Kashmir Journal of Science
Kashmir Journal of Science (2025), 4(2):97-107
https://kjs.org.pk **ISSN: 2958-7832**

DOI: https://doi.org/10.63147/krjs.v4i02.146
Research Paper

Comparative Study on Quality Characteristics of Ice Cream Developed from Camel and Buffalo Milk

Abid Ali[1*], Asadullah Marri[2], Nida Shaikh[2], Asif Irshad[3], Israr Ahmed[4] and Imtiaz Ghafoor[1]

[1]Food Department Balochistan, Quetta, Pakistan
[2]Institute of Food Sciences and Technology, Sindh Agriculture University, Tandojam, Hyderabad, Pakistan
[3]Department of Food Preservation, Technical Wing of Colleges, Higher & Technical Education Department, Balochistan, Pakistan, [4]Balochistan Food Authority, Quetta, Pakistan

*Corresponding author's email: abidbuledi95@gmail.com

ARTICLE INFO
Article history:

Received: 06 March 2025
Revised: 11 April 2025
Accepted: 19 June 2025
Available online: 30 June 2025

Keywords:
Camel milk, Buffalo Milk, Ice cream, Physicochemical properties, Sensorial attributes

Abstract

Modern consumers demand natural, nutrient-rich foods that may have additional biological benefits. This growing demand motivates food researchers and manufacturers to develop new innovative formulations of ice cream enriched with different ingredients. Camel milk is gaining popularity around the globe owing to its excellent nutritional composition, therapeutic properties, and trending food-related uses. The present study compared the physicochemical and sensorial attributes of ice cream samples prepared from camel milk (CM), and buffalo milk (BM) and with their combination. For this reason, three formulations were set for preparing ice cream samples, i.e., T_1= ice cream with 100% CM, T_2= ice cream with 100% BM, and T_3= ice cream with 50% CM and 50% BM, and were assessed for their physicochemical and sensorial properties. The analysis of the attributes was performed using standard analytical methods. The results regarding the physicochemical and sensorial properties of all ice cream treatments were statistically different ($p < 0.05$). The results revealed that T_2 showed to have significantly higher average values for protein (6.51%), fat (6.98%), ash (0.98%), titratable acidity (0.33%), and viscosity (314.00 cp) whereas T_3 showed to have significantly higher average values for pH (6.14), color (8.66), consistency (9.0), taste (8.66), flavor (8.33), and overall acceptability (9.00). It may be concluded from the present study that among all three ice cream samples T_2 proved to have suitable physicochemical properties. Moreover, T_3 exhibited higher average values for pH and sensorial attributes therefore it is recommended that T_2 had good nutritional value while T_3 perceived good average scores for all sensorial attributes.

Comparative Study on Quality Characteristics of Ice Cream

Introduction

Throughout human history, milk has played a crucial role in meeting nutritional needs and preserving consumer health. Milk and its derivatives are distinguished as excellent sources of superior-quality proteins, vitamins, carbohydrates, minerals, and fats. They also offer vital micronutrients, bioactive compounds, lactic acid bacteria, and substances that enhance immunity (Arain et al., 2023). Camel milk is particularly significant in providing nutrition and food security, especially for populations residing in semi-arid and arid regions of Sub-Saharan Africa and Asian deserts. Camel milk possesses unique chemical characteristics and intrinsic functional properties that are distinct from the milk of other livestock (Muthukumaran et al., 2023). Although the chemical composition of key nutrients in camel milk, such as water, protein, lactose, and fat, aligns closely with that of cow's milk, there are significant differences in micronutrients. These include variations in immunoglobulin (IgG, IgA), vitamins (A, and C), as well as mineral salts (Hammam, 2019; Mullaicharam, 2014). Conversely, the molecular composition of the primary components in camel milk differs significantly from that of bovine milk. This variation presents a major obstacle for the dairy industry in transforming camel milk into high-value dairy products (Baig et al., 2022; Ho et al., 2022). Over the past two decades, the global demand for camel milk and its derivatives has significantly increased due to their remarkable medicinal properties and health benefits. This rising demand has encouraged the dairy industry to develop a variety of camel milk-based products, recognized for their superior nutritional and functional attributes (Issimov, 2024).

Ranking as the world's second-largest milk source, water buffalo supplies about half of Asia's total milk production (Servillo et al., 2018; FAO, 2023). Compared to cow's milk, water buffalo milk contains higher levels of fat, protein, amino acids, and unsaturated fatty acids, while having lower cholesterol levels (Jiang et al., 2022; Chen et al., 2020; Du et al., 2019). Therefore, buffalo milk and its dairy products are gaining popularity among consumers due to their rich physicochemical composition and beneficial functional properties. These qualities make buffalo milk an ideal choice for producing various dairy products, including yogurt, mozzarella cheese, ice cream, and casein-based items (Khedkar et al., 2016).

The growing interest in foods that promote human health, and nutrition has encouraged both academia and the food industry to focus on developing innovative and functional ice cream. As one of the most popular frozen dairy products, ice cream presents a promising opportunity to

enhance dietary habits by lowering the consumption of specific nutrients linked to a higher risk of obesity and related health conditions (Genovese et al., 2022). Ice cream is a delicious and refreshing treat that offers both sweetness and nutritional benefits. The nutritional value of ice cream varies based on the ingredients used, making it an important factor for some individuals when selecting their food. Typically, ice cream is made from cow's milk, which contains essential nutrients (Malik and Panuganti, 2023). However, increasing consumer awareness of nutrition's essential role in supporting overall health and well-being is driving interest in the development of innovative and functional frozen dairy desserts, such as ice creams (Genovese et al., 2022; Mohammed et al., 2022). Ice cream is an excellent medium for delivering nutraceutical components because it appeals to consumers of all ages and its frozen storage helps maintain its nutritional value over time (Mohammed et al., 2022).

As health consciousness grows, snacking has become an essential part of consumers' daily eating and drinking routines. Health-conscious individuals seek snacks that not only provide nutritional benefits but also offer a sense of satisfaction. This trend has extended to the ice cream industry, where consumers now demand options that align with their health-conscious preferences. Therefore, the present study was undertaken to develop ice cream from camel and buffalo milk and with their combinations to compare their impact on the physicochemical and sensorial attributes of ice cream.

Materials and Methods

Collection of raw materials

Camel milk (CM) from the *Dhatti* breed and buffalo milk (BM) from the *Kundhi* breed were availed from pastoral camel and buffalo, respectively. Other materials required for ice cream making i.e., skim milk powder, cream, sugar, starch, etc. were purchased from National Super Mart near Hala Naka, Hyderabad, Pakistan.

Sample processing/ development of ice cream samples

The ice cream samples were formulated using camel and buffalo milk, following the method outlined by Bilal et al. (2021) with slight modifications. Milk (camel and buffalo), skim milk powder and cream were all mixed for standardizing ice cream. Other ingredients, sugar and starch were also included and mixed properly at 50°C. The whole mixture was pasteurized at 80°C

for 30 seconds, well homogenized, and placed in a freezer for rapid cooling at 5°C. The content was vigorously stirred several times and re-freezed again. Finally, ice cream was stored for aging for 10-12 hours and then ice cream was hardened at -35°C and placed at -20°C till nutritional and sensorial analysis. Detailed information about the ingredients used in each treatment is given in Table 1.

Table 1. Treatment formulations and list of ingredients used for making ice cream samples

Ingredients (g/ml)	Treatments		
	T_1	T_2	T_3
Camel milk (ml)	100	-	50
Buffalo milk (ml)	-	100	50
Sugar (g)	10	10	10
Starch (g)	01	01	01
Cream (g)	02	02	02
Skim milk powder (g)	0.5	0.5	0.5

Physicochemical analysis

The physicochemical analysis of samples, including pH value, Total solids %, Protein %, Titratable acidity %, Ash %, Fat %, Viscosity, Melting point °C, and Energy value in kcal/100g was carried out by following the standard methods of AOAC (2016).

Determination of sensorial attributes of ice cream samples

The sensorial attributes of ice cream samples i.e., color, flavor, texture, taste, and overall acceptability were determined as per the method described by Iwe (2002) by a panel of 20 judges of the academic staff and most senior students of IFST. The sensory characteristics of the samples were evaluated using a nine-point hedonic scale. The scale includes scores from 1 to 9, each representing the degree of preference for food products as assessed by the panelists.

Statistical analysis

The method described by Gomez and Gomez (1984) was followed for statistical analysis of the recorded data. A total of three replications were studied during the studies for all tests (physicochemical and sensorial properties) in a similar manner. The data obtained from the present study was tabulated in Excel and analyzed using Statistix 8.1 software for one-way ANOVA. The mean values at p-value < 0.05 were evaluated.

Results and Discussion

Physicochemical analysis of ice cream

The results obtained regarding the average physicochemical analysis of ice cream samples developed from camel and buffalo milk are presented in Tables 2 and 3. The one-way ANOVA revealed significant differences ($p < 0.05$) among the treatments.

The pH value in ice cream samples varied from 5.37 to 6.12, with T_3 showing the highest average pH value of 6.04 followed by T_2 (6.00) and T_1 (5.78). Similarly, Elkot et al. (2022) also observed a pH value of 5.32 to 5.77 in ice cream samples developed from camel milk. Furthermore, findings for pH values were also found similarly in a previous study by Sayar et al. (2022) in camel milk ice cream samples. Baloch et al. (2019) observed pH values of 6.51 in raw camel milk and 6.48 in raw buffalo milk which reduced to 6.24 in CM and 6.25 in BM after thermal processing. The protein content in ice cream samples ranged from 2.15 to 6.35%, with T_2 showing a significantly higher protein content (6.51%) followed by T_3 (5.95%) and T_1 (2.21%). Fresh camel milk may have a protein content of around 3 to 4% (Elkot et al., 2022). Sagar et al. (2016) observed 2.93% protein content in camel milk and 3.82% in buffalo milk. The content of fat in ice cream samples ranged from 2.20 to 6.95%, with T_2 having significantly higher fat content (6.98%) followed by T_3 (5.20%) and T_1 (2.53%). Khalifa and Zakaria (2019) noted a fat content of 3.22% in CM and 7.52% in BM which means camel milk is a good alternative to buffalo milk for those who are looking for a product with minimum fat content. The ash content in ice cream samples ranged from 0.68 to 1.10%, with T_2 having significantly higher ash content (0.98%) followed by T_3 (0.90%) and T_1 (0.71%). Rafiq et al. (2015) recorded an ash content of 0.82 in buffalo milk and 0.79 in camel milk. According to Yadav et al. (2015), camel milk contains higher minerals (i.e., sodium, iron, potassium, copper, magnesium, zinc, etc.) therefore the ash content in camel is also higher. The total solids content in ice cream samples ranged from 64.04 to 82.09%, with T_3

showing significantly higher total solids (77.33%) followed by T_2 (71.33%) and T_1 (70.00%). Khaskheli et al. (2005) revealed that total solids in milk are an associated attribute with that of fat, protein, lactose, etc. while Mohamed et al. (2021) recorded a lower concentration of total solids in camel milk. The energy value in ice cream samples ranged from 407.08 to 576.48 kcal/100g. Among all the treatments, T_1 exhibited the highest energy value at 465.27 kcal/100g, which was significantly greater than that of T_2 (430.98 kcal/100g) and T_3 (423.09 kcal/100g). The titratable acidity (%) in ice cream samples varied from 0.20 to 0.33%, with T_2 having significantly higher titratable acidity (0.33%) followed by T_3 (0.28%) and T_1 (0.20%). Baloch et al. (2019) observed the acidity of fresh CM to be 0.13% and fresh BM to be 0.16%. The melting point in ice cream samples ranged from 20.60 to 26.10°C, with T_3 showing a significantly higher melting point at 25.20°C followed by T_2 at 23.43°C and T_1 at 22.10°C. Respectively, some analogous results were obtained from Jafarpour, (2017) regarding the melting properties of camel milk–based ice cream. According to Elkot et al. (2022), a higher viscosity value of ice cream mixes might be responsible for a lower melting rate. This can be attributed to the fact that total solids also tend to increase viscosity and thus enhance the texture and melting properties of ice cream. The viscosity of ice cream samples ranged from 224.14 to 314.49cp. Among all treatments, T_2 exhibited a significantly higher average viscosity (314.00cp) followed by T_3 (280.00cp) and T_1 (225.00cp). In camel milk ice cream, an increase in fat proportion and total solid content increases the viscosity of ice cream. The study on camel milk-based date fruit fortified ice cream showed some relatively similar findings regarding rheological properties such as viscosity (Salem et al., 2017).

Table 2. Physicochemical attributes of ice cream samples developed from CM and BM

Treatments	pH value	Protein %	Fat %	Ash %	Total Solids %
T_1	5.78b	2.21c	2.53c	0.71b	70.00a
T_2	6.00a	6.51a	6.98a	0.98a	71.33a
T_3	6.04a	5.95b	5.20b	0.90a	77.33a
SE±	0.0821	0.1913	0.2684	0.0554	3.9628
LSD =	0.2010	0.4682	0.6567	0.1355	9.6966

T_1 = Ice cream from 100% CM; **T_2** = Ice cream from 100% BM; **T_3** = Ice cream from 50% CM and 50% BM; **SE =** Standard Error; **LSD** = Least Significant Difference.

Table 3. Physicochemical attributes of ice cream samples developed from CM and BM

Treatments	Energy value (kcal/100g)	Titratable acidity (%)	Melting point (°C)	Viscosity (cp)
T_1	465.27a	0.20b	22.10b	225.00c
T_2	430.98a	0.33a	23.43ab	314.00a
T_3	423.09a	0.28a	25.20a	280.00b
SE±	45.435	0.0205	0.8722	2.7080
LSD =	111.18	0.0503	2.1342	6.6263

T_1 = Ice cream from 100% CM; **T_2** = Ice cream from 100% BM; **T_3** = Ice cream from 50% CM and 50% BM; **SE =** Standard Error; **LSD** = Least Significant Difference.

Sensorial attributes of ice cream

The results regarding the average sensorial attributes of ice cream samples prepared with camel and buffalo milk are presented in Figure 1. The observed results revealed that all treatments showed statistically different ($p < 0.05$) mean values for sensory attributes.

The results of sensory attributes revealed that T_3 has significantly higher average values for color (8.66), consistency (9.0), taste (8.66), flavor (8.33), and overall acceptability (9.00) followed by T_2 with color (7.33), consistency (7.66), taste (7.33), flavor (7.33), and overall acceptability (7.33). While the lowest scores for sensory attributes were observed in T_1 i.e., color (6.00), consistency (7.00), taste (6.33), flavor (6.33), and overall acceptability (6.00). Sensorial properties such as texture, taste, and consistencies are important attributes in ice cream development. In studies by Hajian et al. (2020) and Elkot et al. (2022), the sensorial profile for camel milk ice cream was better perceived by panelists. Soni and Goyal, (2013) investigated the production of ice cream using pure camel milk as well as blends of camel and bovine milk, incorporating different flavor variations. They found that camel milk can be successfully used to make ice cream with high sensory appeal. They also suggested that producing ice cream could be an effective method to enhance the value of camel milk. While no modifications in processing parameters are

necessary, variations in composition and colloidal structure may influence the quality and shelf life of the final product.

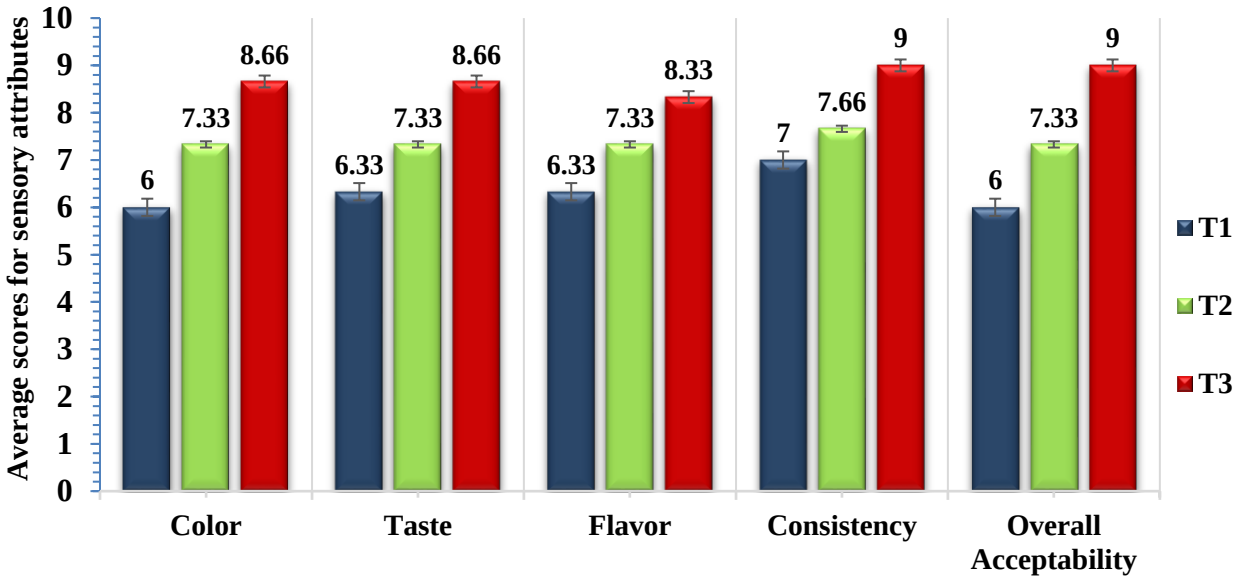

Figure 1. Sensory attributes of ice cream samples developed from camel and buffalo milk

Conclusion

It is concluded from the present study that ice cream samples prepared from 100% buffalo milk (T_2) showed to have relatively higher average values for most of the physicochemical attributes i.e., fat, protein, ash, titratable acidity, and viscosity in comparison to ice cream samples prepared from 100% camel milk (T_1) and the combination of 50% camel milk and buffalo milk (T_3). However, the scores for sensorial attributes i.e., color, flavor, taste, consistency, and overall acceptability were better attained by T_3 compared to the counterpart treatments.

Recommendations

It is recommended that camel milk is a good choice to be used for developing ice cream alone or with a combination of buffalo milk. The ice cream samples prepared from camel milk and the combination of camel and buffalo milk are nutritious and acceptable for sensorial attributes. The commercial production of camel milk ice cream could perhaps begin as soon as possible to meet the demand for a product that is both functional and healthy for the health-conscious consumer.

References

AOAC, (2016). Official methods of analysis of AOAC international. 20th Edition. Association of the Official Analytical Chemists, Gaithersburg.

Arain, M.A., Khaskheli, G.B., Shah, A.H., Marghazani, I.B., Barham, G.S., Shah, Q.A., Khand, F.M., Buzdar, J.A., Soomro, F. and Fazlani, S.A. (2023). Nutritional significance and promising therapeutic/medicinal application of camel milk as a functional food in humans and animals: A comprehensive review. *Animal Biotechnology*, *34*(6), 1988-2005.

Baig, D., Sabikhi, L., Khetra, Y. and Shelke, P.A. (2022). Technological challenges in the production of camel milk cheese and ways to overcome them–A review. *International Dairy Journal*, *129*, 105344.

Baloch, M.H., Shah, A.H., Rajput, M.N., Barham, G.S., Khaskheli, G.B., Magsi, A.S. and Behan, A.A. (2019). Influence of thermal treatments on physico-chemical properties of camel versus buffalo milk. *Sindh University Research Journal-SURJ (Science Series)*, *50*(3), 405-412.

Bilal, R.M. (2021). Physiochemical and sensory characteristics of ice cream from lassi camel milk. *Pak-Euro Journal of Medical and Life Sciences*, *4*(3), 191-194.

Chen, Z., Xie, Y., Luo, J., Chen, T., Xi, Q., Zhang, Y. and Sun, J. (2020). Milk exosome-derived miRNAs from water buffalo are implicated in the immune response and metabolism process. *BMC Veterinary Research*, *16*, 1-5.

Du, C., Deng, T., Zhou, Y., Ye, T., Zhou, Z., Zhang, S., Shao, B., Wei, P., Sun, H., Khan, F.A. and Hua, G. (2019). Systematic analyses for candidate genes of milk production traits in water buffalo (*Bubalus Bubalis*). *Animal Genetics*, *50*(3), 207-216.

Elkot, W.F., Ateteallah, A.H., Al-Moalem, M.H., Shahein, M.R., Alblihed, M.A., Abdo, W. and Elmahallawy, E.K. (2022). Functional, physicochemical, rheological, microbiological, and organoleptic properties of synbiotic ice cream produced from camel milk using black rice powder and Lactobacillus acidophilus LA-5. *Fermentation*, *8*(4), 187.

FAO. Available online: https://www.fao.org/faostat/en/#home (accessed on 1 July 2023).

Genovese, A., Balivo, A., Salvati, A. and Sacchi, R. (2022). Functional ice cream health benefits and sensory implications. *Food Research International*, *161*, 111858.

Gomez, K.A., Gomez, A.A. (1984). *Statistical Procedures for Agricultural Research*. John Wiley & sons.

Hajian, N., Salami, M., Mohammadian, M., Moghadam, M. and Emam-Djomeh, Z. (2020). Production of low-fat camel milk functional ice creams fortified with camel milk casein and its antioxidant hydrolysates. *Applied Food Biotechnology*, *7*(2), 95-102.

Hammam, A.R. (2019). Compositional and therapeutic properties of camel milk: a review. *Emirates Journal of Food and Agriculture*, *31*(3), 148-152.

Ho, T.M., Zou, Z. and Bansal, N. (2022). Camel milk: A review of its nutritional value, heat stability, and potential food products. *Food Research International*, *153*, 110870.

Issimov, A. (2024). Camel Milk Processing Opportunities: A Review. *Preprints*. Doi: 10.20944/preprints202405.0410.v1.

Iwe, M.O. (2002). Handbook of sensory methods and analysis. *Rojoint Communication Services Ltd., Enugu, Nigeria*, 7-12.

Jafarpour, A. (2017). Feasibility of manufacture and investigation of physicochemical properties of camel milk–based ice cream. *Journal of Scientific Agriculture*, *1*, 300-302.

Jiang, M., Meng, Z., Cheng, Z., Zhan, K., Ma, X., Yang, T., Huang, Y., Yan, Q., Gong, X. and Zhao, G. (2022). Effects of buffalo milk and cow milk on lipid metabolism in obese mice induced by high fat. *Frontiers in Nutrition*, *9*, 841800.

Khalifa, M.I. and Zakaria, A.M. (2019). Physiochemical, sensory characteristics and acceptability of a new set yogurt developed from camel and goat milk mixed with buffalo milk. *Advances in Animal and Veterinary Sciences*, *7*(3), 172-177.

Khaskheli, M., Arain, M.A., Chaudhry, S., Soomro, A.H. and Qureshi, T.A. (2005). Physico-chemical quality of camel milk. *Journal of Agriculture and Social Sciences*, *2*, 164-166.

Khedkar, C.D., Kalyankar, S.D. and Deosarkar, S.S. (2016). Buffalo Milk. In B. Caballero, P. Finglas, & F. Toldrá (Eds.), *The Encyclopedia of Food and Health* (Vol. 1, pp. 522–528). Elsevier Ltd.

Malik, T.F. and Panuganti, K.K. (2023). Lactose intolerance. *National Library of Medicine.*

Mohamed, H., Nagy, P., Agbaba, J. and Kamal-Eldin, A. (2021). Use of near and mid-infrared spectroscopy for analysis of protein, fat, lactose, and total solids in raw cow and camel milk. *Food Chemistry*, *334*, 127436.

Mohammed, N.K., Badrul Khair, M.F., Ahmad, N.H. and Meor Hussin, A.S. (2022). Ice cream as functional food: A review of health-promoting ingredients in the frozen dairy products. *Journal of Food Process Engineering*, *45*(12), e14171.

Mullaicharam, A.R. (2014). A review on medicinal properties of camel milk. *World Journal of Pharmaceutical Sciences*, 237-242.

Muthukumaran, M.S., Mudgil, P., Baba, W.N., Ayoub, M.A. and Maqsood, S. (2023). A comprehensive review on health benefits, nutritional composition, and processed products of camel milk. *Food Reviews International*, *39*(6), 3080-3116.

Rafiq, S., Huma, N., Pasha, I., Sameen, A., Mukhtar, O. and Khan, M.I. (2015). Chemical composition, nitrogen fractions, and amino acids profile of milk from different animal species. *Asian-Australasian Journal of Animal Sciences*, *29*(7), 1022.

Sagar, S.P., Mehta, B.M., Wadhwani, K.N., Darji, V.B. and Aparnathi, K.D. (2016). Evaluation of camel milk for selected processing-related parameters and comparisons with cow and buffalo milk. *International Journal of Health, Animal Science and Food Safety*, *3*(1).

Salem, S.A., Meead, G. and El-Rashody, F.M. (2017). Physicochemical and sensory properties of ice cream made from camel milk and fortified with date products. *International Journal of Humanities, Arts, Medicine, and Sciences,* 5, 29-40.

Sayar, E., Sengul, M. and Urkek, B. (2022). Antioxidant capacity and rheological, textural properties of ice cream produced from camel's milk with blueberry. *Journal of Food Processing and Preservation, 46*(3), 16346.

Servillo, L., D'Onofrio, N., Neglia, G., Casale, R., Cautela, D., Marrelli, M., Limone, A., Campanile, G. and Balestrieri, M.L. (2018). Carnitine precursors and short-chain acylcarnitines in water buffalo milk. *Journal of Agricultural and Food Chemistry*, *66*(30), 8142-8149.

Soni, V. and Goyal, M. (2013). The potential of using camel milk for ice cream making. *Journal of Camel Practice and Research*, *20*(2), 271-275.

Yadav, A.K., Kumar, R., Priyadarshini, L. and Singh, J. (2015). Composition and medicinal properties of camel milk: A Review. *Asian Journal of Dairy and Food Research*, *34*(2), 83-91.