

Camel Milk: Opportunity and Challenges

Bhavbhuti M. Mehta, Amit Kumar Jain, Devesh H. Patel and K. D. Aparnathi

Department of Dairy Chemistry, SMC College of Dairy Science, AAU, Anand-388110.

Email: bhavbhuti5@yahoo.co.in

The image of the camel symbol of human survival in the desert is tied to the history of the major nomadic civilizations of the hot dry areas of the northern hemisphere. Camels live in the vast pastoral areas in Africa and Asia and are divided into two different species belonging to the genus *Camelus*. Dromedary camels (*Camelus dromedarius*, one humped) that mainly live in the desert areas (arid), and Bactrian camel (*Camelus bactrianus*, two-humped) which prefer living in the cooler areas. The total population of the Dromedary species (domestic) worldwide is estimated to be about 15 million head (Al Haj and Al Kanhal, 2010). According to statistics by the Food and Agriculture Organization (FAO), the total population of camels in the world is estimated to be about 20 million, with Somalia having the largest herd worldwide (FAO, 2008).

Camel milk has an important role in human nutrition in the hot regions and arid countries. This milk contains all the essential nutrients found in bovine milk (El-Agamy *et al.* 1998). Camel milks have been used in different regions in the world for a series of diseases such as dropsy, jaundice, tuberculosis, asthma and leishmaniasis. Camel milk was also reported to have other potential therapeutic properties, such as anti-carcinogenic, anti-diabetic (Agrawal *et al.*, 2007), and anti-hypertensive and has been recommended to be consumed by children who are allergic to bovine milk. Recently, Wernery *et al.* (2012) studied on the effect of camel milk on autism. A high content in unsaturated fatty acids contributes to its overall dietary quality. The low quantity of β -casein and the lack of β -lactoglobulin are linked to the hypo-allergic effect of camel milk. Other components such as lactoferrin, immunoglobulins, lysozyme or vitamin C were reported to play a central role

in the determination of these properties (Wernery, 2006; Al haj and Al Kanhal, 2010). Readers are advised to refer excellent reviews written by Konuspayeva *et al.* (2009), Al Haj and Al Kanhal (2010) for further details.

Properties of Camel Milk

Camel milk is generally opaque, white in color and different in taste. The variation of taste (sweet, sharp and salty) is due to the type of plants eaten in the desert by the camels (Khaskheli *et al.*, 2005), type of fodder and availability of drinking water. Camel milk is frothy when shaken slightly. The average specific gravity of camel milk is 1.029 (Yoganandi *et al.*, 2014b), and has been reported to be less viscous than bovine milk but Yoganandi *et al.* (2014b) found relatively high viscosity (1.77 cp) in camel milk than cow milk (1.54 cp). The pH of fresh camel milk ranges from 6.5 to 6.7. The buffering capacity of skim camel milk was reported to be lower than that of bovine milk. The highest buffering capacity reported for skim camel milk was at pH 4.95, whereas, bovine skim milk exhibited higher buffering capacity at pH 5.65. The properties of camel milk are shown in Table 1.

Pasteurized camel milk can last for more than 10 days at 4°C (Wernery, 2008) whereas Mehta *et al.* (2014) found 52 days. On the other hand, camel milk was reported to remain stable for a longer time at room temperature when compared with milk from other animals. Whereas bovine milk took 3 h to turn sour (to reach a pH of 5.7) at 30°C, camel milk took a longer time of 8 h to reach a pH of 5.8 at the same temperature (Ohri and Joshi, 196). Similarly Mehta *et al.*, (2014) observed keeping quality of raw camel milk 35 hours when stored at 25°C.



Chemical Composition of Camel Milk

Camel milk composition has been studied in different parts of the world (Haddadin *et al.*, 2008; Ohri and Joshi, 1961; Yoganandi *et al.* 2014b). Literature data have shown wide ranges of variation in camel milk composition. Konuspaveva *et al.* (2009) conducted a meta-analysis of composition of camel milk between 1905 and 2006. The chemical composition of camel milk in Table 1.

the milk (Khaskheli *et al.*, 2005). Camel milk is deficient in β -lactoglobulin, as also observed for human milk. Camel milk whey contains other main components such as serum albumin, lactoferrin, immunoglobulins and peptidoglycan recognition protein (Farah, 1993). The whey released from camel milk after coagulation is known to have a white colour (El-Zubeir and Jabreel, 2008) compared with the greenish whey from bovine milk cheese manufacture.

Table 1 - Properties of camel milk

Parameters	Values
Moisture (%)	86-88
Fat (%)	2.9-5.4
Lactose (%)	3.3-5.8
Protein (%)	3.0-3.9
Ash (%)	0.6-1.0
Acidity (% LA)	0.13-0.21
Specific gravity	1.027-1.038
Viscosity (cp)	1.72-2.24
Surface tension (dyne/cm)	56.39-60.93
Refractive index	1.340-1.346
Freezing point ($^{\circ}$ C)	-0.51 to -0.61
Electrical conductivity (millimohs)	5.89-6.45

Proteins

Total protein content of Dromedary camel milk ranges from 2.15 to 4.90% (Konuspaveva *et al.*, 2009). Camel milk protein can be classified into two main components viz. casein and whey proteins. Casein (CN) is the major protein in camel milk. Camel milk has about 1.63-2.76% casein equal to about 52-87% of the total proteins (Khaskheli *et al.*, 2005). The β -CN is the main camel milk casein followed by α_1 -CN, and constitutes about 65% and 21% of total casein, respectively (Kappeler *et al.*, 1998). Camel milk is similar to human milk in that it contains a high percentage of β -CN. Chymosin is known to hydrolyze bovine milk k-CN at the Phe105-Met106 bond, whereas its hydrolysis site on camel milk k-CN is Phe97-Ile98 (Kappeler *et al.*, 1998). Whey proteins are the second main component of camel milk proteins and constitute 20-25% of the total proteins. The camel milk whey protein content ranges between 0.63 and 0.80% of

Fats

The fat content of camel milk is between 1.2 and 6.4% (Konuspaveva *et al.*, 2009). A strong positive correlation was found between fat and protein contents. Fat content of camel milk was reported to decrease from 4.3 to 1.1 percent in milk produced by thirsty camels. Compared with bovine milk, camel milk fat contains smaller amounts of short chain fatty acids and a lower content of carotene. Higher contents of long chain fatty acids were also reported for camel milk fat compared with bovine milk fat. The average cholesterol content of camel milk fat (34.5 mg/100 g) was found to be higher (25.63 mg/100 g) than that reported for bovine milk fat. Some difficulties were reported in extracting fat from camel milk using some traditional methods such as churning sour milk, because fat globules were firmly bound to the proteins in camel milk.



Lactose

The lactose content of camel milk varies from 2.40 to 5.80% (Konuspayeva *et al.*, 2009). The wide variation of lactose content could be due to the type of plants eaten in the deserts (Khaskheli *et al.*, 2005). Lactose content was only found to change slightly for camel milk of some Dromedary breeds in different parts of the world (Haddadin *et al.*, 2008).

Minerals

The total content of minerals is usually expressed as total ash; this amount varies from 0.60 to 0.90% in camel milk (Konuspayeva *et al.*, 2009). The minerals content of camel are as follows: calcium, 114 mg/ 100 g; potassium, 156 mg/ 100 g; sodium, 59 mg/ 100 g; iron, 0.29 mg/ 100 g; magnesium, 10.5 mg/ 100 g; manganese, 0.05 mg/ 100 g and zinc, 0.53 mg/100 g. Camel milk is a rich source of chloride (Khaskheli *et al.*, 2005) due to the forage eaten by camels, such as Atriplex and Acacia, which usually contains a high salt content (Yagil, 1982).

Vitamins

Camel milk was reported to contain various vitamins, such as vitamin C, A, E, D and B group (Haddadin *et al.*, 2008). Camel milk is known to be a rich source of vitamin C; the vitamin content was reported to be three times to five times higher than that in bovine milk.

Dairy Products From Camel Milk

It has been reported that camel milk is only suitable for drinking (Yagil *et al.*, 1984). However various products produced from camel milk include soft cheese (El-Zubeir and Jabreel, 2008; Mehaia, 1993), fermented milk, yoghurt, ice cream and butter (Rüegg and Farah, 1991). Yoghurt produced from camel milk (with no additives) was reported to have a thin, flow able and very soft texture. The addition of both 0.75% sodium alginate and 0.075% calcium chloride to camel milk was reported to produce acceptable firmness and body similar to that for yoghurt produced from bovine milk.

Ice cream was reported to be produced successfully from camel milk using a mixture of 12% fat, 11% milk solids not fat (MSNF) and 37% total solids. The overrun of camel milk ice cream was found to significantly depend on the fat and MSNF levels in the mixture. For example the increase in fat and MSNF content in the mixture leads to an increase in viscosity.

The camel milk products were made at laboratory scale, but some are usually produced at a larger scale in the pastoral areas during the peak season of milk production or when milk production is above that required for human and young calf use. These products are still not well developed enough to reach a commercial scale, and there is also a need to examine consumer acceptability of these products. The problems associated with production of cheese include:

Camel milk exhibits a two to three fold longer rennet coagulation time compared with bovine milk. This was attributed to the differences in the size of casein particles that is mainly related to the availability of k-CN (Farah and Atkins, 1992). Weak curd is likely due to the low total solids content of the coagulum, especially casein (El-Zubeir and Jabreel, 2008; Ramet, 2001). Other reasons could be the small size of the camel fat globules (2.99 μ m), higher number of large micelles (200-500 nm) (Farah, 1993). The coagulum obtained from camel milk by bovine rennet action showed a fragile and heterogeneous structure. Soft white cheese made from camel milk by conventional processes was reported to give up to a 12% yield, which is 50% lower than for soft cheese produced from bovine milk (El-Zubeir and Jabreel, 2008; Mehaia, 1993). A lower yield of 5% was reported for hard cheese produced from camel milk (Mohamed and Larsson-Raznikiewicz, 1990).

Conclusion

Camel milk and their products are a good nutritional source for the people living in the arid and urban areas. The production of camel milk is gradually increasing due to an increased interest by consumers in recent years. Various dairy products were reported to be produced successfully from



camel milk with some modifications to their production procedure. Some difficulties were reported in producing cheese. Fresh and fermented camel milk were reported to provide particular health benefits to the consumer depending on the bioactive substances in milk. More extensive research is needed to confirm these proposed health benefits. Further work is also needed on camel milk protein coagulation by acid and chymosin enzyme to solve problems associated with cheese making.

References

- Agrawal RP, Budania S, Sharma P, Gupta R and Kochar, DK (2007). Zero prevalence of diabetes in camel milk consuming Raica community of northwest Rajasthan, India. *Diabetes Research and Clinical Practice*, 76: 290-296.
- Al Haj OA and Al Kanhal HA (2010). Compositional, technological and nutritional aspects of dromedary camel milk-Review. *International Dairy Journal*, 20: 811-821.
- El-Agamy, E. I., Abou-Shloue, Z. I., and Abdel-Kader, Y. I. (1998). Gel electrophoresis of proteins, physicochemical characterization and vitamin C content of milk of different species. *Alexandria Journal of Agricultural Research*: 43, 57-70.
- El-Zubeir IEM and Jabreel MSO (2008). Fresh cheese from camel milk coagulated with Camifloc. *International Journal of Dairy Technology*, 61:90-95.
- FAO (2008). Camel milk. Retrieved from. <http://www.fao.org/ag/againfo/themes/en/dairy/camel.html>.
- Farah Z (1993). Composition and characteristics of camel milk. *Journal of Dairy Research*, 60: 603-626.
- Farah Z and Atkins D (1992). Heat coagulation of camel milk. *Journal of Dairy Research*, 59: 229-231.
- Haddadin MSY, Gammoh SI, and Robinson RK (2008). Seasonal variations in the chemical composition of camel milk in Jordan. *Journal of Dairy Research*, 75: 8-12.
- Kappeler S, Farah, Z., and Puhon Z (1998). Sequence analysis of Camelus dromedaries milk caseins. *Journal of Dairy Research*, 65: 209-222.
- Khaskheli M, Arain, MA, Chaudhry, S., Soomro, AH, and Qureshi TA (2005). Physicochemical quality of camel milk. *Journal of Agriculture and Social Sciences*, 2:164-166.
- Konuspayeva, G., Faye, B., and Loiseau, G. (2009). The composition of camel milk:a meta-analysis of the literature data. *Journal of Food Composition and Analysis*, 22: 95-101.
- Mehaia MA (1993). Fresh soft white cheese (Domiaty-Type) from camel milk: composition, yield, and sensory evaluation. *Journal of Dairy Science*, 76: 2845-2855.
- Mehta BM, Sagar SP, Wadhvani KN, Darji VB, Aparnathi KD (2014). Evaluation of camel milk for keeping quality. An abstract presented in National seminar on “New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under Era of Climate Change” and XXI Annual Convention of Indian Society of Animal Production and Management Organized by Department of Livestock Production and Management, Veterinary College, AAU, Anand, held during 28-30 January, 2014.
- Mohamed MA, and Larsson-Raznikiewicz, M. (1990). Hard cheese from camel milk. *Milchwissenschaft*, 45: 716-718.
- Ohri SP and Joshi BK (1961). Composition of camel milk. *Indian Veterinary Journal*, 38: 514-516.
- Ramet JP (2001). The technology of making cheese from camel milk (Camelus dromedary). Animal Production and Health Paper. No. 113. Rome, Italy: F.A.O.
- Rüegg MW and Farah Z (1991). Melting curves of camel milk fat. *Milchwissenschaft*, 46: 361-362.



- Wernery R, Suntiha J, Bobby J, Sherry J, Milen T, Maria RA and Wernery U (2012). Camel milk against Autism–A preliminary report. *Journal of Camel Practice and Research* 19(2): 143-147.
- Wernery U (2006). Camel milk, the white gold of the desert. *Journal of Camel Practice and Research*, 13: 15-26.
- Wernery U (2008). Camel milk-new observations. In Conference proceedings: International Camel conference. Recent trends in camel research and future strategies for saving camels. India, pp. 200-204.
- Yagil R (1982). Camels and camel milk Animal production and health report. Rome, Italy: FAO.
- Yagil R, Saran A, and Etzion Z (1984). Camels milk: for drinking only? *Comparative Biochemistry and Physiology*, 78 A: 263-266.

