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Review Article

A review on medicinal properties of Camel milk

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ABSTRACT

Many research findings proved that Camel milk is closer to human milk than any other milk. It is often easily digested by lactose-intolerant individuals. It is rich in healthy vitamins and minerals, especially B vitamins, vitamin C and iron. The lactoferrin in camel milk has antibacterial, antiviral and anti-tumor properties. It contains disease-fighting immunoglobulins which are small in size, allowing penetration of antigens and boosting the effectiveness of the immune system. It is a rich source of insulin and also it containing approximately 52 units of insulin in each liter of camel milk, making it a great treatment option for Type 1 or Type 2 diabetics as well as Gestational Diabetes. This review focused on the medicinal properties of camel milk which will be more useful to generate value added products formation from camel milk.

Key words: Camel milk- Medicinal properties-Anti-diabetic property of camel milk.

INTRODUCTION

Historically, camel milk has been used for a number of medical problems [1,2]. According to [3] statistics, there are about 18 million camels in the world. Nowadays, camel milk production is in progress in many countries in both Asia and Africa due to increased demand. Raw and pasteurized milk and other dairy products made from camel milk are available in the markets of Gulf area and other countiers [4]. Most of camel milk is consumed in the raw state without any heat treatments and kept at high temperature with lack of refrigeration facilities during milking and transporting [5]. Camel milk has properties that it can be kept for long periods than cow's milk when refrigerated and even with the desert heat it doesnot spoil shortly [6]. Moreover, the milk composition of dromedary camel is excellent from a nutritional view point [7]. Camel milk also has valuable nutritional properties as it contains a high proportion of antibacterial substances and higher concentration of vitamin C in comparison with cow milk [8, 9] have reported a unique camel milk health benefit in diabetic patients. Camel milk is much more nutritious than that of cow milk because it is low in fat and lactose contents, and higher in potassium, iron and vitamin C, [10]. Camel milk has medicinal properties and contains protective proteins, which may have a possible role for enhancing the immune defense mechanism [11]. The triglycerides, which contain a great variety of fatty acids, are accompanied with small amounts of di-and mono-acylglycerols, cholesterols, free fatty acids and phospholipids [12].In average, camel milk contains more proteins and whey protein than cowmilk [13]. The ability of camel milk to inhibit growth of pathogenic bacteria and its relation to whey lysozyme has been demonstratedin previous study. [14].

The reported average of Iysozyme content in human milk is 40 000 mg/100 ml and in cow milk 120 mg/100 ml [15]. The significantly very high level of Iysozyme in camel milk is of importance for the storage of milk and needs further investigation. [5] Also reported about extracted Iysozyme (Lz), lactoferrin (Lf), lactoperoxidase (Lp), immunoglobulin G and immunoglobulin A from camel milk. [16] Reviewed the ability of camel milk to inhibit growth of pathogenic bacteria and its relations to whey lysozyme. The lysozyme content of twenty samples showing growth inhibition was 648 -956 g/100ml which was significantly higher than the average in 38 samples (62.8 -956 g/100ml) with no inhibitory effect. The activity of these protective proteins was assayed against some pathogenic bacteria such as Escherichia coli, Salmonella typhimurium and rotavirus.[17] reported that the proteolytic activities of yogurt starters at (42^{o}C for 4 h) were higher in

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camel milk than in cow milk. [18] observed that camel milk failed to form gel-like structure after 18 h incubation with lactic acid culture; this was attributed to the presence of antibacterial factors such aslysozymes, lactoferrin. Shubat is camel's sour milk from Kazakhstan [19]. Kefir is the Caucasian fermented camel's milk [11]. Lehban is fermented products from camel's milk in Syria and Egypt [20].

Medicinal properties of camel milk

Anti-diabetic property: There is a traditional belief in the Middle East that regular consumption of camel milk helps in the prevention and control of diabetes. Recently, it has been reported that camel milk can have such properties. Literature review suggests the following possibilities: i) insulin in camel milk possesses special properties that makes absorption into circulation easier than insulin from other sources or cause resistance to proteolysis; ii) camel insulin is encapsulated in nanoparticles (lipid vesicles) that make possible its passage through the stomach and entry into the circulation; iii) some other elements of camel milk make it anti-diabetic. Sequence of camel insulin and its predicted digestion pattern do not suggest differentiability to overcome the mucosal barriers before been degraded and reaching the blood stream. However, we cannot exclude the possibility that insulin in camel milk is present in nanoparticles capable of transporting this hormone into the bloodstream. Although, much more probable is that camel milk contains 'insulin-like' small molecule substances that mimic insulin interaction with its receptor[21].

Another study, which was conducted to analyze the possible anti-diabetic effects of camel milk in streptozotocin (STZ)-induced diabetic rats by assaying liver and kidney clinical function parameters. Administration of streptozotocin (55 mg kg^{-1} b.wt.) to the experimental groups of rats resulted in marked detectable changes. The rats were fed daily with fresh camel milk by feeding bottles for 30 days. The effects of camel milk on blood glucose, serum proteins, urea, uric acid, creatinine, lipid profile and the activities of diagnostic marker enzymes of liver function and Alkaline Phosphatase (ALP) were examined in the plasma/serum of control and experimental groups of rats. Camel milk feeding to diabetic rats significantly reduces the levels of blood glucose, urea, uric acid and creatinine and increases the activities of albumin, albumin/globulin ratio and restores all liver function marker enzymes and lipid profile to near control levels. This study shows that feeding of camel milk to diabetic rats has antihyperglycemic effects and consequently may alleviate liver and renal damage associated with streptozotocin-induced diabetic rats.

One of the previous studies was conducted to evaluate the effect of raw, pasteurized and boiled camel milk on Alloxan- induced diabetic dogs. Firstly, three groups of dogs were used: group 1 and group 2 composed each of 4 diabetic dogs and receiving respectively 250 ml of raw camel milk/ dog/ day or 250 ml of raw cow milk/ dog/ day. Group 3 consisted of 4 healthy dogs getting raw camel milk were used as control. Secondly, we tested the effect of heat treatment on the anti-diabetic property of camel milk. Two other groups composed of 4 diabetics dogs each and treated with 250 ml of pasteurized camel milk/ dog/ day (group 4) or with 250 ml of boiled camel milk/ dog/ day (group 5). By the end of milk treatment, group1 showed a significant decrease in blood glucose (from 10.16 ± 1.16 to 5.22 ± 1.06 mmol/l), in cholesterol (6.94 ± 0.06 to 5.04 ± 0.8 mmol/l) and in total proteins levels (from 75.31 ± 4.68 to 65.44 ± 0.76 g/l). A same result was revealed in animals getting pasteurized camel milk: blood glucose, in cholesterol and total protein concentrations. After 3 weeks of treatment with pasteurized milk, all these parameters didn't show any significant differences when compared with group 1 (treated with raw camel milk). Whereas, the animals receiving boiled camel milk (group 5) demonstrated high blood glucose (10.5 ± 0.52 mmol/l), total proteins (72.03 ± 6.49 g/l) and cholesterol levels (7.02 ± 0.44 mmol/l). The investigation during this research was not only the effectiveness of "raw or pasteurized" camel milk to treat diabetic dogs but especially the curative effect of this product shown after stopping to drink milk. However, this therapeutic effect was disappearing using boiled camel milk to treat diabetic dogs. From the results obtained it can be concluded that: (a) Raw camel milk can be used as solution to treat alloxan - induced diabetic dogs. (b) This therapeutic property of camel milk was losing after treatment of camel at 100°C (boiled camel milk).

The long-term study was undertaken previously to assess the efficacy, safety and acceptability of camel milk as an adjunct to insulin therapy in type 1 diabetics. In this 2-year randomized clinical, parallel design study, 24 type 1 diabetic patients were enrolled and divided into two groups. Group I (n=12) received usual care, that is, diet, exercise and insulin and Group II (n=12) received 500 ml camel milk in addition to the usual care. Insulin requirement was titrated weekly by blood glucose estimation. Results were analyzed by using the regression technique. The results showed that, in camel milk group, there was decrease in mean blood glucose (118.58±19-93.16±17.06 mg/dl),

hemoglobin A1c levels (7.81±1.39-5.44±0.81%) and insulin doses (32.50±9.99-17.50±12.09 U/day, P<0.05). Out of 12 subjects receiving camel milk, insulin requirement in 3 subjects reduced to zero. There was non-significant change in plasma insulin and anti-insulin antibodies in both the groups. It may be stated that camel milk is safe and efficacious in improving long-term glycemic control, with a significant reduction in the doses of insulin in type 1 diabetic patients[22].

In India a comparison between conventionally treated juvenile diabetes with those also drinking camel milk showed that the group drinking the milk had significantly reduced blood sugar and reduced HbA1C levels [23]. The amounts of injected insulin were also significantly reduced.

In Israel diabetics drinking camel milk showed similar results as in the clinical trials. A case in particular was a young girl who started drinking camel milk within 2 weeks of the diagnosis of IDDM. After 8 weeks she was getting minimal dose of insulin while blood sugar declined to 80mg% and HbA1C to 7. Insulin in milk is proved by the following many research outcomes.

(a) Camel milk contains large concentrations of insulin - 150 U/ml [24]
(b) Fasted and dehydrated rats and rabbits had a decline in blood sugar after receiving camel milk. As fasting nullifies insulin secretion, the drop in blood sugar indicates insulin activity. It must be noted that fasted rabbits used to be the bioassay for insulin – the concentration of insulin given as rabbit units.
(c) Streptozotocin induced diabetes in rats was controlled and cured with camel milk.
(d) Although human, cow and goat milk contain insulin, it is degraded in the acid environment of the stomach. This does not occur with camel milk which does not react to acid [24] and no coagulum is formed. Personal observation in a calf which died 2 hours after suckling: no coagulum was present in stomach although it was filled with milk.

Anti-bacterial and Immunological properties:

CAMEL IMMUNE SYSTEM:

IgM, IgG, IgA and even IgD have been detected in camel sera on the basis of cross-reactivity with human immunoglobulins [25]. In 1993 Hamers-Casterman et al described the amazing camel immune system, different from all other mammalians. Subclasses IgG2 and IgG3 (natural for camels) consist of only two heavy chains. Light chains (VL) are not present. There is a single V domain (VHH) .Camel VHH have a long complementary determining region (CDR3) loop, compensating for absence of the VL.[26] Conventional antibodies rarely show a complete neutralizing activity against enzyme antigens. Camel IgG has a full neutralizing activity against tetanus toxin as it enters the ezymes structure. Camel hypervariable regions have increased repertoire of antigen binding sites. Camel VHH domains are better suited to enzyme inhibitors than human antibody fragments, thus offering a potential for viral enzymatic neutralization.[27,28] A major flaw in the development of human-immunotherapy is the size of the antibodies. Larger antibodies cannot reach their target. The comparative simplicity, high affinity and specificity of camel Igs, and the potential to reach and interact with active sites allow for penetration of dense tissues to reach the antigen. Camels' immune system is stronger than that of humans' 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.

The immunoglobulins (Igs) are large long and short-chained domains, having difficulties reaching and penetrating antigens. Camel immunoglobulins have no short chains and small so are active against antigens. The camel's immunoglobulins pass into the milk and so are available for combating autoimmune diseases. The most pertinent factor is that conventional treatments of autoimmune diseases are based on immune-suppression, while camel milk Igs enhance the immune system, revitalizing immune integrity. Camel milk was first mentioned in the Moslem Holy Scriptures as being a gift for hungry people and a remedy for sicknesses. This claim is still valid today and, therefore, can be considered a natural and historic treatment.[29]

The Prophet Muhammed considered camels' milk medicinal (Bukhari 7:71 "Medicine" #589 and #590). Scientists theorize that it is due to the immune system. Camel milk contains various protective proteins, mainly enzymes which exert antibacterial and immunological properties [30] . The presence of these proteins help explain some of the natural healing properties of the milk. The known protective proteins, and their immunological action, in camel milk are:
Lysozymes:• participates in primary immune system, which is based on targeting of structures common to invading pathogens.
Immunoglobulins:• These give the immune protection to the body against infections.
Lactoferrin:

• Iron-saturated lactoferrin (from second week lactation) prevents microbial growth in gut.
• participates in primary immune system, which is based on targeting of structures common to invading pathogens.
• Camel milk apparently contains much more lactoferrin than in ruminant (cow, sheep and goat) milk[31] .

Lactoperoxidase
• Lactoperoxidase is found in milk, tears and saliva. It contributes to the non-immune host defense system.
• exerting bactericidal activity, mainly on gram-negative bacteria.
• has growth promotion activity.
• has anti-tumor activity [32] .
• has a close relation (71%) to human thyroid peroxidase, which is involved in iodination and coupling in the formation of the thyroid hormones.

Peptidoglycan recognition protein (PGRP)
• the highest concentrations of this enzyme is in camel milk.
• was first discovered in camel milk
• has apparent effect on breast cancer [33,34] by controlling metastasis
• stimulates the host's immune response
• broad antimicrobial activity.

N-acetyl-§-glucosaminidase (NAGase): The milk enzyme NAGase is an accepted
test for mastitis in cows. When it was first documented that camel milk was rich in
NAGase it was assumed that those camels suffered from subclinical mastitis. However after checking milk of hundreds of camels and llamas all with high NAGase levels another conclusion was reached. It was concluded that NAGase has an antibacterial activity and so strengthens the antibacterial-antiviral activity of the milk. It is noteworthy that the NAGase activity is similar to that in women's milk, confirming the nutritional advantages of camel milk over cow milk[29].

Crohn's Disease: Crohn's disease is becoming an epidemic in many countries. Lately increasing evidence points to a primary bacterial infection by Mycobacterium avium - subspecies: paratuberculosis (MAP). This mycobacterium could spread via cow milk as it is unaffected by pasteurization. Apparently MAP enters the mucosa as saprophytes and only become active when the person is in severe stress, leading to a secondary autoimmune response. As the bacteria belongs to the family of tuberculosis and as camel milk has been used to treat tuberculosis[35] 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, immunoglobulins attack the anti-DNA and restore the immune system.

Autism: As a malfunction of the immune system causes an alimentary enzyme inhibition, causing the breakdown of casein, not to aminoacids, but to casomorphine. The casomorphine is a powerful opioid, much more potent than morphine itself. Autistic children drinking camel milk have had amazing improvements in their behavior and diets.
Extensive studies have demonstrated that oxidative stress plays a vital role in the pathology of several neurological diseases, including autism spectrum disorder (ASD); those studies proposed that GSH and antioxidant enzymes have a pathophysiological role in autism. Furthermore, camel milk has emerged to have potential therapeutic effects in autism. The previous 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 ($P < 0.5$). These findings suggest that camel milk could play an important role in decreasing oxidative stress by alteration of antioxidant enzymes and nonenzymatic antioxidant molecules levels, as well as the improvement of autistic behaviour as demonstrated by the improved Childhood Autism Rating Scale (CARS) [36].

Treatment for Milk allergies:
The fact that camel milk lacks β−lactoglobulin and a "new" β—casein[37] ,two powerful allergens in cow milk, makes the milk attractive for children suffering from milk allergies[38]. Phylogenetic differences could be responsible for the failed recognition of camels' proteins by circulating IgEs and monoclonal antibodies [39] .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. The reactions are rapid and long lasting. Much research still needs to be done on the healing effects of the milk.

Summary of this review [40]: The Camel milk has traditionally been used to treat diabetes. Camel milk contains high levels of insulin or an insulin-like protein which pass through the stomach without being destroyed. The stomach's acidity would normally destroy insulin - this is why developing 'oral insulin' is such a challenge. A month-long study in people with Type 1 diabetes suggested that drinking almost a pint of camel milk daily improved blood glucose levels, greatly reducing the need for insulin. If diabetes is not adequately controlled the patient has a significantly higher risk of developing complications, such as hypoglycemia, ketoacidosis, and nonketotic

hypersosmolar coma. Longer term complications could be cardiovascular disease, retinal damage, chronic kidney failure, nerve damage, poor healing of wounds, gangrene on the feet which may lead to amputation, and erectile dysfunction.

•It lacks beta casein and other common allergens found in cow milk and contains immune system components that might benefit children allergic to milk and other foods.

•It improves the quality of life for people with autoimmune disorders. Helping the immune system respond properly and no longer attacking a person's own body tissues.

•Camel milk is a good source of protein and referred to as whole food. It has enough nutrients to sustain life and is often given to babies suffering from malnutrition.

•Compared to cow, buffalo and ewe milk fat, camel milk fat has fewer short-chained fatty acids and high concentrations of volatile acids especially linoleic & polyunsaturated acids, increasing brain health and overall wellness.

Camel milk is a rich source of proteins with potential antimicrobial and protective activities; these proteins are not found in cow milk or found only in minor amount, moreover camel milk is used in some parts of the world as a cure for certain diseases. Camel milk is a whole food meaning it has enough nutrients to sustain a person through the day.

In many countries, camel milk is given to babies suffering from malnutrition. Compared to cow, buffalo and ewe milk fat, camel milk fat contains less short-chained fatty acids, but the same long-chained fatty acids can be found. Some researchers claim that the value of camel milk is to be found in the high concentrations of volatile acids and, especially, linoleic acid and the polyunsaturated acids, which are essential for human nutrition.

Nutritional fact of camel milk: Camel milk is low in lactose compared with cows' milk. However, levels of potassium, magnesium, iron, copper, manganese, sodium and zinc are higher than in cows' milk. Cholesterol in camel milk is lower than cow or goat milk. Camel milk is 3 times higher in vitamin C than cow's milk and 10 times higher in iron. It is also high in unsaturated fatty acids and B vitamins but less in vitamin A and B2. The fat content in camel's milk is similar to that of cow's milk. Camel milk is rich potassium, iron and minerals such as sodium and magnesium.

Health benefits of camel milk: 'Insulin' of the future: Camel milk has high concentration of insulin that has positive effect on the immunity. It does not thicken easily in an acidic environment. Diabetics in Somalia, Kenya and the USA who recognize the value of Camel milk are using Camel milk therapy to control their Diabetes.

Camel Milk based beauty products: Camel milk is a natural source of Alpha-Hydroxide acids which are known to chubby the skin and smoothies fine lines. Camel Milk soap provides a most deluxe bath experience. Products from Camel milk are already hitting the shelves of shops such as soaps and yogurts[41]

Other benefits: Camel milk is supposed a precautionary in ulcers. Regular intake of camel milk helps to control blood sugar levels. Camel milk helps in reducing coronary heart disease. Camel milk also benefits in infection, tuberculosis, gastroenteritis, etcetera and cancer. Immunoglobulin is the substance in the camel milk that contributes to immunity against infection. Camel milk is also supposed to be a new Viagra. Camel´s milk cures severe food allergies and rehabilitates the immune system in children. Camel´s milk has a number of antibodies that are compatible with human ones and very small molecules that can easily enter the bloodstream by the intestines.

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