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Effect of Heat Treatment, Level of Sodium Chloride, Calcium Chloride On the Chemical Composition of White Cheese

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Abstract Three trials were carried out in this study. In the first trial raw cow's milk with 6% sodium chloride was processed into cheese. In the second and third trials pasteurization temperatures of 72°C/1 min and 63°C/30 min and 2%, 4% and 6% sodium chloride and 0.02% and 0.04% calcium chloride were used in each treatment respectively. Results showed that protein, total solids and ash contents and titratable acidity were significantly (P<0.001) highest in raw milk cheese. Heat treatment had no significant effect on fat content of cheese. The fat content was higher when cheese was made with 2% sodium chloride and lowest when 6% sodium chloride was added to milk (P<0.001). The protein, total solids, ash contents and titratable acidity were significantly (P<0.001) affected by sodium chloride level in cheese. Calcium chloride had no significant (P>0.05) effect on the fat content of cheese. However, the protein, total solids and ash contents were significantly (P<0.001) higher in cheese made without added calcium chloride. There was no significant difference in the titratable acidity in cheese with two levels of calcium chloride

Key words: white cheese, salt level , calcium chloride level, heat treatment, chemical composition

INTRODUCTION

Sudanese white cheese is a unique among cheese varieties in that high concentration of salt is added to milk before processing[10, 11]. Pasteurization of milk for cheese making may be regarded as essential for control of pathogenic organisms and uniform product quality. Degradation of αs and β casein was more severe in pasteurized milk cheese than in raw milk cheese[12]. Fresh cheese made from heat treated milk was superior to that made from raw milk with regard to body and texture[9]. However, higher pasteurization temperature or longer holding time caused more heat induced interactions of caseins and whey proteins[16]. Addition of sodium chloride to milk cheese suppresses the growth of undesirable bacteria, assists the physio-chemical properties in the curd giving flavour to cheese and increases yield[7]. Addition of calcium chloride to the milk had a little or no effect on the composition and quality of white soft cheese[19]. However, some researches indicated that addition of calcium chloride to milk cheese increased the fat, fat in dry matter (DM) and acidity of cheese and reduced water soluble protein and ash contents significantly[17].

The objective of this study is to determine the effect of heat treatment, level of sodium chloride and calcium chloride on the chemical composition and sensory characteristics of white soft cheese.

MATERIAL AND METHODS

Cheese Manufacture: In this study three trials were carried out. The first trial was the control in which the raw milk was just warmed at 40°C and 6% sodium chloride was added. In the second trial milk was heat treated at 63°C for 30 minutes and two levels of sodium chloride (2% and 4%) and two levels of calcium chloride (0.02% and 0.04%) were used respectively. In the third trial milk was heat-treated at 72°C for 1 minute and the two levels of sodium chloride and calcium chloride were added. Starter culture at the rate of 1% (w/w) was added to the milk at 25°C, and the milk was left for 30 minutes to develop acidity. Sodium chloride at 2% and 4% (w/w) and calcium chloride at 0.02% and 0.04% (w/w) were added to milk in each of the second and third trials. Rennet tablets were added to milk, and coagulation time was recorded for each treatment. The curd was cut into small cubes and left for whey separation then the curd was ladled into small perforated cylindrical metal moulds lined with cheese cloth and pressed overnight. Next morning the curd was removed from the mould and cut into small cubes. The weight of the fresh cheese was determined. In the first trial cheese was stored at room temperature for two days,

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while in the other trials cheese was stored at refrigerator (<10°C) for two days.

Chemical Analyses: The chemical composition (fat, protein, total solids, ash and titratable acidity) of cheese was determined according to AOAC[5]. Statistical analysis was done using the Statistical Analysis Systems[21]. Duncan's Multiple Range test was used for mean separation between the treatments.

RESULTS AND DISCUSSION

Data in Table 1 show the effect of heat treatment on chemical composition of white soft cheese. The fat content was not significantly (P>0.05) affected by heat treatment. However, the highest fat content was in cheese from heat treated milk at 63°C/30 min (21.95±3.37%). The above results were in agreement with the findings of Saleem and Abd el Salam[20] and Lau *et al.*[16] who reported that pasteurization has no effect on the fat recovery of cheese. The raw milk cheese (Table 1) showed the highest protein content (23.85±1.60%), while cheese from heat treated milk at 63°C/30 min had the lowest protein content (20.80±1.85%). The low protein content of heat treated milk cheese could be explained by the protein degradation as the result of increased moisture due to the heat treatment. This result was in conformity with the results of Ahmed and Khalifa[2] and Khalid[15]. The result showed that total solids content decreased as the temperature of heat treatment increased (P<0.001), the value being 48.35±1.11% for raw milk cheese and 41.17±2.71% for heat treated milk at 72°C/1 min. The results were in agreement with the findings of Babiker[6], Hofi *et al*.[14] and Dariani *et al*.[7] who found that total solids content of raw milk cheese was higher than that of pasteurized milk cheese. The low total solids content of pasteurized milk cheese may be attributed to the degradation of protein, dissolution of fat and salts into the pickling whey[7,22].

The ash content of raw milk cheese scored the highest (3.70±0.55%), while cheese from heat treated at 63°C/30 min had the lowest ash content (2.29±1.22%). The low ash content of pasteurized milk cheese could be explained by the diffusion of salts from the curd into the pickling solution as the result of high moisture content of pasteurized milk cheese. The above findings were consistent with those of Ahmed and Khalifa[2] , Dariani *et al*.[7] and Zaki *et al*.[22]

The titratable acidity of cheese was significantly (P<0.001) highest in cheese made from raw milk (0.55±0.09%) and lowest when cheese was made from heat-treated milk at 63°C/30 (0.24±0.03%). The highest acidity of raw milk cheese could be due to the fact that storage temperature activated the natural microflora of raw milk to develop acidity as the result of lactose fermentation since the cheese was stored at room temperature. These findings were in agreement with the results concluded by Abdall and Abdel Razig[1], Ahmed and Khalifa[2] and Nour *et al*.[18]

Data in Table 2 show the effect of sodium chloride on the chemical composition of white soft cheese. The fat content was highest when cheese was made with 2% sodium chloride (23.44±2.14%) and lowest (19.63±2.09%) when 6% sodium chloride was added to milk (P<0.001). The above findings agreed with Babiker[6], El-Erian *et al*.[8] and Khalid[15] who found that the fat content of cheese increased with decreasing sodium chloride level and moisture content. The protein content, total solids content and ash content were found to be significantly (P<0.001) affected by sodium chloride level. The raw milk cheese with 6% sodium chloride scored the highest protein content (23.85±1.61%), while the lowest value was in cheese made of 2% sodium chloride (15.75±4.37%). The findings of this study were in agreement with those of Khalid[15] who stated that the protein content of white soft cheese with 8% sodium chloride was higher than that with 6% sodium chloride. Milk cheese with 6% sodium chloride gave the highest total solids content (48.35±1.11%) in comparison with the total solids of cheese with 4% sodium chloride (44.04±4.39%) and 2% sodium chloride (43.73±3.51%). The high total solids content of cheese with 6% sodium chloride could be explained by the fact that high sodium chloride levels inhibited the growth of microorganisms, hence protein was not degraded into soluble protein. This result was in consistent with the findings of Alla Gabo[3], Khalid[15], Alsafty and El-shibiny[4] and Zaki *et al.*[22]

Milk with 6% sodium chloride resulted in cheese with high ash content (3.70±0.35%), while that with 2% sodium chloride level gave the lowest value (1.53±0.48%). The high ash content of 6% sodium chloride could be due to the presence of high levels of sodium chloride in cheese and the lower moisture content. The above findings were confirmed with those of Zaki *et al*.[22] who reported that the ash content of white soft cheese increased with an increase in sodium chloride level.

Table 3 show the effect of calcium chloride level on the chemical composition of white soft cheese. Calcium chloride level did no significantly (P>0.05) affect the fat content of cheese. The findings in this study was in agreement with those of Saleem *et al.*[19] who reported that calcium chloride had a little or no effect on cheese composition and quality. The protein content of raw milk cheese was significantly (P<0.001) higher (23.85±1.60%) than that in which 0.02% and 0.04% calcium chloride were added (16.43±4.42% and

Table 1: Effect of heat treatment on the chemical composition of white soft cheese

Item (%)	Treatment temperature			S.L
	Raw milk	63°C for 30 minutes	72°C for 1 minute	
Fat	20.40±1.80a	21.95±3.37a	21.23±2.23a	NS
Protein	23.85±1.60a	20.80±1.85b	21.61±1.21c	***
Total solids	48.35±1.11a	46.58±2.96b	41.17±2.71c	***
Ash	3.70±0.35a	2.29±1.22b	2.59±0.86b	***
Titratable acidity	0.55±0.09a	0.24±0.03b	0.29±0.03b	***

Means within the row bearing the same superscripts are not significantly different (P>0.05)
S.L. = Significance level

Table 2: Effect of sodium chloride level on the chemical composition of white soft cheese

Item (%)	Sodium chloride concentration (%)			S.L
	2	4	6	
Fat	23.44±2.14a	20.40±1.18b	19.63±2.09b	***
Protein	15.75±4.37b	17.66±0.43b	23.85±1.61a	***
Total solids	43.73±3.51b	44.04±4.39b	48.35±1.11a	***
Ash	1.53±0.48c	3.35±0.49b	3.70±0.35a	***
Titratable acidity	0.28±0.03b	0.25±0.004b	0.55±0.10a	***

Means within the row bearing the same superscripts are not significantly different (P>0.05)
S.L. = Significance level

Table 3: Effect of calcium chloride level on the chemical composition of white soft cheese

Item (%)	Sodium chloride concentration (%)			S.L
	0	0.02	0.04	
Fat	20.40±1.18a	21.38±3.05a	21.69±2.72a	NS
Protein	23.85±1.60a	16.43±4.42b	16.98±4.58b	***
Total solids	48.35±1.11a	43.07±4.57b	44.68±3.07b	***
Ash	3.70±0.35a	2.24±0.99b	2.64±1.09b	***
Titratable acidity	0.55±0.10a	0.26±0.05b	0.26±0.03b	***

Means within the row bearing the same superscripts are not significantly different (P>0.05)
S.L. = Significance level

16.98±4.58% respectively). The lower protein content of cheese with 0.02% and 0.04% calcium chloride level could be due to the effect of proteolytic enzymes as the results of addition of starter culture[13] . Milk cheese with the two levels (0.02% and 0.04%) of calcium chloride was not significantly different, their values being 43.07±4.57% and 44.68±3.07% respectively. The higher total solids content of raw milk cheese (48.35±1.11) could be explained by the presence of higher levels of sodium chloride. Calcium chloride level significantly (P<0.001) affected the ash content and titratable acidity (Table 3). Raw milk cheese with no calcium chloride secured the highest ash content (3.70±0.35% and titratable acidity (0.55±0.10%). The decrease in ash content could be explained by the interaction of calcium ions and sodium chloride that may result in a decrease in ash content of cheese. This result confirmed the previous results of Lucy and Fox[17] who stated that addition of calcium chloride to milk significantly decreased the ash content.

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