



## Milk Production and Composition in Camel and Its Beneficial Uses: A Review

Wajid Ali<sup>1,a,\*</sup>, Ethem Akyol<sup>1,b</sup>, Ayhan Ceyhan<sup>1,c</sup>, Sadia Dilawar<sup>2,d</sup>, Asia Firdous<sup>2,e</sup>,  
Muhammad Zia ul Qasim<sup>2,f</sup>, Muhammad Moiez Ahmad<sup>3,g</sup>

<sup>1</sup>Department of Animal Production and Technologies, Faculty of Agricultural Sciences and Technologies, Nigde Omer Halisdemir University, 51240 Niğde, Turkey

<sup>2</sup>Faculty of Veterinary Sciences, Bahauddin Zakariya University, Multan, Pakistan

<sup>3</sup>Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Sciences, Selçuk University, 42250 Konya, Turkey

\*Corresponding author

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<p><i>Review Article</i></p> <p>Received : 20/08/2019 Accepted : 18/11/2019</p> <p><b>Keywords:</b> Camel Milk Insulin Composition of milk Dairy farming</p>	<p>Globally, 16.9% of milk used by humans is taken from different species other than a cow. These species are sheep, horse, yak, ass, goat, camel and buffalo. The global camel (<i>Camelus dromedarius</i>) population is about 34 million head with sharing of almost 0.4% of world's non-cattle milk. Within the last 20 years, the curiosity of camel farming is amassed remarkably in different countries of the world including the Netherland, Italy and USA for camel milk production. The camel is considered as a goal animal of the 21st century because it produces high quality milk under extreme temperature, deficiency of pasture and dearth of water. The average milk production of camel fluctuates from 4 to 30 lt with lactation length ranges from 9 to 18 months having peak yield in second to the third month of lactation. Camel's milk is used globally because of its salty taste, high vitamin C concentration and its medicinal properties. Nevertheless, it gives many valuable benefits such as treatment of autism, control diabetes and allergy, prevention from liver cirrhosis and replacer of cow milk to avoid an infant's allergic reaction. The camel milk is a natural treatment of diabetes as it has a substantial result in a decrease of mean blood glucose and conserves necessary insulin doses. Camel milk constitutes of protein (2.5-4.5%), fat (2.9-5.5%), solid not fat (8.9 -14.3%), ash (0.35-0.95%), lactose (2.9-5.8%) and water (86.3-88.5%) as mean specific gravity is 1.03. Due to its distinct properties, the consumption of camel milk is increasing day by day and a number of industries are working to promote camel milk production and processing. Therefore, the tenacity of this review article is to explicate the beneficial uses and production of camel milk over the globe.</p>

<sup>a</sup> [wajidali.vet9@gmail.com](mailto:wajidali.vet9@gmail.com)  
<sup>c</sup> [ayhan73ceyhan@gmail.com](mailto:ayhan73ceyhan@gmail.com)  
<sup>e</sup> [asiafirdous35@gmail.com](mailto:asiafirdous35@gmail.com)  
<sup>g</sup> [mnoizahmad05@gmail.com](mailto:mnoizahmad05@gmail.com)

<sup>ib</sup> <https://orcid.org/0000-0001-5800-2031>  
<sup>ic</sup> <https://orcid.org/0000-0003-2862-7369>  
<sup>id</sup> <https://orcid.org/0000-0001-8901-9848>  
<sup>ig</sup> <https://orcid.org/0000-0001-5114-8126>

<sup>ib</sup> [ethemakyol51@gmail.com](mailto:ethemakyol51@gmail.com) <sup>id</sup> <https://orcid.org/0000-0002-1427-9036>  
<sup>id</sup> [dvmsadia@gmail.com](mailto:dvmsadia@gmail.com) <sup>id</sup> <https://orcid.org/0000-0001-6780-3893>  
<sup>f</sup> [bukharizia56@gmail.com](mailto:bukharizia56@gmail.com) <sup>id</sup> <https://orcid.org/0000-0002-2979-3302>



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### Introduction

Milk is a vital ingredient of balance food for human consumption as a good source of water, fat, protein, sugar (lactose), minerals, vitamins and enzymes. Approximately, 80% consuming milk obtained from cattle whereas the remaining 20% portion is engaged with species other than cattle (sheep, horse, yak, ass, goat, camel and buffalo). A camel is a bulky animal that lives in deserts with a population of nearly 34 million as 89% *Camelus dromedaries* and 11% are *Camelus bactrianus* (FAOSTAT, 2017; Kgaudi et al., 2018) to yield milk and meat for human consumption. According to Epstein (1971) three thousand years ago the camels were the first time reared as milking animals and pack animals domestically nevertheless after the end of the 1st world war with urbanization in armies transportation' they become a

primeval animal of populaces (Yagil et al., 1994). Globally, the camels can yield almost 5.4 million tons of milk per year as Somalia is on a top number to produce camel milk in the world (Kgaudi et al., 2018). In a scorched zone of the world, the population of sheep, goats and cattle decreased by desiccated period and dearth years to produce milk but only the camel persists to yield milk for people of deserts extent as being a trustworthy milk producer (Galeboe et al., 2018). In some drought-stricken range of Africa, Middle East, Asia and Indian subcontinent the camel is a goal animal to produce an immense volume of milk for rural income and nutrition refuge as in horn of Africa 10% milk is solitarily resulting from dromedary camels (Faye and Bonnet, 2012). Solanki and Hati (2018) stated that camel milk is rich in obligatory rudiments for a

healthy life and a blessing for the society of deserts and hot climate areas. Camel milk is very healthy for humans as Al-Shamsi et al. (2018) stated that it has a decent extent of B vitamin, minerals, unsaturated fatty acid and three to five times additional vitamin C (58.2 mg/kg) concentration as compared to bovine milk. There are rarer data about physiological vicissitudes in camel milk constituents (Konuspayeva et al., 2009) the main deviation in components of milk is accredited by season, feeding and physiological phases (Abdelgadir et al., 1998). We gathered data from diverse literature to recapitulate the whole composition, deviance of component, significant uses of camel milk and camel population in a different region. The milk production and its constituent peculiarity are directly interconnected to climate, feeding system, animal genetics and lactation period with lactation number and husbandry bravura. In an arid zone of the world, the camel is a superior animal as compared to other ruminants as of its biological specialty to use a smaller amount of water for virtuous value milk production (Yagil et al., 1984) and has very minuscule effect of extreme heat, dearth of water and scarcity of pasture on diurnal life. Yagil and Etzion (1984) listed that camels belonging to a Bedouin can yield 9.2 lt to 15 lt milk per day in 3rd to 4th month of lactation with 3-time milking. Camels are created to absorbed miniature water by mammary glands for milk production in drought regions (Yagil and Etzion, 1984) as an average of 3 to 10 lt per day with lactation span of 12 to 18 month (Faraz et al., 2019a). Camels of diverse sections have unlike milk production level as dromedary camels of Ethiopia, Maghrebi camels of Tunisia and Raigi camels of Pakistan and Afghanistan yield milk as 6.6, 6.72 and 6 to 10 liters, respectively (Raziq et al., 2011; Jemmali et al., 2016). Camels can yield milk averagely 9 to 14 lt daily (Khan and Iqbal, 2001) but it can be augmented up to more than 30 lt by well-feeding and appropriate management. The camels engaged with well feeding and decent circumstances produced 2722-3629 lt milk with lactation length of 16-18 months while in deserts constituencies its volume reduces to 1134-1588 lt with a reduction in lactation period as well (Khan and Iqbal, 2001). Khanna and Rai (1993) identified that Indian camels of drought regions can yield 1000 – 3500 lt milk with lactation era of 12 months while in Punjab, Pakistan camels of Undulating and pebbly parts having same lactation length yield milk up to 4260 lt (Iqbal et al., 2001; Khan and Iqbal, 2001). Aujla et al. (1998) listed that camels in Balochistan, Pakistan yield milk 1250 to 3650 lt in 9 to 18 months of lactation duration and Araba et al. (1998) also itemized the specialty of Moroccan camels to produce 935 lt milk with lactation length of 10 months in deserts capacities. Naturally daily milk production of camel may vary between 8 and 20 lt but in well-feeding and concentrated managing systems, it could increase up to 15 – 40 lt with a range of lactation length fluctuating from nine to eighteen months (Khan and Iqbal, 2001). The peak milk production duration in the camel lactation span is 2nd to 4th month considered with a high maintain feeding system and well-developed condition of farm.

### Camel population

Globally, the camel population is more than about thirty-four million (single-humped and double-humped), mostly present in drought areas of Africa, the Middle East, central Asia, the Indian subcontinent and some countries of Europe (FAOSTAT, 2017). In these extends the camels are raised for meat, milk and carriage tenacity to sustenance the regional economy and diet scarcity under drought-stricken conditions. Faraz et al. (2019b) reported that India and Pakistan possess almost seventy percent population of Asian camels. Africa is on a top number to contain almost 80% portion of the total world's camel population (Faye, 2015; Khan and Iqbal, 2001). The highest population of dromedary camel is present in Somalia, Sudan and Ethiopia (Kgaudi et al., 2018; Khan and Iqbal, 2001) for example, an area of Kenya named as Wajir adjoining to Somalia and Ethiopia possesses 120000 camels (Yagil et al., 1994; Khan and Iqbal, 2001; Kgaudi et al., 2018). Faraz et al. (2019c) indicated that various countries of the world have different number of camels. (Figure 1). The camel is a very eminent animal in the drought capacity of Pakistan with 1.1 million total population (Punjab 34%, Baluchistan 36%, Sindh 22% and Khyber-Pakhtunkhwa 8%) as 8th prime camel rearing country of the world. In past decades, the whole camel population was reared for transportation, meat, and milk purposes but nowadays some European countries (Netherland, Italy, Sweden), New Zealand, Australia and the USA also focusing on the processing of camel milk and its products. This trend is coercing these countries to endorse and enhance camel farming on a large scale.

### Milk Composition

The camel is a protagonist animal of drought-stricken capacities as it's milk has maximum concentrations of vitamin C, niacin, chloride ratio, unsaturated fatty acids, poorer saturated and short chain fatty acids with subordinate fragments of carotene than ruminants like sheep, goat, cow and buffalo (Claeys et al., 2014; Galeboe et al., 2018). The camel milk is exact unlike to other animals as its milk constitutes of protein (2.5-4.5%), fat (2.9-5.5%), SNF (8.9 -14.3%), ash (0.35-0.95%), lactose (2.9-5.8%), water (86.3-88.5%) and mean specific gravity is 1.03. Besides the use of camel as transportation and meat animal, its milk has 10 billion USD worth in the world market if strategic enhancement can be made while most of the milk is traded locally with no record (FAOSTAT, 2018). The cow milk is much creamy, fatty and less diluted as compared to camel milk because camel's milk possesses more water subjects during hot seasons (Farah, 2011). Khalifa and Zakaria (2019) described the complete physical, the biological and chemical composition of natural fresh milk of camel with its all constituent's percentage. General composition of raw camel milk has been indicated in Figure 2 (Khalifa and Zakaria, 2019).

The camel milk is much salty in taste and high chloride proportion due to the noticeable extent of iron, copper, phosphorous, feeding of a camel by dry plants and less usage of water as compared to other ruminants (Khaskheli et al., 2005). The camel milk has low cholesterol and nearly 10 times additional iron than cow milk (Sharma and Singh, 2014; Mohan et al., 2018).

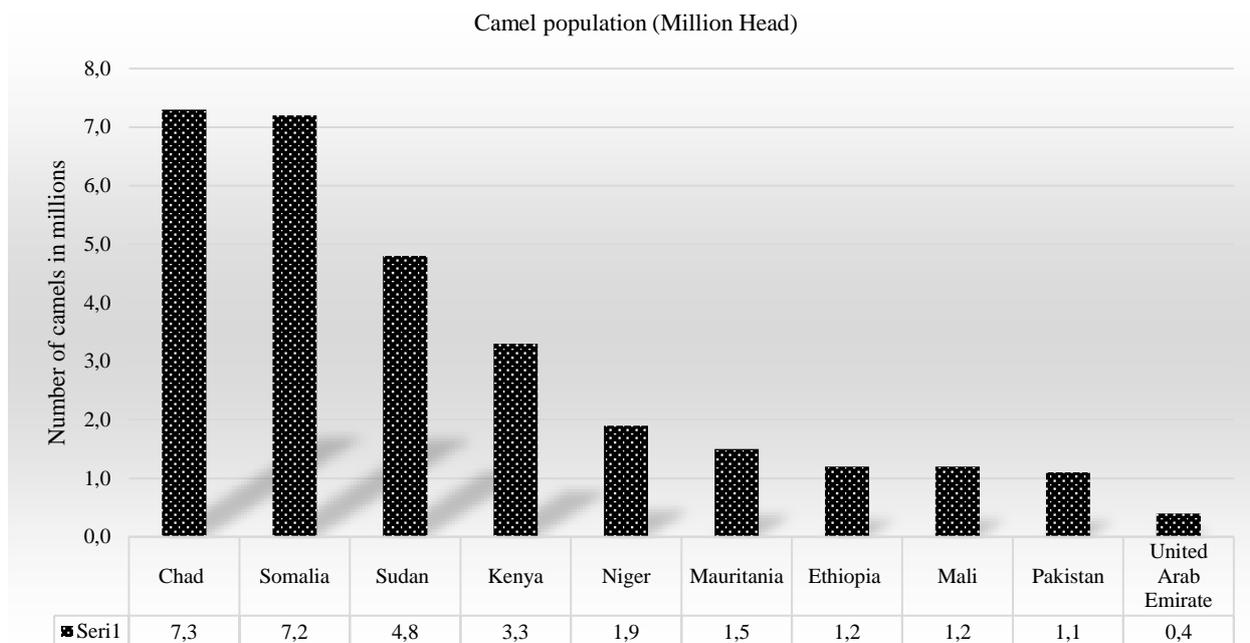


Figure 1 Camel population reported in various countries of the world (Faraz et al., 2019b)

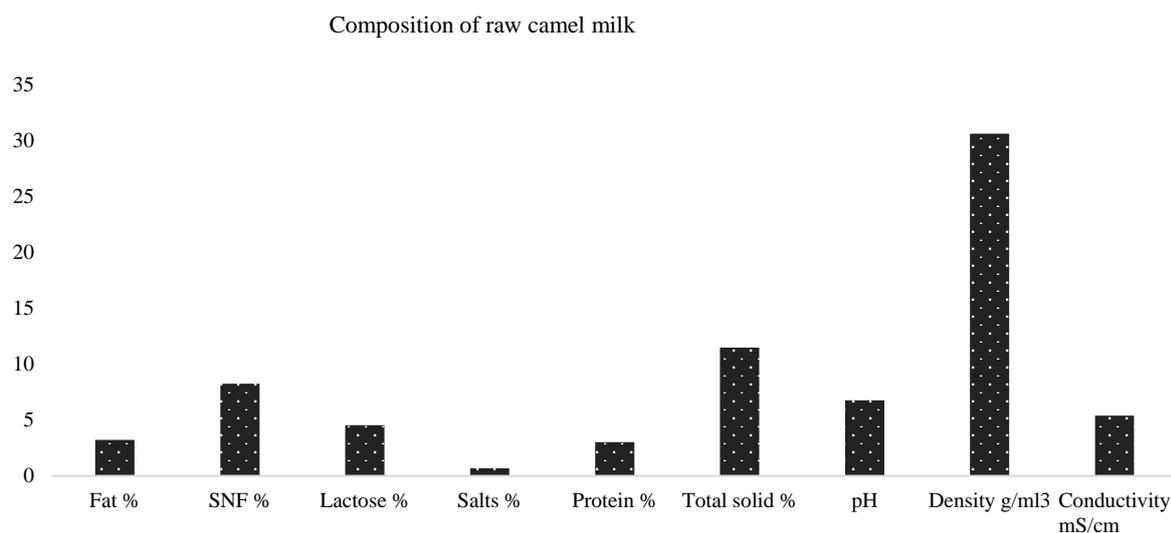


Figure 2 Composition of Camel plain milk

Farah (2011) noticed that camel milk has no  $\beta$ -Lactoglobulin, as it is part of bovine milk, but camel can manage the good level of vitamin C in milk with less green nutrition (minimum fruits and vegetables) of drought-stricken regions. The composition of camel milk varies from region to region with environs and system of production as some researchers gathered data about the milk of camel present in different constituencies of the globe. Sohail (1983) analyzed that camel milk has more than 80% moisture, 3.67% protein, 0.66% ash with a range of fat percentage between 5.76 to 6.59 in first to the third month of lactation. Khan and Iqbal (2001) described the milk composition of Riyadh area's camels that have fat 2 to 6%, lactose 3 to 5.5% and moisture level 85 to 90% with a specific gravity of 1.028 to 1.038. Abu-Lehia (1987) indicated that Najdi camels have superior quality of milk with 4.7% lactose, 2.7% protein, 88% moisture, 0.80% ash

and 3.13% fat. Karim and Gooklani (1987); Khan and Iqbal (2001) listed that the camels of Turkman Sahara have milk with moisture, fat, protein, lactose, ash, and specific gravity as 87.62%, 4.19%, 2.9%, 4.52%, 0.77% and 1.031%, respectively. The dromedary camel milk constituents of 86.4% moisture, 3.5% protein, 4.9% lactose and 0.7% ash (Meredove, 1989). Elamin and Wilcox (1992) and Khan and Iqbal (2001) quantified that the milk of Majaheem breed of camel has divergent chattels with 88.33% moisture, 3.15% fat, 2.81% protein, 4.16 % lactose, and 0.83% ash.

The Indian subcontinent has ample numeral of camels in the drought-stricken zone and their milk constituents of 2.9 to 5.5% fat, 2.5 to 4.5% protein, 2.9 to 5.8% lactose and 1.03% specific gravity (Khan and Iqbal, 2011). El-Naggar (1998) reported that camel milk is extremely comparable with cow milk as it has extraordinary vitamins, sugary in

taste, extra viscosity and fat contents range between 2.9% to 5.5%. The camel milk constituent's ratio changes with the proceeding of lactation as it is advanced the ratio of ash, water, and fat contents improved whereas the ratio of protein, lactose, and total solids comparatively declined (Zia-ur-Rehman et al. 1998).

### Consumer Acceptability for Camel Milk and Its Products

In earlier epochs, the cognizance of consumers about camel's milk and its characteristics as advantageous for health was very limited (Mohan et al., 2018) but nowadays the role of some advanced countries (Italy, Sweden, Netherlands, and USA) is much cherished to endorse camel production and its milk consumption. These countries have been developed new technologies for the processing of camel's milk and milk products furthermore they are equally contributing to promoting awareness about the consumption of camel milk and their products. Kadim and Mahgoub (2012) and Mohan et al. (2018) indicated some ways of promoting camel's milk like advertising through newspapers, TV shows, radio programs and the internet to generate awareness in user community as it is a rudimentary prerequisite to escalation the consumption of camel milk and its product in the world. Through all these conducts of exertions, the camel milk has been conquered sound spot on the scale of milk consumption nevertheless their products need further shards of struggles for popularization. The camel product as yogurt is not frankly acceptable as equaled to yogurt of other species milk like sheep, goat, cow, and buffalo (Ibrahim and El Zubeir, 2016) because camel milk yogurt has noteworthy titratable acidity as compared to cow milk yogurt although further constraints are nearly parallel (Galeboe et al., 2018). Globally, the cow milk yogurt is excellent in taste, enriched in flavor and highly acceptable as compared to camel milk yogurt. Galeboe et al. (2018) signposted that camel milk's yogurt can be prepared by incubation of camel milk at 42°C for 18 hours with the addition of some supplementary ingredients furthermore its acceptability can be improved with the use of fruits and some flavors. The fermented camel milk possesses a very eminent position across the world as it is a quite worthy therapeutic product (Solanki and Hati, 2018) to cure the obesity and it provides more than 750 kcal on 1 kg consumption. Some countries of the world like Pakistan, Turkmenistan, India, Mongolia and Kazakhstan have a trend to produce fermented camel milk products such as gariss, chal, dhannan, arkhi, shmeen and airag. The camel milk soft white cheese is an emerging product in some European countries as a novel ingredient of breakfast. So many authors described that the production of camel milk soft cheese is very challenging as compared to cow milk because camel milk has slight size fat globules and meager coagulation property but camel milk processing for cheese production can be enhanced by the accumulation of camel chymosin, aroma flavor, and a starter culture. Khalifa and Zakaria (2019) stated that the addition of other species' plain milk in camel milk is very active to upsurge acceptability of camel milk and its products as additional milk reduce the saltiness of taste and reimburse other deficiencies (aroma, flavor and low total solids).

### Beneficial and Medical Effect of Camel Milk

Globally with fetching stake of the camel in basic diet, its milk and by-products also have some distinct characteristics to uphold healthy activities in the world population. Camel is going to be a superior animal of the 21st century as its milk has splendid potentials of therapeutic factors, immune restorative, rich in taste and nutrients as paralleled to other milk-producing species. The bioactive peptides of camel milk protein are actually foremost factors to persuade virtuous health of humankind as they play a positive role in preventing many microbial infections and boost up the natural immune system. Mudgil et al. (2018) indicated that bioactive peptides yield during assimilation of camel milk's protein which performance as hypoglycemic, hypo allergic, immune tonics, antimicrobial and anti-carcinogenic. El-Agamy (2000) and Al-Shamsi et al. (2018) described that camel milk is non-allergic to people because it has a pure form of B-casein and lactoalbumin of whey protein as akin to human milk. The milk of bovine has low shelf-life as compared to camel milk even in the form of pasteurized milk and fresh raw milk at room temperature (Wernery, 2008; Khalifa and Zakaria, 2019). Muhialdin and Algboory (2018) and Khalifa and Zakaria (2019) indicated that camel milk holds a specific character as a dynamic antimicrobial system that directly depended on lengthy shelf-life of camel milk and furthermore this dynamic antimicrobial system consists of H<sub>2</sub>O<sub>2</sub>, lysozymes, Immunoglobulins, antioxidants and less-weight molecular antibodies. So many writers narrated about beneficial therapeutic practices of camel milk in human health like it is used as a remedy of liver dysfunction, diabetes, long bone pain, tuberculosis, asthma, dropsy, leishmaniosis or kala-azar, piles, spleen disorders, food allergies, arthritis and anemia (Abdelgadir et al., 1998; Solanki et al., 2017; Galeboe et al., 2018; Faraz et al., 2019a). Camel milk is greatly supplemented with indispensable nutritious components like bovine milk, but camel milk is most preferable in allergic reaction sensitive infants as compared to bovine milk because camel milk possesses pretty similar B-casein and lactoalbumin whey protein to human milk (El-Agamy et al., 2009; Solanki et al., 2017). Issa and Tahergorabi (2019) stated that the camel milk being a whole diet has an additional concentration of mesophiles (*Lactobacilli* and *Leuconostoc*), some micro-organisms (*E-coli* and *salmonella*) and their accretion are might be due to extreme scorching environments of drought-stricken regions. These organisms have both positive and negative effects on human health nonetheless their most imperative encouraging possessions are to intensification the intestinal digestibility. With these all properties, the camel milk also has some other benefits like it act as glycemia regulator (Agarwal et al., 2003), remedy for stomach and intestinal diseases (Solanki et al., 2017) and anti-hypertensive (Quan et al., 2008). Some results enlisted that some countries of the globe use fermented camel milk as a therapeutic remedy for inflammation related to obesity (Badkook, 2013; Solanki and Hati, 2018). The lactic acid is a unique product of fermentation in camel milk as it is supportive to lessen pH for digestibility improvement, headway in mineral absorption, determined milk preservation and maintain a check and balance for injuries bacteria (McBean, 1999; Solanki and Hati, 2018). The bovine milk has a lesser

quantity of bioactive peptides (ACE-inhibitory peptides and anti-oxidative) produced by lactic acid bacteria as compared to camel milk (Moslehihad et al., 2013). Ali et al. (2003) specified that fermented camel milk (Gariss) has *Bifidobacterium lactis* which is very favorable to reduce plasma and liver cholesterol levels. Fermented camel milk has high ACE-inhibitory activity as compared to plain camel milk and another species milk. Solanki et al. (2017) summarized some distinguish properties of camel milk as it has hypo-cholesterolaemic upshot, antimicrobial property, antioxidant importance, antihypertensive significance, the remedy of diarrhea, anticancer action, the movement against Carbon tetrachloride (CCl<sub>4</sub>) and resistance against lead (Pb) infection. A list of authors described about the therapeutic use of camel milk against diabetes and tuberculosis as it has nutritive appendage for tuberculosis patients and grounds noteworthy insulin decline in insulin-reliant patients (type-1 diabetes) by glycaemic regulator (Agrawal et al., 2005; Al-Numair et al., 2011; Abdalla, 2014; Galeboe et al., 2018; Mohan et al., 2018). This anti-diabetic action of camel milk is just because of immuno-modulatory consequence on beta cells (Breitling, 2002). Agarwal et al. (2005) estimated a study on therapeutic uses of camel milk against diabetes and he originate substantial results in lessening of HbA<sub>1c</sub> ( $7.8 \pm 1.38 - 6 \pm 0.96$ ;  $p < 0.001$ ), escalation of MBI ( $17 \pm 4.4 - 19.7 \pm 2.97$ ;  $p < 0.001$ ) and required insulin dose ( $32 \pm 12 - 17.88 \pm 12.40$ ;  $p < 0.005$ ) as related to the values at the beginning of the study. The camel milk has a worthy name in the field of cosmetics as it possesses the high number of alpha-hydroxyl acid and liposomes, which remove wrinkles and dryness of skin with the anti-aging outcome (Choi et al., 2014; Mohan et al., 2018). Due to all these beneficial uses of camel milk, it also needs much focus on its product formation and camel production in some advanced countries of the globe.

## Conclusion

The camel is an objective animal of the 21st century as it has a distinct property to rear at low pasture and in a drought-stricken area. Its milk has very much importance in the field of therapeutic and humankind nutrition. Camel is a vital genetic resource which demands to be managed properly and rear on a big scale for meat and milk purpose. Public awareness about benefits of camel creates the concept of dairy and meat farming of camel at large scale. By transmuted the camel farming from open desert extent to intensive and semi-intensive management, the milk production level has been improved with the good health status of farm animals. Camel milk has a superior quality of milk as compared to some other ruminant species and nowadays some advanced European countries also have the interest to rear camel for milk and meat purpose. These countries also sharing their high contribution to product formation and create awareness about consumer acceptability of milk and its products.

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