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CHEMICAL COMPOSITION OF CAMEL MILK AND ITS BENEFICIAL EFFCTS ON HUMAN HEALTH

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Abstract

Camel milk is considered one of the main components of the human diet in many parts of the World. The main components of whey proteins in camel milk and colostrum were similar to that in bovine, except for the lack in β-lactoglobulin. Due to its property camel milk has been also recommended to be consumed by children who are allergic to bovine milk. Other whey proteins which have been identified in camel milk include serum albumin, α-lactalbumin, immunoglobulins, lactophorin and peptidoglycan recognition protein. It has a high concentration of insulin used for diabetes. In addition, camel milk is used to stabilize the condition of patients with biliary atresia due to vitamin concentration at high concentration. Another application area of the camel milk due to its antibacterial and anti-viral properties is to use in human medicine. It has high concentration of insulin which is used for diabetes. Aditionally, camel milk is used for stabilize the conditions of biliary atresia patients due to its higher concentration of vitamin.

Key words: *camel milk, chemical composition, beneficial effects, human health.*

INTRODUCTION

Camels were domesticated and developed approximately 5,000 years ago and throughout these years have played an integral role in the daily life of camel owners. They are distributed in Africa and Asia, where other livestock farming cannot be easily implemented (Gupta et al., 2015).

According to the recent statistics by the Food and Agriculture Organization (FAO), the total population of camels in the world is estimated to be about 20 million, with Somalia having the largest herd worldwide (FAO, 2008). Also, according to FAO data the production of camel milk is 5.3 million/liter in the world. At the present time, depending on the camel cultivation camel milk production is also becoming increasingly common. For this reason, the number of scientific research on camel milk have increased in recent years. Today, camels and their products have been using by humans for transport, traction power, milk, meat, fiber (wool and hair). At the same time, it is used as a raw material for textile industry.

Milk is a complete food for newborn mammals during the early stages of rapid development (Shah, 2000). Camel milk composition has been studied in different parts of the world including Saudi Arabia (Elamin & Wilcox, 1992; Haddadin et al., 2008; Mehaia et al., 1995; Omer & Eltinay, 2009; Sawaya et al., 1984; Shuiep et al., 2008). Literature data have shown wide ranges of variation in camel milk composition, these variations will be discussed later. Konuspayeva, Faye, and Loiseau (2009) conducted a meta analysis study and given the means of camel milk composition (Bactrian and Dromedary) for the period between 1905 and 2006.

According to the present studies, camel milk can precisely play a far more important role in the protection of malnutrition than it does. Expanding and elevation foodstuffs for the rapidly increasing human population is particularly uncertain in the hot and arid zones of the world- the very areas where the camel is one of the few animals not only to keep alive, but also to profit man. Before presenting data on milk production, both quantity and quality, one must consider in detail all the suitable knowledge about the camel in order to sense the full value that this animal can play in human diet. According to studies, the production of camel milk has significantly increased during the last few years with now pasteurized fresh camel milk in the supermarket. These studies include that done to date of camel milk jaundice, asthma, in the treatment of various diseases such as tuberculosis it has been found to be helpful. In addition to this column cancer, diabetes, hypertension was identified that help to treat their patients (Hossam Ebaid et al., 2015). Nowadays, there is a general need to start a number of camel milk based functional products to the commercial markets due to increasing demand in recent years (Al haj and Al Kanhal, 2010). These products have to be clinically proven and scientifically evident supported (Ghosh, 2009). Camel milk has lots of functional properties. These are antioxidant activity, bioactivity, anti-cancer activity, hypoallergenicity activity.

Chemical composition of camel milk

The camel has the ability to produce more milk for a longer period of time in arid zones and dry lands (an environment of extreme temperature, drought, and lack of pasture) than in other domestic livestock species (Yagil and Etzion, 1980).

Most camel milk is drunk fresh. Also, it is consumed slightly sour or strongly soured. In generally, camels' milk is opaque white (Dihanyan, 1959; Kheraskov, 1961; Yagil and Etzion, 1980). Normally it has a sweet and keen taste, but sometimes it is salty (Rao, 1970). Sometimes the milk tastes watery. In particular countries there are concerns between the urban population concerning camel milk. It is considered as having an flavorless taste (Yasin and Wahid, 1957). It is foamy when afflicted slightly (Shalash, 1979). The varies in taste are caused by the type of forage and the presence of drinking water.

The pH of milk is around 6.5–6.7 (Shalash, 1979). This is parallel to the pH of sheeps' milk. It is also possible that the camel milk is kept at room temperature for a longer time without deterioration, since the acidity of camel milk is much slower than that of cow milk.

The first milk, called the colostrum, is white and slightly diluted as compared with the colostrum of cow (Yagil and Etzion, 1980). Other studies on the composition of the milk, contingent the stage of lactation, approve these data. During the first 2 days of lactation the total solid content decreased to 18.4%. This decreases in total solid was not draw on by a changing in fat content, as firstly the fat percentage was low, at 0.2%, and after 2 days of lactation fat percentage greatly increased to 5.8%; quite the decreases in total proteins and minerals was responsible.

Milk examined at monthly aperture until the 6th month of lactation, and at the end of the 14–17 months total lactation period, indicated that the average composition observed during the first month of lactation stayed stationary for the first 6 months. As a result of this study at the end of 14-17 months, average values of fat 1.079 %, protein 0.15 %, lactose 17.78 %, ash 2.60 %, and acidity 0.38 % have been observed (Ohri and Joshi, 1961).

In camel milk, the most important factor is water content. Camel's milk water content ripples from 84% (Knoess, 1976) to 90 percent. When, the diet remained unchanged throughout the year, studied only the effects of the lack of drinking water on camel milk, largely alters in water content of milk were based upon (Yagil and Etzion, 1980).

Generally, camel milk contains 2.9 to 5.5% fat, 2.5 to 4.5% protein, 2.9 to 5.8% lactose, 0.35 to 0.90% ash, 86.3 to 88.5% water, and 8.9 to 14.3% total solid non-fat (Khan & İkbal, 2001). Camel milk has similar protein content, lower lactose content (Elamin & Wilcox, 1992), and lower fat containing less saturated fatty acids (Gorban & Izzeldin, 1999) compared with cow's milk. Camel milk has greater contents of vitamin C (Mehaia, 1994), ash, and sodium, potassium, phosphorus, zinc, iron and manganese (Gorban & Izzeldin, 1997) than cow's milk.

Geographical root and seasonal variations are factors which influence most changes in composition of camel milk. Konuspayeva et al., (2009) studied the effect of geographical root on the composition of camel milk and the research indicated that camel milk from camels located in east Africa has more fat than milk from camels in Africa and western Asia. Seasonal variations also play a significant role in the composition of camel milk, also with camels of the same type and from the same district (Bakheit et al., 2008).

According to other research related to compositional, technological and nutritional aspects of dromedary camel milk; the average values of camel milk composition reported from 1980 to 2009 are as follows: protein 3.1%; fat 3.5%; lactose 4.4%; ash 0.79% and total solids 11.9% (Adel et al., 2009)

Dry matter in milk

The dry matter in milk, in mean of 10.4 %, consists of fat, lactose, proteins and ash (Kouniba et al., 2005). Stage of lactation and season have a substantial impact on the daily production of milk, composition of fat, protein and dry matter (Zeleke, 2007).

In dry matter (average 15.06 %) of camel milk, the main ingredients in camel milk are protein (4.9 %), milk fat (5.60 %), lactose (5.85 %), mineral substances (0.99 %).

Milk proteins and lactose

The total amount of proteins varies from 2.15 to 4.90 % (Konuspayeva et al., 2009). The content of proteins in camel milk is influenced by the type and season. The content of protein is lowest in August (2.48 %), and highest in December and January (2.9 %) (Haddadin et al., 2008).

According to Gorban and Izzeldin (1999) the protein and lactose in camel milk compared with cow milk, although similar in both types of milk protein content, camel milk has a low level of lactose and less saturated fatty acid composition. Milk from the thirsty camel has a seriously decreased percentage of protein (Yagil and Etzion, 1980). This situation shows the direct effect of drinking water on the composition of milk.

Also, it must be emphasized that protein content of the feed will directly affect that of milk. The substances of methionine, valine, phenylalanine, arginine and leucine are higher than in cow milk.

Whey proteins

In general, the composition of camel milk whey protein is different to that of bovine milk whey, where camel milk is deficient in β-lactoglobulin, as also observed for human milk (El-Agamy et al., 2006).

In bovine milk whey proteins, β-lactoglobulin is the main component (50%) and α-lactalbumin is the second (25%), whereas in camel milk whey, β-lactoglobulin is deficient (El-Agamy, 2000; Farah ve Atkins, 1992; Kappeler et al., 2004; Merin et al., 2001) and α-lactalbumin is the main component.

Camel milk is different from cow milk in point of chemical composition but it contains all essential nutrients as cow milk (El-Agamy, 1996), besides its high whey proteins such as lactoferrin and immunoglobulin that are give to it the high antimicrobial properties. In equated, camel milk includes more proteins and whey protein than cow milk (Farah et al., 1993, Walstra et al., 1999). The quantity of whey proteins of camel milks and cow milks are respectively, at 0.9 to 1.0 % and 0.7 to 0.8 % (Mohamed, 1990). This is primarily due to the higher content of albumin and lactoferrin (Farah, 1993). The functional properties of bovine milk proteins with camel milk proteins, the proteins were separated and characterized and found that an important thermodynamic property related to the heat stability (Beg et al. 1986). They showed that the whey proteins of camel milk were found to be much more heat stable than proteins of cow's milk (Farah and Atkins, 1992).

Casein

Casein forms approximately 80% of cow milk proteins (Hipp et al., 1952), while camel milk casein content is 52–87 % (Al haj and Al Kanhal, 2010). The cow milk main casein fractions are αs1-, αs2-, β- and κ-casein in ratio 4:1:4:1 (Walstra et al., 1984) and the amino acid numbers of residues in these four casein fractions were 199, 207, 209, 169, in order of as compared to 207, 178, 217 and 162, in order of for camel casein (Kappeler et al.,1998).

The content of casein fractions is very different between each fractions it is showed that the amount of κ-casein fraction of camel milk is of about 5% of the total casein, compared with about 13.6% in bovine casein (Ramet, 2001). Camel milk casein is different from cow's milk casein in terms of micellar size distribution. This large difference in the κ-casein content impairs the cheese making properties (Mohamed, 1990), There is little information available on the ability of camel milk to undergo enzymatic coagulation. When compared with cow milk camel milk casein and their fractions were found to be weak in crude protein (Pant and Chandra, 1980).

Concentration of nonessential amino acids of κ-casein in cow milk is higher than in camel milk, outside arginin the concentration is higher in camel milk of κ-casein. Cows milk κ-casein includes a higher concentration of essential amino acids in comparison of camel milk, outside for lysine whose concentration is higher in the camel milk of κ-casein (Salmen et al., 2012).

However, it would be untimely to dispute the effect of this difference in relation to the preparation of camel milk products. Therefore various biochemical aspects of camel milk should be considered and additional studies should be done.

Vitamin

In the studies performed about the vitamin concentration of camel milk showed that the camel milk contains less vitamin A than cows milk while the content of vitamin E is about the same level with comparison of camel milk (Farah et al., 1992), and the level of vitamin C is in average three times higher than that of cow milk (Stahl et al., 2006).

The availability of a relatively abundant amount of vitamin C (average 37.4 mg/l) in camel milk is of significant relevance from the nutritional viewpoint in the arid areas where fruits and vegetables containing vitamin C are scarce.

Also according to bovine milk, the niacin (B_3) content was noticed that to be higher in camel milk (Haddadin et al., 2008; Sawaya et al., 1984).

Milk fat

Milk fat is emulgated in milk, which means that it is found in the form of fat globules dispersed in milk serum. The diameter of fat globules varies between 1.2-4.2 μ. The amount of fat in camel milk ranges between 1.8% and 5.0 % (Khaskheli et al., 2005), with a mean of 2.63 %., compared camel milk with cow's milk and found that fat globules of cow's milk similar to the distribution of camel milk fat globules.

In compared with cow milk, camel milk fat contains less short-chain fatty acids (Abu-Lehia et al., 1989) and a lower concentration of carotene (Stahl et al., 2006). Due to the lower concentration of carotene, camel milk is significantly white. Camel milk also includes a higher concentration of long-chain fatty acids compared to cow milk (Konuspayeva et al., 2008). Similarly, mean values of unsaturated fatty acids (43 %) are higher in camel milk than cow milk, especially essential fatty acids (Haddadin et al., 2008). In cow milk, the amount of saturated fatty acids is higher (69.9 %) than in camel milk (67.7 %) (Konuspayeva et al., 2008).

Gast et al. (1969) asserted 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 and health.

Additionally, the dispersion state of milk fat has a considerable impact on the technological processes in dairy products as it determines the texture, flavor, and physicochemical properties of cheese and butter.

The beneficial effect of camel milk on the human health

Camel milk used for medical purposes for cure material of diseases. Camel milk can also be considered as a promising new protein source for children who are allergic to cow milk protein, and camel milk infant formula can be taken into account. Kappeler (1998) reported that camel milk is free of β-lg, which is considered as one of the major antigens of cow milk proteins responsible for the incidence of hypersensitivity reactions (allergy) in babies. Camel milk fat is mainly consists of polyunsaturated fatty acids that are completely homogenized and gives the milk a smooth white appearance.

The proteins of camel milk are the decisive components for preventing and curing food allergies because camel milk contains no β-lactoglobulin and a different β-casein, these two components in cow milk that are responsible for allergies.

Camel milk contains a number of immunoglobulins that are compatible with human ones which is reduce children's allergic reactions and strengthen their future response to foods. The importance of treating food allergies by using camel milk in children is therefore found in its non-allergenic properties and the child's immunologic rehabilitation. Two main categories of hypersensitivity are that allergy and autoimmune disease. Strongly and rapidly the immune system develops and it is challenged at a young age would also be contributing factors.

Milk allergy is caused by the immune system reacting to the protein in the milk as a threat to the body. Most allergic people produce immunoglobulin E as an antibodies. In vitro tests have shown that camel milk reduces anti-immunoglobulins in the blood.

Hamers-Casterman et al. (1993) described the magnificent immune system of the camel, which is different from of all other mammals. IgG2 and IgG3 consist of only two heavy chains and there are no light chains. There is a single V domain (VHH) (Riechmann and Muyldermans, 1999).

Camel VHH has a long suppmentary determining region (CDR3) loop, compensating for absence of the VL. Conventional antibodies seldom exert a complete neutralizing activity against enzyme antigens. Camel IgG has full neutralizing activity. Camel hypervariable regions have increased the repertoire of antigen binding sites (Muyldermans et al., 2001). VHH domains of the camel are better suited to enzyme inhibitors than human antibody fragments (Riechmann and Muyldermans, 1999).

Viral enzymes play an important role in triggering diseases, their neutralization can prevent their replication. Variable domain antibody fraction of camel is a potent and selective inhibitor of the hepatitis C enzyme system (Martin et al., 1997). The size of the antibodies is a major flaw in the development of immunotherapy. Larger antibodies cannot reach their target. The camel's antibodies have the antigen similarity as human antibodies but they are ten times smaller (Jassim and Naji, 2001).

In camel milk there are many protective proteins that exert immunologic, bactericidal and viricidal properties (Kappeler et al., 1998). The most important of these are lactoferrin, lactoperoxidase, PGRP and NAGase.

Camel milk is also rich in vitamin C, calcium and iron. Diabetic patients start insulin therapy, they have to take it permanently and usually insulin dose continue to increase as time progresses. Clinical research on the use of camel milk by patients with type 1 diabetes has indicated that drinking camel milk daily decreases the blood glucose level and reduces insulin requirement by 30%. Clearly, that camel milk provides an insulin-like protein in a different form than in other mammals and gives some other therapeutic compounds that raise the health of diabetic patients.

As a unique property of camel milk, the insulin-like protein could be protected in the stomach and absorbed efficiently into blood stream to reach the target. This is why camel milk does not coagulate in an acidic environment and it has a higher buffering capacity than the other ruminant milks. Camel milk also contains approximately 52 micro unit/ml of insulin-like protein compared to cow milk (16.32 micro unit/ml) which imitates insulin interaction with its receptor, and it has a higher content of zinc which has a key role in insulin secretory activity in pancreatic beta cells.

Beg et al. (1986) found that the amino acid series of some camel milk protein is rich in half cystine, which has a cursory similarity with the insulin family of peptides. Camel milk has high concentration of vitamin C which is used for stabilize the conditions of biliary atresia patients. It also has a positive effect of chronic fatigue.

According to studies of Agrawal et al. (2003) in order to detect effective of camel milk on glycemic control and treatment of type-1 diabetes disease, camel milk demonstrated effective extention in the management of type 1 diabetes as there was important reduction in doses of insulin, diabetes quality of life however, there was no change in lipid profile and insulin levels. It is based on that one of the camel milk protein has many characteristics similar to insulin (Beg et al., 1986) and it does not compose coagulum in acidic medium (Wangoh, 1993). This lack of coagulum formation consents the camel milk to pass quickly through stomach together with the certain like protein/insulin and remains present for absorption in intestine.

According to studies of Agrawal et al. (2003), observed a significant improvement of camel milk treatment and the positive effects in weight gain.

These positive results are due to the nourishing qualities of camel milk. Camel milk was found to include about 52 units/litre insulin (Singh, 2008) and it may be the cause for smaller necessity of insulin in camel milk group.

Beg et al. (1986) has based upon that amino acid sequence of some of the camel milk protein. According to this study, camel milk is rich in half cystine, which has superficial similarity with insulin family of peptides. Lots of experiments shows that its therapeutic impact may be due to lack of coagulum creation of camel milk in acidic medium. Especially considering the level of insulin for diabetic patients is important to note the value of camel milk could be a success.

CONCLUSIONS

The production of camel milk has gradually increased due to an increased interest by consumers in recent years.

Camel milk was found to be different in some aspects from milk of other animal species, such as bovine milk.

Use of camel milk is widely spread not only during production of different kinds of milk products but also as cure material of different kinds of diseases such as cancer, diabetes, hypertension, autism dropsy, jaundice, tuberculosis, asthma.

One of the more important property of camel milk is suitable for people who have problem with milk protein allergy.

Therefore it is consumed especially for infants and babies.

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