



## Chemical composition and medicinal values of camel milk

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**ABSTRACT:** Out of 25.89 million camel populations on the world 89% are one-humped camels and the remaining 11% are the two-humped. More than 60% of the dromedary camel population is concentrated in the arid areas of North East African countries. Ethiopia ranks third by the number of camel population and second by camel milk production from the globe. Camel milk, white gold of the desert is more similar to human milk. Camel milk differs from other ruminant milk as its chemical composition is low cholesterol, low sugar, high minerals, high vitamin C and higher protective proteins like lactoferrin, lactoperoxidase, immunoglobulins and lysozyme, lacks of  $\beta$ -lactoglobulin milk is unique in terms of antioxidative factors, antibacterial, antiviral, antifungal, anti-hepatitis, anti arthritis, treatment for paratuberculosis, prevents aging, remedy for autoimmune diseases and has cosmetic values. Insulin in camel milk is safe and efficacious in improving long-term glycemic control in diabetic patient. Camel milk reduces autism symptoms in children. Lactoferrin has ability to inhibit the proliferation of cancer cell. Camel milk is rich in magnesium and zinc thus endowed antiulcer properties. Camel milk has high  $\alpha$ -hydroxyl acids which are known to plump and smoothies the skin and also used to treat skin disorders such as dermatitis, Acne, Psoriasis and Eczema. Although camel milk has such values, it's less appreciated thus its consumption is restricted to pastoral area so further studies should be conducted on the chemical composition and medicinal value of camel milk.

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## Introduction

As stimulation of Food and Agriculture Organization (2013) the total population of camel in the world is believed to be 25.89 million, of which 89% are one-humped dromedary camels (*Camelus dromedarius*) and the remaining 11% are the two-humped (*Camelus bactrianus*) that generally found in the cold deserts of Asia while more than 60% of the dromedary camel population is concentrated in the arid areas of North East African countries like Somalia, Sudan, Ethiopia and Kenya. Ethiopia ranks third in the world by the number of camel herd after Somalia and Sudan (Simeneh *et al.*, 2015).

For desert people in Asia and Africa, camel is vital to daily life as a source of food and a means of transportation, and just as importantly, its milk has been used as medicines for diverse ailments since ancient times (Gader *et al.*, 2016). Camel can produce more milk for a longer period of time in arid zones and harshy environment than any other domestic livestock species (Ahmed *et al.*, 2015). The daily yield of camel milk ranges from 3 to 10 kg in a lactation period of 12 to 18 months (Gizachew *et al.*, 2014). Ethiopia which possesses about 2.4 million heads camels ranks second in camel milk production in the world next to Somalia. The annual camel milk production in Ethiopia is estimated as 75,000 tones (Asres and Yusuf, 2014).

Camel milk so called white gold of the desert is more similar to human milk than any other milk and differs from other ruminant milk because it contains low cholesterol, low sugar, high minerals (sodium, potassium, iron, copper, zinc and magnesium), high vitamin C, protective proteins like as lactoferrin, lactoperoxidase, immunoglobulins, lysozyme (Yadav *et al.*, 2015). Camel milk has been acknowledged for a long time to provide a potential treatment for a series of diseases such as dropsy, jaundice, anti-hypertensive, asthma, and leishmaniasis or kala-azar. (Asres *et al.*, 2014 and Yardav *et al.*, 2015).

It has been reported that camel milk contains the low quantity of  $\beta$ -casein and the lack of  $\beta$ -lactoglobulin which cause allergic reaction in lactose intolerant person (Konuspayeva *et al.*, 2009). Nevertheless, it contains insulin-like and protective protein used for the treatment of many ailments like diabetes, autism, and diarrhea and possesses anti-tumors properties (Gul *et al.*, 2015). Moreover, camel milk is endowed with very strong immune system (Grader *et al.*, 2016) and remedy for peptic ulcers anti-malignant (Korashy *et al.*, 2012) anti-platelet and anti-thrombotic properties (Abdelgadir *et al.*, 2013). More recently, studies confirmed that camel's milk is unique in terms of antioxidative factors, antibacterial, antiviral, antifungal, anti-hepatitis, treatment for paratuberculosis, hypoglycaemic activity, anticancer,

preventives of aging, remedy for autoimmune diseases, cosmetic and detergents (Al-Juboori *et al.*, 2013, Sharma *et al.*, 2014, Keskes, 2015).

A numerous reviews have been carried out in different milking animals despite these all benefits chemical composition and medicinal values of camel milk was not reviewed which created information gap in the area.

Therefore in the line with the above, the objectives of this paper are:-

- To review available information on chemical composition and medicinal values of camel milk.
- To recommend further investigation concerning chemical composition and medicinal values of camel milk based on the information from this review.

## 2. LITERATURE REVIEW

### 2.1 Chemical Composition of Camel Milk

Camel's milk is generally an opaque white color and has a faint sweetish odor and sharp taste; some times it can be salty (Abbas, 2013). Its opaque white color because of the fats are finely homogenized throughout the milk where as, the changes in taste are caused by the type of fodder and availability of drinking water (Yadav *et al.*, 2015). Its density ranges from 1.026-1.035 and the pH from 6.2-6.5, both are lower than those of the cow's milk and maximum buffering capacity of skim milk is at pH 4.95. (Gul *et al.*, 2015)

According to most authors the composition of camel milk varies due to difference of geographical origin and year of publication of the published datas but other factors such as the physiological stage, feeding conditions, seasonal or physiological variations, genetic or health status of camel have also a paramount importance (Konuspayeva *et al.*, 2009). In general the average amount of components of camel milk is protein 3.4%; fat 3.5%; lactose 4.4%; ash 0.79%, while water covers 87% (Kanhall and Hamad, 2010).

Table 1: chemical composition of milk of different species

Proximate	Water %	Protein %	Fat %	Ash %	Lactose %
Camel	86-88	3.0-3.9	2.9-5.4	0.6-0.9	3.3
Cow	85-87	3.2-3.8	3.7-4.4	0.7-0.8	4.8-4.9
Buffalo	82-84	3.3-3.6	7.0-11.5	0.8-0.9	4.5-5.0
Sheep	79-82	5.6-6.7	6.9-8.6	0.9-0.1	4.3-4.8
Goat	87-88	2.9-3.7	4.0-4.5	0.8-0.9	3.6-4.2
Human	88-89	1.1-1.3	3.3-4.7	0.2-0.3	6.8-7.0

Source: (Kanhall and Hamad, 2010)

### 2.2.1 Proteins

Milk proteins are a heterogeneous group of compounds that differ in composition and properties (Gizachew *et al.*, 2014). Dromedary camel milk contains 3 to 3.90 percent of protein (table 1). It contains two main groups (Caseins and Whey proteins and relatively higher amount immune proteins (*Peptidoglycan Recognition Protein, Lactoferrin Lysozyme and Lactoperoxidase*) and insulin (Abbas *et al.*, 2013, Gul *et al.*, 2015).

Casein is the most important and higher in proportion, while the proportion of whey proteins is relatively low (Guo *et al.*, 2007). Shamsia (2009) also confirmed that camel milk contains higher protein (especially casein) and lower in whey milk than human milk.

Casein is a major part of protein in camel milk. Dromedary camel milk has 1.63 to 2.76 percent of casein protein that constitutes 52 to 87 percent of total milk protein (Khaskheli *et al.*, 2005). There are 4 main casein fractions casein:  $\alpha 1$ -,  $\alpha 2$ -,  $\beta$ -, and  $\kappa$ . their proportion is diverse and polymorphism of these proteins was demonstrated in most of the animal species (Barłowska, 2007). The human casein does not contain the  $\alpha 1$ -fraction, which is the predominant factor causing milk protein allergy. However; it is rich in the  $\beta$ -fraction. But casein in cow and buffalo milk is very abundant (38.4% and 30.2% of total casein, respectively) in the  $\alpha 1$ -fraction (Zicarelli, 2004). Milk protein allergy (MPA) is an allergic reaction to proteins commonly found in cow milk. In whole casein portion,  $\beta$ -CN is 65 percent and  $\alpha 1$ -CN is 21 percent. Camel milk has more digestibility and less allergic reactions in infants as  $\alpha$ -CN slowly hydrolyze than  $\beta$ -CN (El-Agamy *et al.*, 2009).

Whey protein is the second biggest fraction of protein of camel milk which covers 20 to 25 percent of camel milk protein. The milk of dromedary camel has a whey protein in range of 0.63 and 0.80 percent (Khaskheli *et al.*, 2005). B-lactoglobulin is found in trace, while  $\alpha$ -lactalbumin comprises the major camel milk portion. In the milk of bovines,  $\alpha$ -lactalbumin constitute only 25 percent, while  $\beta$ -lactoglobulin made 50 percent of the total whey protein that make it the major whey protein of bovine milk (Laleye *et al.*, 2008). Whey protein of camel milk consists of some other main components such as peptidoglycan, recognition protein, immunoglobulins, lactoferrin and serum albumin (Kappeler *et al.*, 2005)

*Peptidoglycan Recognition Protein (PGRP)*; its highest concentration was first discovered in camel milk and it has apparent effect on breast cancer by controlling metastasis and stimulates the host's immune response (Gizachew *et al.*, 2014). It stimulates the host's immune response and has potent antimicrobial

activity. It even appears to have an effect on breast cancer in studies (Gul *et al.*, 2015).

*Lactoferrin* is a glycoprotein which has an ability to bind two metal cations (preferably Fe<sup>3+</sup>) to the binding sites that are structurally closely related. The majority of lactoferrin is needed for transportation or storage of iron and possesses antioxidant properties. Lactoferrin contents of camel milk (0.22 mg.mL<sup>-1</sup>) were significantly higher than goat, sheep, buffalo and cow milk (Abas *et al.*, 2013). The research of El-Hatmi (2007) revealed that highest level of lactoferrin (2.3 g.L<sup>-1</sup>) was noticed after 2 days of parturition. *Lactoferrin* is among the protective proteins in camel milk with higher concentration and thus prevents microbial overgrowth and invading pathogens (Hosam HM *et al.*, 2013)

*Lactoperoxidase* is resistant to acidic and proteolytic digestion contributes to the non-immune host defense system, exerting bactericidal activity, growth promotion activity, anti-tumor activity and it has a close relation (71%) to human thyroid peroxidase, which is involved in iodination and coupling in the formation of the thyroid hormones (Mullaicharam *et al.*, 2014). *Lactoperoxidase* has bactericidal activity mainly on gram-negative bacteria like *Escherichia coli*, *Salmonella*, and *Pseudomonas*, (Abbas *et al.*, 2013, Gul *et al.*, 2015).

*Lysozyme* is a protective protein highest in camel milk than milk of cow and human. It has antibacterial activity against gram-positive bacteria like N-acetyl-beta-D-glucosaminidase (NAGase) found in similar quantities in human milk (Gul *et al.*, 2015).

The immunoglobulins in camel milk contribute to camel milk's incredible infection fighting. Camel Igs are able to penetrate tissues and cells that human Igs were unable to. Because of their reduced size, one-tenth the size of human antibodies, thus can readily pass to the milk of the lactating camel, can pass the BBB, and readily absorbed from the gut into the general circulation (Gader, 2016). Additionally, the level of immunoglobulin G in camel milk is 1.64 mg.mL<sup>-1</sup> which is highest as compared to 0.70, 0.67, 0.55, 0.63 and 0.86 mg.mL<sup>-1</sup> for goat, cow, sheep, buffalo and human milk respectively (El-Agamy and Nawar, 2009).

### 2.2.2. Fats

The level of dromedary camel milk fat believed to be 2.9 to 5.4 percent (table 1) and can be reduced from 4.3 to 1.1 percent in the milk of thirsty camels (Haddadin *et al.*, 2008, Konuspayeva *et al.*, 2009). But, a recent study reported as camel milk contains only 2% fat which are mainly composed of polyunsaturated fatty acids and omega fats (Gul *et al.*, 2015).

Mansson (2008) claims that fat globules with the biggest average diameter are found in buffalo milk (8.7  $\mu\text{m}$ ), the smallest in camel (2.99  $\mu\text{m}$ ) and goat milk (3.19  $\mu\text{m}$ ). A high state of dispersion of milk fat has a positive influence on the access that lipolytic enzymes have to small fat globules (SFGs). Therefore, milk from goats or camels is more digestible for humans (D'Urso *et al.*, 2008). The lipid fraction in camel milk is characterized by a high proportion of long chain fatty acids, which accounts for 96.4 percent compared to 85.3 percent in bovine milk (Abbas, *et al.*, 2013).

It is reported that the cholesterol level of fat of camel milk (34.5 mg.100 g-1) is higher as compared to cholesterol level (25.63 mg.100 g-1) of bovine milk fat (Konuspaveva *et al.*, 2008). Milk fat of dromedary camels carries a lower level of carotene and lesser concentrations of short chain fatty acids as compared to milk of bovine (Stahl *et al.*, 2006)

Cholesterol is present in the milk fat globule membrane (MFGM) and it accounts for 95% of the sterols of milk fat. SFGs are characterized by a larger surface area of MFGM per fat unit. Therefore, a bigger share of SFGs is connected with a relatively higher concentration of cholesterol in milk. Camel milk, which has the highest state of dispersion of milk fat, contains the most (of the studied animals species) cholesterol (31.3 to 37.1 mg/100 g milk). Camel milk is also unique concerning its fatty acid profile. It contains 6 to 8 times less of the short chain fatty acids compared to milk from cows, goats, sheep, and buffalo (Gizachew *et al.*, 2014). Various fatty acids such as butyric, caproic, caprylic, capric, lauric, myristic, myristoleic, palmitic, palmitoleic, stearic, oleic, linoleic and arachidic acids are present in camel milk (Panwar *et al.* 2015).

### 2.2.3 Carbohydrate

The major carbohydrate fraction in camel milk is lactose sugar which range between 3.3 to 5.80 percent (table 1). The nature of vegetation eaten by the camels in desert areas could be a significant factor for extensive variation in lactose contents. Camels generally like to take halophilic plants like Salosa, Acacia and Artiplex to fulfill their physiological necessities of salts. However, in some dromedary varieties of the world lactose contents found to be changed slightly over a period of time (Abas *et al.*, 2013). Lactose readily digested by human lactase with no signs of "lactose intolerance".

### 2.2.4 Minerals

The total amount mineral dromedary camel milk is between 0.60 to 1.0 percent (Konuspaveva *et al.*, 2009). There are significant fluctuations in minerals level due to the differences in feeding, breed, water intake (Haddadin *et al.*, 2008) Camel milk is rich source of various minerals like Na, K, Ca, P Mg Fe, Zn, Cu are present in camel milk (Onjoro *et al.*, 2003). The

mean values for zinc, manganese, magnesium, iron, sodium, potassium and calcium in mineral contents of dromedary camel milk (100g-1) are 0.53, 0.05, 10.5, 0.29, 59, 156 and 114 mg respectively (Abas *et al.*, 2013).

### 2.2.5 Vitamins and electrolytes

Numerous vitamins such as D, E, A, C and vitamins of B group are found in dromedary camel milk (Haddadin *et al.*, 2008; Stahl *et al.*, 2006). Camel milk rich in vitamin C is. It was revealed that camel milk contained three to five times more vitamin C as compare to bovine milk. The mean value of vitamin C concentration present in camel milk is 34.16 mg.L-1. It was reported that camel milk contains higher concentration of niacin (B3) as compared to bovine milk. According to USDA (2009), milk (250 mL) of dromedary camel nourish a normal adult by means of 10.5 percent of ascorbic acid (C), 5.25 percent of vitamin A, 8.25 percent of riboflavin (B2), 15.5 percent of cobalamin and pyridoxine and thiamin of the Recommended Daily Intake (RDI). In comparison, bovine milk (250mL) nourish a normal adult by means of 9 percent of vitamin A, 3.5 percent of ascorbic acid (C), 11.5 percent of pyridoxine (B6), 36 percent of riboflavin (B2) and 43.5

The low pH due to higher concentration of vitamin C, stabilizes the milk and therefore it can be kept for relatively longer periods without cream layer formation. The availability of relatively higher amount of vitamin C in camel milk is of significant relevance from the nutritional point of view as it exerts powerful anti-oxidant activity (Mal *et al.*, 2007).

vitamin C and important electrolytes like calcium and iron are need for duodenal acid for calcium absorption in cases of osteoporosis is satisfied by camel milk rapidly passing the stomach, with the acid that is constantly being secreted and the vitamin C (ascorbic acid) increasing the amount of calcium absorbed and deposited in the bones (Levy A *et al.*, 2013).

### 2.2. Medicinal Values of Camel Milk

Health benefit potentials of camel milk are obtained through a number of bioactive components in camel milk. These components were reported to exist naturally in camel milk (Agrawal *et al.*, 2007a; El-Agamy, 2007); or derived from camel milk proteins using probiotic strains (Elayan *et al.*, 2008; Quan *et al.*, 2008). Study conducted between July, 2005 and January, 2006 in Babilie and Kebribeyah woredas, Jijiga Zone of the Somali Regional State reported that respondents (97.5 and 85% for Babilie and Kebribeyah, respectively) recognized the medicinal value of camel milk. This research indicated the medicinal value of camel milk for a treatment of gastritis, asthmatics, stomach discomfort, HIV, hamot (*kar*), tuberculosis, fever, urinary problems and hepatitis (Asresie *et*

*al.*,2014).Interviewed pastoralistsclaimed that camel milk is used to treat a number of illnesses in human beings such as Jaundice, Malaria, Constipation, to clear the stomach, post-partum care of women, to detoxify snake venom and flatulence, jaundice, malaria and constipation for reason that camels browse on various plant species and active agents with therapeutic properties from these plant species are secreted into the Milk (Eyassu, 2007).

Sharma (2014) also agreed with the above scholars and Alemayehu (2001) who stated that in all camel rearing countries, the breeders are convinced that camel milk has special medicinal properties, especially for dropsy, jaundice and conditions affecting the lungs and spleen. Camel milk have 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 *et al.*, 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

Camel milk is enriched with various protective proteins like lysozyme, lactoferrin, lactoperoxidase, NAGase, PGRP, IgG and IgA which exert antibacterial, antiviral, antifungal and antiparasitic activity, immunological properties, growth promotion activity and anti-tumor activity (Mona *et al.*,2010)According to Conesa *et al.*, 2008; the known protective proteins, and their immunological action, in camel milk are:Lysozymes which participates in primary immune system based on targeting of structures common to invading pathogens, Immunoglobulins; give the immune protection to the body against infections, Lactoferrin; Iron-saturated lactoferrin prevents microbial growth in gut, participates in primary immune system, which is based on targeting of structures common to invading pathogens.

Camel milk contains peptides and proteins that exhibit its biological activities that have beneficial effect on many bioprocesses as digestion, absorption, growth and immunity (Omar *et al.*, 2008). Further more; camel's milk can be stored at room temperature longer period than milk from other animals (YASSIN *et al.*, 2015). Currently, the value of camel milk has increased worldwide due to its high therapeutic value for human health. Studies confirmed that the composition of camel's milk is unique in terms of antioxidative factors, antibacterial, antiviral, antifungal and anti-tumor activity, hypoglycaemic, anticancer, to preventive aging, for autoimmune diseases effect (Al-Juboori *et al.*,2013, Sharma *et al.*,2014)

### 2.2.1 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 *et al.*, 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 (2002) 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 Immuno modulatory function on cells (Agrawal *et al.*, 2005).

(b) Camel milk contains large concentration of insulin 150 U/ml (Gizachew *et al.*, 2014). (c) Although human, cow and goat milk contain insulin, it is degraded and forms coagulum in the acids environment of the stomach (A.R. Mullaicharam, 2014). On contrary, the insulin of camel is contained within micelles and thus protected from digestion and proteolysis in the upper gastrointestinal tract; it is encapsulated in nanoparticles that facilitate its absorption and easy passing to the blood stream; it is again plausible that the antioxidant action of camel milk prevents metabolic syndrome, including hyperglycaemia, hyperlipidaemia, and insulin resistance (Gader *et al.*, 2016).

The study conducted by India's Bikaner Diabetes Care Research Center (2005), reported the beneficial effects of camel milk consumption on type-1 diabetes as it significantly reduced insulin doses required to maintain long-term glycemic, or blood sugar level under control. This study also demonstrated the insulin concentration in camel milk is higher as compared to cow milk. In the same way, a recent study also proved that camel milk is rich source of insulin (Grover *et al.*, 2014). Furthermore, it is proved that camel milk can be used as an adjunct to insulin therapy as it appears to be safe and efficacious in improving long-term glycemic control and also helps in the reduction of insulin requirement in type 1 diabetic patient (Agrawal *et al.*, 2011).

Biochemical studies have revealed the components of camel milk e.g. insulin like protein; lactoferrin and immunoglobulins are responsible for camel milk as anti-diabetic. In parallel, epidemiological surveys stating low prevalence of diabetes in communities

consuming camel milk clearly indicate towards its hopeful role in maintaining hyperglycemia (Agrawal *et al.*, 2013)

The long-term study was undertaken to assess the efficacy, safety and acceptability of camel milk as an adjunct to insulin therapy in type 1 diabetics. Type 1 diabetic patients were grouped into two groups. Group I received usual care: diet, exercise and insulin and Group II received camel milk in addition to the usual care. The results showed that, in camel milk receiving group, there was decrease in mean blood glucose, hemoglobins and insulin doses. From group receiving camel milk, insulin requirement reduced to zero. There was non-significant change in plasma insulin and anti-insulin antibodies in both groups. It may be stated that camel milk is safe and efficacious in improving long-term glycemic control in type 1 diabetic patients (Amjad *et al.*, 2013).

### 2.2.2 Anti-bacterial and antiviral properties

Camel milk contains antimicrobial enzymes (lactoferrin and Lactoperoxidase) protective protein like caseins, stronger immune system and smaller immunoglobulins than other ruminants.

Camel milk has higher concentrations of lactoferrin and lysozyme than bovine milk (Konuspayeva *et al.*, 2005). Literature has shown that lactoferrin can act as either a bacteriostatic and/or bactericidal agent (Al-Majali *et al.*, 2007). This difference in the activity may, in part, explain the wide range of MIC values for lactoferrin activity. As several studies revealed lactoferrin has inhibitory activity on both Gram-positive and Gram-negative bacteria *in vitro* (Lee *et al.*, 2004, Farnaud *et al.*, 2004, Nozaki *et al.*, 2004)

Benkerroum (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 antimicrobial effect of raw camel milk and heated milk suggested that the raw milk is more effective. This justified the clue that 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.

Al-Majali (2007) reported study of protective proteins of against gram negative and gram positive bacteria and rotavirus. Study conducted by extracting Lysozyme, lactoferrin, lactoperoxidase immunoglobulin G and secretory immunoglobulin A were extracted from camel milk and the activity of these protective proteins was assayed against

*Lactococcus lactis* subsp. *cremoris*, *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhimurium* and rotavirus. The result concluded that camel milk LP was bacteriostatic against the Gram-positive strains and bactericidal against Gram-negative cultures and immunoglobulins have little effect against bacteria but high titres of antibodies against rotavirus is found in camel milk

Camel milk has been noted to have medicinal properties treating tuberculosis. 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 (Mall *et al.*, 2006).

Recent study done to test antimicrobial activity of camel caseins proved that it has bactericidal activity. Caseins were hydrolyzed successively by pepsin and pancreatin mainly into fragments with a molecular weight below 1 kDa. The antibacterial activity of camel milk of hydrolyzed caseins was increased when compared with that of native casein after successive hydrolysis by proteolytic enzymes. This suggests that antibacterial fragments derived from camel caseins were released (Jrad *et al.*, 2015)

Immune system of camel is stronger than that of human and the small immunoglobulins pass from the camel milk into the human blood. As immunoglobulins are found in camel milk throughout lactation, drinking milk will provide a 'tool' for combatting autoimmune diseases by rehabilitating the immune system rather than is depression (Yagil and Reuven, 2004). Addition, another study also clarified that camel milk has antibacterial effect against pathogenicity induced by *E. coli* and *S. aureus* in doing trial on rats (Mall *et al.*, 2006). Moreover, camel milk has synergistic action with antibiotics which may be used to reduce the dose of antibiotics and decrease bacterial antibiotic resistance. Camel milk supplementation decreased the oxidative stress and normalized antioxidants biomarkers that were ameliorated by *E. coli* and *S. aureus* injection (Yassin *et al.*, 2015)

### 2.2.3 Camel milk for 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 *et al.*, 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 *et al.*, 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 co-workers reported that camel milk has shown good effect for treating Crohn's diseases. As the bacteria belongs 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. In addition, immunoglobulin's restore the immune system. (Yadav *et al.*, 2015)

#### 2.2.4 Camel milk for treatment Autism

Autism disease is general terms for a group of complex disorders of brain development. The etiology of many autistic cases is based primarily 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 power ful opioid, casomorphine instead of primarily beta-casein and betalactoglobulin. This opioid leads to typical cognitive and behavior symptoms due to brain damage (Al-Juboori *et al.*, 2013).

The most prominent cerebral symptoms are caused by a malfunction in the formation of amino acids from two caseins in cow milk, beta-casein and beta-lactoglobulin. Instead, a powerful opioid, casomorphine, is formed (Yagil and Reuven, 2013). This opioid elicits the cerebral symptoms of the autism syndrome.

But Camel milk does not contain the two caseins that form casomorphine from cow milk, so symptoms do not develop (Reichelt KI, 2003). In addition, camel milk contains protective proteins, including Igs necessary for initiating the immune system and nutritional advantages for brain development (Al-Juboori *et al.*, 2013). Furthermore, camel milk has emerged to have potential therapeutic effects in autism. (Sharma and Singh, 2014)

The consumption of camel milk in children suffering from autism showed reduction in autism symptoms and improved motor skills, language, cognition, joint coordination and skin health (Grover *et al.*, 2015). V. Popov (2013) also reported that children drinking camel milk have had amazing improvements in their behavior and diets.

Study evaluated the effect of camel milk consumption on oxidative stress biomarkers in autistic children, by measuring the plasma levels of glutathione, superoxide dismutase, and myeloperoxidase before and 2 weeks after camel milk consumption, using the ELISA

technique. All measured parameters exhibited significant increase after camel milk consumption. These findings suggest that camel milk could play an important role in decreasing oxidative stress by alteration of antioxidant enzymes and non enzymatic antioxidant molecules levels, as well as the improvement of autistic behaviour as demonstrated by the improved CARS (Laila and Nadra, 2013).

#### 2.2.5 Treatment for allergies

The milk protein called  $\beta$ -lactoglobulin present in cow and mare milk is responsible for allergies in humans. However, camel milk lacks this protein and thus do not cause problem of allergies in sensitive individual.  $\beta$ -casein present in cow milk also causes hypersensitivity into humans. Beside, camel milk contains  $\beta$ -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.*, 2015) According to El-Agamy *et al.*, (2009) absence of immunological similarity between camel and cow milk proteins may be taken an important criterion from clinical point of view. Therefore, camel milk may be suggested as a new protein source for nutrition for children allergic to cow's milk.

A person allergic to cow milk will develop an allergic reaction after ingesting buffalo, goat, sheep and horse milk proteins due to the presence of positive immunological cross-reaction with their counterparts in cow milk but researchers confirmed that camel milk does not contain the allergens which are present in ruminant milk (El-Agamy *et al.*, 2009). So, camel milk is recognised as a good substitute for human milk as it does not contain  $\beta$ -lactoglobulin, a typical milk protein characteristic of ruminant milk (Shabo *et al.*, 2005).

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

Camel's milk can used as an option for the individuals intolerant to lactose of cow's milk (de Almeida *et al.*, 2011) Camel milk contained low lactose of small molecules and easily digests and metabolized by the human body (Ehlayel *et al.*, 2011). Individuals intolerant to lactose are able to accept camel milk without adverse symptoms (Yosef *et al.*, 2005).

#### 2.2.6 Anti-diarrheal properties of camel milk

Camel's milk contains a number of '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 they 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 the diarrhea subsides.

### 2.2.7 Therapeutic effects of camel milk on cancer, tumor and ulcer

It has been confirmed that lactoferrin has ability to inhibit the proliferation of cancer cell *in vitro*, and repair of DNA damage (Hosam *et al.*, 2013). The main iron binding protein of camel milk, lactoferrin is potent for 56% reduction of cancer growth (Habib *et al.*, 2013). Korashy and co-researchers (2012) investigated the molecular mechanisms that govern the effect of camel milk on human cancer cells demonstrated that camel milk induces apoptosis in HepG2 and MCF7 through apoptotic and oxidative-stress-mediated mechanisms. Other scholars also added that camel milk has antigenotoxic and anticarcinogenic effects through inhibition of MnPCEs and improves the mitotic index of bone marrow cells (Salwa *et al.*, 2010). More recent literature claims that in a series of *in vitro* experiments, Dr Fatin Khorshid succeeded in demonstrating as camel milk can stop the growth of tumour cells and malignant cells such as hepatocellular carcinoma, colon carcinoma, human glioma cells, lung cancer cells and leukaemic cells (Gader *et al.*, 2016). Dr Fatin Khorshid also suggested that this anti-cancer action could be both a direct cell cytotoxicity and anti-angiogenic action (cutting blood supply to tumour cell) of camel milk lactoferrin.

There are a number of tumors which can be cured with camel milk; very active antibodies bind onto the tumors, killing the tumor cells without damaging healthy tissue. But human antibodies are too big to do this (Levy *et al.*, 2013). It is also revealed that anti-tumor properties of camel milk are due to strong antimicrobial and anti-oxidative activities that help in reduction of liver inflammation and camel milk is rich with nutrients that are required for healthy liver function. Conversely, camel milk also shown to have potential thrombolytic action, as it causes inhibition of coagulation and fibrin formation which in turn hinders the spread and growth of metastatic tumour cells (Abdelgadir *et al.*, 2013).

Camel milk has been proved to have pronounced antiulcer properties. Nonetheless, it contains high levels of vitamins C, A, B2 and E (acidic pH) and is very rich in magnesium and zinc (Al-wabel and Naser, 2012). These vitamins are useful in reducing the oxidative stress caused by toxic agent and Magnesium is very essential for absorption and metabolism of vitamins, B, C and E (Traber and Stevens, 2011). Additionally, magnesium is essential for biosynthesis of glutathione; prevents damage to cellular components caused by free radicals, peroxides, heavy metals. More recently, magnesium significantly enhances the antioxidant defence (Markiewicz *et al.*, 2011).

A protective effect of zinc has been reported against the cellular toxicity due to palliative effect on oxidative stress and apoptosis, activation of the antioxidant system to decreased lipid peroxides (Jihen *et al.*, 2011). Moreover, camel milk can generate nitric oxide it stimulates mucus production, inhibits the adherence of neutrophils to the endothelial cells and, especially, increases the blood flow to the gastric mucous membrane (Al-wabel and Naser A., 2012).

### 2.2.8 Camel milk effect as antiaging

Salami and co-workers (2011) studied the effect of camel milk as anti-aging and suggested that when camel milk is consumed and digested, the produced peptides start to act as natural antioxidants and ACE-inhibitors. Camel milk is good for anti-ageing as the high levels of vitamin C protect collagen. 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. 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 aging.

Camel milk has anti aging effect due to presence of  $\alpha$ -hydroxyl acids which are known to plump the skin and smooths 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. This helps in revealing new cells, which are more elastic and clear. Alpha-hydroxyl acids helps to eliminate wrinkles and age spots and relieve dryness as they make the outer layer



of the skin thinner and support the lower layer of the dermis by making it thick. In addition, liposome occurring in camel milk is applicable for a potential cosmetic ingredient to improve anti-aging effect (Choi *et al.*, 2013).

### 2.2.9 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 beneficial action on chronic liver patients (Saltanat H, 2009). There is also a possibility that the relatively high concentrations of ascorbic acid in camel milk helps 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, 2016). Additionally, camel lactoferrin is more potent anti-viral agent than bovine and human lactoferrins, even its anti-parasitic action can clear *Schistosoma Mansoni* (Redwan *et al.*, 2007, Maghraby *et al.*, 2005).

### 2.2.10 Camel milk for treatment of arthritis

Camel milk has higher amount of iron chelating protein known as lactoferrin. This protein removes free iron from joints of arthritic patients thereby improves arthritic. (Panwar *et al.*, 2015)

### 2.2.11 Skin disease treatment and cosmetic values of camel milk

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. More over, camel milk is 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>.

## 3. CONCLUSION AND RECCOMENDATION

Camel is a vital animal to daily life of desert dwellers as a source of food and a means of transportation, and just as importantly, its milk uses as medicines for diverse ailments. Camels produce more milk and for longer period of time than any other milk animal held under the same harsh condition. Camel milk so called white gold of the desert is more similar to human milk than any other milk. Camel milk is unique containing various protective proteins like lysozyme, lactoferrin, lactoperoxidase, immunoglobulins which exert antioxidatives, antibacterial, antiviral, antifungal, hypoglycaemic, antiparasitic, growth promotion, aging

prevention, autoimmune diseases and anti-tumor activity.

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 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 to diabetic patients as adjunctive with insulin therapy.
- Camel should be incorporated in to dairy sector
- Training on camel in general and the chemical composition and medicinal value of camel milk in particular should be integrated in the livestock extension program
- Ethiopia which has the highest potential of camel population should give priority to further investigate the medicinal value of the animal.

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