winter (40.68 ± 0.054%). Whereas, the corresponding average values of P/DM ± SD in the cheese made from pasteurized milk were 44.12 ± 0.062, 44.26 ± 0.065 and 44.08 ± 0.075%, respectively, and the cheese made from raw milk in winter had significantly lower content. Generally, P/DM gradually increased in all cheese samples through the ripening period.

The Salt/DM content, as shown in Table 2, was significantly higher in the fresh cheese made from pasteurized milk in summer and spring than that in winter cheese, and the corresponding average values of Salt/DM content ± SD were 6.45 ± 0.032, 6.26 ± 0.025 and 5.79 ± 0.016%, respectively. During ripening, the salt/DM content gradually increased and the average values of Salt/DM content ± SD were 7.89 ± 0.041, 7.72 ± 0.027 and 6.32 ± 0.024% for summer, spring, and winter cheese respectively, at the end of ripening period. Contrary to that, for the fresh cheese made from raw milk, the higher average value of Salt/DM content ± SD was 6.32 ± 0.026% in summer but the lower average value of ± SD was in winter (4.96 ± 0.009%).

However, the average values of Salt/DM content ± SD were 7.05 ± 0.018, 7.12 ± 0.029 and 7.41 ± 0.036% for summer, spring, and winter cheese respectively, at the end of ripening period. Ayad (2004) and Awad (2006) reported that the salt content in raw milk cheese was slightly lower than those of pasteurized milk cheese.

The average values ± SD of titratable acidity were also found to be significantly different in fresh cheese due to the applied feeding systems, as summarized in Table 3. Gradual increase was

Table 3. Acidity (TA), pH and some ripening indices of Ras cheese during ripening as affected by pasteurization and season*

Property	Ripening (mon.)	Winter		Spring		Summer	
		Raw	Past.	Raw	Past.	Raw	Past.
TA (%)	Zero	1.08 ± 0.012^{c}	0.72 ± 0.015^{C}	1.24 ± 0.018^{b}	0.74 ± 0.013^{B}	1.46 ± 0.023^{a}	0.86 ± 0.014^{A}
	2	1.54 ± 0.016^{c}	1.32 ± 0.018^{C}	1.68 ± 0.024^{b}	1.28 ± 0.016^{B}	1.96 ± 0.028^{a}	1.09 ± 0.012^{A}
	4	2.03 ± 0.024^{c}	1.68 ± 0.021^{C}	2.26 ± 0.029^{b}	1.76 ± 0.025^{B}	2.48 ± 0.032^{a}	1.95 ± ^{A}0.026
	6	1.26 ± 0.015^{c}	0.82 ± 0.011^{C}	1.34 ± 0.022^{b}	1.05 ± 0.014^{B}	1.64 ± 0.027^{a}	1.16 ± 0.028^{A}
pH	Zero	5.55 ± 0.036^{c}	5.66 ± 0.048^{C}	5.46 ± 0.046^{b}	5.69 ± 0.035^{B}	5.32 ± 0.031^{a}	5.76 ± 0.045^{A}
	2	5.38 ± 0.031^{c}	5.41 ± 0.041^{C}	5.31 ± 0.037^{b}	5.48 ± 0.043^{B}	5.26 ± 0.022^{a}	5.52 ± 0.035^{A}
	4	5.06 ± 0.041^{c}	5.20 ± 0.029^{C}	4.91 ± 0.028^{b}	5.32 ± 0.028^{B}	5.12±0.035^{a}	5.28 ± 0.029^{A}
	6	5.16 ± 0.029^{c}	5.38 ± 0.035^{C}	5.06 ± 0.029^{b}	5.46±0.036^{B}	5.24 ± 0.043^{a}	5.52 ± 0.037^{A}
TVFA**	Zero	10.44 ± 0.046^{b}	8.20 ± 0.038^{B}	10.22 ± 0.054^{a}	8.86 ± 0.049^{A}	10.00 ± 0.058^{c}	8.12 ± 0.042^{C}
	2	14.68 ± 0.053^{b}	12.68 ± 0.048^{B}	14.42 ± 0.062^{a}	14.24 ± 0.057^{A}	14.20 ± 0.068^{c}	12.42 ± 0.049^{C}
	4	16.46 ± 0.059^{b}	16.46 ± 0.054^{B}	16.22 ± 0.069^{a}	18.26 ± 0.069^{A}	16.36 ± 0.076^{c}	16.06 ± 0.068^{C}
	6	18.66 ± 0.063^{b}	18.28 ± 0.065^{B}	18.20 ± 0.079^{a}	19.20 ± 0.098^{A}	17.26 ± 0.098^{c}	17.28 ± 0.096^{C}
SN/TN (%)	Zero	5.21 ± 0.025^{b}	4.68 ± 0.027^{B}	5.36 ± 0.039^{a}	4.42 ± 0.036 ^{A}	5.12 ± 0.045^{c}	4.22 ± 0.035^{C}
	2	9.26 ± 0.038^{b}	8.12 ± 0.045^{B}	8.46 ± 0.052^{a}	7.86 ± 0.049^{A}	8.68 ± 0.053^{c}	7.64 ± 0.046
	4	9.66 ± 0.058^{b}	8.86 ± 0.049^{B}	9.84 ± 0.063^{a}	8.46 ± 0.062^{A}	8.96 ± 0.064^{c}	8.22 ± 0.067^{C}
	6	10.46 ± 0.065^{b}	10.26 ± 0.082^{B}	10.28 ± 0.079^{a}	10.06 ± 0.092^{A}	10.00 ± 0.078^{c}	9.66 ± 0.069^{C}
NPN/TN (%)	Zero	4.86 ± 0.028^{b}	4.36 ± 0.032^{B}	4.48 ± 0.042^{a}	4.34 ± 0.028^{A}	4.68 ± 0.034^{c}	4.46 ± 0.029^{C}
	2	6.88 ± 0.035^{b}	6.64 ± 0.039^{B}	7.22 ± 0.048^{a}	5.86 ± 0.046^{A}	6.68 ± 0.036^{c}	6.28 ± 0.042^{C}
	4	8.42 ± 0.045^{b}	8.16 ± 0.046^{B}	8.24 ± 0.058^{a}	8.00 ± 0.052^{A}	8.69 ± 0.049^{c}	8.48 ± 0.038^{C}
	6	10.89 ± 0.059^{b}	10.76 ± 0.058^{B}	10.86 ± 0.092^{a}	10.52 ± 0.069^{A}	10.72 ± 0.058^{c}	10.60 ± 0.062^{C}

*Means within the same row (a, b and c) with different superscripts differed significantly (P<0.05), whereas averages with different superscripts (a, b and c) and (A, B and C) for the same age of cheese differed significantly (P < 0.05). TVFA** expressed as ml 0.1- N NaOH/100g of cheese.

noticed during the first four months of ripening followed by a gradual decrease reaching the minimum at 1.26 ± 0.015, 1.34 ± 0.022 and 1.640.027 ± for the average values ± SD of the titratable acidity (P < 0.05) at the end of ripening period for summer, spring, and winter cheese made from raw milk, whereas the cheese made from pasteurized milk the average values ± SD of the titratable acidity were 0.82 ± 0.011, 1.05 ± 0.014 and 1.16 ± 0.028% respectively at the end of ripening period.

The pH average values ± SD in the fresh and mature cheese were found highest in winter cheese compared to those of spring and summer cheese. The corresponding average values ± SD were 5.55 ± 0.036, 5.46 ± 0.046 and 5.32 ± 0.031 in fresh cheese made from raw milk and were 5.16 ±, 5.06 ± and 5.24 ± at the end of ripening period. On the other hand, in fresh cheese made from pasteurized milk, the corresponding average values ± SD were 5.66 ± 0.048, 5.69 ± 0.035 and 5.76 ± 0.054 and were 5.38 ± 0.035, 5.46 ± 0.036 and 5.52 ± 0.037 at the end of ripening period. The gross chemical compositions in the current

Table 4. Influence of pasteurization and season on fat and protein recovery as well as cheese yield during ripening period.

Property (%)	Winter		Spring		Summer	
	Raw	Past.	Raw	Past.	Raw	Past.
Fat recovery	84.88 ± 0.048^{b}	86.55 ± 0.057^{B}	85.68 ± 0.068^{a}	86.98 ± 0.069^{A}	83.86 ± 0.075^{c}	84.56 ± 0.055^{C}
Protein recovery	76.68 ± 0.069 ^{b}	78.23 ± 0.038^{B}	77.87 ± 0.079^{a}	78.68 ± 0.057^{A}	75.88 ± 0.078^{c}	76.69 ± 0.066^{C}
Cheese yield						
When Fresh	13.22 ± 0.069^{b}	13.98 ± 0.067^{B}	12.68 ± 0.085^{a}	13.28 ± 0.087^{A}	12.12 ± 0.067^{c}	12.98 ± 0.057^{C}
After ripening	12.56 ± 0.058^{b}	12.76 ± 0.059^{B}	11.42 ± 0.074^{a}	12.20 ± 0.085^{A}	10.00 ± 0.056	11.12 ± 0.066^{C}

*Means within the same row (a, b and c) and (A, B and C) with different superscripts differed significantly ($P < 0.05$).

study, especially those obtained from winter and spring cheese, are in good agreement with the figures quoted by Awad et al. (2003) for Ras cheese. They gave values of 2.34% and 5.36 for acidity and pH of typical market Ras cheese. Abou-Donia (2003), reported that the variations in the chemical composition to many factors, but nothing was mentioned on the effect of cattle feeding systems in season.

The differences in TVFA, shown in Table 3 due to the applied feeding systems in season were significant in fresh cheese made from raw or pasteurized milk and significant in mature cheese. However, in winter cheese (raw milk), the TVFA had the highest corresponding average values ± SD of 10.44 ± 0.046 and 18.66 ± 0.063 ml 0.1N NaOH/100 g in fresh and mature cheese respectively. Whereas, the lower average values ± SD were in summer cheese (pasteurized milk), and were 8.12 ± 0.042 and 17.28 ± 0.096 in fresh and mature cheese. TVFA content gradually increased with nearly the same rate in all samples with the prolongation of the ripening period. The impact of SN/TN content in fresh and mature (raw or pasteurized milk) winter cheese resulted in higher values of NPN/TN.

The NPN/TN was significantly higher in fresh winter cheese made from raw milk (4.86 ± 0.28%), whereas for those in spring and summer cheeses were insignificantly different (4.48 ± 0.042 and 4.68 ± 0.034%, respectively). In mature cheese, the average values of NPN/TN ± SD were 10.89 ± 0.0, 10.86 ± 0.092 and 10.72 ± 0.058% in winter, spring, and summer cheeses, respectively with significant differences. However, NPN/TN was significantly higher in summer cheese made from pasteurized milk (4.46 ± 0.029%), compared to 4.36 ± 0.032 and 4.34 ± 0.028% for winter and spring cheeses. In mature cheese, the average values of NPN/TN ± SD were 10.76 ± 0.058, 10.52 ± 0.069 and 10.60 ± 0.062% winter, spring, and summer cheeses, respectively with significantly differences.

Table 3 also reveals the proteolysis indices expressed as SN/TN and NPN/TN. The values of both gradually increased on ripening feeding systems in season. The role of lipolysis and proteolysis in improving quality of Ras cheese was previously demonstrated in some recent studies (Awad, 2006; Awad et al., 2007 and Mehanna et al., 2009). This role is clearer in the present study from the values of TVFA, SN/TN and NPN/TN which were greatly correlated with the sensorial properties of the mature cheese. Fat and protein recoveries are also shown in Table 4.

The highest fat recovery was noticed in spring cheese made from raw or pasteurized milk (85.68 ± 0.068, 86.98 ± 0.069), compared with winter and summer (84.88 ± 0.048, 83.86±0.075, respectively) raw cheese and (86.55 ± 0.057, 84.56 ± 0.055) from pasteurized cheese. Johnson et al. (2001) explained that the reason for higher casein milks to the produced gels of larger pore size, which may lead to higher fat losses. There was no significant difference in recovery of protein in the form of cheese. There was a higher percentage of protein recovery in spring cheese (pasteurized cheese) than that in the winter and summer cheeses, whereas the percentage protein recovery in summer cheese (raw cheese) was lower than that in winter and spring cheeses. Pirisi et al. (2000) reported that the protein recovery values for uncooked semi hard cheese from ovine milk ranging from 75.4 to 79.5 %.

Cheese yield are given also in Table 4. The substantial differences in composition-adjusted percentage cheese yield, and the small differences in percentage fat and percentage protein recoveries between trials, indicate that the difference in milk composition (casein and fat) was the major factor responsible for the change in the cheese yield.

The highest yield cheese recorded for the cheese made from pasteurized milk, compared to

Table 5. Organoleptic properties and the corresponding scores of Ras cheese during ripening period as affected by pasteurization and season*.

Property	Ripening (mon.)	Winter		Spring		Summer	
		Raw	Past.	Raw	Past.	Raw	Past.
Flavour (60)	Zero	30.48 ± 0.098^{b}	28.66 ± 0.136^{B}	32.48 ± 0.154^{a}	30.26 ± 0.168^{A}	30.00 ± 0.145^{c}	25.46 ± 0.148^{C}
	2	40.22 ± 0.156^{b}	37.86 ± 0.145^{B}	40.56 ± 0.165^{a}	38.66 ± 0.179^{A}	37.42 ± 0.157^{c}	36.86 ± 0.158^{C}
	4	47.68 ± 0.185^{b}	42.64 ± 0.156^{B}	48.96 ± 0.175^{a}	45.86 ± 0.186^{A}	45.22 ± 0.169^{c}	40.84 ± 0.169^{C}
	6	55.86 ± 0.197^{a}	54.68 ± 0.167^{A}	55.64 ± 0.187^{b}	54.42 ± 0.198^{B}	52.68 ± 0.186^{c}	51.22 ± 0.178^{C}
Body and texture (30)	Zero	17.64 ± 0.058^{b}	16.46 ± 0.068^{B}	18.86 ± 0.078^{a}	17.82 ± 0.068^{A}	16.22 ± 0.086^{c}	15.66 ± 0.065^{C}
	2	23.62 ± 0.089^{b}	21.24 ± 0.075^{B}	24.46 ± 0.085^{a}	22.68 ± 0.079^{A}	20.24 ± 0.097^{c}	19.86 ± 0.049^{C}
	4	28.00 ± 0.095^{b}	26.00 ± 0.086^{B}	25.69 ± 0.094^{a}	25.42 ± 0.086^{A}	24.66 ± 0.087^{c}	23.26 ± 0.068^{C}
	6	28.68 ± 0.087^{b}	28.22 ± 0.076^{B}	28.13 ± 0.096^{a}	27.22 ± 0.096^{A}	27.22 ± 0.095^{c}	26.64 ± 0.079^{C}
Appearance (10)	Zero	6.20 ± 0.035^{b}	6.14 ± 0.028^{B}	6.46 ± 0.035^{a}	6.22 ± 0.048^{A}	6.14 ± 0.036^{c}	6.00 ± 0.029^{C}
	2	7.42 ± 0.045^{b}	7.12 ± 0.036^{B}	7.82 ± 0.046^{a}	7.46 ± 0.058^{A}	6.42 ± 0.049^{c}	6.12 ± 0.038^{C}
	4	8.46 ± 0.052^{b}	8.22 ± 0.045^{B}	8.20 ± 0.057^{a}	7.86 ± 0.067^{A}	7.64 ± 0.058^{c}	7.42 ± 0.047^{C}
	6	9.00 ± 0.056^{b}	9.20 ± 0.058^{B}	8.96 ± 0.069^{a}	8.88 ± 0.098^{A}	8.21 ± 0.069^{c}	7.96 ± 0.058^{C}

*Means within the same row (a, b and c) with different superscripts differed significantly (P<0.05), whereas averages with different superscripts (a, b and c) and (A, B and C) for the same age of cheese differed significantly (P < 0.05).

raw milk cheese, can be explained as the pasteurized milk can hold moisture in cheese than raw milk. On the other hand, the highest average value ± SD of cheese yield was found in spring cheese before and after ripening from pasteurized milk (13.98 ± 0.067 and 12.76 ± 0.059), whereas the lowest average values ± SD was found to be in summer cheese (12.12 ± 0.067 and 10.00 ± 0.056) in cheese made from raw milk, before and after ripening, respectively.

The organoleptic evaluation, shown in Table 5 revealed that feeding cows on diet in season significantly improved flavour, body and texture of the 4, 5 and 6 months old Ras cheese. The scoring points given for flavour were the highest in winter cheeses made from raw and pasteurized milk, followed by spring cheese and summer made from raw and pasteurized milk, respectively. The corresponding scores at the end of ripening period were 55.86 ± 0.197 - 54.68 ± 0.167; 55.64 ± 0.187 - 55.64 ± 0.198 and 52.68 ± 0.186 - 51.22 ± 0.178 out of 60 points.

The present results agree with the results reported by Bugaud et al. (2001), who found that the proteolysis products play an important role in the flavour of cheese by the contribution either directly to cheese taste or indirectly as precursors of flavour components. However, many gaps remain unknown concerning the impact of forage on cheese flavour.

Regarding the body and texture (shown in Table 5), the aforementioned trend of results was also noticed. Winter cheese made from raw and pasteurized milk had always significant higher scores followed by raw milk spring cheese and pasteurized milk summer cheese, respectively.

The corresponding scores at the end of ripening period differed significantly and reached average values of 28.68 ± 0.087 - 28.22 ± 0.076; 28.13 ± 0.096 - 27.22 ± 0.096 and 27.22 ± 0.095 - 26.64 ± 0.079 out of 30 points, respectively.

In general, an improvement in body and texture was noticed with the increase in ripening time for all cheese samples. This trend of results agrees well with that mentioned by Bugaud et al. (2001) for Abondance cheese (French type). They were able to establish significant relationships between the textures properties and the nature of pastures involved through the changes in milk and cheese composition. The rheological properties were linked firstly to the fatty acids composition and proteolysis and secondly to the pH of mature cheese.

Insignificant differences were observed for the “Appearance” of the fresh cheese as shown in Table 5, whereas at the end of ripening period in winter cheese had a significant higher value being

9.00 ± 0.056 and 9.20 ± 0.058 points out of 10 and those of spring cheese and summer cheese were 8.96 ± 0.069 - 8.88 ± 0.098 and 8.21 ± 0.069 - 7.96 ± 0.058 out of 10 points for cheese samples made from raw and pasteurized milk, respectively.

Conclusions

The results of this study showed that the seasonal changes had significant impacts on milk composition, cheese composition and cheese yield. As the season progressed, milk fat and casein decreased because of the increased solids in winter milk and the decreased solids in the milk produced during hot summer temperatures and poorer quality pastures. This resulted in decreased cheese yields. Fat and protein recoveries in the cheese were not significantly different over the season. Cheese yield were directly related to the level of fat and casein in the initial milk. Cheese made from pasteurized milk had superior body and texture smoother texture and more holes and cracks.

ACKNOWLEDGMENTS

The authors would like to thank the Animal Production Research Institute, Animal Production Research Station and Animal Production Research laboratory for financial support.

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