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Physico-Chemical Characteristics of Raw Milk of One-Humped Camel from Khur and Biabanak in Isfahan Province of Iran

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ABSTRACT: The aim of the present study was to investigate the physico-chemical quality of raw milk of one-humped camel coming from Khur and Biabanak known as a camel-rearing area located in Isfahan province of Iran. 500 milliliters of raw milk from thirty individual one-humped camels were randomly collected and subjected for proximate analyses indicating the amounts of total solid, protein, fat, lactose, ash, acidity and pH that were 11.24±0.41%, 4.61±0.5%, 2.72±0.54%, 3.05±0.4%, 0.86±0.07%, 0.12±0.002% and 6.52± 0.18 respectively. The mean values of calcium, zinc, magnesium, and iron were demonstrated to be equal in respective order of 79.18± 0.58, 0.78±0.6, 1.44±0.14 and 0.69±0.33 mg.100 g^{-1}. Analysis of the physical properties revealed that the specific gravity, L*, a*, b*, whiteness and yellowness of the milk were 1.025± 0.009, 77.74±0.67, -0.90±0.37, 2.492 ±0.27, 39.3±0.91 and 4.81±1.06 respectively. According to the results mentioned earlier, it might be concluded that the raw milk produced from one-humped camels reared in Khur and Biabanak could provide a valuable source of energy for the consumers.

Keywords: *Khur and Biabanak, One-Humped Camel, Physico-Chemical Characteristics, Raw Milk.*

Introduction

Milk is globally produced by five animal species including dairy cattle, buffalo, goat, sheep, and camel. According to the statistical databases of Food and Agriculture Organization (FAO) (2010), the total amount of milk produced across the world is reported to be 696.6 million kg^3 of which 83.3%, 13%, 2.2% , 1.3%, 0.2% is allocated to cow milk, buffalo milk, goat milk, sheep milk and camel milk accordingly (Barłowska *et al*., 2011). As Al Haj and Al Kanhal (2010) and Zhang *et al.* (2005) expressed different species of camels belong to the genus camels that include the one-humped dromedary camel (*Camelus dromedarius*) and the two-humped bacterian camel (*Camelus bactrianus*). For the purpose of meat and milk production the one-humped camel was domesticated in 3000 B.C.E. in southern Arabia according to Mehaia *et al.* (1995), Zhang *et al.* (2005), Bulliet (1975) and Yagil (1982). According to FAO reports, there are about 19 million camels in the world of which 15 million camels are in Africa and the rest are located in Asia (Royatvand *et al.*, 2013).

Camel milk that is generally opaque and white has a sweet and sharp taste, but it is sometimes salty (Al Haj and Al Kanhal, 2010). According to the Statistical Center of Iran (2006) approximately 149,600 camels are located particularly in Iran in Yazd, Kerman, Sistan and Baluchistan, Isfahan and Semnan provinces.

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Recently, camel milk was reported to have potential therapeutic properties, such as anti-carcinogenic, anti-diabetic and anti-hypertensive (Al Haj and Al Kanhal, 2010). Despite the large population of the camels and the neutraceutical and therapeutical properties mentioned, camel milks is not utilized to a significant extent. However there are significant research works and studies concerned with camel milk in comparison with other milk sources namely bovine and goat milks. Sharing the same thought, Al Haj and Al Kanhal (2010) declared that the anatomical and physiological properties of camels have gone much more noticed due to the neutraceutical and therapeutical characteristics. Therefore, the present study was intended to make a significant contribution to the enrichment of the literature regarding the characteristics of the one-humped camel milk through scientifically exploring the physicochemical properties of one-humped camel milk produced in Khur and Biabanak which is known to be a camel-rearing area, among many other regions in Iran.

Materials and Methods

- *Milk Sampling*

This experimental study was undertaken from July 2013 to mid-March 2014. Some 30 one-humped camels that were at differing stages of lactation and on a normal diet were randomly selected for the purpose of milk sampling. Khur and Biabanak are situated in Isfahan province and are the historical cities of Iran famous for one-humped camel rearing. All the milk samples (500 ml each) were stored at 4℃ in sterilized bottles during transportation to the laboratory.

- *Chemical Analysis*

Titrable acidity based on lactic acid and pH values were determined according to AOAC, 2002. Total solids were measured by the gravimetric technique after drying the samples in an oven at 102 ℃ until the weight remained constant (Meiloud *et al.*, 2011). Ash content and mineral composition were determined as described by AOAC procedures (AOAC, 2002). Lactose content was determined by the difference of total solid minus other solid components (Zhang *et al.*, 2005). Fat content of milk was analyzed by Gerber method (Khaskheli *et al.*, 2005). Protein content was determined by the Kjeldahl method (AOAC 2002). The mineral content (Zn, Mg, Ca, Fe) were assessed using atomic absorption spectrophotometer (Perkin-elmer 800, USA).

- *Specific Gravity and Color Determination*

Specific gravity was measured using Density Meter (DMA 38, Anton paar, Canada). Hunter values including L^*, a^*, and b^* were determined using a Tex flash (Data color2000, Switzerland). All the tests were carried out in duplicate order.

Results and Discussion

Table 1 below displays the chemical composition of the milk samples from different regions. The variation in the values of the compositions stems from some factors some of which, according to Khaskheli *et al.* (2005) include lactation stage, feeding conditions, number of samples, age of the camels, and the number of the camel children.

The chemical compositions of one-humped camel milk from Khur and Biabanak are presented in Table 2. The average content of the fat in the samples was 2.72±0.54%. Variation in fat content is directly and/or indirectly related to the total solids content (Khaskheli *et al.*, 2005). The results gained from the present study are very similar to those reported by Khaskheli *et al.* (2005) who found out that the average was 2.63±0.40% that is lower than those (3.60±0.5%) reported by Sawaya *et al.* (1984) and Elamin and Wilcox (1992) who

Table1. Exhaustive references on camel milk composition from the literature (2000 until 2009).

Country	Protein	Fat	Lactose	Ash	Total solid	References*
Kenya	2.79	3.39	4.81	0.77	11.5	Guliye *et al*., 2000
Tunisia	2.81	1.20	5.40	0.99	9.61	Attia *et al.*, 2001
Israel	2.69	2.61	4.61	0.78		Sela *et al*., 2003
India	2.30	2.30	4.05		9.50	Raghvendar *et al*., 2004
Morocco	3.25	2.65	4.05	0.83	10.80	Kouniba *et al*., 2005
Tunisia	3.10	3.00	4.20	1.05		El-Htami *et al*., 2006
Arabian camel, Sudan	3.50	3.26	3.60	0.67	11.03	Abdoun *et al*., 2007
Egypt	3.30	3.78	5.85	0.70	15.06	Kamal *et al*., 2007
Jordan	2.69	2.95	3.92	0.82	12.30	Haddadin *et al*., 2008
East Sudan	2.93	2.64	3.12	0.73	9.56	Musa *et al*., 2008
West Sudan	2.94	2.85	2.90	0.73	9.41	Musa *et al*., 2008
North Sudan	3.40	3.40	3.60	0.80	10.90	Bakheit *et al*., 2008
Sudan	2.06	2.35	4.41	0.94	9.78	Omer and Eltinay, 2009

Table 2. Chemical composition of one-humped camel milk from Khur and Biabanak in Isfahan province of Iran

Component	Average (%)
Fat	2.72±0.54
Protein	4.61±0.50
Total solids	11.24±0.41
Ash	0.86±0.07
Water	88.75±0.41
Lactose	3.05±0.40
Acidity	0.12±0.00
pH values	6.52 ±0.18
Specific gravity	1.025±0.009

finally came up with 3.15±0.32% value.

In addition to fat content, protein content, as indicated in Table 2, is important to be considered here. The protein content was determined to be 4.61±0.5% (w/w). This finding is in agreement with the results reported by Raziq *et al*. (2011) claiming that the amount of protein existing in the camel milk turned out to be 4.01% and also, in agreement with Mukasa-Mugerwa (1981), Yagil and Etzion (1980) who concluded that the protein contents were 4.02% and 4.6% respectively. It should be emphasized that total protein content of Dromedary camel milk, according to Konuspayeva *et al*. (2009), varies from 2.15 to 4.90%.

However the comparison with the results (i.e. 2.81% and 2.95%) obtained by Sawaya *et al*. (1984) and Elamin and Wilcox (1992), the present study demonstrated higher values. The protein contents of the camel milk from three ecotype camels including Majaheim, Wadah and Hamra camels, in the central part of Saudi Arabia, were 2.91±0.23, 2.36±0.13, 2.52±0.19% respectively (Mehaia *et al.*, 1995). Khaskheli *et al.* (2005) argues that the protein content of the feed as well as the water intake directly affect the protein content of the milk. They added that camel breeds and seasonal conditions play vital roles in enhancing the protein content. Haddadin *et al.* (2008) reported that protein content was found to be at the lowest value (2.48%) in August but highest (2.9%) in December and January.

Lactose is a major carbohydrate in milk (Meiloud *et al.*, 2011). Lactose content is the only component that remains almost unchanged over a season and under hydrated/dehydrated conditions (Al Haj and Al Kanhal, 2010). The lactose composition of milk from Dromedary camels, bacterian, and hybrids was 4.46% (Konuspayeva *et al*. 2009). Lactose content in the present study was determined at 3.05±0.4%. However, a higher level of lactose content was reported (4.16%) by Elamin and Wilcox (1992) , 4.21% by Mukasa-Mugerwa (1981), 4.6% by Yagil and Etzion (1980) and 5.43% by Khan and Appanna, (1964). Raziq *et al.* (2011) made the claim that lactose content was 2.56% which is lower than the values reported.

The total solid (TS) content of the camel milk turned out to be 11.24±0.41% which is higher than the value reported by Elamin

and Wilcox (1992) and in agreement with the value claimed by Sawaya *et al*. (1984). The moisture content of the camel milk which is inversely proportional to TS content was observed to be 88.75±0.41. Interestingly, this finding is in conformity with those findings reported by Yagil and Etzion (1980) and Elamin and Wilcox (1992) whose studies were carried out under similar climatic conditions.

The ash content was another focal point of the present study. Ash content of the milk was observed to be 0.86±0.07%. As Meiloud *et al*. (2011) expressed, milk minerals have particular roles in the body as bone formation, water balance maintenance and oxygen transport. The mineral contents such as Fe, Zn, Ca, and Mg are presented in Table3. In the present study, the Magnesium value was 1.24± 0.14 mg.100g^{-1} which is lower than those reported by Sawaya *et al*. (1984), Mehaia *et al*. (1995), Abu-Lehia (1989) and Khan and Appanna (1964).

The Iron value in the present study was 0.69±0.33 mg.100^{-1}g. Interestingly enough, this value is higher than the values reported by Abu-Lehia (1987), Sawaya *et al*. (1984) and Elamin and Wilcox (1992) concerned with Saudi Arabia and India (Khan and Appanna, 1964). Such a difference might be due to the camel breed, the nature of feed and the topography of the habitat. Sharing the same thought, Raziq *et al*. (2011) stated that the mountainous regions have a higher level of Iron content in the soil than the deserts. In addition to Iron, Zinc existing in the Khur and Biabanak camel milk (Table 3) was determined at 0.78± 0.06 mg.100^{-1}g concentration which is a higher value than those reported by Abu-Lehia (1987) and Haddadin *et al*. (2008), but lower than 1.42 mg.100^{-1}g as reported by Raziq *et al*. (2011). The higher Zinc content could be correlated positively to the composition of the soil (Raziq *et al*., 2011). Further studies are needed to evaluate the correlation between the nature of the soil and the Zinc content of camel milk. Calcium content of the milk sampled in this study was 79.18±0.58 mg.100^{-1}g that it is higher than the report by Elamin and Wilcox (1992) whom found the Calcium concentration about 30.03 mg.100^{-1}g. However some reports have confirmed higher Calcium concentration in the examined samples (Farah and Ruegg, 1989; Sawaya *et al*., 1984).

Table 3. Mineral contents of one-humped camel milk from Khur and Biabanak in Isfahan province of Iran

Component	Average (mg.100g^{-1})
Fe	0.69± 0.33
Zn	0.78± 0.06
Ca	79.18±0.58
Mg	1.24± 0.14

Besides the mineral content discussed earlier the acidity that is characterized by Meiloud *et al*. (2011) to be considered as an important factor employed to determine the milk quality should be taken into careful consideration here. The mean value of the acidity was 0.12% that it is lower than the values obtained by Khaskheli *et al*. (2005) and Elamin and Wilcox (1992). The value attributed by this study to pH as a physical property was 6.5. This finding could be confirmed by the results achieved by Khaskheli *et al*. (2005) and Mehaia. (1996). On the contrary, this value of the acidity seems to be slightly higher than the pH value (6.4) reported by Abu-Taraboush *et al*.(1998).

The specific gravity of the randomly sampled milk was witnessed to be 1.025± 0.009. In a similar vein, this finding is in conjunction with the findings reached by Khaskheli *et al*. (2005) who concluded that a high level of water content brings about a low level of specific gravity and is influenced by climatic conditions.

Table 4 presents the color feature of one-humped camel milk from Khur and Biabanak in Isfahan province of Iran. Hunter

values for L*, a* and b* indicate the lightness, redness and yellowness of the samples respectively. Series of studies concerned with color feature have been investigated by many workers namely Al Haj and Al Kanhal (2010), Quinones *et al*. (1998), Stahl *et al*. (2006) and Abu-Lehia (1989).

Table 4. Color feature of one-humped camel milk from Khur and Biabanak in Isfahan province of Iran

Feature	Average
L*	77.74±0.67
a*	-0.90±0.37
b*	2.492 ±0.27
c*	2.652±0.71
Yellowness	4.81±1.06
Whiteness	39.3±0.91

Conclusion

The variations in camel milk composition were attributed to the reign, season, feed (nutritional status), age and stage of lactation. The results of the current study could contribute to the overall knowledge about the composition of camel milk from Khur and Biabanak in Isfahan province of Iran. However further studies are needed to evaluate the products that might be provided from this nutritious and efficient food.

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