Nutritional and medicinal value of camel (*Camelus dromedarius*) milk

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Abstract

The camel (*Camelus dromedarius*) is of significant socio-economic importance in the United Arab Emirates and its milk constitutes an important component of human diets in this country. In the present study, the analysis of nutritional value and medicinal properties of camel milk was recorded. The mean values of the main components monitored (g per 100 g) were: density (1.024±0.0021), pH values (6.67±0.059), moisture (88.96±1.222), proteins (3.71±0.16), fat (2.21±0.16), lactose (3.36±0.25), ash (0.48±0.05) and total solids (11.26±0.69). The overall mean values (%) were 14.65±7.70 for iron, 8.19±0.01 for zinc, 0.42±0.02 for copper, 0.19±0.01 for potassium, 0.14±0.02 for sodium, 0.11± 0.02 for calcium, 0.05±0.01 for phosphorus and 0.03±0.02 for sulphur. Camel milk is highly nutritious and is very suitable for human nutritional requirements. Camel milk is safe for consumption by human babies. However, be advised that camel milk is saltier than human and cow milk. Camel milk is richer in iron, zinc, copper, potassium, sodium, calcium and vitamin C than cow milk which makes it closer to human breast-milk than cow milk. The fat content of camel milk consisting of unsaturated fatty acids, volatile fatty acids, mainly linoleic acid, makes the milk more digestible and more cardiovascular friendly. Camel milk also has valuable therapeutic properties as it contains a high concentration of anti-bacterial, anti-fungal, anti-viral and anti-parasitic compounds and these help fight serious diseases like hepatitis, Rota viral diarrhoea, tuberculosis, and shistosomiasis. Also, camel milk has been used therapeutically against certain types of cancer, diabetes, colitis, autism and Crohn's disease. Camel's milk can

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be considered an option for individuals intolerant to lactose and children allergic to cow's milk.
Keywords: Camelus dromedarius, camel milk composition, antimicrobial activity, antitumor activity, diabetes, lactose intolerance, milk allergy, autism, Crohn's disease.

1 Introduction

Camels are multipurpose animals; they are used for milk, meat and hide supply, as well as for other purposes such as transport, entertainment, celebration and competition as in racing and beauty show [1]. The camel (*Camelus dromedarius*) is of significant socio-economic importance in many arid and semi-arid parts of the world and its milk constitutes an important component of human diets in these regions [2]. Camel milk is still the most important nutritional source for pastoralists in many Asian and African countries [3]. Dromedary camels produce more milk of high nutritional quality and for a longer period of time than other species in an environment that may be rightly termed as hostile in terms of extreme temperature, drought and lack of pasture [4, 5]. Camels can graze on low productive pastures on which the production of milk is possible and economically profitable. For this reason, camels may reduce the dependence of pastoralists on other livestock that usually is much more vulnerable to drought than camels [6.7]. Camel milk is one of the most valuable food resources for nomads in arid regions and can contribute to a better income for pastoralists, especially as in the last years milk consumption among the urban population was increasing [3, 7]. There are few countries as the UAE, Saudi Arabia, Mauritania and Kazakhstan where camel dairies exist and camel milk and milk products are produced in pasteurized form for placing on the national market [3]. Average milk yield of camel per day ranged between 3.5 (under desert conditions) to 40 liters (under intensive management). This great variation in camel milk production may be attributed to the high genetic variation between individuals, breed, feeding and management conditions, type of work, milking frequency, age of animal, persistency of lactation, lactation number and stage of lactation [8–11]. Depending on management and environmental conditions, the average lactation length in camel is 12 months with a range from 9 to 18 months [11, 12]. Worldwide, camel milk is not utilized to any significant extent probably due to unawareness of the use, and the market value of camel milk or because of its saltish taste and high acidic nature. However, it is much more nutritious than that from cow milk because it is low in fat and lactose contents, and higher in potassium, iron and vitamin C [9, 13, 14]. The value of camel milk in human nutrition and medicine has so far received very little factual and academic attention. Accordingly, the present study was taken up with a view to determine the nutritional and medicinal value of camel milk on the basis of the available literature. Accordingly, the Present study was carried out to investigate the nutritional and medicinal value of camel milk.

2 Materials and methods

2.1 Samples collection

Milk samples from fifty two she camels (Magater camels) at various stages of lactation were collected at random from camel-rearing areas around Abu Dhabi Emirate. The camels were allowed to graze freely in the desert, but were also supplemented with concentrate feed and green grass. Milk samples were collected at milking time in clean and dry bottles and brought to the laboratories of Al-Salamat Research Station and faculty of Food and Agriculture at Al-Ain, UAE for conducting various physicochemical analyses.

2.2 Physical and chemical analysis

The physical characteristics of various milk samples were determined shortly after they were brought to the laboratory. All determinations were carried out according to AOAC's [15] methods. The moisture content was determined by the difference between the known weight of milk sample and the determined weight of the total solid after evaporating the liquid component of the milk sample on a hot plate. The pH measurement was made using a pH-meter (WTW) in range of 0–14 units in aqueous samples. The total soluble solids were determined using a refractometer (Bellingham Stanley, England). Protein content was estimated using Buchi Digest System K437 (Astoria Pacific, USA). The mineral contents were measured in the ash using ICP-OES Varian Vista-MPX CCD Simultaneous. Fat content of milk was analyzed by Gerber method. Lactose content was determined by using Fehling's solution method. The ash content was obtained by incineration of the sample placed in the muffle furnace at 550°C for 6 h (15).

2.3 Statistical analysis

The collected data were subjected to statistical analysis and various descriptive statistics (means and standard deviation) were calculated.

3 Results and discussion

3.1 basic composition of camel milk

The present study revealed that the density (specific gravity) of camel milk was ranged in between 1.021 and 1.028 with an average of 1.024±0.0021 (Table 1). These results are in agreement with results reported by [16–18]. However, [11] who reported less density of camel milk (1.014 to 1.017), while the present findings were higher than those reported by [19, 20]. pH values of camel milk (Table 1) was observed in between 6.59 and 6.72 with an average of 6.67±0.059. These results were more or less relatively similar to that reported [8, 9, 16, 17], while higher than those of reported by [11, 20]. The low pH of camel's milk appears to be correlated with the high vitamin C content, giving the milk its sour

taste, which can be masked if the animal eats salty or bitter vegetation. The pH of fresh camel milk is lower than that of cow (6.54–6.8), human (7.03–7.6) and commercial infant formula [20, 21]. The percentage of water (moisture) in the camel milk varied between 86.5–91% with an average of 88.96±1.222. These results were relatively similar to that of reported by [17, 18, 19, 22]. However, [8, 11] reported wide variation (84 to 93 g per 100 g) in the moisture content of camel milk. Results indicated that the water content of milk was directly proportional when water is available for camel and inversely when exposed to drought. This could be a natural adaptation in order to provide necessary fluid to the dehydrated calf as well as for the Bedouin in long trips through the desert [22]. It has been reported that anti-diuretic hormones secretion is elevated in the dehydrated camels and thus the loss of water into the milk is due to the acts of this hormone [22, 24]. The most important factor affecting the overall composition of camel milk is water content.

Table 1: Physical quality of camel milk.

Parameters	Mean	SD	Minimum	Maximum
Density	1.024	0.0021	1.021	1.028
pH values	6.67	0.059	6.59	6.72
Moisture %	88.96	1.222	86.5	91

Table 2: Chemical composition of camel milk.

Components (g per 100 g)	Mean	SD	Minimum	Maximum
Protein	3.71	0.16	3.5	4.5
Fat	2.21	0.16	2	2.7
Lactose	3.36	0.25	3.0	3.7
Ash	0.48	0.05	0.42	0.55
Total solid	11.26	0.69	10.5	12.5

Mean value of protein (Table 2) was found to be 3.71±0.16, ranging from 3.5 to 4.5g/100g. These results are in consonance with the results of [11, 17, 25, 26]. These findings are higher compared to those of [26–31] which revealed the protein content of camel milk ranging from 1.80–3.9%. While the protein content in the present study were lower than those reported by [32, 33] (5.78 and 5.5%, respectively). It could be affected that protein content of the feed as well as water intake had directly affected the protein quality of milk [8]. According to the available literature, four casein fractions of camel protein have been isolated [22]. Shamsia [34], who revealed that camel milk proteins contained satisfactory balance of essential amino acids. So, camel milk can be considered as good source of protein and can meet part of the daily needs of humans from these nutrients. Table 2 presents the fat content of camel milk within the range of 2 and 2.7 g per 100 g with an average percentage of 2.21±0.16. These results are in

consonance with the results of Wernery *et al*. [35]. The fat content in the present study was found lower in comparison to that of fat content noted in camels by [5, 18, 23, 26, 28, 29, 31, 32, 36, 37]. This low percentage is certainly due to an environmental difference reflecting the desert nature of our country. Generally, estimates of fat percentage of camel fat vary with the season [38] and stage of lactation [28]. Yagil and Etzion [39] reported that high temperature and water restriction increased the water contents in camel milk and reduced its fat percentage. Lactose content of camel milk (Table 2) varied between 3.0 to 3.7 g per 100 g with an average of 3.36±0.25. [11, 16, 18, 22, 23, 29, 31, 37, 40], reported the lactose content ranged from 2.91 to 6.30%. The lactose content of camel milk varies depending on water intake. When water is restricted, the lactose content decreased as so the taste of milk is less sweet in cases of dehydration. The total solids of camel milk (Table 2) in the present study varied between 10.5–12.5% and average 11.26±0.69. These results were in agreement with the results reported [5, 9, 11, 20, 27, 31]. These findings are higher as compared to cow (9.48), but lower than that of human (11.80) and commercial infant formula (12.88) [20]. Ash content of camel milk (Table 2) was observed to vary between 0.42 and 0.55 g per 100 g and average 0.48±0.05. These results were lower than those reported by different workers *i.e.* in between 0.60 to 1 g per 100 g [5, 11, 16, 26, 31, 32, 35, 40]. However, on some occasions, it possessed lower average [25, 41]. Halima *et al*. [20] reported that camel milk (0.86g/l) had very high ash content, compared with human milk (0.17g/l) and commercial infant formula (0.32g/l). In general, the variability of camel milk composition worldwide clearly depended on the geographical origin, breed, physiological stage, feeding conditions, milk production, genetic, stage of lactation, lactation number and health status of the udder [10, 42]. The mineral composition of camel milk is presented in Table 3. The present findings revealed that camel milk is rich in iron (14.65%), zinc (8.19%), copper (0.42%), potassium (0.19%), sodium (0.14%) and calcium (0.11%). Therefore, camel milk can be considered as a good source of these minerals for human. These findings were in agreement with the results reported by [9, 18, 26, 34, 35, 37, 43]. However, Farida and Srikumar [44] reported that the concentration of manganese

Table 3: Mineral composition of camel milk.

Parameters (%)	Minimum	Maximum	Mean	SD
Phosphorus (P)	0.04	0.09	0.05	0.01
Potassium (K)	0.1037	0.2029	0.19	0.04
Calcium (Ca)	0.1103	0.1738	0.11	0.02
Sulfur (S)	0.0241	0.0715	0.03	0.02
Sodium (Na)	0.09	0.21	0.14	0.02
Iron (Fe)	9.50	37.4	14.65	7.70
Copper (Cu)	0.0	2.3	0.42	0.02
Zinc (Zn)	4.9	18.7	8.19	0.01

and iron in camels' milk was higher (7–20-fold and 4–10-fold, respectively) than in human milk, cows 'milk and infant formula. The content of mineral salts in camel milk varies in concentration by up to 5% in situations of water restriction [45]. Taking into consideration all the main camel milk composition in this study, it may say that camel milk is highly nutritious and is very suitable for human nutritional requirements, and its composition is safe for consumption by human babies, as well as contain lower protein, fat and lactose, higher levels of iron, zinc, copper, potassium, sodium and calcium.

3.2 Medicinal value of camel milk

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 effect.

3.2.1 Antimicrobial activity of camel milk:

Camel milk contains various protective proteins (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 [46–51]. Camel milk has 30–100 times higher concentrations of lactoferrin than bovine milk and 648 ug/dL lysozyme which is higher than that found in bovine milk, which is 120 ug/dL, but less than the content found in human milk which is 40,000 ug/dL [40, 52]. Camel milk has been noted to have other medicinal properties, among others: treating tuberculosis [24, 34, 53, 54], ulcers, respiratory ailments [55] and hepatitis [56–59].

3.2.2 Camel milk for food allergies in children

The effect of camel milk on food allergies is based on the fact that it does not contain allergens that are so potent in cow milk. There is no beta-lactoglobulin [60, 61] a powerful allergen in cow milk, makes camel milk a potent alternative for children suffering from milk allergies [62] and another betacasein is present [60]. Another pertinent 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 [62].

3.2.3 Camel milk is the better choice for lactose intolerant people

Camel's milk can be considered an option for the individuals intolerant to lactose who presents symptoms when ingesting cow's milk [63, 64]. Camel milk contained low lactose of small molecules and easily digests and metabolized by the human body [45, 65]. Individuals intolerant to lactose are able to accept camel milk without adverse symptoms [63]. Shabo *et al.* [67] suggested that the lactose in camel milk is readily metabolized.

3.2.4 Camel's milk to treat diabetes

The milk of the camel has traditionally been used to treat diabetes. Camel milk does seem to contain high levels of insulin or an insulin-like protein which

appears to be able to pass through the stomach without being destroyed [67–75] and it does not form a coagulum in an acidic environment [76]. Radioimmunoassay tests of camel milk has revealed high concentration of insulin i.e. 52 micro unit/ml [77]. The concentration of insulin in human milk is also significantly higher (60.23 ± 41.05 micro unit/ml) whereas it is low in cow milk (16.32 ± 5.98 micro unit/ml) [78].

3.2.5 Camel milk is the alternative medicine for the Autoimmune Diseases

Camel milk has been identified as assisting in the recovery processes of autoimmune diseases such as autism and Crohn's disease. The etiology of many autistic cases is based primary autoimmune disease, affecting an intestinal enzyme responsible for the formation of amino acids from the milk protein casein. Instead, the breakdown of the casein, primarily beta-casein and beta-lactoglobulin, is to powerful opioid, casomorphine. The opioid leads to typical cognitive and behavior symptoms due to brain damage [79]. As camel milk does not contain beta-casein and beta-lactoglobulin, camel milk does not lead to autism symptoms. In addition, camel milk contains protective proteins, including the immunoglobulins necessary for initiating the immune system and nutritional advantages for brain development [79]. de Almeida reported that children drinking camel milk have had amazing improvements in their behavior and diets. 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 [80, 81]. It becomes apparent, that the powerful bactericide properties of camel milk, combined with PGRP (Peptidoglycan recognitian protein) have a quick and positive effect on the healing process [81].

3.2.6 Camel milk protect against types of cancer

Camel's milk has been shown to trigger apoptosis (controlled cell death) in human breast cancer and liver cancer cells via epigenetic mechanisms [82, 83]

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