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Development and Evaluation of Camel Milk Cheese

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Abstract

A nutrient-rich liquid food that comes from the mammary glands of animals is called milk. Camel milk is a great source of carbohydrates, protein and energy. Camel milk is not yet widely used in dairy products and camel milk products are not common in food industries. Therefore, this research has been conducted on making cheese from camel milk with different combinations of sheep milk. In first phase, chemical composition of camel milk was determined. In next phase, fresh cheese was prepared from camel milk, using the camifloc powder as a coagulation with different combination of sheep milk Camel (40%) + Sheep (60%), Camel (50%) + Sheep (50%) and Camel (60%) + Sheep (40%). The causes of chemical, microbial, and sensory analysis were examined, which included protein, fat, ash and total solids 16.92%, 18.71%, 1.61% and 44.82% respectively. The total bacteria count for camel's milk cheese was also lower 9.12 * 105 counts. The highest average values of color, taste, texture, and overall acceptability were 3.40 ± 0.221, 3.80 ± 0.416, 3.80 ± 0.327, and 4.30 ± 0.335 respectively. The addition of sheep's milk was also affecting the sensory characteristics of camel cheese. The results showed that the best cheese was decided by a panelist consisting of 50% camel's milk and 50% sheep's milk.

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Introduction

Milk is a white fluid substance that bring out from the mammary organs of warm-blooded animals that feed their newborn. Early lactation incorporates colostrum's, exchange, the mother's antibodies are exchanged for her offspring and can reduce the risk of many diseases. It contains many different supplements such as protein and lactose (Krivošíková *et al.*, 2019).

Milk is one of the top ten sources of saturated fat and daily calories (Huth *et al.*, 2013). In addition, according to data from the 2003–2006 National Health and Nutrition Examination Survey, milk is the third driving source of saturated fat and the seventh best source of calories (Huth *et al.*, 2013). Some investigations have suggested that conjugated linoleic acid, which can be found in dairy products, is a viable supplement for muscle loss in proportion to fat (Whigham *et al.*, 2007). Milk is high in vitamin B12, vitamin A, riboflavin, folate and calcium, yet the amount of press is low (Drewnowski, 2011). Vitamin B12 has been discovered in animal source substances in most developing countries (Agrawal *et al.*, 2007). Milk claims to strengthen bones and reduce the risk of bone fractures. Milk is a rich source of iron, vitamin A, zinc, and iodine, with microscopic nutrition being the highest deficiency.

The World Health Organization's (WHO) wide-ranging descriptive audit from 1993 to 2005 found that 47% of young people experience the harmful effects of pre-school anemia. Iron deficiency, the main driver of which is low consumption of meat, poultry, and fish, is thought to be the region of elimination of half of the iron deficiency intestinal diseases (Lynch, 2011).

The camel is one of the animals which told the Qur'an the wonder of God (Yadav *et al.*, 2015). Milk has a number of properties that make it a very important decision because camel's milk is used as part of some medicines to cure diseases. Camel milk is consumed by camel farmers in many areas and is considered an essential part of the daily routine of this population in rural areas. Camel handlers use raw milk or boiled milk. Camel milk was used to manage various matters all over the world (Attia *et al.*, 2001).

The structure of camel's milk is not taken into account in the manufacture of a portion of recognized products that are made using the milk of other breeds. In any case, dairy products were made using camel's milk and used only for purposes other than food. Camel milk products are made after mixing the milk of different animals (Getahun and Belay, 2002). Various products made from camel's milk include delicate soft cheese, fermented milk, yogurt, sweets and margarine (El Zubeir & Jabreel, 2008; Elayan *et al.*, 2010). The attractive production of camel cheese is also understandable using dynamic camel chymosin given by the subjects in the yeast strain, pichia pastoris GS115 (Wang *et al.*, 2015).

Many cheeses are made in traditional shapes and sizes, ranging in size from 5 to 40 kg. In some cases, the traditional form has been abandoned, for example, cheese is now made into rectangular or square blocks. Breaking down the protein network is important for the taste and softening of cheese by breaking the casein network (Broadbent & Steele, 2005). According to the present study, camel's milk may have reduced the production of cheese due to the ambient temperature which affected the amount of dry matter, which reduced the total solids in the milk and these are the main factors in the processing of cheese such as milk composition, addition of salt, pasteurization of milk, milk concentration and addition of starter culture affect the yield (Ayad, 2009).

The purpose of this study is to examine the camel milk cheese characteristics, to improve the production of camel's milk cheese mixed with sheep's milk and to compare different percentages of milk with camel's milk cheese. Consumers demand low-fat products, but without the loss of quality. Camel and sheep milk have been used in dairy products to improve the nutritional synthesis as well as the functional properties of cheese.

Materials and methods

Fresh camel and sheep milk were collected in sterile cans from the various domains of Faisalabad, Pakistan. The milk was immediately cooled to refrigerated temperature and transported to Food Technology Laboratories of Government College University, Faisalabad Pakistan and maintained at 5°C until it was used. Camifloc powder (product from Bio Serae Laboratories, Bram, France) recommended by the FAO (2001). Calcium chloride (product of Merck, Denmark) was used to make cheese collect from the local scientific market.

Cheese Processing

Milk samples were prepared according to the ratios of camel and sheep milk (40: 60, 50: 50 and 60:40) respectively. All milk samples were refrigerated at low temperature. Different ratio of milk was used in starter culture with coagulating enzyme and calcium chloride salts to prepare the experimental dairy product.

Camel cheese was prepared according to this method, as described by El Zubeir and Jabreel (2008). Firstly, milk was purified using white muslin cloth at NIFSAT, University of Agriculture Faisalabad, Pakistan. Milk was pasteurized at 62°C for 30 minutes and then cooled in ice water to 35°C.

The milk was then kept for about an hour until the pH reached 5.5. When the desired pH was observed then added the rennet solution at the rate of 0.15ml/L of milk which was made by adding 2g of dry rennet in 10ml of distilled water. Calcium chloride salt was added at the rate of 0.03-0.05 percent (w/v) to improve coagulation of the milk and mixed thoroughly and milk was left to coagulate 3-4 hours. When the coagulation was completed, the coagulum was cut by sterile knife and whey drained off.

The curds placed into clean cheese cloth and hanged at a height and eft for 2-3 hours to drain the excess water. The cheese was stored weighed, and packed at refrigerator temperature (4°C) for further evaluation purposes.

Chemical Composition of Camel Cheese

Determination of Protein Contents

The protein contents of cheese were determined by the Kjeldahl method AOAC (1990). Three grams of cheese weighed and two Kjeldahl tablets were placed into Kjeldahl flask and 25 ml of concentrated H_2SO_4 was added to the flask. The mixture was then digested on heater until a clean solution is obtained. It took 3-4 hours; removed the flasks and allowed it to cool. The digested sample was place in a 100ml volumetric flask and diluted with distilled water. Then put 5ml of dilution into Kjeldahl flask and add 10ml of NaOH. Then received in conical flask containing 25 ml of 4% boric acid and three drops of indicator (Bromo Cresol Green + Methyl Red), distillation continued until the volume in the flask reached 75 ml. The flask was removed from distillatory and distillate titrated against 0.1N HCl until the end point (red color) was obtained. Protein contents was calculated by following equation;

$$Nitrogen\ (\%) = T \times 0.1 \times 0.014 \times 20\ /W \times 100$$

$$Protein\ (\%) = Nitrogen\ (\%) \times 6.38$$

Ash Contents

The ash content was calculated using the method described in AOAC (1990). 2g sample was weighed and dry in the steam bath. The sample was then placed in muffle furnace (550°C) for three hours then cooled in dissector and weighed again. Ash content was calculated using the following formula.

$$Ash\% = \frac{W1}{W} \times 100$$

W1/W×100

W_1 = Weight of ash residue

W = Weight of sample

Fat Contents

According to AOAC (1990) the fat content was analyzed by Gerber's method. a 10ml of sulfuric acid (90 % conc.) was poured into a spotless dry Gerber tube, and then a sample of 3 gram of cheese were weighed and added. Amyl alcohol (1ml) was added to the mixture followed by addition of distilled water.

The contents were well mixed until no white particles were visible. The gerber tube was centrifuged at 1100 rpm for five minutes and then the tubes were transferred to a water bath for three minutes at 65ºC. Then the separated fat percentage was read immediately.

Total Solid Contents

Total solid contents were estimated using the method as described in the AOAC (1990). The cheese sample weighs two grams and was placed in a clean dry aluminum plate and heated for 10-15 minutes at 37ºC. The plates were then heated in the oven at 105ºC for three hours. The plates were then cooled in a desecrator and weighted quickly until they reached constant weight. The total solids content was calculated by equation;

$$T.S\,\% = \frac{W1}{W} \times 100$$

W_1 = Weight of sample after drying

W = Weight of sample before drying

Microbiological Examination

According to Marshall (1992), in this study plate count agar method was used to prepare media for microbial analysis. Ten-gram cheese sample was added into 90ml of hot distilled water and mixed for two minutes approximately.

The 1ml sample solution was then poured into a test tube through a sterile pipette of 9ml distilled water and mixed well. Another puppet also contained 1ml of the previous solution with distilled water. This process was repeated to make ten folds dilution from 10-1 to 10-10. Appropriate dilution was used for determination of total bacterial count.

Colony Counting

The Plates were inoculated and left to dry for two minutes and then incubated at 32ºC for at least 24 hours. The plates were inspected and the colonies were counted using the colony counters.

The plates of the colony forming unit (cfu / ml) consisted of between 30 and 300 colony forming colonies.

Sensory Evaluation

After 10 days of storage at refrigerator temperature using sensory evaluation (9-point hedonic scale), ten inexperienced panel asked to decide the quality of cheese, such as texture, color, taste and overall acceptability. They scored 1 to 9 as per hedonic scale where likeness decreased in descending order 1 for "like extremely" and 9 indicated "dislike extremely".

Statistical Analysis

Data analyzed by SPSS (Statistical Package for Social Sciences) program by using Least Significant Design (LSD) to compare samples. The analysis was carried out by ANOVA test (Steel *et al.*, 1997).

Results and discussion

Chemical Composition of Camel Milk

Table 1 clarifies that the chemical and microbiological analysis of raw camel's milk was used to make cheese. He clarified that the protein content of camel's milk was 3.12 + 0.047% which did not agree with Ahmed *et al.* (2014) who noted a protein content of 3.5-4.5% but closed with El- Iqbal *et al.* (2001) who documented the same 2.8-3.1%.

Table 1. Camel Milk Composition.

Contents	Mean
Protein%	3.12±0.047
Fat%	2.99±0.071
Ash%	0.95±0.026
Total Solids%	11.09±0.116
Total Bacterial Count (cfu/ml) x10⁴	1.03±0.033

The percentage of fat contents recorded was 2.99 + 0.071% and also in the range of 3.07-5.5% mentioned by Ahmed *et al.* (2014). A similar result was found in the study of Mal *et al.* (2006) in range between 2.60 to 3.20%. Ash contents of mean values were 0.95+ 0.026% disagreed by Inayat *et al.* (2003). The total bacterial count of camel milk was analyzed as 1.03 + 0.03×104 which prove that the antimicrobial effect of camel milk may be due to the presence of lactoperoxidase, lectoferrine and lysozyme. Camel milk has contained higher value of antibacterial supplies as compared to cow and buffalo milk (El-Hatmi *et al.*, 2007). It was revealed that the total solid content was 11.09 + 0.116% higher than the percentage that is presented in the range specified by Mall *et al.* (2006).

Chemical Composition of Camel Cheese

Protein Contents

In the current research, the outcome showed that higher and lower quantities of protein were measured in Camel (40%) + Sheep (60%) and pure sample respectively as shown in the Table 2. Our outcome cleared that camel milk cheese was contained low protein contents as compare to sheep milk. Mehaia, (1996) and Derar & El Zubeir, (2014), were confirmed that the protein value of camel milk cheese is less as compared to sheep milk cheese.

Another previous study in which, Inayat *et al.* (2003) was revealed that by using of Camifloc enzyme the result of camel cheese was different.

Table 2. Effect of treatment on the chemical composition of camel cheese.

Treatment	Protein%	Fat%	Ash%	Total Solids%	Total Bacterial Count (cfu/mg) x10^5
Control	16.92 ± 0.185 ^{C}	18.71 ± 0.382 ^{B}	1.61 ± 0.043 ^{A}	44.82 ± 0.212 ^{C}	9.12 ± 0.097 ^{C}
Camel (40%) + Sheep (60%)	22.77 ± 0.219 ^{A}	21.73 ± 0.210 ^{A}	1.59 ± 0.012 ^{AB}	47.04 ± 0.292 ^{A}	17.76 ± 0.218 ^{A}
Camel (50%) + Sheep (50%)	22.26 ± 0.350 ^{A}	21.44 ± 0.208 ^{A}	1.51 ± 0.015 ^{BC}	47.16 ± 0.050 ^{A}	15.89 ± 0.093 ^{B}
Camel (60%) + Sheep (40%)	19.07 ± 0.063 ^{B}	19.46 ± 0.072 ^{B}	1.47 ± 0.018 ^{C}	45.93 ± 0.072 ^{B}	16.05 ± 0.306 ^{B}

Means sharing similar letters are statistically non-significant (P>0.05).

Fat Contents

The fat contents in pure, Camel (40%) + Sheep (60%), Camel (50%) + Sheep (50%) and Camel (60%) + Sheep (40%) were 18.71 ± 0.382 B, 21.73 ± 0.210 A, 21.44 ± 0.208 A and 19.46 ± 0.072 B respectively as shown in Table 2. A higher value was found in Camel (40%) + Sheep (60%) and lower was found in the control sample. Compared with other milk fat, camel milk contained less short-chain unsaturated fats (Akbar, 2011). The lower level of short-chain unsaturated fats in camel milk causes the gentle crystallization point in cheese (Farah & Ruegg, 1991).

Fats are the critical factor affecting the cheese quality directly. Three replications performed to calculate the mean value of the fat percentage.

Table 3. Effect of treatment on sensory attributes of camel cheese.

Treatment	Taste	Color	Texture	Overall Acceptability
Control	3.80 ± 0.416 ^{A}	3.40 ± 0.221 ^{A}	3.80 ± 0.327 ^{A}	4.30 ± 0.335 ^{A}
Camel (40%) + Sheep (60%)	3.30 ± 0.423 ^{AB}	3.30 ± 0.396 ^{A}	2.00 ± 0.258 ^{B}	2.80 ± 0.291 ^{B}
Camel (50%) + Sheep (50%)	2.40 ± 0.371 ^{B}	3.20 ± 0.249 ^{A}	2.20 ± 0.200 ^{B}	2.40 ± 0.267 ^{B}
Cmel (60%) + Sheep (40%)	2.50 ± 0.307 ^{B}	2.30 ± 0.213 ^{B}	3.40 ± 0.340 ^{A}	2.60 ± 0.221 ^{B}

Ash Contents of Cheese Samples

Cheese prepared from pure camel milk yielded the highest mean ash percentage 1.61 + 0.043 as recorded was higher as compared to camel mixed sheep milk cheese samples (1.59 ± 0.012, 1.51 ± 0.015 and 1.47 ± 0.018). Adding up sheep milk placed a negative effect on ash value. Ash percentage was lowest at 1.47% when sheep milk percentage has raised 40% and camel milk was 60% respectively as shown in the Table 2. Other two treatments when camel milk was 40% and 50% while sheep milk was 60% and 50% respectively analyzed 1.59 and 1.51 percent ash contents. The previous estimation of trace minerals such as Fe, Zn, and Cu was observed high in camel milk and camel milk products (Hashim *et al.*, 2009). Another study in which khan *et al.* (2004) were called that pure camel milk cheese contains a higher value of ash.

Total Solids of Cheese Samples

Cheese formulated from the pure camel milk was yielded lowest mean total solid content percentage 44.82 + 0.212 as compared to camel mixed sheep milk cheese verified by Yaqoob & Nawaz (2007). Incorporating sheep milk settled satisfying impact on total solid contents tends to increase the total solid contents in cheese. Total solid content percentage was highest 47.16 + 0.050 when camel milk percentage was 50% and sheep milk was also 50% as described by Derar & El Zubeir (2014), 47.57 % respectively.

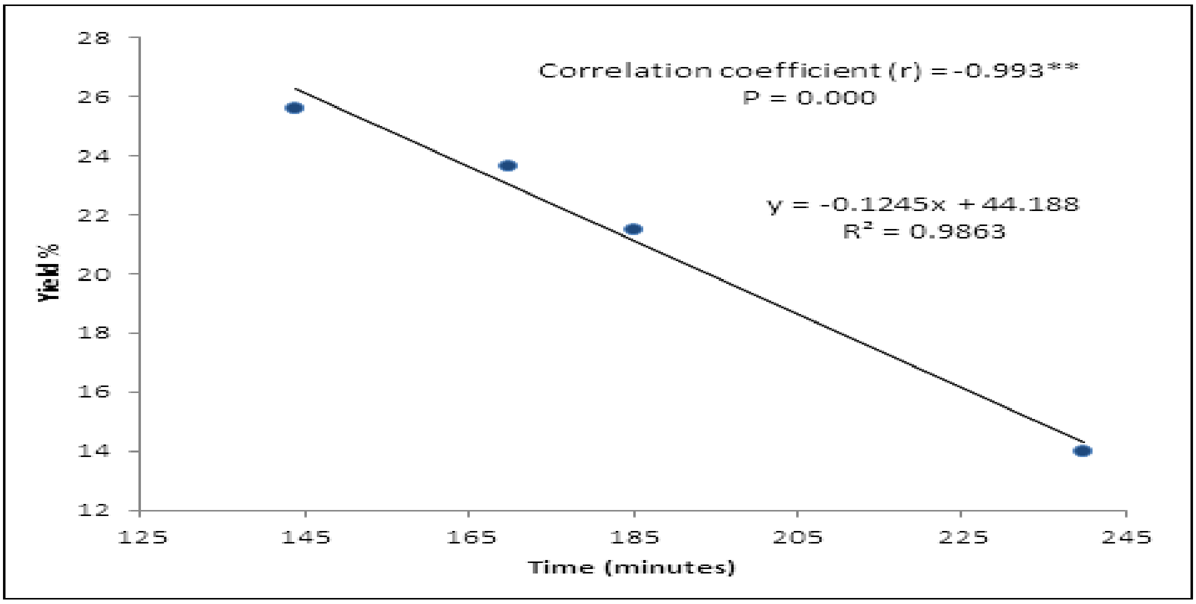

Fig. 1. Relationship between yield and time.

T_0 = 100% Camel milk (control)

T_1 = Camel milk: Sheep milk (40:60)

T_2 = Camel milk: Sheep milk (50:50)

T_3 = Camel milk: Sheep milk (60:40).

The camel's milk with respect to sheep's milk (50%:50%) cheese recorded most noteworthy extent of total solids Further two treatments when camel milk was 60% and 40% while sheep milk was 40% and 60% produced 45.93 and 47.04%. In hot season with the shortage of water difficulties occur in the production of cheese from camel milk as the water contents increased and value of total solids decreased and result in disturb the handling abilities as mentioned by Ramet (1990).

Total Bacterial Count of Cheese Samples

Cheese obtained from the pure camel milk was observed lowest total bacterial count 9.12 + 0.097×105 (cfu/ml) with respect to others. Addition of sheep milk had enhanced the rate of total bacterial count at highest 17.76 + 0.218×105when the ratio between sheep and camel milk percentage was 60% and 40%. On the other two treatments camel milk was 50% and 60% while sheep milk was 50% and 40% produced 15.89 + 0.093×105 and 16.05 + 0.306×105.

Yield and Time Relationship of Cheese Samples

In Figure 1 the relationship between the percentage of cheese production and the time spent in different treatments in making cheese was explained. This figure shows that the correlation coefficient was -0.993 between variables cheese yield and time. The value of correlation coefficient (r) very closed to -1 indicated the very weak relationship between variables yield percentage and time of processing. It is cleared from the graph that cheese percentage decreased as the time increase higher than 10.67% as described by Derar & El Zubeir (2016). Camel milk cheese takes 240 + 5 hours to solidify and was obtained at 13.99% respectively. On the other hand, as the sheep milk 40% added into camel milk time reduced to 185 + 5 and yield increased expressed the inverse relation. When sheep milk percentage enhanced to 50% and 60% it reduced time to 175 + 5 and 144 + 5 minutes while cheese yield increased 23.66 and 25.60% respectively. Value of R2 represented that there is a linear regression between two variables.

Sensory Analysis of Experimental Product

The current research was conducted on taste in which higher value was evaluated in the control sample (3.80 ± 0.416) and 2.40 ± 0.371 detected in Camel (50%) + Sheep (50%). This finding was confirmed that pure camel has more taste as compared to another mixed sample with sheep milk. Mehaia (1993) was predicted that color, texture, taste and overall acceptability were affected by the salt of fat concentration of cheese which is come from milk and a starter culture. Lower fat milk cheese has lower color and texture then higher fat milk cheese, whereas the cheese formation from high-fat milk is lower the taste and overall acceptability. So, the methods investigated for soft white cheese have potential for the development of cheese with good acceptability from camel milk. It is confirmed that the cheese formation from camel's milk: sheep's milk (50%: 50%) were acidic taste (Pelissier and Manchon, 1976). Furthermore, Freitas and Malcata, (2002), who was confirmed that panelists liked the sharp taste of the camel milk cheese and the Sudan consumers, have accepted the taste.

Cheese color was detected higher in the control sample and lower Camel (60%) + Sheep (40%) sample were 3.40 ± 0.221 and 2.30 ± 0.213 B respectively as shown in the Table 3. The result has been shown that pure camel milk according to the color point of view was more suitable. The result revealed that the cheese made by camel milk using starter culture was higher because it contained more color and texture (Sulieman *et al.*, 2016). Texture comparison showed that the 100% camel milk cheese (3.80 ± 0.327 A) was contained more texture and a lower value was found from Camel (40%) + Sheep (60%) (2.00 ± 0.258 B). The result was verified that cheese pure camel milk has been kept higher texture. The result of the present research matches Khan *et al.* (2004), who was confirmed that cheese made starter has more texture and flavor because it contains higher amounts of total solids, protein and fat. Derar & Zubeir, (2016) was reported that the texture of cheese made from camel's milk and camel's milk: sheep's milk (75%: 25%) was pasty. Sensory parameters show that camel milk cheese was soft with moist. Another prediction was revealed attributed this to the reduced fat content of the cheese, because of more fat wastes in the whey and create weak binding of camel milk curd (Ramet, 2001).

The higher mean value of cheese in the control sample and low value in Camel (50%) + Sheep (50%) were predicted 4.30 ± 0.335 A and 2.40 ± 0.267 B respectively. Our findings have been revealed that the overall acceptability of pure camel milk cheese is better as compare to other samples as shown in the Table 3. A previous study was conducted on a camel and cow milk cheese in which Siddig *et al.* 2014 was clarified the Overall acceptability of mixed samples prepared from starter culture has 6.40 and pure camel milk cheese was 5.80, however, this result is slightly different from our finding.

Conclusion

Current research has shown that there was an opportunity to make cheese from camel's milk. The study also concluded that mixing different percentages of sheep's milk with camel's milk increased camel's milk processing capabilities. Camel milk cheese protein, fat, ash and total solids were 16.92%, 18.71%, 1.61% and 44.82% respectively. The total bacteria count for camel's milk cheese was also as low as 9.12 * 105 counts. Fortification of sheep milk made significant differences in all properties of final product cheese such as yield percentage, coagulation time, protein (%), fat (%), ash (%), total solid contents and bacterial count with respect to camel milk cheese.

Sensory attributes also affected by fortifying of sheep milk. The sheep milk can be added at the ratio of 40, 50, and 60 with respect to camel milk. The data revealed that best cheese judged by panelists was that containing 50% camel milk and 50% sheep milk. Whereas, pour camel milk cheese showed lowest acceptability by judges. This camel and sheep milk combination might be help to overcome the processing challenges of camel milk such as lower yield, long coagulation time and also gave acceptable nutritional and sensory attributes. This will make the camel milk a valuable food for the entire desert community as well as uplift their standard of life economically. So, it is concluded that fortifying 50% sheep milk to expand camel milk cheese qualities. But further research is required to investigate other factors for the improvement of camel milk products.

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