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# Camel Milk: A Boon to Mankind

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**Abstract:** *This paper embraces most of the medical benefits of camel milk. It is far better than cow milk and most of its contents and properties resemble to those of mother's milk. It has low fats, have insulin-like and protective protein and have lactose as the major carbohydrate. It can be used for the treatment of many ailments like diabetes, autism, diarrhea, it possesses anti-tumors properties and the potent immune system components help fight diseases. Due to these qualities it has been utilized for ages by the nomads and Bedouins.*

**Keywords:** *camel milk, medical benefits, autism, immune system, nomads*

## 1. Introduction

For centuries, camel (*Camelus dromadarium*) milk is used medicinally by the nomadic people as it is quite closer to human mother's milk and better than cow's milk. It is more similar to goat milk. It is opaque with a sweet sharp taste but sometimes it can be salty. 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. It sours slowly and can be kept longer without refrigeration as compared to cow's milk. The production of milk in camels has been found to be in the range of 17-26 liters per day [1]. Milk yield varies with breed, stage of lactation, management conditions and feeding. Camels produce diluted milk in hot weather when water is scarce [2]. It has distinctive composition that differs from other animal's milk. It contains lower fat, cholesterol, and lactose [3, 4]. It also contains higher minerals (calcium, iron, magnesium, copper, zinc, and potassium) and vitamins A, B2, E, and C as compared to cow's milk and it contains no beta lactoglobulin and beta casein present in cow's milk which are the main causative of allergy in humans [5]. Furthermore, camel milk contains various protective proteins, mainly enzymes which exert antibacterial, antiviral, and immunological properties [6] ; these include immunoglobulins, lysozymes, lactoferrin, lactoperoxidase, N-acetyl-§- glucosaminidase (NAGase), and peptidoglycan recognition protein (PGRP) [5], which are fundamental in preventing food allergy and rehabilitating the immune system [7]. It is an alternative for people suffering from allergy against cow's milk. For all these effects camel milk is now widely used to treat several disease conditions.

Another good quality of camel milk is that the milk of dehydrated camels is rich in salt and water content and its nutritive value also remains the same. A study has shown the milk of dehydrated camels have increased concentration of sodium, potassium, phosphorous and chloride while calcium and magnesium levels were decreased. There was increased concentration of water as compared to the milk of hydrated camels [8].

## 2. Composition and Constituents of Camel Milk

The most important component of camel milk is water content which is about 84-90% [9]. Along with other factors minerals are the major content. The mineral compositions of camel milk are summarized in figure 1.

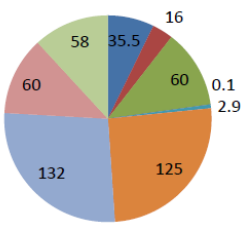


**Figure1.** *Mineral composition of camel milk in mg/100g (Na= 35.5; Mg= 16; Fe= 60; Mn= 0.1; Cu= 2.9; Zn= 125; Ca= 132; K= 60 and P= 58) [10, 11]*

### 2.1. Fat

Milk fat serves as an energy source, acts as a solvent for fat-soluble vitamins and provides essential fatty acids. Camel milk contains only 2% fat which are mainly composed of polyunsaturated fatty acids and omega fats. These fats are completely homogenized so they appear as minute globules in the milk. The white color of the milk is due to the presence of these globules. On standing camel's milk creams less rapidly and completely and contains less short-chain fatty acids than the cow's milk [2].

### 2.2. Sugar

The major carbohydrate fraction in milk is lactose. Lactose present in the milk is readily digested by human enzyme lactase and does not produce signs of lactose intolerance in humans. It ranges from 4.8-5.8% [2] the value is constant throughout lactation.

### 2.3. Proteins

Camel milk does not include the allergens. Insulin is one of the camel milk proteins. Camel milk contains a number of protective proteins which keep the body healthy. Casein and whey proteins in camel's milk are between 72-76% and 22-28% respectively [2]. They consist of strong antibacterial, antiviral and antifungal substances and the immune globulins [12].There are also some tissue repair substances among the protein protectors.

Camel milk contains the following immune proteins in high quantity

#### *2.3.1. Peptidoglycan Recognition Protein*

PGRP is very high in camel milk. It stimulates the host's immune response and has potent antimicrobial activity. It even appears to have an effect on breast cancer in studies. [13]

#### *2.3.2. Lactoferrin*

Among the protective proteins in camel milk is lactoferrin which was examined for its ability to inhibit the proliferation of colon cancer in vitro, and repair of DNA damage [14]. It can bind with iron and has antioxidant properties. This explains the healing of stomach and colon cancers. Lactoferrin is in higher concentrations in camel milk and thus prevents microbial overgrowth and invading pathogens. [13] *Lactoperoxidase:* Lactoperoxidase has bactericidal activity on gram-negative bacteria like *Escherichia coli* , Salmonella, and, Pseudomonas, and has antitumor activity.

#### *2.3.3. Lysozyme*

It is an enzyme that is part of the innate immune system that targets gram-positive bacteria. N-acetyl-beta-D-glucosamidase (NAGase) found in similar quantities in human milk has antibacterial activity. [13]

### 2.4. Vitamins and electrolytes

The most important vitamin is vitamin C and calcium and iron are the most important electrolytes. The 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 [15].

## 3. Potential Effects of Camel Milk In Treating Diseases

### 3.1. Diabetes

Camel milk contains a protein which is similar to insulin, which has been shown to be beneficial [7, 16]. Diabetes is caused by a malfunction of the receptors for insulin on the cell surface. As camel milk contains tissue repairing proteins, the problem is cured. Insulin is one of the camel milk proteins and as camel milk does not form cheese the milk quickly passes the stomach into the intestines. Therefore, insulin is not destroyed and coagulated and is absorbed rapidly into the blood where it reduces blood sugar [7]. It is affective blood sugar and lipid profile of patients with type 2 diabetes [17]

### 3.2. Allergies

Many children and adults suffer from food allergies. As camel milk does not contain allergens and the immune system is rehabilitated, children recover from their allergies. According to a study, by using camel milk children recovered from their allergies with no side effects. In fact, researchers stated that results were spectacular when compared with traditional treatments [18]. Disease-fighting immunoglobulins in camel milk were believed to play a key role in reducing allergic symptoms [19].

Camel milk proved its potential effect in the treatment of food allergies, due to its inflammation-inhibiting proteins, and hypoallergenic properties, in addition to its smaller size nanobodies, which are different than those found in human.

Casein molecules are actually micelles and camel micelles have been found to be larger in size (15 nm) than those of cow milk or human milk [12]. Therefore it is not reactive to children with autism and even non-allergenic to those with even the most sensitive allergy to milk and casein. One study found Camel' Children with severe food allergies react well to the milk, and astonishingly [14] Camel milk has a lower pH than other milk, so that upon entering the stomach the casein micelles do not breakdown into casein and whey and therefore do not break into casomorphins. Casomorphin creation from cow milk consumption is a common problem in autism that increases autistic symptoms [13]. milk was also not recognized from circulating IgEs from a child specifically allergic to ewe's milk.

### 3.3. Immune benefits

The potent immune-system components in camel milk might help fight diseases. Supposedly, the small size of the immunoglobulins, or antibodies, found in camel milk enables easy targeting and penetration of foreign disease-causing substances, called antigens, for destruction by the immune system. People with autoimmune system disorders, such as Crohn's disease and multiple sclerosis, have immune systems that attack their own body tissues. Although traditional treatments for autoimmune disorders suppress the immune system, camel milk benefits these disorders by boosting it.Camel milk nanobodies, as a single domain, show many promising and therapeutic potencies in infection and immunity [20].

Furthermore, camel milk has an amazing immune profile. The immunoglobulins (Igs) and protective proteins in camel milk contribute to camel milk's incredible infection fighting and eradication capacity. Camel Igs are able to penetrate into tissues and cells that human Igs were unable to. Therefore, they are able to get into the kidney or inside a cell, where they are also able to completely neutralize the enzyme activity of an infectious agent such as a bacteria or virus [13]

### 3.4. Autism

Autism spectrum disorder (ASD) is a severe neurodevelopment disorder with onset prior to 3 years of age [21, 22] . It is characterized by impairments in social orientation, communication, and repetitive behaviors [23, 24]. In addition to behavioral impairment, ASD is associated with high prevalence of autoimmune disease [25, 26] , gastrointestinal disease and dysbiosis [27], and mental retardation [28].

Although the etiology and pathology is poorly understood, different factors have been suggested to affect autism, for example, immune factors, environmental, neurochemical and genetic factor [6].

Extensive studies have demonstrated that oxidative stress plays a vital role in the pathology of several neurological diseases such as Alzheimer's disease, Down syndrome, Parkinson's disease, schizophrenia, bipolar disorder, and autism [6].

Oxidative stress occurs when reactive oxygen species (ROS) levels exceed the antioxidant capacity of a cell. It acts as a mediator in brain injury, strokes, and neurodegenerative diseases [29, 30] thus, the control of ROS production is necessary for physiologic cell function. The ROS within the cells are neutralized by antioxidant defense mechanisms; including superoxide dismutase (SOD), catalase, and glutathione peroxidise (GSH-Px) enzymes [31]. The increased production of ROS both centrally (in the brain) and peripherally (in the plasma) may result in the reduction of brain cell number leading to autism pathology and apoptosis [32].

*Pathology and mechanism of action of milk in autism* - Low plasma antioxidant enzymes, GSH-Px and SOD [5], were reported. Low level of antioxidant enzymes indicated increased vulnerability to oxidative stress due to impaired antioxidant defense mechanisms, which lead to harmful effects of

free radicals that could have an important role in the etiology of autism. Moreover, increased oxidative stress in autistic subjects leads to a decrease in the levels of nonenzymatic antioxidants like GSH, vitamin E and C [33] , which in turn leads to impairment of metabolic pathways and may contribute to the developmental delays which occur in autism; this could be corrected by micronutrient supplementation . In addition, lower plasma levels of glutathione and cysteine in subjects with ASD were documented [34, 35].

Camel milk has been reported to improve clinical outcomes of ASD, as casein- and gluten-free diet has been reported to improve autistic behavior, possibly by reducing excess central opioid effects.

Glutathione is one of the most important intracellular antioxidants, responsible for maintaining the reducing intracellular microenvironment that is essential for normal cellular function and viability. It also exerts neuroprotective properties and reduces neuropathy and hence decreases oxidative stress [6]

The results of the present study show a significant increase in GSH level after camel milk consumption; this could be attributed to the antioxidant nutrients constituents of camel milk. Magnesium is known to reduce oxidative stress and enhance vitamin E and C absorption [25], whereas zinc increases total glutathione, GSHPx, and SOD levels. Moreover, vitamin E has been suggested to enhance glutathione levels. Taken together, high levels of Mg and Zn and vitamin E in camel milk might help to increase glutathione production and enzymes production and hence to decrease the oxidative stress in autistic subjects [6].

Proinflammatorychemokines, such as monocyte chemotactic protein-1 and thymus and activation-regulated chemokine (TARC), along with cytokines, such as tumor necrosis factor α, were consistently elevated in the brains of individuals with autism [25] .at critical times of infantile development, immune dysregulation may result in the release of immune-modulatory molecules, such as chemokines and cytokines, leading to altered neuronal development and neural function [36,37] it was found that reduced levels of the modulatory cytokine, transforming growth factor-β1 (TGF-β1), in autistic children contributed to the dysregulation of adaptive behaviors and predisposal for autoimmune responses this is contributed by camel milk [38].

Briefly, the physiological breakdown of two cow milk proteins casein and lactoglobulin-to amino-acids is abnormal, forming a powerful opioid, casomorphin. If the formation of the opioid that cause the brain symptoms but if continued for years will eventually cause permanent brain damage, creating a window of opportunity to cure autism at an early age. Because cow milk caseins produce enough opioid to completely remove cow milk and its products from the diet to alleviate the symptoms. The symptoms are then removed but the children are still ill. Camel milk does not contain the two caseins responsible for the formation of the opioid and rehabilitates the immune system, so-doing curing the autism [21].

### 3.5. Crohn's Disease

Scientific evidence indicates that it is not primarily an autoimmune disease but rather a bacterial infection caused by Johne's disease in cows, the bacteria being MAP (*Mycobacterium avium paratuberculosis*). The symptoms of these cows are identical to those of persons with Crohn's Disease. It has been established that MAP passes into cow milk and is not destroyed by pasteurization. The MAP then enters the intestinal tissue as a saprophyte, not creating any symptoms. A very severe emotional stress activates the MAP and it becomes active in the intestinal tissue. The reaction of the body is to send antibodies to the intestines but as they cannot pass into the thick tissue they attack the intestines themselves, creating an autoimmune disease. Camel milk's protective proteins pass into the intestinal tissue, destroying the MAP and rehabilitating the immune system [15].

### 3.6. 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 signaling pathways such as the Fas pathway, resulting in the inhibition of tumor 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 tumor treatment by blocking tumor 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 further therapeutic potential for camel milk lactoferrin[39].

### 3.7. Hepatitis and other liver problems

Hepatitis is a world-wide affliction, often requiring inoculations against it. Scientific publications have shown that camel milk cures both hepatitis B and hepatitis C. The special fat in camel milk also soothes the liver [40]. It has beneficial action on chronic liver patients [41]. There is a possibility that the relatively high concentrations of ascorbic acid in camel milk helps in improving liver function [42].

### 3.8. Tumors

There are a number of tumors which can be cured with camel milk; the action is due to the fact that the very active antibodies bind onto the tumors, killing the tumor calls without damaging healthy tissue. Human antibodies are too big to do this [15].

### 3.9. Diarrhea

It should be noted that rotavirus is the most common cause of diarrhea in children under 5 years old. Since camel milk is rich in anti-rotavirus antibodies .the diarrhea subsides.

It has anti-diarrheal/antibacterial action as well as high titers of antibodies against rotavirus, and they impact on the immune system. Only human and camel milk have physiologically high concentrations of the enzyme NaGase (N-acetylB-glucosaminidase) which in cow's milk is an indication of mastitis. Camel immunoglobulins are a tenth the size of human ones and are highly potent. For hundreds of years camel milk has been used to treat diarrhea even though the identity of the active substance in the milk was not known [43] research is in process to use camel's milk as an alternative or supplement to mother's milk in areas prone to diarrhea due to bad hygienic conditions.

Besides the above mentioned benefits, there are many diseases and ailments which can be cured by drinking camel's milk. It has positive effect in the management of both arteriosclerosis and osteoporosis [44]. Camel milk is also considered for the treatment of constipation, dental problems, chicken pox and diseases related to digestive system by the Bedouin and nomad. It has also been effective in tuberculosis [45], asthma, anemia, piles [46] and lung [47] and liver diseases [41]. It also contains a natural source of alpha hydroxy acids which makes the skin smooth and prevents wrinkles. Camel milk has angiotensin 1-converting enzyme inhibitory activity, hypoglycemic effect and antimicrobial properties [48]. It has slimming properties [49] and is healthier when drunk cool [50]

## 4. CONCLUSION

Nature has gifted us with lots of things for our sake [51] among which milk is considered as the most functional natural liquid as it is produced abundantly and has numerous nutritional values. Camel milk embraces many benefits for the mankind. It has less short-chain fatty acids than cow milk. It is rich in immune globulins and lacks β-lactoglobulin which makes it similar to human milk. Camels can not only lactate under drought conditions but also the quality of milk is very much suitable to human's need [52]. The lists of its health benefits are endless. No doubt camel milk is the white gold of the desert.

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