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An overview of the physicochemical, technological and therapeutic properties of camel milk

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Abstract:
Camel milk is opaque white in color, foamy, with a weak sweet smell, spicy taste and sometimes a little salty. Its opaque white color is due to the fats that are well-homogenized throughout the milk, and its taste changes due to feeding on shrubs. And special plants in the dry area and water consumption.
Camel has the ability to live in harsh conditions, hot and harsh weather and frequent lack of water, and in these conditions it produces more milk than other species.
The most important factors affecting milk production in camels include: breed, age, breed, season, feeding and management (milking routine and milking method: manual or machine milking).
The components of camel milk are protein 3.4%, fat 3.5%, lactose 4.4%, ash 0.79% and water 87%. Its density is reported from 1.026 to 1.035, pH from 6.2 to 6.5, and its viscosity at 20°C is 1.72 mPa/s.
Key words: camel milk, physical and chemical properties, biotechnological properties, therapeutic properties

Introduction

Camel milk is mentioned for the first time in the Muslim Bible as a gift for the hungry and as a cure for diseases. Hazrat Muhammad considered camel milk as medicine.
This claim is still valid today and therefore it can be considered a natural and historical treatment. Scientists believe that this is due to the body's immune system.
Camel milk contains various protective proteins, mainly enzymes that have antibacterial and immunological properties.
Also, many nutritional and medicinal properties have been expressed for camel milk because it contains high amounts of antibacterial substances, low fat and lactose content, high potassium, magnesium and iron, numerous vitamins such as E, A, B1 less than cow's milk and vitamin C. It is more compared to other ruminants.
In addition, it contains protective proteins that may have a possible role in strengthening the immune defense and triglycerides that contain many types of fatty acids with small amounts of di- and monoacylglycerol, cholesterol, free fatty acids and phospholipids.
The amount of lysozyme in camel milk is higher than human and cow milk. Camel milk is opaque white in color, foamy, with a weak sweet smell, spicy taste and sometimes a little salty. Its opaque white color is due to the fats that are well-homogenized throughout the milk, and its taste changes due to feeding on shrubs. And special plants in the dry area and water consumption.
Camel has the ability to live in harsh conditions, hot and harsh weather and frequent lack of water, and in these conditions it produces more milk than other species. The most important factors affecting milk production in camels include: breed, age, breed, season, feeding and management (milking routine and milking method: manual or machine milking).
The components of camel milk are protein 3.4%, fat 3.5%, lactose 4.4%, ash 0.79% and water 87%. Its density is from 1.026 to 1.035, pH is from 6.2 to 6.5, its viscosity at 20 degrees Celsius is 1.72 mPa/s and its freezing point is reported as -0.57 to -0.61 (Abrhaley, 2018, Alavi, 2017) , kumar 2016, Mullacharam, 2014, singh, 2017,).

Compositions of camel milk

Protein

Camel milk contains two main parts of protein: casein and whey protein, the total amount of proteins varies from 2.15 to 4.90% and in some sources from 3 to 3.9%, and on average, the content of proteins in camel milk is 3.1%. It is influenced by season and race. The Majaheim breed has higher protein than other breeds, and the highest amount of protein is in November and December and the lowest amount is in August.
Casein is the main part of camel milk protein. Casein protein, which makes up 52 to 87% of the total milk protein, and whey protein is the second largest part of camel milk protein, which covers 20 to 25% of camel milk. Casein parts in camel milk include: αs1-casein (22%), αs2-casein (9.5%), β-casein (65%) and κ-casein (3.5%).
The average diameter of casein micelles in camel milk is 260-300 nm, which is twice as much as 130

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nm in cow milk. Camel milk is similar to human milk in that it contains a high concentration of beta-casein, which may be the reason for its better digestion and reduced allergies in infants.

Also, camel milk contains more protein (especially casein) and less whey than human milk. Camel milk protein has whey protein in the range of 0.63 and 0.80. β-lactoglobulin and α-lactalbumin are also part of it.

Camel milk whey protein consists of other main components such as peptidoglycan recognition protein, immunoglobulins, lactoferrin, lysozyme, lactoperoxidase and serum albumin, all of which are a heterogeneous group of compounds that differ in composition and properties (Brezovchi, 2015, Jilo, 2016).

Fat

The fat level of camel milk is 2.9 to 5.4% and its amount decreases to 1.1 to 4.3% in thirsty camels. But a recent study showed that camel milk contains only 2% fat, which is mainly composed of polyunsaturated fatty acids and omega fats.

The smallest fat globule is found in camel milk with 2.99 µm and the largest with an average diameter of 8.7 µm in buffalo milk. The high dispersion state of camel milk fat has a positive effect on the access of lipolytic enzymes to small fat globules (SFGs).

Therefore, camel milk is more digestible for humans. The cholesterol level of camel milk fat is 34.5 mg/100 grams compared to the cholesterol level of 25.63 mg/100 grams of cow milk fat.

Cholesterol is present in the milk fat globule membrane (MFGM) and constitutes 95% of it. Milk fat sterols SFGs are characterized by a larger level of MFGM per unit of fat. Therefore, a higher contribution of SFGs is associated with a relatively higher concentration of cholesterol in milk.

Camel milk is unique in its fatty acid profile and contains 6 to 8 times less short chain fatty acids compared to cow, goat, sheep and buffalo milk.

The composition of fatty acids is influenced by the environment and physiological factors such as nutrition, stage of lactation and genetic differences within the species.

The majority of fatty acids in camel milk are palmitic acid and oleic acid. Compared to cow's milk, camel milk fat has less short-chain fatty acids, and its vitamin A and carotene levels are less, so its color is whiter. Camel milk contains more long-chain fatty acids than cow's milk.

Its average amount of unsaturated fatty acids is 43%. Camel milk has more essential fatty acids. The amount of saturated fatty acids in cow's milk is (69.9%) and in camel milk (67.7%). Cholesterol concentration in camel milk is 37.15 mg/100 grams and in cow milk is 25.63 mg/100 grams.

Studies related to physical constants such as melting temperature and crystallization temperature showed that these values are 41.9 °C and 30.5 °C in camel milk and 32.6 °C and 22.8 °C in cow milk.

The concentration of caprylic acid, palmitoleic acid, oleic acid and α-linoleic acid is higher in camel milk compared to cow milk. The concentration of myristic acid, palmitic acid and stearic acid is also higher in camel than in mare's milk (Brezovchi, 2015, Jilo, 2016).

Lactose

The majority of carbohydrates in camel milk is lactose, which is between 3.3 and 5.80%, and the lactose content is the only component that remains almost unchanged in a season, and the lactose content changes slightly only under the influence of hydrated or dehydrated conditions. Of course, the nature of the vegetation eaten by camels in desert areas can be a factor for wide changes in lactose content.

Camels usually like to use halophilic plants such as Salusa, Acacia and Artiplex to meet their physiological salt requirements. However, in some dromedary species the lactose content changes slightly over a period of time.

Lactose is easily digested by human lactase and there are no symptoms of lactose intolerance. Camel milk is a better choice for people with lactose intolerance because camel milk is easily digestible and easily metabolized by the human body, and can help reduce digestive system disorders that occur in people with lactose intolerance. (Abrhaley, 2018, Al haj, 2010).

Minerals

Total mineral content is usually expressed as total ash. This amount varies from 0.60 to 0.90 percent in Dromedary camel milk and the average is 0.79 to 0.07 percent.

Changes in the content of minerals are related to differences in breed, nutrition and water consumption. Camel milk is a rich source of

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chloride due to the fodder eaten by camels, such as atriplex and acacia, which usually contain a lot of salt.

Therefore, the reduction of the main components of milk and the increase of chloride in the milk of dehydrated camels may be another reason for the salty taste in camel milk.

Camel milk is a rich source of various minerals such as sodium, potassium, calcium, iron, manganese, phosphorus, zinc and copper, and the average amount of zinc is 0.53 mg, magnesium 0.5 mg, and iron 10.5 mg. Sodium is 0.29 mg, potassium is 59 mg and calcium is 156 mg per 100 grams of camel milk. Sodium, potassium, iron, copper and manganese minerals in camel milk are reported to be significantly higher than cow's milk.

Iron

Iron plays an essential role in a number of biological systems, including oxygen transport and storage as well as DNA synthesis. Manganese plays a key role in cell metabolism, the existence of this element is important for the function of enzymes that protect cells from free radical damage. Also, the content of calcium, phosphorus and magnesium in camel milk is close to cow's milk (Al Haj, 2010, Jilo, 2016).

Vitamins

Camel milk contains various vitamins such as vitamin C, A, E, D and group B. Camel milk is a rich source of vitamin C and its content is three times higher than cow's milk. Hence, raw and fermented camel milk can be a good source of vitamin C for people living in desert areas where vegetables and fruits are not available. The average content of vitamin C in camel milk is 34.16 mg/liter. The content of niacin (B3) in camel milk was reported to be high.

The content of vitamin A and riboflavin (B2) in camel milk is reported to be lower than that of cow milk. In Jordan, the average concentration of pantothenic acid, folic acid and B12 in camel milk is much higher than that of cow milk.

The concentration of thiamine (B1) and pyridoxine (B6) in camel milk was comparable to that of cow's milk, while the concentration of vitamin E was very close to that of cow's milk. 250 ml of camel milk contains about 15.5% cobalamin (B12), 8.25% riboflavin (B2), 5.25% vitamin A and 10.5% ascorbic acid ©, while 250 ml Cow's milk contains 43.5% cobalamin, 36% riboflavin, 9% vitamin A and 3.5% vitamin C (Al Haj, 2010).

Water

The amount of water in camel milk (81.4-87%) was similar to that of goat milk (84-88%), and the water in camel milk is mostly free water, while some of it is limited water. Ingredients soluble in milk water are lactose, α-lactalbumin and some salts (Brezovchi, 2015).

Therapeutic properties of camel milk

Antidiabetic properties

There is a traditional belief in the Middle East that regular consumption of camel milk helps prevent and control diabetes. Recently, it has been reported that camel milk can have such properties for the reasons mentioned.

1) Insulin in camel milk has special properties that make it easier to absorb into the bloodstream than insulin from other sources or cause resistance to proteolysis.

2) Camel insulin is enclosed in nanoparticles (lipid vesicles) that allow it to pass through the stomach and enter the blood circulation. The sequence of camel insulin and its predicted digestion pattern do not show the ability to differentiate to overcome mucosal barriers before being degraded and reaching the bloodstream.

However, we cannot rule out the possibility that the insulin in camel milk is contained in nanoparticles that are able to transport this hormone into the bloodstream. It is possible that camel milk contains small molecular "insulin-like" substances that mimic the interaction of insulin with its receptor.

Camel milk contains a high concentration of insulin 150 U/ml, although human, cow and goat milk contains insulin, but it breaks down in the stomach environment and coagulates in acids. Conversely, camel insulin is contained within the micelles and thus protected from digestion and proteolysis in the upper part (Jilo, 2016, Mullicharam, 2014).

Antimicrobial properties and strengthening of the immune system

IgG, IgA and IgD have been identified in camel serum based on cross-reaction with human immunoglobulins, and the level of immunoglobulin G in camel milk is 1.64 mg/ml, which is the highest level. IgG2 and IgG3 subtypes (normal for camels) consist of only two heavy chains.

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There are no light chains (VL). Camel IgG has a complete neutralizing activity against tetanus toxin by entering the enzyme structure. The highly modified regions of camel have an increased set of antigen binding sites.

Camel VHH domains are better suited for enzyme inhibitors than human antibody fragments, thus offering potential for viral enzymatic neutralization.

A major drawback In the development of human immunotherapy is the size of antibodies. Larger antibodies cannot reach their target.

The relative simplicity, high affinity and specificity of camel Igs, and the potential to reach and interact with active sites, allow penetration of dense tissues to reach antigens. The immune system of camels is stronger than that of humans, and small immunoglobulins enter human blood from camel milk.

Since immunoglobulins are found in camel milk throughout lactation, drinking milk provides a way to combat autoimmune diseases by rehabilitating the immune system rather than depressing it. Immunoglobulins (Igs) are large long and short chain domains that have difficulty reaching and penetrating antigens.

Camel immunoglobulins do not have short and small chains, so they are active against antigens. Camel immunoglobulins enter the milk and are therefore available to fight autoimmune diseases.

The most important factor is that conventional treatments for autoimmune diseases are based on suppressing the immune system, while camel milk Igs strengthen the immune system and restore immune integrity. The presence of these proteins helps explain some of the natural healing properties of milk.

Known protective proteins and their immune functions in camel milk include: lysozymes, which participate in the primary immune system based on targeting common structures of invading pathogens; Immunoglobulins protect the body against infections.

Lactoferrin saturated with iron (from the second week of lactation) prevents microbial growth in the intestine. It participates in the primary immune system, which is based on targeting the common structures of invading pathogens. Camel milk contains much more lactoferrin than other ruminant milk (cow, sheep and goat).

It is closely related (71%) to human thyroid peroxidase, which is involved in iodination and coupling in the formation of thyroid hormones. Lactoperoxidase is found in milk, tears and saliva, which helps the defense system of the non-immune host.

It has bactericidal activity, mainly on Gram-negative bacteria such as Escherichia coli, Klebsiella pneumoniae, Salmonella, Pseudomonas and Gram-positive bacteria Listeria monocytogenes, Staphylococcus aureus and Clostridium.

Some studies showed that milk LP was inhibitory against Gram-positive bacterial strains and bactericidal against Gram-negative strains. Also, the antiviral effects of camel milk against hepatitis viruses, herpes simplex and human immunodeficiency virus (HIV) have been proven.

Of course, it also has antifungal effects (Candida albicans). The antibacterial and antiviral activity of camel milk, which has NAGase activity similar to the activity of women's milk, shows the nutritional benefits of camel milk compared to cow's milk, in addition, it has anti-tumor activity. Peptidoglycan recognition protein (PGRP) has the highest concentration of this enzyme in camel milk. (Jilo, 2016, Mullacharam, 2014).

The property of treating Crohn's disease

Crohn's disease is becoming an epidemic in many countries. Recently, evidence has shown that a primary bacterial infection is caused by Mycobacterium avium – subspecies: paratuberculosis (MAP). This mycobacterium can be spread through cow's milk because it is not affected by pasteurization.

Apparently, MAP enters the mucosa saprophytically and is only activated when the individual is under severe stress, leading to a secondary autoimmune response.

Since this bacterium belongs to the tuberculosis family and camel milk has been used to treat tuberculosis, it is clear that the strong bactericidal properties of camel milk combined with PGRP have a positive and rapid effect on the healing process. In addition, immunoglobulins attack anti-DNA and restore the immune system (Mullacharam, 2014).

The property of treating autism

Because a malfunctioning immune system inhibits the digestive enzyme and causes the breakdown of

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casein, not into amino acids, but into casomorphin. Casomorphin is a strong opioid that is much stronger than morphine itself. Autistic children who drink camel milk have made amazing improvements in their behavior and diet.

Extensive studies have shown that oxidative stress plays a critical role in the pathology of several neurological diseases, including autism spectrum disorder (ASD). These studies suggested that GSH and antioxidant enzymes play a pathophysiological role in autism.

In addition, camel milk has potential therapeutic effects in autism. A previous study evaluated the effect of camel milk consumption on oxidative stress biomarkers in autistic children by measuring glutathione, superoxide dismutase and myeloperoxidase plasma levels before and 2 weeks after camel milk consumption using ELISA technique.

All measured parameters showed a significant increase after consumption of camel milk ($P < 0.5$). These findings indicate that camel milk can play an important role in reducing oxidative stress by changing antioxidant enzymes and non-enzymatic antioxidant molecules, as well as improving autistic behavior as shown by the Children's Autism Rating Scale (Mullacharam, 2014).

Rejuvenating properties

A-Hydroxyl acids which are known as fattening and skin smoothing. These acids help shed the outer stratum corneum, remove dead skin cells (epidermis) by breaking down the sugars that are used to hold skin cells together. And new cells are revealed, which are more elastic and transparent.

A-Hydroxyl acids help to eliminate wrinkles and age spots and eliminate dryness, and by making the lower layer of the dermis thick, it helps in this process.

In addition, the liposome in milk Camel can be used as a potential cosmetic ingredient to improve the anti-aging effect.

Vitamin C in camel milk has antioxidant and tissue repairing properties and is necessary for the production of collagen, a protein that increases the growth of cells and blood vessels and gives strength to the skin, and the power of collagen production in the skin and increases joints.

Vitamin C is an antioxidant that slows down the rate of free radical damage that causes skin dryness and wrinkles (Abrhaley, 2018).

Treatment of milk allergy

The fact that camel milk is now known to be free of β-lactoglobulin and a "new" β-casein, two potent allergens in cow's milk, makes the milk attractive to children suffering from milk allergies.

Phylogenetic differences could account for the failed identification of camel proteins with circulating IgE and monoclonal antibodies Children with severe food allergy recovered rapidly with camel milk.

Camel milk seems to have a positive effect on children with severe food allergies. Reactions are fast and long lasting. There is still much research to be done on the healing effects of milk (Mullacharam, 2014).

Discussion and conclusion

They found that milk fat is about 2%, that this low amount of fat is more suitable for people with high blood fat. On the other hand, Al-hagi realized that camel milk contains a lot of vitamin C and B3.

Abrhaley came to the conclusion that vitamin C in camel milk has antioxidant and tissue repairing properties and is necessary for the production of collagen, a protein that increases the growth of cells and blood vessels and strengthens the skin.

It increases the power of collagen production in the skin and joints. Vitamin C is an antioxidant that slows free radicals, the damage that causes skin dryness and wrinkling. Cow's milk makes milk attractive to children who suffer from milk allergies.

From the present studies, it can be concluded that camel milk is a valuable food for the people of desert and arid regions, which in addition to meeting the nutritional needs of the people, also has therapeutic properties, which include:

1- Regular consumption of camel milk helps control blood sugar levels.

2- Immunoglobulin in camel milk helps immunity against infection.

3- Camel milk treats severe food allergies and restores the immune system in children and adults.

4- Camel milk has a number of antibodies that are compatible with human milk and has very small molecules that can easily enter the bloodstream through the intestine.

5- People with Crohn's disease can use camel milk for treatment.

6- Camel milk consumption is considered a good option for women or people who care about the beauty and health of their skin.

7- It is possible to treat children with autism using camel milk.

8- Camel milk can be useful for pregnant women due to the presence of various vitamins and minerals.

Therefore, breeding camels in order to use its milk can be a good economic solution. On the other hand, the development of this industry and the production of related products such as yogurt, cheese, butter, cream, buttermilk, and ice cream create diverse products in the market that can find their customers. This work requires extensive advertising to introduce this valuable product (white gold of the desert).

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