Importance of camel milk - An alternative dairy food

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Abstract

Camel is known as "Ship of the Desert". Camel milk is different from cow milk in its chemical composition but it contains all essential nutrients as cow milk. Indian camels yield 3.5 kg to 10 kg of milk per day. The taste of camel milk depends upon availability of plants for grazing. The water content of camel milk fluctuates from 84 percent to 90 percent. Camel keepers utilize milk either raw, boiled or for tea preparation. Various camel milk products were prepared and commercialized available viz., ice cream/ kulfi with different flavors, flavored milk, fermented milk, cheese, tea and coffee. The vitamin C levels are three times that of cow milk and one-and- a-half that of human milk. Camel milk is used for treating dropsy, jaundice, spleen ailments, tuberculosis, asthma, anemia and piles.

***Keywords*:** milk; milk composition; milk products; camel

Introduction

An important component of desert ecosystem from time immemorial which has been recognized as the "Ship of the Desert" is the camel. Majority of the population of the desert depends upon this animal for the meat, milk, hides and also for transportation in the desert.

The camel belongs to genus *Camelus* having two species:

1. *Camelus dromedariu*s Dromedary or One humped camel- found in Africa, Arabia, Iran, Afghanistan and India.
2. *Camelus bactrianus* Bactrian or Two humped camel- found in Central Asia reaching up to Mongolia and Western parts of China.

The females calve for the first time at the age of 4-5 years. They lactate for 8–18 months. The camels are milked twice a day. Lactation yields range from 2000 kg (Gohl, 1979) to 2700–3600 kg (Rao *et al.*, 1970) under good feeding conditions and about 1360 kg when feed supplies are poor. (Yasin and Wahid, 1957)

Characteristics of Camel milk

Camel milk is generally opaque white (Dihanyan, 1959; Heraskov, 1953; Yagil and Etzion, 1980). Normally it has a sweet and sharp taste, but sometimes it is salty (Rao *et al.*, 1970). It is frothy when shaken slightly (Shalash, 1979). The changes in taste are caused by the type of fodder and the availability of drinking water. Camel milk is somehow different from cow milk in its chemical composition but it contains all essential nutrients as cow milk (Elagamy, 1996). Unlike cow milk, it was found that camel milk can be preserved for a longer time at 30º C and most importantly the camel milk can be kept at 4º C for more than three months without any visible change (Yagil *et al*., 1978). Indian camels yield 3.5 kg to 10 kg of milk per day. The taste of camel milk depends upon availability of plants for grazing. Camel milk can be preserved for 2-3 days at room temperature under field conditions. (Khedkar *et al*., 2002).

Composition of Camel's Milk

The first milk, the colostrum, is white and slightly diluted as compared with the colostrum of cow (Yagil and Etzion, 1980). The specific gravity of camel milk is less than that of cow, sheep or buffalo milk (Shalash, 1979). The most important factor in camel milk is water content. Young camels, and especially the humans living in drought areas, are in need of fluid to maintain homeostasis and thermo-neutrality. The water content of camel milk fluctuates from 84 percent (Knoess, 1976) to 90 percent (Ohri and Joshi, 1961).

Fat %	**SNF %**	**Protein %**	**Lactose %**	**Ash %**	**Density %**	**Water %**	**References**
3.78	9.59	4.0	4.9	0.95	1.03-1.04		Ohri & Joshi, 1961
3.08	9.92	3.8	5.4	0.7	1.04		Khan & Appena, 1964
2.9	10.1	3.9	5.4	0.8	-	87.6	Singh, 1962
4.1	-	2.0	4.7	0.7	-	88.5	Singh, 1962
2.3		2.3	4.05	-	-	91.5	Raghvendar *et al*., 2004

Fat

The milk fat is also different from that of other animals. When left standing, fat is distributed as small globules throughout the milk (Yagil and Etzion, 1980). The ratio of fat to total solids average 31.6 percent (Shalash, 1979). This is much lower than that of the buffalo, which is 40.9 percent. These difference in milk fat necessitated saponification of camel milk in order to extract vitamin A and carotene (Khan and Appena, 1967). Camel milk fat has a low Reichert value of 16.4 (Dhingra, 1934). The fatty acid composition of camel milk fat was found to be as follows (in weight percentage):

Butyric acid	2.1
Caproic acid	0.9
Caprylic acid	0.6
Capric acid	1.4
Lauric acid	4.6
Myristic acid	7.3
Palmitic acid	29.3
Stearic acid	11.1
Oleic acid	38.9
Linoleic acid	3.8

Compared to cow, buffalo and ewe milk fat, camel milk fat contains less short-chained fatty acids, but the same long-chained fatty acids can be found (Dhingra, 1934). Gast *et al*. (1969) claim that the value of camel milk is to be found in the high concentrations of volatile acids and especially, linoleic acid and the polyunsaturated acids, which are essential for human nutrition. The molar percentage distribution of the glycerides in camel milk fat is as follows (Dhingra, 1933).

Fully saturated glycerides	25.6
mono-oleo unsaturated glycerides	37.8

The total saturated acids in whole fat were 62.6 percent mole. The distribution of phospholipids in camel milk (expressed in mole percent of phospholipids) was as follows (Morrison, 1968)

Phosphatidyl ethanolamine	35.9
Phosphatidyl choline	24.0
Phosphatidyl serine	4.9
Phosphatidyl inositol	5.9
Sphingomyelin	28.3
Lysophosphatidyl ethanolamine	1.0
Lysophosphatidyl choline	0.0
Total choline phospholipids	52.3
Ethanolamine plasmalogen	15%

Low fat (2%), completely homogenized into minute globules, mainly poly unsaturated fatty acids (PUFAs-Omegas). This natural source of Alpha-hydroxyl acids is known to plump the skin and smooth fine lines. PUFAs also help to reduce inflammation by giving rise to the potent signaling molecules, called eicosanoids.

Protein

The average main composition of protein and nitrogen fractions of camel milk is generally similar to those of cow's milk. Milk protein content of camel milk ranges from 2 to 5.5 percent (Yasin and Wahid, 1957). Dilanyan (1959) reported the casein content of dromedary and Bactrian milk as 2.7 and 0.89 percent respectively and that of albumin as 3.8 and 0.97 percent respectively. Kherashov (1961) examined four breeds of camels and found the value for total protein to vary from 3.5 to 3.8 percent and casein from 2.7 to 2.9 percent. Camel milk casein and their fractions were found to be poor in crude protein when compared with cow milk (Pant and Chandra, 1980).

Casein fractions have been isolated in camel milk and found to be homologous with bovine casein. The balance between the different casein fractions is very different, however, and chiefly identified by a low amount of kappa casein of only about 5 percent of the total casein, compared with about 13.6 percent in bovine casein (Ramet, 1993). This major difference in kappa casein content has shown difficulties in cheese making (Mohamed and Raznikiewicz, 1990; Laleye *et al*., 2008). There is little information available on the ability of camel milk to undergo enzymatic coagulation.

The quantity of whey proteins is higher in camel milk than cow's milk, at 0.9-1.0% and 0.7-0.8%, respectively. Individual fractions have been identified according to chromatographic and electrophoretic mobility and to the primary sequence of their amino acid chains (Farah, 1986). The heat stability of camel milk whey proteins was found to be considerably higher than in cow's milk. Camel milk contains high whey proteins such as lactoferrin and immunoglobulin confer to it the high antimicrobial properties. Lactoferrin helps to establish a favourable microflora in the guts and consequently promotes growth of bifidobacteria.

Lactose

The average lactose content of camel milk is slightly lower (4.62%) than cow's milk (4.80%). Sestuwheva (1958) found that the lactose content of camel milk remained unchanged from the first months up to the end of lactation. The changes in lactose concentration would account for the milk being described as sometimes sweet and other times bitter.

Vitamins and Minerals

Camel milk is rich in vitamin C (Knoess, 1979). This is important from the nutritional stand point in areas where fruit and vegetables containing vitamin C are scarce. Kheraskov (1961) found the vitamin C content of camel milk to vary between 5.7 and 9.8 mg percent. The vitamin C levels are three times that of cow milk and one-and- a-half that of human milk (Gast *et al*., 1969). Vitamin B_{12} in camel milk declined from 3.9 ug/l at 1.5 months lactation to 2.3 ug/l at the fourth month of lactation (Kheraskov, 1961) The vitamin A content has been reported as being as little as 0.037 mg percent to

1.264 mg/l (Anderson *et al*., 1940). Khan and Appona (1967) found an average of 7.57 ug/ml of vitamin A and 9.4 ug/ml of carotene. The levels of vitamin A, E and B_1 were reported to be low in camel milk compared to the cow milk (Stahl *et al.* 2006). The total ash content of camel milk varies greatly, and the lowest percentage of ash was found in the milk produced by dehydrated camel (Yagil and Etzion, 1980). Camel milk is rich in chloride (El-Bahay, 1962). Although milk from the dehydrated camel showed decrease of fat, protein and lactose content, that of sodium and chloride increased (Yagil and Etzion, 1980). This would account for the salty taste.

Vitamin C in camel milk has antioxidant and tissue repair protection activities. Vitamin C is an essential water soluble vitamin that helps protect the immune system. According to Natural Standard Research, Vitamin C is necessary in the body for the production of collagen, a protein that aids in the growth of cells and blood vessels and gives skin its firmness and strength. Collagen is found in the skin, joints and cartilage; by increasing the production of collagen. Vitamin C strengthens the structural support and resiliency of skin so helps repair it. Vitamin C is an antioxidant that slows the rate of free-radical damage which causes skin dryness and wrinkles (Escott-Stump, 2008). Vitamin C can literally reverse skin ageing.

Enzymes

The activities of aspartate aminotransferase (AST), alanine aminotransferase (ALT), gamma glutamyl transferase (γ-GT), acid phosphatase (ACP), alkaline phosphatase (ALP) and lactate dehydrogenase (LDH) was found to varies between 7.98- 9.21 IU/L, 9.49-11.00 IU/L, 254.00-296.00 IU/L, 2.74-3.08 IU/L, 16.04-24.93 IU/L and 132.00-168.00 IU/L in Indian dromedary camels (NRCC, 2007). The activity of catalase was ranged from 0.083-0.193 moles/min/gm of protein in Indian dromedary camels. Milk enzymes play an important role in the keeping quality of camel milk. γ-GT can be used as an indicator for the proper heat inactivation of camel milk because it is destroyed between 10 to 20 minutes at 72˚C (Wernery, 2007).

Electrolytes

Magnesium slows down the ageing process in the skin because magnesium stabilizes DNA and RNA which are both negatively charged and are attracted to the positively charged magnesium. Magnesium is also needed for hair to grow properly because chronic stress can cause hair to fall out as a result of unstable blood sugar, chronic inflammation, not eating properly or getting enough sleep. All of the above-mentioned camel milk contents explain the ability of penetrating the skin layers without leaving a fat or other residue on the skin. Camel milk creams are skin friendly and rapidly penetrate into the deeper layers of the skin.

pH

Fresh camels' milk has a high pH (Grigoryants, 1954; Ohri and Joshi, 1961). The pH of milk is between 6.5–6.7 (Shalash, 1979). This is similar to the pH of sheeps' milk. When camel milk is left to stand, the acidity rapidly increases (Ohri and Joshi, 1961).

Ratio of Milk Yield to Body Weight

Knoess (1977) found that the ratio of average daily milk yield to camel's body weight was 1.86%. Shalash (1979) reported that the ratio of fat to total solids in camel milk ranged from 20 to 43% with a mean of 31.16% which is near to that of cow milk (32.1 %), but definitely lower than that of buffalo milk (40.91%). Knoess (1979) observed that daily milk production of the dromedary may range from 15 to 40 litres, which represents 3.3 to 8.9% of body weight. Knoess *et al*. (1986) stated that mean daily milk yield (18.68 litres) of seven dromedaries constituted 3.26% of body weight. Khanna (1986) observed that average daily milk yield during different stages of lactation in camel ranged between 1.9 and 2.5% of body weight. The ratio of fat to total solids ranged from 20 to 43%.

Milking Frequency

Milking frequency of camels was found to be six to eight times a day (Knoess, 1977). It was reported that milking frequency in camels varies between two to six times daily depending on season, stage of lactation and milk yield (Dioli *et al*., 1992).

Medicinal properties of camel milk

There is reports that camel milk has medicinal properties (Yagil, 1982) suggesting that this milk contains protective proteins which may have possible role for enhancing immune defense mechanism. Camel milk also contains higher amount of zinc. The rapidly dividing cells of the immune system are sensitive to zinc deficiency. The role of Zn in the development and maintenance of a normally functioning immune system has been well established (Hansen *et al*.,

1982). Camel milk lysozyme showed a higher lysis value towards *Salmonella typhimurium* compared to egg white and bovine milk lysozymes. The inhibition of pathogenic bacteria by camel's milk was also observed (Barbour *et al*., 1984). Camel milk is used for treating dropsy, jaundice, spleen ailments, tuberculosis, asthma, anemia and piles (Rao et al. 1970). The patients suffering from chronic hepatitis had improved liver functions after drinking of camel milk (Sharmanov *et al*., 1978). Camel milk has insulin like activity, regulatory and immune-modulatory functions on β cells (Breitling, 2002). Camel milk exhibits hypoglycemic effect when given as an adjunctive therapy, which might be due to presence of insulin like protein in it (Agrawal *et al*. 2003) and possesses beneficial effect in the treatment of diabetic patients. Camel milk has been used for the treatment of food allergies (Shabo *et al*. 2005) and autism (Shabo and Yagil, 2005). Camel milk can be used for the treatment of different types of tuberculosis (Mal et al. 2000, 2001 and 2006). Camel milk possesses medicinal properties to treat different ailments such as multiple sclerosis, psoriasis, lupus, allergies-asthma (Wernery, 2006). Camel milk has positive effects in controlling high blood pressure and helps in the management of Arteriosclerosis and Osteoporosis. Clinical trials showed that recovery from infectious disease (e.g. Tuberculosis) was significantly faster in patients consuming camel milk regularly.

In India camel milk is used therapeutically against dropsy, Jaundice, problems of the spleen, tuberculosis, asthma, anemia, and piles (Rao *et al.*, 1970). Camel milk was also reported to have other potential therapeutic properties, such as anti-carcinogenic (Magjeed, 2005), anti-diabetic (Agrawal *et al*., 2007) and anti-hypertensive (Quan *et al.,* 2008) and has been recommended to be consumed by children who are allergic to bovine milk (El-Agamy *et al.,* 2009). Moreover, camel urine was also reported to be used as a treatment for diarrhoea (Al-Attas, 2008). Close analysis of camel milk does show some medicinal potential. The milk protein lactoferrin, which is present in large quantities in camel milk (ten times higher than in cow milk), does have some anti-viral and anti-bacterial properties. Fermented camel milk is high in lactic bacteria, which have been shown to be effective against pathogens including Bacillus, Staphylococcus, Salmonella and Escherichia. Furthermore, vitamin C content in camel milk is generally double that in cow's milk. A natural component of cow and human milk, lactoferrin is also found throughout the human body; it occurs in all secretions that bathe mucous membranes, such as saliva, tears, bronchial and nasal secretions, hepatic bile and pancreatic fluids. Exactly how lactoferrin functions is not entirely clear, but it is known to enhance the immune response, both directly and indirectly (passively) in reaction to a wide range of immune challenges and is an essential factor in the immune response in humans.

Camel milk products

Value additions of camel milk can be an alternative to make it more important in daily life; bye-products can be prepared and stored for longer period for transportation. Camel milk is consumed by the camel keepers of Rajasthan, Gujarat and Haryana. Camel keepers utilize milk either raw, boiled or for tea preparation. Various camel milk products were prepared and commercialized available viz., ice cream/kulfi with different flavors, flavored milk, fermented milk, cheese, tea and coffee. Recently, camel milk skin cream has been developed and it can be used as an emollient agent. Yoghurt produced from camel milk (with no additives) was reported to have a thin, owable and very soft texture (Hashim *et al*., 2008). Ice cream was reported to be produced successfully from camel milk using a mixture of 12% fat, 11% milk solids not fat and total solids (Abu-Lehia *et al.,* 1989).

Conclusion

Camels produce more milk of high nutritional quality and for a longer period of time than other species in an environment that may be rightly termed as hostile in terms of extreme temperature, drought and lack of pasture. Camel milk is rich in vitamin C, which should not be present in cow milk. Camel milk and its products are a good nutritional source for human diet. It has potential therapeutic properties and useful for preparation of milk products.

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