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COMPARATIVE ANALYSIS OF PHYSICO-CHEMICAL PROPERTIES OF BUFFALO, CAMEL AND BLENDED (BUFFALO 70%: CAMEL 30%) MILK

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ABSTRACT

The present study was conducted on comparative analysis of physico-chemical properties of buffalo, camel and blended milk. The buffalo milk is white in colour with and thick consistency, however, the camel milk is opaque white with salty in flavour. The fat (6.03±0.143%), SNF (9.44±0.016), total solids (15.4±0.156), lactose (5.00±0.091) and protein (3.65±0.050%) of milk was significantly higher in buffalo as compared with camel milk. However, water content (88.40±0.143) and freezing point (-0.519±0.002°C) was significantly higher in camel milk as compared with buffalo milk. The pH of camel milk (6.52±0.006) was more acidic as compared with buffalo milk (6.73±0.012). The physico-chemical properties of blended milk were observed.

Key words: Buffalo, Camel, Blended Milk and Physico-chemical

People living in the arid lands of the world use camel milk as an important source of proteins. Approximately, 2.9 million tones of camel milk are produced annually, globally. Camel milk possess numerous medicinal properties which strengthen it's therapeutic potential against many diseases including autism (Gahlot and Adams, 2023), diabetes, anaemia, jaundice, arthritis, and cancer (Patel *et al,* 2022; Alkattan *et al,* 2023). In recent past, lot of studies were done to compare the camel milk with other domestic large ruminants. The comparison was made between various physico-chemical properties of camel milk with cow and buffalo milk (Yoganandi *et al,* 2015). The physico-chemical and protein profile of milk obtained from local Pakistani breeds of milch animals such as Nilli-Ravi buffalo, Sahiwal cow, Kajli sheep, Beetal goat and Brela camel has also been studied (Yasmin *et al,* 2020). The various physico-chemical parameters of milk of two species, camel and buffalo has been studied (Singh *et al,* 2013). Efforts are made to increase the palatability of camel milk by blending it with other ruminant milk, i.e. cow and buffalo milk. Present study is therefore, planned to compare the diverse physico-chemical parameters of blended milk (buffalo and camel) with buffalo and camel milk.

Materials and Methods

Buffalo milk samples were obtained from a local buffalo dairy farm located on the outskirts of Bikaner, while camel milk samples were collected from the National Research Centre on Camel, Bikaner. A total of 20 milk samples were collected, each promptly sterilised, labelled, and transferred to a container with ice cubes. These containers were immediately transported to the Department of Livestock Products Technology, CVAS, Bikaner (RAJUVAS, Bikaner) in Rajasthan. The samples were appropriately tagged and labeled with information such as the collection date, time, and sample names. Subsequently, the samples underwent analysis for various laboratory tests in triplicate, with readings recorded. Throughout the testing process, strict adherence to hygiene and safety protocols was maintained to prevent any potential contamination.

The physio-chemical properties like colour, odour, consistency, SNF, protein, fat, total solids, and pH were recorded. The pH was measured using digital pH meter (LABMAN pH METER LMPH-10) equipped with a combined glass electrode. Specific gravity was detected by using lactometer

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as described by Aggarwala and Sharma (1961). The fat, protein, lactose, freezing point, were determined by the Milkoscan (LM2, Milkotester Ltd., Bulgaria) at milk research laboratory, Department of livestock production and technology, College of Veterinary and Animal Science, RAJUVAS, Bikaner and total solids contents according to A.O.A.C. (1995), and the solids not fat (SNF) and water contents were determined by differences, as indicated:

- SNF content = TS % - Fat %
- % water contain = (100 -%total solids)

Results and Discussion

In present study, the visual inspection of buffalo milk revealed a characteristic whitish colour, consistent with the typical appearance of buffalo milk. On the other hand, camel milk displayed an opaque whitish appearance upon observation. This disparity in colouration between the two types of milk samples was noteworthy and may be attributed to inherent differences in the composition of proteins, fats, and other components in buffalo and camel milk. Opaque white colour present in camel milk was because the fats are finely homogenised throughout the milk (El-Deeb *et al,* 2017). The whitish colour of buffalo milk is a common visual trait associated with the presence of casein proteins, which constitute a significant portion of the milk solids. The blended milk exhibited a colour that was distinct from both individual sources, indicating a blending effect. This finding is in line with the intended composition and reflects the visual integration of buffalo and camel milk characteristics in the composite sample.

The consistency of buffalo milk revealed a notably thick texture, consistent with the common perception of buffalo milk as having a rich and dense consistency. In contrast, camel milk exhibited a comparably thinner consistency, aligning with prior observations of camel milk being generally less viscous. According to a study by Guo *et al* (2016), buffalo milk exhibited significantly higher fat content compared to other milk types, contributing to its denser and creamier consistency. The blended milk exhibited a consistency that was thinner than buffalo milk but thicker than camel milk. This suggests a synergistic effect arising from the combination of the two milks. The thickness of milk is influenced by various factors, including the concentration of milk solids, especially fat and proteins.

The fat content of buffalo, camel, and blended (70% buffalo, 30% camel) milk samples yielded distinctive findings. The fat content of buffalo milk measured was 6.03±0.143% (Table 1), a value consistent with the well-known richness of buffalo milk. In comparison, camel milk had a lower fat content (2.78±0.062%) (Table 1). In blended sample, the fat content was 5.68±0.062% (Table 1). Buffalo milk's higher fat content can be attributed to the specific genetic characteristics of buffalo breeds and their propensity to produce milk with elevated fat levels. According to a study by Cosenza *et al* (2018), certain buffalo breeds genetically produce milk with higher fat content as compared to other dairy animals.

The solid-not-fat (SNF) content in buffalo, camel and blended (70% buffalo, 30% camel) milk samples revealed distinctive compositions. The SNF content of buffalo milk was 9.44±0.016% (Table. 1), reflecting the expected richness associated with buffalo milk. In contrast, camel milk had slightly lower SNF content (8.92±0.034%) (Table 1). The SNF content of the blended milk was 9.26±0.007% (Table 1). The solids-not-fat (SNF) content in milk generally ranges from 8.5% to 9% in cows, approximately 9.5% to 10% in buffaloes 10% to 12% in camel, as indicated by various studies (Oftedal, 1984; Cosenza *et al,* 2018; Konuspayeva *et al,* 2009). The solids-not-fat (SNF) content in milk can be influenced by factors such as species, breed, stage of lactation, and dietary composition (Zicarelli, 2016).

Table 1. Physico-chemical (mean±SE) properties of buffalo and camel milk.

Physico-chemical properties	Buffalo milk (mean±SE)	Camel milk (mean±SE)	Blended milk (Buffalo 70%: Camel 30%) (mean±SE)
Fat %	6.03±0.143	2.78±0.062	5.68±0.062
SNF %	9.44±0.016	8.92±0.034	9.26±0.007
Total solids %	15.4±0.156	11.59±0.143	14.93±0.061
Protein %	3.65±0.050	3.45±0.028	3.52±0.006
Lactose %	5.00±0.091	4.48±0.047	4.90±0.040
Water content %	84.53±0.156	88.40±0.143	85.07±0.061
Freezing point (°C)	-0.548±0.000	-0.519±0.002	-0.535±0.003
pH	6.73±0.012	6.52±0.006	6.62±0.010
Specific gravity	1.032±0.001	1.025±.001	1.028±0.000

The total solids content in buffalo, camel, and blended (70% buffalo, 30% camel) milk samples unveiled noteworthy disparities in their compositions. Buffalo milk had a robust total solids content of 15.4±0.156% (Table 1), aligning with the anticipated

richness associated with this milk type. In contrast, camel milk displayed a comparatively lower total solids content at 11.59±0.143% (Table 1). The blended milk had a total solids content of 14.93±0.061% (Table 1). The total solids content in milk varied from 12 to 13% in cows, 16 to 17% in buffaloes and 10 to 12% in camels (Hayes *et al,* 2011; Haenlein and Caccese, 2006; Konuspayeva *et al,* 2009). Variations in the total solids content of milk are influenced by factors such as breed, nutrition, and lactation stage (Shamsia, 2016). Changes in total solids content in milk, whether increased or decreased, can influence properties such as viscosity and nutritional value, with specific effects owing to factors like fat and protein content (Albenzio *et al,* 2019).

The lactose content, buffalo milk exhibited a value of 5.00±0.091%, while camel milk showed a slightly lower lactose content at 4.48±0.047%. The blended milk, combining 70% buffalo and 30% camel milk, demonstrated a lactose content of 4.90±0.040%. The lactose content in milk varies among species, with approximate ranges as follows: in cows (4.8% to 5.1%), buffalo (4.8% to 5.2%), camel (4.5% to 5.5%), (Haenlein, 2007). The sweatness of buffalo milk due to the presence of higher content of lactose in buffalo milk (Parker *et al,* 2010), however, the saltyness taste of camel milk is due to the lower amount of lactose content in camel milk (Szilagyi, 2015).

The protein content buffalo milk was 3.65± 0.050%, while camel milk exhibited a slightly lower protein content (3.45±0.028%). The blended milk, a combination of buffalo and camel milk, demonstrated a protein content of 3.52±0.006%. Protein content in milk varies among species, ranging approximately from 3.2% to 3.5% in cows, 3.3% to 4.2% in buffalo, 2.9% to 3.5% in camel (Haenlein, 2007). The higher protein content in buffalo milk compared to camel milk can be attributed to the differences in the amino acid composition and casein micelle structure of the two milks. Buffalo milk, like cow milk, is characterised by a higher casein content, which contributes to its overall protein content. Additionally, the specific amino acid profile of buffalo milk proteins may be different from that of camel milk, influencing the overall protein concentration (Haenlein, 2007).

The water content percentages were 84.53± 0.156% for buffalo milk, 88.40±0.143% for camel milk, and 85.07±0.061% for the blended milk. Camel milk generally has a higher water content than buffalo milk due to differences in the composition of these milks, particularly in terms of fat and protein contents (Farah *et al,* 2007). The approximate water percentages in milk also vary, i.e. cow's milk 87% (Bijlani and Joshi, 1985), buffalo's milk 82-86% (Guinee *et al,* 2004), camel's milk 87-90% (Konuspayeva *et al,* 2009).

The freezing points observed were -0.548±0.091°C for buffalo milk, -0.519±0.002°C for camel milk, and -0.535±0.003°C for the blended milk. The elevated freezing point in camel milk aligns with its lower fat content, and the blended milk's freezing point falling between the individual types illustrates the blending effect on achieving an intermediary freezing point. The freezing point of milk is primarily determined by its water content, with lactose concentration acting as a key factor

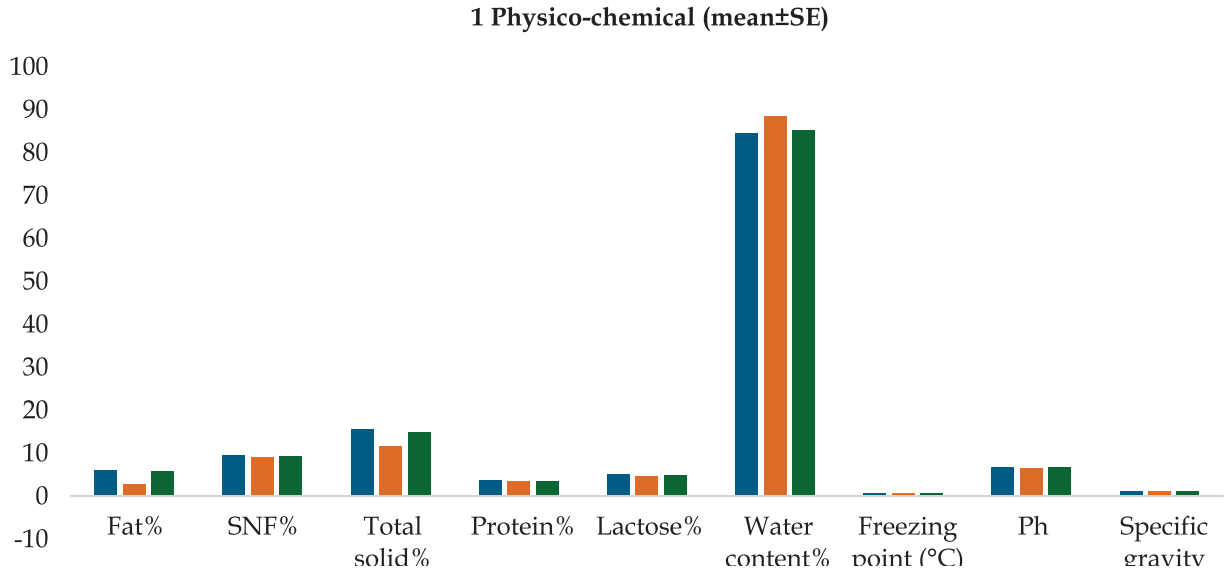

Fig 1. Physico-chemical (mean±S.E.) properties of buffalo and camel milk.

contributing to the depressant effect on the freezing point (IDF Standard 152A, 1995a; Hayes & Prosser, 1973). The freezing point depression (FPD) of milk varies among species, with approximate values for cow's milk around -0.520°C (Fox *et al,* 2000), buffalo's milk around -0.520 to -0.530°C (Fox *et al,* 2000), camel's milk around -0.520 to -0.530°C (Konuspayeva *et al,* 2009).

The pH values recorded were 6.73±0.012 for buffalo milk, 6.52±0.006 for camel milk, and 6.62±0.010 for the blended milk. The pH values of various milks were approximately, i.e. cow's milk 6.5 to 6.7, camel's milk 6.4 to 6.6 (Chavez-Servin *et al,* 2008) and buffalo's milk 6.7 to 7.0 (Seth *et al,* 2016). Camel milk typically has a higher pH than buffalo milk due to differences in protein composition and buffering capacity (Konuspayeva *et al,* 2009; Guinee *et al,* 2015).

Specific gravity values were 1.032±0.001 for buffalo milk, 1.025±0.001 for camel milk, and 1.028±0.000 for the blended milk. The specific gravity of milk varies among species, with approximate values for cow's milk around 1.028 to 1.033 (Marshall, 1993), buffalo's milk around 1.031 to 1.034 (Park *et al,* 2007), camel's milk around 1.030 to 1.033 (Konkuspayeva *et al,* 2009). The specific gravity of buffalo milk is higher than that of camel milk due to differences in fat content and protein composition (Konuspayeva *et al,* 2009).

Conflicts of Interest

The authors declare no conflict of interest.

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