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Efficiency of Cheese Making from Camel Milk by Blending with Cow Milk at Different Proportion

Abebe Gemechu [a*], Balako Gumi [b], Sisay Girma [c], Zelalem Ayana [c] and Gabeyehu Goshu [d]

[a] Department of Animal Production Study, College of Veterinary Medicine and Agriculture, Addis Ababa University, P.O.Box-34, Bishoftu, Ethiopia.
[b] Aklilu Lemma Institute of Pathobiology, Addis Ababa University, P.O.Box 1176, Ethiopia.
[c] College of Veterinary Medicine, Haramaya University, P.O.Box-138, Dire Dawa, Ethiopia.
[d] Department of Veterinary Medicine, Bule Hora University, P.O.Box-144. Bule Hora, Ethiopia.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

With the aim of assessing the effect of milk blend on physical-chemical composition of milk and cheese, sensory qualities, time of coagulation, and cheese yield, the current inquiry was carried out to ascertain the effectiveness of cheese producing from camel milk by blending with cow milk. To reduce the effect of lactation stage on milk composition, a sample of milk was obtained from pastoral communities in the Borena zone using stratified sampling procedures. The cheese was made using a starter culture (Thermophilic culture STI-12) and camel chymosin in various ratios with a blend of camel and cow milk. Prior to the creation of the cheese, the chemical makeup of the milk used was examined. Cheese's physicochemical characteristics were also assessed. When compared to the other milk a sample, the yield of cheese made from 100% camel milk (T1) was

**Corresponding author: E-mail: abitygemechu@gmail.com;*

considerably lower (P 0.05). Higher values were seen in treatments that combined 25% camel milk with 75% cow milk and 100% cow milk, significantly (P0.05). When compared to the other milk samples under treatments T2, T3, T4, and T5, pure camel milk (T1) coagulated in significantly longer (P0.05) time (210 minutes), but pure cow milk (T5) coagulated in significantly shorter (P0.05) time (95.67 minutes). In all of the study's treatments, there were significant variations in the physico-chemical composition of raw milk (p 0.05), in TS, TA, Fat and Ash. Cheese may demonstrate the effects of the camel blend if protein, fat, totals solids, and ash content improved significantly (p0.05). The significance (p0.05) boost in cheese's protein, fat, total solids, and ash content could indicate how camel milk has influenced cheese production.

Keywords: Cheese; coagulation; pasteurization; starting culture; rennet.

1. INTRODUCTION

Many arid and semi-arid countries depend on camels (Camelus dromedarius) as a supply of milk since they can produce more milk over a longer length of time than any other species in these challenging environments [1]. 60% of the world's camels are found in the Horn of Africa, where 10% of the milk produced has a camel origin [2]. Despite their ability to thrive in harsh environments on minimal resources, camels have not been widely used as a food source.

With the exception of certain historically fermented camel milk in the Somali region, many pastoralist groups in Ethiopia believe that it is impossible to process camel milk to make butter, yoghourt, and cheese [3]. This is due to the fact that camel milk doesn't naturally cream up and the fat is tightly bonded to the protein. On the other hand, modernized camel dairy processing is now available in various parts of the world and can generate a variety of camel milk products [4]. According to a study, camel milk is converted into butter less efficiently and with a longer churning time than cow and goat milk [5]. According to reports, camel milk has a higher whey protein to casein ratio than bovine milk, which results in a soft, quickly digestible curd in the digestive tract [6]

The process of making cheese aids in keeping milk's important components intact. A product known as cheese is produced by coagulating and separating the whey from milk, cream, partially skimmed milk, buttermilk, or a combination of these items [7]. Due to its high presence of antibacterial components such lysozyme, lactose, and immunoglobins, processed camel milk has great biological properties [8]. Additionally, it is used medically to treat Spleen disorders, anemia, asthma, and tuberculosis [9]. Lysozyme, lactoferrin, lactoperoxide, immunoglobulin, and secretary immunoglobulin A are all present in significant quantities in camel milk. Compared to cow and buffalo milk, camel milk has much higher concentrations of these antimicrobial compounds and is also more heat stable [10]. However, it is challenging to make cheese from camel milk naturally without the use of a coagulant due to the big casein micelles, low total solids, and higher whey protein to casein proportion [11]. Rennet is the most popular coagulant used by cheese-makers to manufacture many different types of cheese [12]. An increase in acidity, prolonged heating, or enzyme activity could cause coagulation [13]. Cheese manufactured from a combination of cow and camel milk has better aroma, appearance, hardness, and textural qualities than cheese made exclusively from camel milk [14]. Hence, this finding was designed to evaluate the impacts of mixing cow milk with camel milk on milk coagulation, cheese yield, and chemical composition and sensory attributes of the cheese.

1.1 Significances of the Study

Processing camel milk is an essential tool to extend the shelf life of the products. However, due to the natural features of camel milk, it is difficult to transform it under natural conditions. Thus, the mixtures of camel's milk with cow is used improve coagulation, chemical constitutes and products quality, which had the effect of increasing the acceptances of camel milk cheese and changing the perception pastoral communities regarding camel milk processing. Furthermore, camel milk processing is used as an input for those targeted on camel dairy technology in general.

2. MATERIALS AND METHODS

2.1 Milk Samples Collection

First-time breastfeeding cows and camels were divided into early (1-3 months), mid (3-5 months), and late lactation stages (above 6 months). From lactating Borena cows and camels belonging to a particular household, fresh cow and camel milk was gathered. By permanently identifying a sterile container with three digital identifiers, the milk was transported into the lab over a three-term period.

2.2 The Making of Cheese

Five different combinations of raw milk were tested: 100% camel milk (T1), 75% camel and 25% cow milk (T2), 25% camel and 75% cow milk (T3), 50% camel and 50% cow milk (T4), and 100% cow milk (T5). By gently stirring to homogenize, the milk was heated to a temperature of 60 °C. Once more, the heated milk was cooled to 42°C by being placed in a cold water bath. Then, in 45-minute intervals, ST1-12 Thermophilic starter culture, calcium chloride, and chymosin rennet were added and stored for coagulation (varies time). The cheese was sliced into squares when the curd had formed and then put into a cheese cloth to drain the whey. Whey was properly drained for 30 minutes by having a 3 kg weight on top of it. Using the methods described by Newcomb WL, et al. [15]. The experiment was three times repeated.

2.3 Coagulation of Milk

Applying the International Dairy Federation standard allowed for the determination of milk coagulation (1992). When the rennet was introduced, a 75mm long glass slide was suspended from the top of the cooking pot and placed inside the milk.

The time that it took for milk to coagulate was calculated from the addition of rennet to the appearance or observation of curd flecks on the slide and was observed in a two-minute period interval. To this objective, the time of setting was measured up to the curd that was cut squarely and exuded pure whey.

2.4 Sensory Assessment

The cheese was obtained, presented to the panelists in three coded replications on flat platters. Twelve semi-trained panelists comprised of M.Sc students, staffs from the Department of Animal and Range Sciences, and local cheese and camel milk consumers evaluated the sensory qualities of the cheese samples for roughness, surface moisture, firmness, a taste, adhesiveness, solubility, saltiness, appearance, and overall acceptance using a seven-point hedonic scale ranging from 7 (the highest score) to 1(Lowest score). Using the criteria established by Hashim (2002), the panelists were chosen to be between the ages of 25 and 40 years old. The descriptive sensory analysis method used category scaling procedures.

Fig. 1. Curd formed

Fig. 2. Squarely cut of curd

Fig. 3. Separation of curd from whey

Fig. 4. Cheese made from 50:50%

2.5 Designing Experiments and Statistical Analysis

The statistical analysis tool Statistical Package of Social Sciences (SPSS) version 21 was used to differentiate the significant mean from the rest of the significant means. For the evaluation of cheese, a completely randomized design was adopted. Yij= +ti + ij, where Yij is the response variable, is the overall mean, ti is the treatment effect (blend level) of the ith treatment, and ij is the random error, was the model used to analyze the cheese yield and sensory score data.

3. RESULTS

3.1 Chemical Makeup of Milk Used to Make Cheese

According to the chemical composition data, cow milk had higher total solid, solid not fat, TA, fat, CP, lactose, and specific gravity than camel and their blends, with the exception of ash content (Table 1). Camel milk had a considerably (P0.05) greater ash value than cow milk, whereas the CP values of the three treatments (T2, T3, and T3) did not differ significantly (P>0.05).

3.2 Milk Coagulation Effectiveness

The results revealed significant variations (P0.05) in the mean values of the coagulation and setting times across the study's five treatments (Table 2). For both categories, the sample with the purest and highest percentage of camel milk took longer. Contrarily, pure cow milk had much lower levels of coagulation and setting time. The findings showed that milk coagulation and setting times decreased as cow milk percentage rose (Table 2). The PH value, however, did not indicate a significant difference (P>0.05). This study showed that the PH of treatments was not significantly affected by the effects of various camel and cow samples. The cheese yield created from cow milk had higher values, however treatment one's cheese values were noticeably lower than those of the other samples. The cheese output had greater values than the other milk samples because it had higher percentages of cow milk (Table 2).

3.3 Camel Milk Cheese's Chemical Makeup When Combined with Cow Milk

Table 3 lists the physicochemical characteristics of cheese prepared from camel milk and a combination of cow milk. In contrast to the ash and moisture percentages of the cheese, the protein, fat, and total solids of the analyzed cheese are raised with higher level cow milk. From T1 to T3, the ash and moisture content levels were noticeably (P0.05) increased. According to this research, treatment four, which contains 50% camel milk and 50% cow milk, had the greatest value for fat content. While the sample of 100% camel milk had cheese with a much reduced fat level.

Table 1. Physicochemical composition of raw milk of camels, cow and their blends used for cheese making

Variable	Treatments (Mean±SD)				
	T1	**T2**	**T3**	**T4**	**T5**
T S (%)	11.537[a]±0.14	11.55[a]±0.11	13.77[c]±0.17	12.82[b]±0.16	14.23[d]±0.38
pH	6.210[a]±0.36	6.363[ab]±.31	6.727[bc]±.02	6.393[ab]±0.25	6.727[bc]±0.05
TA(%)	0.1435[a]±0.01	0.1465[a]±0.02	0.172[b]±0.10	0.1685[c]±0.30	0.1725[b]±0.02
Fat (%)	3.61±[a]0.14	3.72[b]±0.13	4.18[c]±0.10	4.07[d]±0.87±	4.520[e]±0.36
CP (%)	3.195[b]±0.18	3.220[a]±0.21	3.350[a]±0.15	3.265[a]±0.20	3.353[c]±0.16
Lactose(%)	4.077[a]±0.57	6.579[a]±0.34	3.350[ab]±0.16	5.767[ab]±0.81	4.3347[c]±0.75
SNF (%)	8.05[a]±0.10	7.85[a]±0.17	9.65[d]±0.17	8.82[c]±0.16	9.78[d]±0.38
SG	1.027[a]± 0.01	1.032[ab]±0.05	1.037[b]±0.02	1.038[b]±0.09	1.039[b]±0.08
Ash (%)	0.7742[c]±0.06	0.7384[b]±0.06	0.728[b]±0.04	0.735[b]1±0.04	0.690[a]±0.19

Note: T1=100% camel milk, T2=75%camel milk and 25%cow milk, T3=25%camel milk and 75%cow milk, T4=50%camel milk and 50%cow milk, T5=100% cow milk, SD= Standard Deviation

Table 2. Cheese yield and coagulation efficiency camel milk and it blend

Variables	Treatments (Mean ±SD)				
	T1	**T2**	**T3**	**T4**	**T5**
CT(M)	69.00[e]±1.00	60.67[d]±3.79	26.67[b]±2.08	51.67[c]±2.9	19.00[a]±1.00
ST(M)	1160.0[d]±5.84	96.33[c]±5.85	32.83[a]±0.29	65.00[b]±5.00	31.67[a]±0.58
pH	4.79[a]±0.43	4.73[a]±0.18	4.57[a]± 0.15	4.74[a]±0.8	5.07[a]±0.68
Y (g/100g Milk)	17.96[a]±0.28	18.50[a]±2.18	19.70[ab]±0.27	21.18[b]±1.26	24.70[c]±0.48

Note: CT=Coagulation Time, ST=Setting Time, Y=Yield, T1=100% camel milk, T2=75%camel milk and 25%cow milk, T3=25%camel milk and 75%cow milk, T4=50%camel milk and 50%cow milk, T5=100% cow milk, SD= Standard Deviation, Min=Minutes, L=Liter

Table 3. Physicochemical composition of a cheese made from cow and camel with its blend

Treatments	Components				
	Protein (%)	**Fat (%)**	**TS (%)**	**Ash (%)**	**Moisture (%)**
T1	14.89[a]±.13	17.60[a]±1.00	40.23[a]±6.95	2.59[d]±0.06	59.79[c]±1.00
T2	15.85[b]±.14	19.12[b]±.57	46.89[b]±1.87	2.39[bc]±0.06	53.13[b]±6.98
T3	16.17[bc]±.02	20.66[b]±.93	45.79[ab]±.38	2.49[cd]±0.02	54.20[bc]±1.84
T4	16.12[c]±.03	30.60[d]±.10	48.36[b]±2.08	2.32[ab]±0.06	51.63[b]±2.08
T5	22.69[d]±.33	21.78[b]±.19	57.85[c]±1.27	2.26[a]±0.09	42.15[a]±1.27

TS= Total Solid, T1=100%camel, T2=75%camel milk and 25%cow milk, T3= 25% camel milk +75%cow milk, T4=50%camel milk +50%cow milk, T5=100% cow milk

3.4 Cheese Sensory Assessment

Table 4 displays the sensory characteristics of a cheese made with various ratios of a blend of camel and cow milk. The cheese prepared from pure camel milk scored higher than others in terms of roughness, surface moisture, hardness, adhesiveness, and saltiness, while the cheese created from pure cow milk scored worse (Table 4). Contrary to popular belief, pure cow milk cheese received good marks for its flavors, solubility, looks, and general acceptance. A 25% addition of cow milk to camel milk did not, almost universally, result in a significant difference (P0.05), while 50% and 75% additions had a substantial impact on the cheese's physical characteristics. Compared to other samples of the mix, the cheese made from 50% cow milk was more widely accepted (Table 4), while the cheese made from 75% cow milk had a good appearance. The greater quantity of cow milk cheese may have been preferred over the lower percentage due to its tasty texture. Pure camel milk cheese may have a more pronounced salty feel than other samples due to the camel milk's salinity flavor.

4. DISCUSSION

The average chemical composition values for cow, camel, and their blend in Table I demonstrated that the chemical composition of blended milk improved with increasing cow milk proportion. This result is consistent with the findings of Derar AMA and El Zubeir IE. [16] and Mustafa MS et al. [17] who observed that the chemical composition of camel milk rose when it was combined with cow and sheep milk. On the other hand, Eissa EA et al. [18] observed that during yoghurt preservation periods, the fat content of mixed camel and cow milk remained steady. The results of earlier research [19] and, [20] revealed that total solids content of camel milk was 8.62%, 8.64%, and 9.78%, respectively. The total solids of pure camel milk in the current study are higher than those results. However, the result of 12-15% in total solid cow milk is consistent with the findings of [21] and [22]. Climate, feeding method, and cow lactation stage may be to blame for the variance in total solids content between the current study and previous findings. According to the findings of [19] and [23] who reported pH values of 6.2–6.7 for fresh camel milk, the pH of camel milk as observed in the current study is consistent with those results.

The camel milk's ability to coagulate may be increased by adding cow milk to the mixture. The milk's coagulation time was kept lower with a lower amount of camel milk, but a higher percentage of cow milk considerably sped up the production of curd. This is probably brought on by the fact that cow milk contains more solids than camel milk does. The current finding was consistent with the reports of [24] and [25], which showed that camel milk blended with Bufallo milk might be better in coagulation than pure camel milk. The present coagulation time of camel milk, however, is longer than the results reported by Walle T, et al. [26], who found that the shortest gelation times, 348 and 433 seconds, were recorded with the highest chymosin concentrations. Additionally, Vos T, et al. [27] found that a higher chymosin content could reduce the time required for milk to coagulate, which is somewhat consistent with the current investigation. As the amount of cow milk in the mixture grew, the coagulation time continued to shrink.

In the current investigation, the cheese prepared from pure camel milk was observed to have 17.96g/100g milk (Table 2), which is consistent with the earlier result of 17.2–18.10g/100g milk [28]. The pure cow milk and its larger proportion in the mixture led to a higher cheese yield. The fact that the fat globules in cow milk are practically completely absorbed into the casein network during the coagulation process, which is analogous with the report of the higher output of cheese in mixture of camel milk than pure camel milk, may be the cause of this [29]. The cheese yield obtained with 100IMCU/L uncooked cheese samples in the current study (12.60g/100ml) is significantly higher than that reported by Walle T et al. [26]) who found that the highest cheese yield was obtained with goat milk cheese. This might be explained by higher solid recovery and more moisture being incorporated into the curd in uncooked cheese samples, which leads to the production of more cheese [30]. The shape of the curd and the cheese yield are influenced by the interaction of the fat globule and protein. The cheese yield in the current study could be raised from 17.96g to 21.18g/100g milk by mixing cow's milk with camel's milk.

Table 4. Sensory attributes of cheese

Variables	Treatment (Mean ±SD)				
	T1	**T2**	**T3**	**T4**	**T5**
Roughness(F)	5.67^{d} $\pm^{a}$0.76	4.50^{cd}±.0.87	3.67^{bc}±0.29	3.35^{ab} ± 0.29	2.37^{a} ±0.32
SM(F)	6.13^{d} ± 0.23	5.17^{cd} ±0.29	4.50^{bc} ±0.50	3.87^{b}±0.38	3.00^{a} ±0.50
Taste(M)	2.53^{a} ± 0.15	2.13^{a} ±0.15	3.27^{b}±0.30	4.47^{c} ±.0.23	5.73^{d} ±0..25
Firmness(M)	6.17^{d}±0.16	5.50^{d}±0.30	5.10^{b} ±0.17	4.60^{c}±0.30	4.70^{a}±0.10
Adhesiveness (M)	5.93^{b} ±1.00	5.23^{ab} ±0.34	3.93^{a} ±0.64	5.00^{ab} ±0.57	3.87^{a} ±0.81
Solubility(M)	2.30^{a} ± 0.30	2.80^{b} ±0.100	4.63^{d} ± 0.15	3.57^{c} ±0.40	5.57^{e} ±.0.20
Saltiness	5.83^{c} ±0.58	5.27^{c}±0.06	3.27^{a}±0.41	4.40^{b}±0.35	3.43^{e}±.0.25
Appearance	3.53^{a}±0.30	4.20^{b}±0.20	5.17^{c}±0.11	4.27^{b}±0.26	5.30^{c}±0.10
Acceptance	3.30^{a}±0.17	4.20^{a}±0.65	5.13^{b}±1.07	5.47^{b}±0.47	6.80^{b}± 0.44

Values are in the mean of triplicate data ±stander deviation (SD) of the mean. F=Finger M=Mouth
T1=100%camel, T2=75%camel milk and 25%cow milk, T3= 25% camel milk +75%cow milk, T4=50%camel milk +50%cow milk, T5=100% cow milk. SM=Surface Moisture

Similar findings regarding the cheese's protein, fat, total solids, and ash concentrations were made in a prior study using a similar experimental design [31,32,33]. While the moisture of cheese manufactured from cow milk in the current study is much lower than the 59.98% reported by Jung HJ, et al. [34], the moisture contents of cheese created from camel milk were significantly higher than the 48.9% reported by Akinloye AM, et al. [35]. According to findings by Habtegebriel H, et al. [28], the cheese production of real camel milk was 18.10g/100g of milk, which is comparable to values for pure camel milk but much lower than the blend one in this study. Different camel milk blend ratios would have produced cheese with higher ash content. The ash contents of cheese manufactured from camel milk were 1.60 and 1.98-20.20%, respectively, according to [33] and [29], which is lower than the study's present finding . The varieties of vegetation that camels browse during their feeding behavior contribute to the high salty characteristics of pure camel milk cheese.

The cheese made from camel milk and high percentages of camel milk mixed with cow milk produced the highest values for roughness, surface moisture, firmness, adhesiveness, and saltiness in the current finding/study/, whereas the cheese made from pure cow milk and high percentages of cow milk proportion in the treatment produced the best values for solubility, tastes, appearance, and acceptances. This result is consistent with [8], who showed that the general acceptance of yoghurt was significantly increased by the larger percentages of cow milk in the blend of camel and cow milk. The glandular surface of cheese manufactured with 100% camel milk may help to increase the roughness features of cheese made with a higher percentage of camel milk in the milk mixture. As a consequence of the panelists' evaluation, camel milk's contribution to the cheese's roughness was maintained at a lower level than pure cow milk. This may be because camel milk still contains some unhydrolyzed fat globulin compared to cow milk, which is corroborated by [36], that found uncompletely hydrolyzed fat globulin in raw milk could raise the amounts of surface moisture in the final products. Additionally, [37] found that cheese created from pure camel milk had higher surface moisture than cheese manufactured from cheese that contained 50% cow milk.

According to Kraggerud H et al. [38] the combination of cow and camel milk may alter the physical characteristics of cheese, which is consistent with the findings of this investigation. Overall approval of the camel milk cheese, as reported by Walle T, et al. [39], was 4.40, which was somewhat higher than the present rating of the cheese produced from only camel milk. According to this study's findings, camel milk cheese received fewer overall acceptances than combined camel and cow milk cheese [40].

5. CONCLUSSION

The present study concluded that blending of camel milk with cow milk could be improved the processing properties of camel milk for cheese making. The blend of milk brought the significant difference with the proportion of milk mixed in all patterns of study that was included physicochemical properties of milk and cheese, cheese yield, coagulation and setting time and sensory attributes of cheese. The present of cow milk in the blend made the cheese produced to have a great sound in over all acceptances cheese.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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