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Development of camel milk soft cheese with different levels of salt, fat and solid not fat

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Abstract— *Camel milk is unique from other ruminant's milk in terms of its composition as well as in its health effects. Cheese production from camel milk is considered to be a difficult task due to unique physicochemical properties and its compositional structure. The basic purpose of this research was to optimize the processing conditions of camel milk cheese by using different levels of solid not fat (SNF), fat and $CaCl_2$. Buffalo milk (0.0%, 05%, 10%, and 15%) was mixed with camel milk and the cheese produced, shown better results (protein 17.86%, fat 16%, moisture 64.66%) as compared to other concentrations. The cheese with skimmed camel milk incorporated with 5% buffalo milk gave highly significant ($p<0.01$) results with maximum yield 21.15%, fat 15%, acidity 3.10%, moisture 68% and protein 16.71% with good texture as compared to cheese from whole camel milk and skimmed camel milk. While, for the $CaCl_2$ addition (0.0%, 0.3%, 0.6% and 0.9%) the cheese with 0.9% $CaCl_2$ resulted in increased yield (5 %) with an improved texture and coagulation time ($p<0.01$).*

Keywords— ***Soft cheese, Camel milk cheese, Bovine milk cheese, Fresh cheese, Sensory***

I. INTRODUCTION

Camels can survive in harsh environment, drought-stricken regions and mountainous areas where the other livestock does not survive better for long period of time with remarkably low inputs in terms of feed and water as most often, they browse the shrubs and leaves of trees. Hence, camels contribute an important role in securing food for farmers in these areas [1]. Total world's camel population is about 25.89 million [2]. Approximately in Pakistan, there is about 1.0 million camel population with 818 million litres annual milk production. In Pakistan mostly camels are found in arid and semi-arid areas of Punjab, Baluchistan, Sindh, and few hilly places of KPK [3].

Camel milk, so called white gold of the desert, is more similar to human milk than any other milk and differs from other ruminant milk because it contains low cholesterol, low sugar, high minerals (sodium, potassium, iron, copper, zinc and magnesium), high vitamin C, protective proteins like lactoferrin, lactoperoxidase, immunoglobulins, lysozyme and has potential treatment for a series of diseases such as dropsy, jaundice, anti-hypertensive, asthma, and leishmaniasis or kala-azar [4]. Cheese making from camel milk is not an easy task as compared to milk from bovine milk due to its low level of total solids, unique composition of casein with lower amount of kappa casein and presence of high concentration of lysozymes and lactoferrins [5]. The main problems faced by the processers are the longer coagulation time, texture and yield. The rennet concentration, pasteurization temperature, $CaCl_2$ concentration and selection of the starter culture have strong impact on the cheese attributes [6]. Although camel milk production is very high, so there

is a need to develop new dairy products from this milk due to its high nutritious and therapeutically importance to cure main health problems.

The primary objectives of this study are to optimize the processing conditions for the production of soft cheese from camel milk, focusing on achieving the best manufacturing practices. Additionally, the study aims to investigate the effects of varying levels of fat, solids-not-fat (SNF), calcium, and sodium chloride (NaCl) on the quality and characteristics of the resulting cheese. Furthermore, the research seeks to assess the consumer acceptability of camel milk cheese produced under different processing conditions, ensuring that the variations in composition are aligned with sensory preferences and market demands.

II. MATERIALS AND METHODS

2.1 Materials

This research was conducted in Laboratory of Dairy Technology NIFSAT, University of Agriculture Faisalabad. The main objective of current study was to improve the production of camel milk cheese by using different levels of fat, SNF and salt $CaCl_2$ for production.

2.2 Procurement of chemicals and Raw-material

For the preparation of camel milk cheese, the camel milk was obtained from nearly situated village of Faisalabad. The culture (*Streptococcus thermophiles & Lactobacillus bulgaricus*) was produced from (SAAF INTERNATIONAL), (Chr. Hansen Denmark Ltd) provided rennet and chemicals were purchased from the local scientific store of Faisalabad.

2.3 Research treatment plan

Flow diagram of camel milk cheese production is shown in **Figure 1.** The research treatment plan for this study was conducted in three distinct steps. In the first step, the solids-not-fat (SNF) content of camel milk was standardized by blending it with buffalo milk in varying proportions. Four treatments were applied, with the ratios of camel milk to buffalo milk as follows: CB0 (100% camel milk and 0% buffalo milk), CB1 (95% camel milk and 5% buffalo milk), CB2 (90% camel milk and 10% buffalo milk), and CB3 (85% camel milk and 15% buffalo milk). The aim of this step was to optimize the texture and flavour of the cheese. In the second step, cheese was prepared using both full-fat and skimmed camel milk, combined with buffalo milk in different ratios. The treatments included C1 (100% skimmed camel milk), C2 (95% skimmed camel milk and 5% buffalo milk), and C3 (95% full-fat camel milk and 5% buffalo milk). Finally, in the third step, the dosage of calcium chloride ($CaCl_2$) was optimized to improve the texture and overall acceptability of the cheese. Four different $CaCl_2$ levels were tested: Ca1 (0%), Ca2 (0.3%), Ca3 (0.6%), and Ca4 (0.9%). This step focused on fine-tuning the cheese's structural and sensory properties to enhance its marketability.

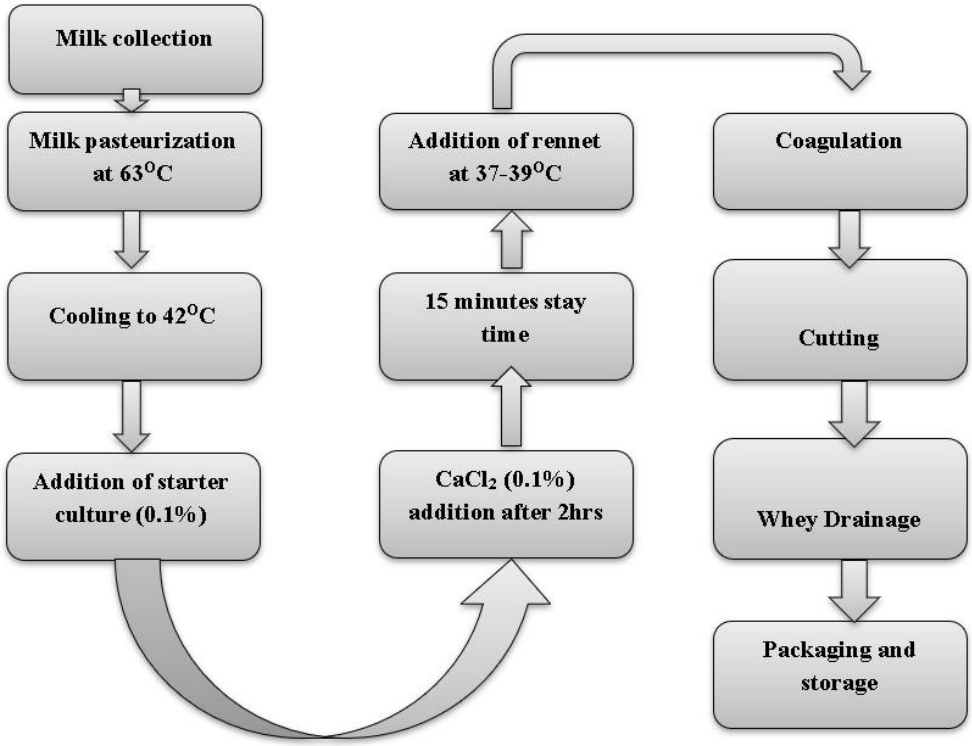


Fig.1: Flow diagram of camel milk cheese production

2.4 Physicochemical analysis

The preparation of camel milk cheese, physicochemical analysis of camel milk; fat, protein, acidity, total solids, moisture content, pH, specific gravity and lactose content, was carried out by AOAC [7]. Similarly, physicochemical analysis of camel milk cheese was carried out by standard methods of AOAC.

2.5 Cheese yield

Cheese yield was calculated after the drainage of whey following the equation as given below:

$$\text{Yield (\%)} = \frac{Cheese\ weight\ (kg)}{Milk\ weight\ (kg)} \times 100$$

2.6 Statistical analysis

The statistical analyses were performed using SPSS software (version 15). The data obtained from every parameter was statistically analysed to find the level of significance and a confidence level 0.05 was used to evaluate significant differences. The means were compared through CRD. Each test was performed in triplicates.

III. RESULTS AND DISCUSSION

Camel milk soft cheese was prepared with traditional cheese making procedure by adding thermophilic starter culture, rennet enzyme and calcium chloride. Before cheese preparation camel milk was analysed for its physicochemical composition. During cheese preparation different concentration such as calcium chloride, fat% and SNF were optimized for better cheese quality. Afterward, compositional analyses along with sensory attributes were performed. The results of physicochemical analysis of fresh camel milk as well as soft cheese are described below.

3.1 Compositional analysis of whole camel milk

The compositional analysis of whole camel milk was shown in **Table 1**. Average pH value of fresh camel milk was 6.67. The similar observations (6.66 pH) was reported by Bhagiel, Mustafa [8]. The average acidity of fresh camel milk was 0.13% to 0.18%. Fahmid et al [9] also reported the 0.12% to 0.15% acidity of fresh raw camel milk. While Galeboe, Seifu [10] observed 0.84% acidity during the summer season. The protein contents of raw camel milk were 4.56%. The result was compatible with the observation of Abd El-Aty, Abdou [11], who found 4.35% protein contents in the raw camel milk. The results of present study were different Babiker and El-Zubeir [12] who stated 3.81% protein in fresh camel milk. Zhao et al [13] reported variation in protein contents of raw camel milk may be due to breed of camel and weather conditions. Average percentage of lactose in raw camel milk was 3.38%. Present study results were supported by Benmeziane–Derradji [14], who found 3.27% lactose in raw camel milk.

Table 1: Physicochemical composition of whole camel milk and skimmed camel milk

Parameters	Whole camel milk (%)	Skimmed camel milk (%)
pH	6.67±0.23	6.00±0.08
Acidity	0.14±0.02	0.22±0.10
Protein	4.56±0.20	3.64±0.26
Fat	2.9±0.52	0.83±0.28
Lactose	3.38±0.10	3.19±0.08
Moisture	85.44±0.50	84.7±0.70
Total solids	14.33±0.57	15.21±0.50
Specific gravity	1.018±0.002	1.020±0.01

In fresh raw camel milk moisture contents were in range of 85.0% to 86.0% while Ahmed, Sayed [15] found 88.0% moisture in raw camel milk. Results for total solids (14.33%) in present study were also supported by Ahmed, Sayed [15]. Specific gravity of raw camel milk was 1.018, while Yoganandi, Mehta [16] reported the normal range of specific gravity up to 1.029, and acclaimed that variation in specific gravity of raw camel milk might be caused due to its adulteration with water.

3.2 Compositional analysis of skimmed camel milk

Results for physicochemical analysis were shown in **Table 1**. pH of skimmed camel milk was 6.05. But results were found dissimilar by Inayat, Arain [17] who reported 6.89 pH of skimmed camel milk. The average acidity of skimmed camel milk was 0.22%. Abeiderrahmane [18] also reported the 0.30% acidity of skimmed camel milk. The difference in pH and acidity of skimmed camel milk may be due to presence of chloride in higher concentration. The protein contents in the range of (3.34% to 3.8%) were studied in skimmed camel milk. The

results were compatible with the investigation of Inayat, Arain [17], who found the maximum value of protein 4.01% and minimum value of protein 3.57% in skimmed camel milk. Average fat contents of skimmed camel milk were observed 0.83% in present study. Kaskous [19] also reported 0.88% fat in skimmed camel milk.

The average lactose concentration in skimmed camel milk was 3.19% observed. The results which were comparable to Inayat, Arain [17] who examined 3.14% lactose contents in skimmed milk of camel. Total solids of skimmed milk were 8.26% observed. The total solids in skimmed camel milk investigated by Babiker and El-Zubeir [12], who found maximum level of total solids 8.56% in skimmed camel milk. Specific gravity of skimmed camel milk was in between 1.019 to 1.021 studied. Comparable results were reported by Inayat, Arain [17] who found 1.024 specific gravity of skimmed camel milk. By skimming the camel milk, the fat%, ash% and chlorides decreased but total protein contents of skimmed camel milk increased Inayat, Arain [17].

3.3 Effect of fortification of buffalo milk with camel milk on processing conditions of soft cheese

Soft cheese was prepared by adding different concentration of buffalo milk (CMC, CM+5% Buff, CM+10% Buff, CM+15% Buff) and analysed for the compositional consequences **(Table 2)**. Acidity of camel milk cheese were 1.32%, 1.34%, 1.37% and 1.41% observed prepared with CB_0, CB_5, CB_{10}, CB_{15} respectively. The results of present study showed significant ($P<0.01$) differences for cheese acidity prepared with CB_{15} as compared to CB_0, CB_5, CB_{10} respectively. Variation in cheese acidity may be due to culture used during processing of cheese, lactic acid production in buffalo milk is more than camel milk and camel milk has weak buffering capacity. Thermophilic starter culture has capacity to produce more acidity as compared to mesophilic [20-22]. Results of cheese acidity were dissimilar to Qadeer, Huma [23], who reported 0.92%, 0.96%, 0.96% and 1.03% acidity for cheese prepared with CM, CM+10% Buff, CM+20% Buff and CM+30% Buff milk. The results were comparable 1.65% to 2.0% for soft cheese [24, 25].

Table 2: Effect of treatments on various parameters of cheese produced by fortifying camel milk with buffalo milk

Treatments	Acidity (%)	Fat content (%)	Moisture content (%)	Protein content (%)	TSS (%)	Cheese yield (%)
CB_0	1.32 ± 0.03^{B}	13.33 ± 0.57^{C}	67.16 ± 0.5^{A}	12.82 ± 0.18^{AB}	33.05 ± 0.85^{C}	12.383 ± 1.71^{C}
CB_5	1.34 ± 0.011^{B}	14.83 ± 0.28^{B}	66.16 ± 0.5^{AB}	16.81 ± 3.89^{AB}	33.83 ± 0.50^{BC}	16.490 ± 0.21^{AB}
CB_{10}	1.37 ± 0.01^{AB}	16.33 ± 0.76^{A}	64.96 ± 0.06^{B}	17.31 ± 0.68^{AB}	35.03 ± 0.06^{AB}	13.810 ± 1.45^{BC}
CB_{15}	1.41 ± 0.03^{A}	16.50 ± 0.5^{A}	64.33 ± 0.33^{B}	18.21 ± 0.35^{A}	35.66 ± 0.33^{A}	18.973 ± 0.18^{A}

Cheese prepared with CB_0, CB_5, CB_{10} and CB_{15} had 13.33%, 14.83%, 15.33% and 16.50% fat contents. Significant differences ($P<0.01$) were found for cheese fat prepared with CB_{15} as paralleled to CB_0, CB_5 and CB_{10} respectively. Similar results were observed by Qadeer, Huma [23], who reported fat contents 15.33%, 16.02%, 16.67% and 17.33% for cheese prepared with CM, CM+10% Buff, CM+20% Buff and CM+30% Buff milk. But results were found by Derar and El Zubeir [26], who reported 16.56%, 18.10%, 21.23%, 22.21% and 23.08% fat contents of soft cheese prepared with mixing of camel milk with sheep milk respectively. Variation in fat contents is because of buffalo and sheep milk had more fat contents as compared to camel milk and camel milk had weak coagulum feature as compared to cheese prepared with buffalo and sheep milk that is why fat particles drained out through whey [13, 27].

Moisture contents of cheese prepare with CB_0 was 67.16%, CB_5 had 66.16%, CB_{10} contained 64.96% and CB_{15} had 64.33% respectively. Significant ($P<0.01$) differences were observed in cheese moisture prepared with CB_0 than that of CB_5, CB10, CB_{15}. Results of protein contents were 12.82%, 16.81%, 17.31% and 18.21% for cheese prepared with CB_0, CB_5, CB_{10} and CB_{15} respectively. Increase significant ($P \geq 0.01$) differences were examined in cheese protein prepared with CB_{15} as compared to CB_0, CB_5, and CB10 respectively. But results of cheese protein were observed match able with present study by Derar *et al.*, *(*2016) who investigated 13.10%, 14.43% and 15.315 in cheese prepared with CM, CM+10% Buff and CM+20% Buff milk. Different results were examined by (Hayaloglu *et al*., 2005) who found protein 16.41%, 17.99%, 21.85% and 21.41% prepared with blending of camel milk with buffalo milk. Variation

of protein contents in camel milk cheese observed because camel milk had lower total solids than buffalo and camel milk. Total solids improve the rheological properties of cheese curd and also increase the protein, casein contents, lactose and yield of cheese [20-22].

Total solids of cheese were 33.05%, 33.83%, 35.07% and 35.66% for cheese prepared with CB_0, CB_5, CB10, and CB_{15} respectively. Highly significant differences ($P<0.01$) were observed for total solids of cheese prepared with CB_{15} than CB_0, CB_5, and CB_{10}. Cheese yield were 12.38% for cheese prepared with CB_0, CB_5 had 16.49%, CB_{10} had 13.81% and CB_{15} had 18.97% respectively. Significant differences ($P<0.01$) were found for cheese yield prepared with CB_{15} as compared to cheese prepared with CB_0, CB_5, and CB_{10} respectively. Results of cheese yield were different to Qadeer, Huma [23], who reported 20.21%, 22.0%, 25.00% and 27.33% for cheese prepared with CM, CM+10% Buff, CM+20% Buff and CM+30% Buff milk respectively. But results were investigated by Shahein, Hassanein [28], who stated that cheese yield 10.63%, 13.76%, 21.33% 26.20% and 23.53% respectively. Variation in cheese yield is due to presence of maximum total solids present in buffalo milk as compared to camel milk [29]. Mixing of camel milk with buffalo milk enhance the cheese yield along with other quality parameters such as flavour, fat%, protein and total solids Shahein, Hassanein [28], and improves the coagulation process as well.

3.4 Effect of skimmed camel milk on compositional characteristics of soft cheese

Camel milk cheese was prepared by skimming the milk and comparison were marked with cheese prepared by whole milk with 5% buffalo milk. Cheese was prepared with skimmed camel milk (C_1), mixture of skimmed camel milk+ 5% buffalo milk (C_2) and mixture of whole camel milk + 5% buffalo milk (C_3) and compositional differences observed respectively and the results are mentioned in **Table 3**, and discussed below;

Table 3: Effect of skimmed camel milk on compositional characteristics of soft cheese

Treatments	Acidity (%)	Fat content (%)	Moisture content (%)	pH	Protein content (%)	TSS (%)	Cheese yield (%)
C_1	3.15 ± 0.70 ^{A}	8.33± 2.08 ^{B}	67.66 ± 0.57^{A}	4.13 ± 0.06 ^{A}	17.86 ± 5.80 ^{A}	32.33 ± 0.57 ^{A}	8.33 ± 0.85 ^{B}
C_2	3.10 ± 0.45 ^{A}	6.43 ± 1.40 ^{B}	70.66 ± 3.21 ^{A}	4.12 ± 0.04 ^{A}	26.05 ± 3.22 ^{A}	29.77 ± 3.34 ^{A}	14.73 ± 5.53 ^{AB}
C_3	2.91 ± 0.80 ^{A}	15.66 ± 1.15 ^{A}	66.66 ± 1.15 ^{A}	4.17 ± 0.06 ^{A}	17.09 ± 0.66 ^{A}	33.11± 1.01 ^{A}	18.39 ± 3.56 ^{A}

Table 4: Effect of $CaCl_2$ on compositional characteristics of soft cheese

Treatments	Acidity (%)	Fat content (%)	Moisture content (%)	pH	Protein content (%)	TSS (%)	Cheese yield (%)
Ca_1	2.97 ± 0.54 ^{A}	13.33 ± 4.93 ^{A}	64.16 ±1.83 ^{A}	4.31 ± 0.01^{A}	21.00 ± 1.02 ^{A}	35.50 ± 2.35 ^{A}	8.32 ± 0.39 ^{A}
Ca_2	2.88 ± 0.23 ^{A}	13.33 ± 4.16 ^{A}	66.33 ± 1.67 ^{AB}	4.22 ± 0.01 ^{B}	18.75 ± 0.25 ^{AB}	33.67 ± 1.67 ^{AB}	8.62 ± 1.02 ^{AB}
Ca_3	2.91 ± 0.18 ^{A}	13.00 ± 4.35 ^{A}	67.50 ± 1.5 ^{AB}	4.17 ± 0.01 ^{C}	17.71 ± 0.15 ^{BC}	32.50 ± 1.5 ^{AB}	12.34 ± 2.76 ^{BC}
Ca_4	3.03 ±0.28 ^{A}	12.00 ± 4.35 ^{A}	69.16± 0.83 ^{B}	4.17 ± 0.01 ^{C}	19.86 ± 0.295 ^{C}	30.83 ± 0.83 ^{B}	13.50 ± 0.73 ^{C}

pH of cheese was 4.17, 4.12 and 4.13 prepared with C_3, C_2 and C_1 respectively. Results of the present study showed the non-significant differences ($P>0.05$) among the pH of soft cheese. Throughout cheese preparation pH is the key point in cheese coagulation and ripening process. Texture of cheese depends on pH of milk at which cheese prepared reported by Fukuda [30]. Inayat, Arain [17] found that the average pH of soft cheese prepared with skimmed camel milk was 5.23. On the other hand same results were found in cheese pH that was 4.30 investigated by Allam, Darwish [31]. Certain factors such as lactase enzyme present in milk and type of culture used during cheese production caused variation in cheese pH reported [32-34]. Results of cheese acidity for cheese prepared with C_1, C_2 and C_3 were 3.15%, 3.10% and 2.9% respectively. Results of all treatment showed the non-significant ($P>0.05$) differences. Acidity is the main factor after pH in cheese processing for ripening, rennet

actions, enhance the syneresis process which ultimately affects the cheese flavor, texture and taste as well [30].

Acidity of soft cheese prepared with skimmed camel milk was 1.80% for Inayat, Arain [17], but results observed in the current study were 2.9% to 3.15%. Reason behind the variation in acidity of cheese was form of bacterial culture used. Cheese prepared with thermophilic starter culture have highest acidity [20-22].

Fat contents of cheese were 8.33%, 6.43% and 15.66% for cheese prepared with C_1, C_2 and C_3 respectively. Increase in significant differences (P<0.01) were observed for cheese prepared with C_3 as compared to C_1 and C_2. Fat contents of cheese improves the taste, texture, chewiness flavor as well as appearance reported by Küçüköner and Haque [35]. However fat contents of milk directly affect the useable and processing conditions of cheese. Results were related to Shahein, Hassanein [28], who found 10.0% fat in soft unripen cheese prepared with mixture of camel milk with buffalo milk. Inayat, Arain [17] investigated 3.54% fat in soft cheese prepared with skimmed camel milk; results were different to current study. Adding buffalo milk into camel milk increased the fat contents of soft cheese. Camel milk has week coagulation so fat globules drained out through whey drainage that reduced the fat percentage in camel milk cheese (Shahein, Hassanein [28], Sameen, Anjum [36]).

Moisture contents of soft cheese prepared with C_1, C_2 and C_3 were 67.66%, 70.66% and 66.66% respectively. Non-significant (P>0.05) differences were examined among the cheese moisture. Results of total solids were 32.33%, 29.77% and 33.11% for cheese prepared with C_1, C_2 and C_3 respectively. Non-significant differences (P>0.05) were observed for total solids of cheese. Protein contents of cheese were 17.86%, 26.05% and 17.09% for cheese prepared with C_1, C_2 and C_3 respectively. Increase in Significant differences (P≤0.05) were found for protein of cheese prepared with C_2 as compared to $C_1$and C_3 respectively. Similar results for cheese protein were observed by Inayat, Arain [17], who examined the maximum 19.64% and minimum 17.57% protein in skimmed milk cheese. But results were found for cheese protein by Sameen, Anjum [36], who reported 11.0% protein. Difference in protein of cheese depends on factors like mixing of buffalo milk in camel milk because buffalo milk has higher protein contents along with casein as compared to camel milk while, storage stability also decreased the protein contents of cheese by hydrolysing the protein into amino acids and ammonia [37]. Cheese prepared with C_1, C_2 and C_3 had cheese yield 8.33%, 14.73% and 18.39% respectively. The results of present study showed the increase significant (P<0.01) differences for cheese yield prepared with WCM+5% Buff as compared to C_1 and C_2. Results for total solids were match able to present study observed by Inayat, Arain [17] who reported 30.69% total solids in soft cheese prepared with skimmed camel milk.

3.5 Effect of $CaCl_2$ on compositional characteristics of soft cheese

$CaCl_2$ has main part in improving the chemical properties of the camel milk soft cheese. The results of physic-chemical analysis of cheese with different calcium chloride doses (0%, 0.3%, 0.6% and 0.9%) were described in **Table 4**. Acidity of camel milk cheese were 3.6%, 3.15%, 2.9% and 2.7% prepared with Ca_1, Ca_2, Ca_3 and Ca_4 $CaCl_2$ concentration respectively. The present study results showed the non-significant value (p>0.05) due to maximum increase in acidity value. The cheese prepared with Ca_1, Ca_2, Ca_3 and Ca_4 $CaCl_2$ had 19%, 18%, 18% and 17% fat contents. Thus, due to decrease in amount of fat on increase of $CaCl_2$ results were non-significant (p>0.05). In camel milk cheese pH is most important because coagulation of milk depends on it. pH value was (4.3%, 4.2%, 4.1% and 4.1%) in cheese on Ca_1, Ca_2, Ca_3 and Ca_4 $CaCl_2$ which showed the result was highly significant (p<0.01) because on increasing of salt concentration the pH of cheese was dropped respectively.

Table 4: Effect of $CaCl_2$ on compositional characteristics of soft cheese

Treatments	Acidity (%)	Fat content (%)	Moisture content (%)	pH	Protein content (%)	TSS (%)	Cheese yield (%)
Ca_1	2.97 ± 0.54 ^{A}	13.33 ± 4.93 ^{A}	64.16 ±1.83 ^{A}	4.31 ± 0.01^{A}	21.00 ± 1.02 ^{A}	35.50 ± 2.35 ^{A}	8.32 ± 0.39 ^{A}
Ca_2	2.88 ± 0.23 ^{A}	13.33 ± 4.16 ^{A}	66.33 ± 1.67 ^{AB}	4.22 ± 0.01 ^{B}	18.75 ± 0.25 ^{AB}	33.67 ± 1.67 ^{AB}	8.62 ± 1.02 ^{AB}
Ca_3	2.91 ± 0.18 ^{A}	13.00 ± 4.35 ^{A}	67.50 ± 1.5 ^{AB}	4.17 ± 0.01 ^{C}	17.71 ± 0.15 ^{BC}	32.50 ± 1.5 ^{AB}	12.34 ± 2.76 ^{BC}
Ca_4	3.03 ±0.28 ^{A}	12.00 ± 4.35 ^{A}	69.16± 0.83 ^{B}	4.17 ± 0.01 ^{C}	19.86 ± 0.295 ^{C}	30.83 ± 0.83 ^{B}	13.50 ± 0.73 ^{C}

The results of protein contents were 21%, 18%, 17% and 19% for cheese prepared by Ca_1, Ca_2, Ca_3 and Ca_4 $CaCl_2$ respectively. Thus, present study results showed highly significant ($p<0.01$) results of protein. Moreover, Ahmed [38] reported that factors such as milk composition, addition of salt, pasteurization of milk, milk concentration and addition of starter culture affect the yield. The low pH increased acidity, and also there was decrease in fat content and total solids content. The data indicated that there was a ratio of milk total solids retained in the whey which was white in color; this result was in agreement with that of Mehaia [39]. Otherwise, the total protein and fat content were not altered. Yield of cheese was (7%, 8%, 12% and 14%) which indicated that the results of stat highly significant ($p<0.01$) on Ca_1, Ca_2, Ca_3 and Ca_4 $CaCl_2$ concentration. In comparison of our study the cheese yield obtained using camel milk in this study was reported as 7-14% which was similar to the finding of Mehaia [39] who obtained 10.5-11.5%. On the other hand, Qadeer, Huma [23] acclaimed that the yield of camel milk cheese with starter culture was 13.22% compared with cheese prepared by acidification and rennet action which yielded 12%, Moreover Derar and El Zubeir [26] obtained less yield (11.3%) using Camifloc enzymes and calcium chloride, however, the camel cheese made without addition of calcium chloride was 10.2% while our research cheese was 7% without salt. The latter workers concluded that addition of calcium chloride improved the manufacturing of cheese from camel milk. The high yield of the present study may have been caused by good and favourable temperature that was (63ºC) which could not affect dry mater intake and this increase the total solids in milk which it was the main factor in cheese processing.

Total solids in cheese were (33%, 35%, 32% and 31%) thus results showed significant ($p<0.05$) results. The research which was conducted by Ahmed [38], overall average contents of total solids obtained from camel milk cheese was 35.72 %. Thus, findings indicated significant changes ($P<0.05$) among the camel milk cheeses made with three different doses of salt. Moisture is main component in cheese for its classification. Cheese shelf life improves on the base of moisture level which is present in it. Moisture percentage in cheese was (64%, 66%, 67% and 69%) that indicated the significant ($p<0.05$) results according to statistics.

3.6 Sensory evaluation of cheese prepared with different processing conditions

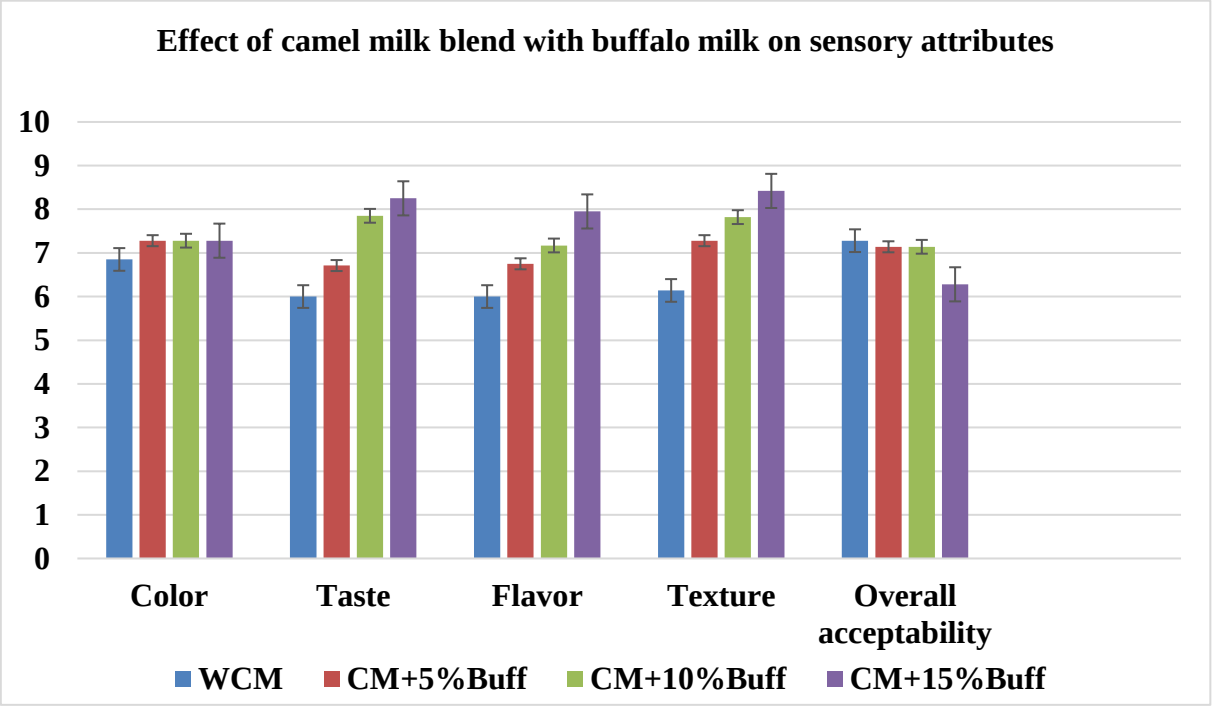
Sensory attributes of freshly prepared cheese were executed by the faculty students, who were well aware to the soft cheese. Sensory attributes such as color, flavour, texture, taste and overall acceptability were evaluated by the panellists. A 9-point Hedonic scale (1= like extremely, 5 = Neither like nor dislike and 9 = Dislike extremely) were developed for evaluation. Cheese was displayed with randomly three digits codes.

3.6.1 Effect of fortifying buffalo milk with camel milk on sensory attributes of soft cheese

Effect of blending camel milk with buffalo milk on final product and sensory attributes of soft cheese is shown in **Figure 2 (a & b).** The mean scores for color of the cheese prepared with CM, CM+5% Buff, CM+10% Buff, CM+15% Buff milk respectively. Results of statistical data showed the increase significant differences ($P>0.05$) for color of cheese prepared with CB_{15} than that of CB_0, CB_5, CB_{10} respectively. Taste of the cheese prepared with CB_0 had 6.0, CB_5 had 6.71, CB_{10} had 7.85 and CB_{15} had 8.25 mean scores respectively. Increase significant ($P<0.01$) differences were observed for the taste of cheese prepared with CB_{15} as compared to the cheese prepared with CB_0, CB_5 and CB_{10} respectively. Flavour of the cheese was more liked by the panellists prepared with CB_{15} had 7.95 mean score than the cheese prepared with CB_0, CB_5 and CB_{10} with mean scores of 6.0, 6.75 and 7.17 respectively. Highly significant differences ($P<0.01$) were found for the cheese prepared with CB_{15} as compared to CB_0, CB_5 and CB_{10} respectively. Mean scores was 7.28 for the cheese prepared with CB_0 and CB_{15} had for the texture but cheese prepared with CB_5 and CB_{10} had scores of 6.0 and 7.14 respectively. Non-significant differences ($P>0.05$) were observed among the texture of the cheese. Overall-acceptability of cheese were preferred by the more panellist prepared with CB_{15} (8.42) than CB_0, CB_5 and CB_{10} (6.14, 7.28 and 7.82) respectively. Highly significant differences ($P<0.01$) were observed among Overall-acceptability of the cheese supported by the results of Ong, Soodam [40].

Guasch-Jané, Andrés-Lacueva [41] reported the extreme flavour liked for the cheese prepared with camel and buffalo milk (75:25). Because buffalo milk cheese has strong aroma, flavour and good in taste as compared to camel milk cheese. Qadeer, Huma [23] concluded that the texture of the cheese prepared with camel milk mixed with 10% Buff milk was more firm than pure camel milk cheese. Sensory characteristics of camel milk cheese improved by using more modified starter extracted from pure camel milk microflora [42].

(a)



(b)

Fig.2: (a) Soft cheese curd of camel milk (85%) and buffalo milk (15%) blend, (b) Effect of camel milk blend with different levels of buffalo milk on sensory attributes

3.6.2 Effect of skimmed camel milk on sensory characteristics of soft cheese

Effect of skimmed camel milk on sensory characteristics of soft cheese is shown in **Figure 3.** Color of the cheese was more preferred prepared with WCM + 5% Buff milk with highest mean score of 8.42 as compared to cheese prepared with SM and SM+5% Buff milk (7.28 and 6.85) respectively. Present results showed

the highly significant differences (P<0.01) among the color of the cheese. Mean score for the taste was 5.85 prepared with C_1, C_2 cheese had 7.42 and C_3 cheese had 8.75 respectively. Cheese taste was more liked prepared with C_3 as compared to C_1 and C_2 cheese. Results showed highly significant (P<0.01) data among the cheese taste. Flavour of the cheese prepared with C_2 and C_3 had same score (6.57) than cheese prepared with C_1 (6.0). Results indicated that flavour of cheese prepared with C_2 and C_3 more liked than C_1 cheese. Present study results showed the non-significant (P>0.05) results for the flavour of cheese. Texture of the cheese was more preferred for the cheese prepared with C_3 with mean score of 8.85 than the cheese prepared with C_1 and C_2 had 6.42 and 7.42 mean score respectively. Increase significant (P<0.01) results were observed for the cheese prepared with C_3 as compared to C_1 and C_2 cheese. Overall acceptability of cheese showed non-significant (P>0.05) differences prepared with C_1 and C_2 and C_3 with 6.42, 6.57 and 7.28 mean scores respectively.

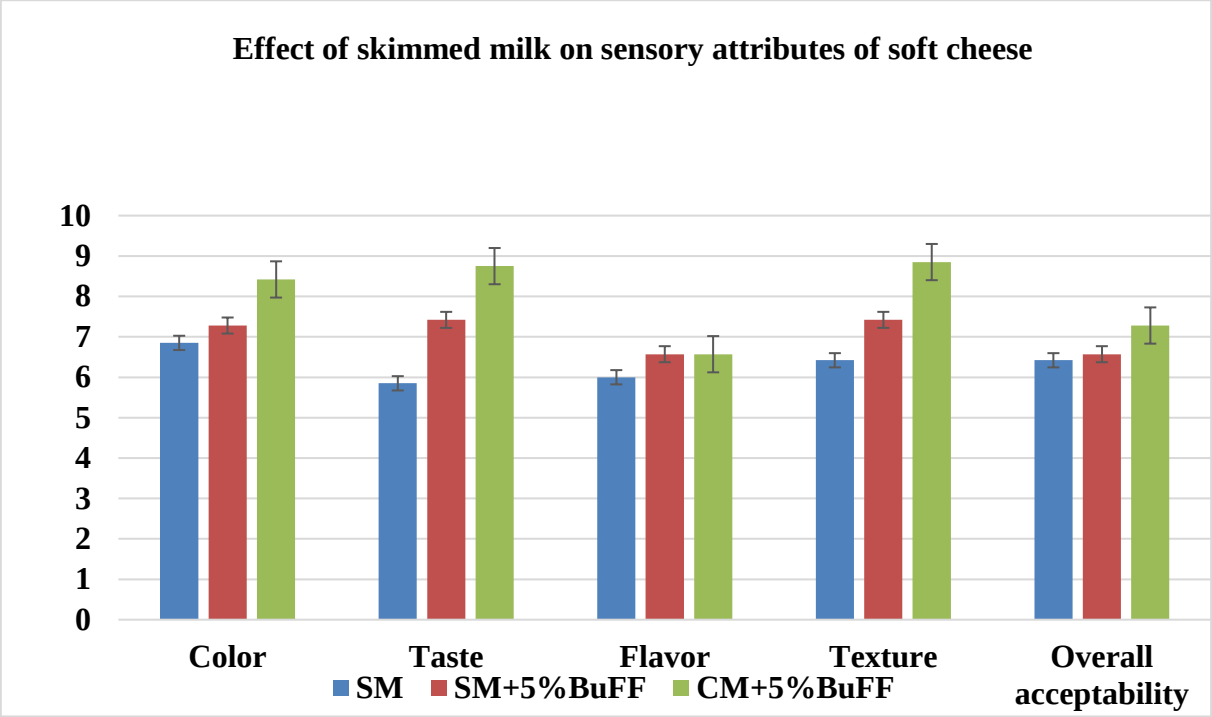


Fig.3: Effect of skimmed milk on sensory attributes of soft cheese

3.6.3 Effect of different $CaCl_2$ dose on sensory evaluation of the cheese

Effect of $CaCl_2$ concentration on sensory evaluation of cheese is shown in **Figure 4.** Color of cheese prepared at 0%, 0.30%, 0.60% and 0.90% $CaCl_2$ dose had mean score of 7.42, 8.0, 8.0 and 7.57 respectively. Results indicated the non-significant (P>0.05) differences among the color of the cheese. Most favoured taste of cheese was that prepared at Ca_2 and Ca_3, $CaCl_2$ had mean score 7.42 than Ca_1 and Ca_4 dose (5.71 and 6.14) respectively. Present study showed the non-significant (P>0.05) results for the cheese taste. Flavour of the cheese was preferred prepared at Ca_2 and Ca_3, $CaCl_2$ dose had average points of 7.0 as compared to the cheese prepared at Ca_1 and Ca_4 dose (6.0 and 6.442) respectively. Non- significant (P>0.05) results were observed among the flavour of cheese. Texture of cheese prepared at Ca_2 and Ca_3, $CaCl_2$ dose had same mean score 8.14 than that of Ca_1 and Ca_4 dose of $CaCl_2$ (7.0 and 7.71). Increase in non-significant (P>0.05) differences were noticed for the cheese prepared at Ca_2 and Ca_3, $CaCl_2$ dose than Ca_1 and Ca_4 respectively. Overall acceptability of cheese was preferred most for the cheese prepared at 0.30% and Ca_3, $CaCl_2$ dose had average value 7.85 than cheese prepared at Ca_1 and Ca_4, $CaCl_2$ dose having 6.71 and 7.42 respectively. Increase in significant (P>0.01) differences were observed the overall acceptability of cheese prepared at Ca_2 and Ca_3, $CaCl_2$ dose as compared to Ca_1 and Ca_4 dose respectively. Results for sensory attributes of cheese prepared at (0.0%, 0.55 and 1.0%) $CaCl_2$ dose like flavour, taste and overall acceptability were preferred more than colour and texture of the cheese [43]. For the production of soft cheese, the concentration of salt affected the flavour, texture, color, taste and overall acceptability. Panellists preferred the cheese with high salt concentration than controlled [44].

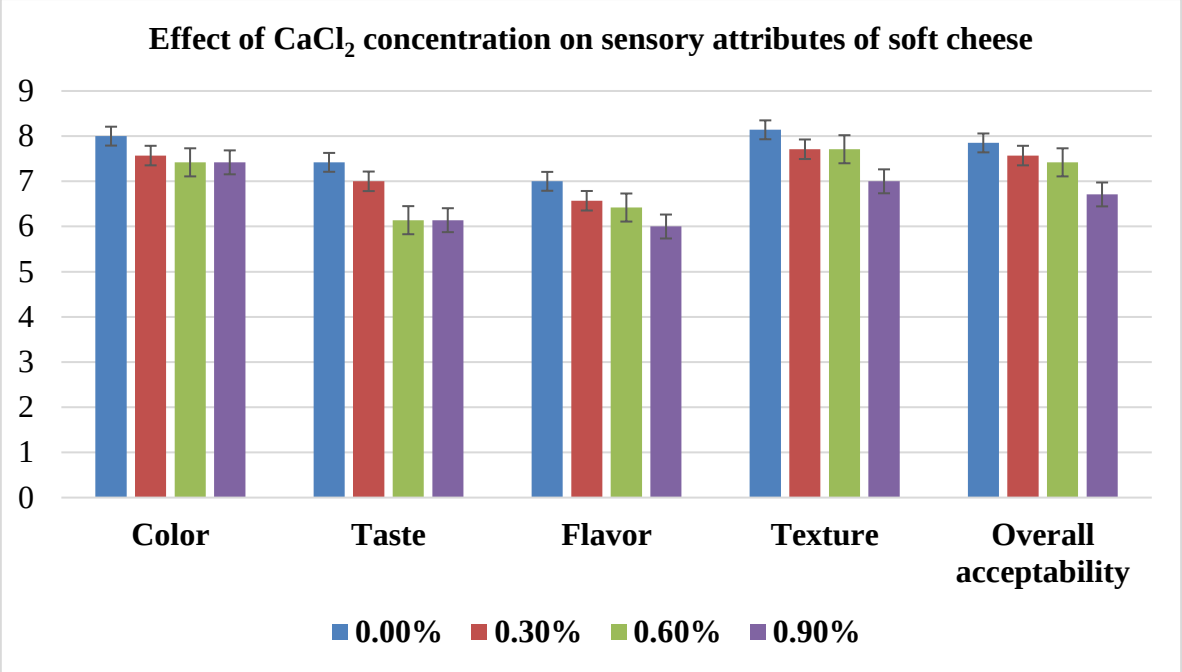


Fig.4: Effect of different salt concentration ($CaCl_2$) on sensory attributes of soft cheese

IV. CONCLUSION

On the basis of present study's results, it is concluded that camel milk cheese can be developed efficiently by 15:85 ratio of buffalo in to camel milk. For further improvements in camel milk cheese flavour and texture, the level of 0.9% $CaCl_2$ added which showed significant results. On the other hand, the cheese quality can further be improved by adjusting the fat percentage of camel milk with addition of 5% whole buffalo milk.

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