

Review Article

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Camel Milk: The Natural Gift for Medicinal Uses for Humans-A Review

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ABSTRACT

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Camel milk called as white gold of the desert has valuable nutritional properties as it contains a high proportion of antibacterial substances and a higher concentration of vitamin C in comparison with cow milk. Milk has been a symbol of purity and was often used in religious ceremonies. Healing properties of camel milk were first mentioned in the “Words of The Prophet Mohamed” in the Surah, a section of the Koran. The global camel population, spread across 47 countries, is estimated to be around 26.99 million. About 83 percent of the camel population inhabits mainly the Eastern and Northern Africa and the rest are present in the Indian subcontinent and the Middle East. Camel milk has been acknowledged for a long time in different parts of the world to provide a medicinal use for a series of diseases such as dropsy, jaundice, tuberculosis, asthma, and leishmaniasis or kala-azar.

Introduction

Milk is the primary resource of nutrition for newborn and young mammals until they can digest another type of food. The mammary gland produces highly nutritious milk that is tailor-made nourishment for the neonatal after parturition. Other mammals, especially humans take advantage of the nutrition available in the milk. Since 3500-2800 BC milk from different animals like cow, goat, reindeer, horse buffalo and camel has been a

source of nutrition for human in a different part of the world. Milk has been a symbol of purity and was often used in religious ceremonies. Healing properties of camel milk were first mentioned in the “Words of The Prophet Mohamed” in the Surah, a section of the Koran (Khan and Bukhari, 1974). Today cow milk is mostly utilized as a nutrient resource, but in recent years the interest for camel milk has increased. Camel milk so-called white gold of the desert has valuable nutritional properties as it contains a high

proportion of antibacterial substances and a higher concentration of vitamin C in comparison with cow milk (Barłowska *et al.*, 2012). In a historical view, camels have been used as means of payment. In African cultures, it is traditional for the groom to pay a "bride price" to the bride's family, usually in livestock. The price may vary from 3-100 camels reflecting the groom's wealth (Abokor, 1986).

The genus *Camelus* has two species (Fig. 1), the heavily built, two-humped Bactrian camel (*Camelus bactrianus*) which inhabits the desert of central Asia reaching up to Mongolia and western part of China. The other species are single-humped Arabian camel (*Camelus dromedarius*) commonly known Dromedary widespread throughout the Middle East, India and North Africa. The global camel population, spread across 47 countries, is estimated to be around 26.99 million. About 83 percent of the camel population inhabits mainly the Eastern and Northern Africa and the rest are present in the Indian subcontinent and the Middle East. Somalia has the highest population of 7.10 million. India stands tenth in the world with 0.38 million camels (FAOSTAT, 2015). In last five decades, the world's camel population increased by about twofold as a result of a nearly threefold increase in the Africa region, while it recorded a decreasing trend in the Asian region including India (Table 1). Total Camel Population in India is 0.25 Million during 2019, decreased by 37.1% over the previous census (Table 2). Total camel population has decreased by 37.1% over previous livestock census (2019). In India, camels are mainly confined to the states of Rajasthan (2.13 lakhs), Gujarat (0.25 lakhs), Haryana (0.05 lakhs), and Uttar Pradesh (0.02 lakhs) according to 20th livestock census, DAHDF, 2019 is presented in (Table 3).

Milk production potential of camel breeds

The annual world production of camel milk is estimated to be 2.9 million tonnes. Somalia is a top producer with 1.1 million tonnes followed by Kenya, Mali, Ethiopia Saudi Arabia, Niger, Sudan, UAE, Mauritania and Chad. The total world camel milk production increased by 4.6 times from 629 to 2928 thousand tonnes between 1961 and 2013, mainly due to an increase in the production in Africa (Fig. 1). Similarly, it increased to 4.8 times of total African countries, while it is recorded 3.2 times in Asia due to the increase in the camel population (FAOSTAT 2015). The overall camel milk production in Asia also increased from 65 to 205 thousand tonnes although there was a decline in the camel population in the region (Table 1). The highest camel milk yield per animal is recorded to be 971 kg in Ethiopia followed by camels of Kenya, Qatar, Saudi Arabia, Niger, Somalia, Eritrea, Tunisia, Afghanistan and Mali (FAOSTAT 2015).

Properties of camel milk

The colour of camel milk is white and opaque and has a faint sweetish odour but sharp taste, sometimes it can be salty (Rao *et al.*, 1970, Yagil and Etzion, 1980 and Abbas, 2013). This is regulated by the feedstuff consumed by the camel in the desert (Khaskheli *et al.*, 2005). The variations in taste are mainly affected by the type of fodder and the amount of drinking water available (Farah, 1996). The average density is 1,029 g cm⁻³ (Farah, 1996), and the camel milk has shown to be less viscous than bovine milk (Laleye *et al.*, 2008). The viscosity of camel milk at 20 °C is 1.72 mPa s compared to bovine milk which is 2.04 mPa s (Kherouatou *et al.*, 2003)

In fresh camel milk, the pH ranges from 6.5-6.7. (Khaskheli *et al.*, 2005), but it has also been measured as low as 6.0 (El-Hadi

Suliman *et al.*, 2006). The pH of camel milk resembles sheep milk (Yagil, 1982) and is slightly lower than cow milk (Sawaya *et al.*, 1984). When the camel milk is left to stand in room temperature will rapidly increase the acidity. Compared with milk from another animal, camel milk could remain stable for a longer period at room temperature. In 3 hours bovine milk turned sour (pH 5.7) at 30 while camel milk used 8 hours to reach pH 5.8 at the same temperature (Ohri *et al.*, 1961). A study showed that stored in 30°C bovine milk turned sour and completely coagulated in 48 hours, while camel milk turned sour in 5 days and coagulated in 7 days at 30 °C (Yagil, 1982).

Composition of camel milk

The complete camel milk consultation percent of water, dry matter (DM), fat, total protein, lactose, solid not fat (SNF) and ash are presented in (Table 4).

Fat

In dromedary camel milk, the fat content is about 1.2-6.4%. The average fat content is around 3.5±1.0% (Konuspayeva *et al.*, 2009). There is a strong correlation between fat and protein (Haddadin *et al.*, 2008). A study reported that in milk from thirsty camels, the fat content decreased from 4.3 to 1.1% (Yagil and Etzion, 1980). Camel milk contains a smaller amount of short-chain fatty acid and lowers the content of carotene compared to bovine milk that makes it whiter in colour (Stahl *et al.*, 2006). Compared to bovine milk fat the cholesterol is also higher in camel milk fat.

Proteins

The total protein content in camel milk is estimated to 2.15-4.90 % (Konuspayeva *et al.*, 2009), where the average is 3.1±0.5% (Abbas,

2013). Breeds and seasonal conditions play a role in protein content. The protein in camel milk consists of casein and whey proteins. Milk from the Majaheim breed demonstrates higher protein content than other dromedary breeds, (Mehaia *et al.*, 1995). The camels from the same breed have very similar protein content, but there are huge differences between the breeds (Elamin *et al.*, 1992). The protein content was highest in December/January with 2.9% and lowest in August with 2.48% (Haddadin *et al.*, 2008).

Lactose

In camel milk, the lactose content is about 2.40-5.80%, with an average of 4.4±0.7% (Konuspayeva *et al.*, 2009). The camel consumes plants that contain different amounts of lactose, causing wide variations in the milk (Khaskheli *et al.*, 2005). To reach their physiological requirements of salts the camels eat mostly Atriplex, Salosa and Acacia which are halophilic plants (Yagil, 1982). Lactose seems to be the only component in the milk composition that stays stable during the season (Haddadin *et al.*, 2008), also during hydrated and dehydrated times (Yagil and Etzion, 1980).

Caseins

In camel milk the major part of the protein is casein. It constitutes about 52-87% of the total proteins. About 1.63-2.76% casein is found in dromedary camel milk (Frag and Kabary, 1992). Camel milk contains a high percentage of beta-casein and this can be the reason for the higher digestibility rate and lower allergy incidence in the guts in children. Beta-casein has shown to be more sensitive to peptic hydrolysis than the alpha s casein. The high percentage of beta-casein in camel milk is similar to human milk (Abou-Soliman, 2005). In a study of the amino acid composition of dromedary milk, it was

reported that camel milk is similar to bovine milk except for glycine and cysteine. These two amino acids were significantly lower in dromedary milk casein (Farah *et al.*, 1989). Camel milk has shown to have a lower degree of hydrolysis after reaction with pancreatic enzyme compared to bovine milk (Salami *et al.*, 2008).

Minerals

The minerals expressed in total ash are between 0.6-0.9% with an average of 0.79 ± 0.07 in Dromedary camel milk (Konuspayeva *et al.*, 2009). The variations are found to be due to breed types, feeding systems (Mehaia *et al.*, 1995) and water intake (Haddadin *et al.*, 2008). Chloride is found in the rich amount in camel milk (Khaskheli *et al.*, 2005) due to the feedstuff (Yagil, 1982).

During dehydration, there is a loss of milk components and increase amount of chloride may contribute to the salty taste of the camel milk (Yagil and Etzion, 1980). Compared to bovine milk the levels of sodium, potassium, iron, copper and manganese be significantly higher in camel milk (Mehaia *et al.*, 1995).

Vitamins

Camel milk contains vitamin A, B group, C, D, and E (Haddadin *et al.*, 2008 and Stahl *et al.*, 2006). Especially vitamin C has been measured in high amounts and compared to bovine milk the vitamin was found three times (Farah *et al.*, 1996) and five times higher in camel milk (Stahl *et al.*, 2006).

Ascorbic acid intake through camel milk, both fresh and fermented, is an important vitamin supplement in desert areas where the availability for vegetable and fruits is limited (Sawaya *et al.*, 1984).

Medicinal values of camel milk

Health benefit potentials of camel milk are obtained through several bioactive components in camel milk. These components were reported to exist naturally in camel milk or derived from camel milk proteins using probiotic strains (El-Agamy, 2009). Camel milk has been acknowledged for a long time in different parts of the world to provide a potential treatment for a series of diseases such as dropsy, jaundice, tuberculosis, asthma, and leishmaniasis or kala-azar (Asresie and Mohammed, 2014). Also revealed that several studies have shown that milk is an important nutritional and functional source and could provide particular health benefits due to the presence of bioactive substances in milk.

Anti-diabetic properties of camel milk

Diabetes mellitus is characterized by abnormally high blood glucose levels, resulting from low insulin secretion and/or increased insulin resistance (Gader and Abdulqader, 2016). Diabetes mellitus type 1 caused by autoimmune destruction of insulin-producing beta cells of the pancreas or malfunction of the receptors for insulin on the cell surface. The subsequent lack of insulin leads to increased blood and urine glucose. But as camel milk contains tissue repairing proteins, the problem is cured (Gul *et al.*, 2015). According to Agarwal and co-researchers (2003) in India, a comparison between conventionally treated juveniles diabetes with those also drinking camel milk showed that the group drinking the camel milk had significantly reduced blood sugar and reduced HbA1C levels. Because camel milk has following properties Camel milk has insulin-like activity, regulatory and Immunomodulatory function on cells (Agrawal *et al.*, 2003).

Anti-bacterial and anti-viral properties of camel milk

Camel milk contains antimicrobial enzymes (lactoferrin and Lactoperoxidase) protective protein like caseins, stronger immune system and smaller immunoglobulins than other ruminants. Noreddine (2004) reported from his study on antimicrobial effects of camel milk against *E. coli* and *L. monocytogenes* confirmed that camel milk has a bacteriostatic effect against both pathogens tested, while the colostrum is bactericidal to *E. coli* and bacteriostatic to *L. monocytogenes*. This study also compared the antimicrobial effect of raw camel milk and heated milk suggested that raw milk is more effective. This justified the clue that the heat treatment process may have destroyed, at least partially, some of the inhibitory systems present in the milk. The lysozyme is sensitive to heat and the LPS was shown to be completely inactivated when heated at 80°C for 40 s or at 76°C for 1 min.

Camel milk has been noted to have medicinal properties treating tuberculosis. A study conducted on the effect of camel milk on multiple drug resistance patients with tuberculosis concluded that camel milk can act as an adjuvant nutritional supplement in MDR patients (Mal *et al.*, 2006).

Camel milk for the treatment of Crohn's disease

Crohn's disease is a condition that causes inflammation of the digestive system or guts that boosts with autoimmune disease. It has been approved that infection by *Mycobacterium avium*-subspecies: paratuberculosis (MAP) lead to a secondary autoimmune response, paving the way for Crohn's disease (Ahmed, 2007). Camel milk has been identified as assisting in the recovery processes of autoimmune diseases. It becomes apparent, that the powerful bactericide

properties of camel milk, combined with PGRP have a quick and positive effect on the healing process (Ahmed, 2007). Camel milk has powerful bactericidal properties and can rehabilitate the immune system. It was observed that drinking non-pasteurised camel milk is beneficial to people with all the variety of symptoms associated with an infection of the alimentary canal (Shabo *et al.*, 2008) Shabo and coworkers reported that camel milk has shown good effect for treating Crohn's diseases. As the bacteria belong to the family of tuberculosis and as camel milk has been used to treat tuberculosis it becomes apparent that the powerful bactericide properties of camel milk combined with PGRP have a quick and positive effect on the healing process.

Camel milk for treatment autism disease

Autism disease in general terms for a group of complex disorders of brain development. The aetiology of many autistic cases is based primary on autoimmune disease, affecting an intestinal enzyme responsible for the formation of amino acids from the milk protein casein. Some times casein break down to powerful opioid, casomorphine instead of primarily beta-casein and beta-lactoglobulin. This opioid leads to typical cognitive and behavioural symptoms due to brain damage (Al-Juboori *et al.*, 2013). The consumption of camel milk in children suffering from autism showed a reduction in autism symptoms and improved motor skills, language, cognition, joint coordination and skin health (Gizachew *et al.*, 2014).

Treatment for allergies

The milk protein called β -lactoglobulin present in cow and mare milk is responsible for allergies in humans. However, camel milk lacks this protein and thus do not cause a problem of allergies in a sensitive individual.

β -casein present in cow milk also causes hypersensitivity into humans. Beside, camel milk contains β - casein, but its structure is very different from the cow milk protein. Phylogenetic differences could be responsible for the failed recognition of camels proteins by circulating IgEs and monoclonal antibodies. Children with severe food allergies improved rapidly with camel milk. It appears that camel milk has a positive effect in children with severe food allergies (Gizachew *et al.*, 2014) According to El-Agamy *et al.*, (2009) absence of immunological similarity between the camel

and cow milk proteins may be taken an important criterion from a clinical point of view. Therefore, camel milk may be suggested as a new protein source for nutrition for children allergic to cows milk.

Another fact is that the components of camel milk include immunoglobulins similar to those in mother's milk, which reduce children's allergic reactions and strengthen their future response to foods. It appears that camel milk has a positive effect on children with severe food allergies. The reactions are rapid and long-lasting (Shabo *et al.*, 2005).

Table.1 Periodical change in camel population of major regions of the world (1961-2013)

Camel population (Million)			
Year	World	Africa region	Asia region (India)
1961	12.93	8.63	4.02 (0.9)
1971	16.82	12.41	4.17 (1.1)
1981	18.41	14.00	4.17 (1.08)
1991	19.32	14.73	4.33 (1.03)
2001	20.78	17.11	3.66 (0.63)
2013	26.99	23.00	3.98 (0.4)

Source: FAOSTAT (2015)

Table.2 Camel population 2012 and 2019

Category	Population (In millions) 2012	Population (In millions) 2019	% Change
Camel-Total	0.40	0.25	-37.05
Male	0.19	0.08	-56.40
Female	0.21	0.17	-19.46

Table.3 Camel population 2012 and 2019 of major states

S.No.	States	Population (In lakhs) 2012	Population (In lakhs) 2019	% Change
1	Rajasthan	3.26	2.13	-34.69
2	Gujarat	0.30	0.28	-9.19
3	Haryana	0.19	0.05	-72.65
4	Uttar Pradesh	0.08	0.02	-69.45

Table.4 Composition percent of camel milk

	%						
Water	DM	Fat	protein	Lactose	SNF	Ash	References
86.43	13.57	3.78	3.95	4.88	9.59	0.95	Ohri and Joshi (1961)
87.02	12.98	3.08	3.80	5.40	9.92	0.70	Khan and Appana (1965)
87.60	13.00	2.90	3.90	5.40	10.10	0.80	Harbans (1966)
90.50	9.50	2.30	2.30	4.05	-	-	Raghvendar et al., (2004)
88.55	-	2.60	3.73	-	7.25	0.82-0.85	Mal et al., (2006)
90.15	-	3.20	3.89	-	8.25	-	Mal et al., (2007)

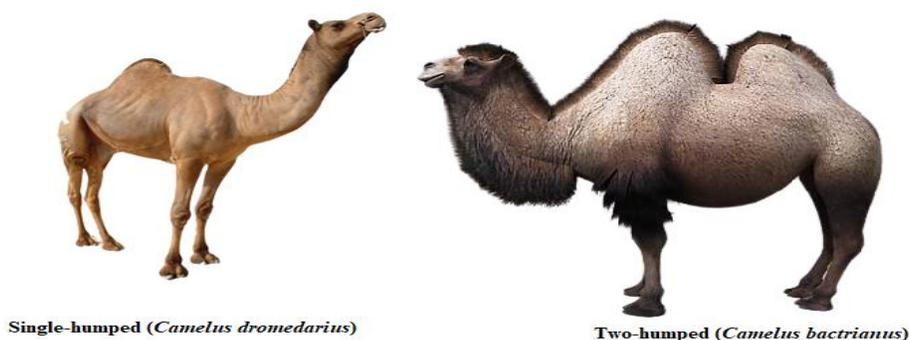


Fig.1: Two type species of camel : single-humped and two-humped

Anti-diarrheal properties of camel milk

Camel milk contains many “protective proteins” like lactoferrin, lactoperoxidase, Nagase and PGRP that exert immunologic, bacteriocidal and viricidal properties. Among the “protective proteins” in camel milk lysozyme, lactoferrin, LP and PRP (Yagil and Reuven, 2013) have anti-diarrheal/antibacterial action as well as high titers of antibodies against rotavirus, and the impact on the immune system. It should be noted that rotavirus is the most common cause of diarrhea in children under 5 years old (Greenberg and Estes, 2009). Since camel milk is rich in anti-rotavirus antibodies diarrhea subsides.

Effects of camel milk on colon cancer

Camel milk components inhibit the growth of colon cancer cells. Lactoferrin, a glycoprotein has a high affinity for iron and may aid cell

proliferation by transporting iron into cells. Lactoferrin has also been shown to have a variety of biological activities, including providing antibacterial activity in infants. It interacts with polysaccharides ligands on cell surfaces and may activate cell signalling pathways such as the Fas pathway, resulting in the inhibition of tumour growth via apoptosis. Lactoferrin can also penetrate cells and function as a transcription factor, activating the transcription of specific DNA sequences. Thus lactoferrin has potential in tumour treatment by blocking tumour cell proliferation. A recent study examined the ability of camel milk lactoferrin to block cancer cell growth. This study has reported that high concentrations (3-5 mg/ ml) of camel milk lactoferrin inhibit the proliferation of HCT-116 colon cancer cells by as much as 56 %. In contrast, no significant inhibition of cell proliferation was noted at lower concentrations (≤ 1 mg/ml). Whilst this study did not determine the anti-proliferative

mechanisms, it was shown that camel milk lactoferrin exerts significant antioxidant activity in NO scavenging, DPPH assays, FRAP and total antioxidant equivalents assays. Furthermore, lactoferrin also inhibited DNA damage. Cellular redox state and oxidative stress have been linked to cell death via apoptosis, DNA damage and a wide variety of chronic diseases, providing the further therapeutic potential for camel milk lactoferrin (Tsuda and Sekine, 2000).

Therapeutic effect camel milk on hepatitis

Scientific publications have shown that camel milk cures both hepatitis B and hepatitis C. The special fat in camel milk soothes the liver and has a beneficial action on chronic liver patients (Saltanat, 2009). There is also a possibility that the relatively high concentrations of ascorbic acid in camel milk help in improving liver function (Gul *et al.*, 2015). But Subsequent studies have shown that camel lactoferrin markedly inhibits hepatitis C virus genotype 4 infection through preventing the entry of the virus into the cells (Gader and Abdulqader, 2016). Additionally, camel lactoferrin is more potent anti-viral agent than bovine and human lactoferrins, even its anti-parasitic action can clear *Schistosoma Mansoni* (Maghraby *et al.*, 2005).

Camel milk for the treatment of arthritis

Camel milk has a higher amount of iron-chelating protein known as lactoferrin. This protein removes free iron from joints of arthritic patients thereby improves arthritic (Panwar and Rohit, 2015).

Skin disease treatment and cosmetic values of camel milk

Camel milk has a cosmetic effect due to the presence of α -hydroxyl acids which are

known to plump the skin and smoothes fine lines. Alpha-hydroxyl acids help to shed the outer horny layer of dead cells on the skin (epidermis) by helping to break down sugars, which are used to hold skin cells together. Besides, liposome occurring in camel milk is applicable for a potential cosmetic ingredient to improve anti-ageing effect (Choi *et al.*, 2013) Researchers say that the ingredient's vitamin B, C carotin and iron content have crucial for skin.

The milk contains lanolin and other moisturizing properties providing a calming and soothing effect on the skin. In addition to keeping the skin beautiful used to treat skin disorders such as dermatitis, Acne, Psoriasis and Eczema. Moreover, camel milk is a natural source of alpha-hydroxy acids for softening the skin, keeping it supple, smooth and preventing wrinkles. (<http://www.camelproductsaustralia.com/#!benefits-of-camel-milk/cmu9>).

In conclusion the nature has gifted us with lots of things for our sake among which milk is considered as the most functional natural liquid as it is produced abundantly and has numerous nutritional values. The future for camel milk is very promising. It has a wide field of applications and the results from studies make way for worldwide distribution and consummation in the future.

The camel milk seems to have several health benefits, however, more research is needed. Camel milk contains high levels of insulin or insulin-like protein which pass through the stomach without being destroyed. Camel's milk cures severe food allergies, skin diseases and hepatitis. Although camel milk has such values, it's less appreciated thus its consumption is restricted to a pastoral area. Based on the above outline the following recommendations are forwarded:

Further studies should be conducted on the chemical composition and medicinal value of camel milk.

Camel milk should be given to the people with lactose intolerance and diabetic patients as adjunctive with insulin therapy.

Camel should be incorporated into the dairy sector

Training on a camel in general and the chemical composition and medicinal value of camel milk, in particular, should be integrated with the livestock extension program

India stands tenth in the world of camel population should give priority to further investigate the medicinal value of the animal.

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