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PHYSICO-CHEMICAL AND BIOLOGICAL HARACTERISTICS OF CAMEL MILK

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ABSTRACT

The present study was carried out to investigate some of the physical and principal chemical components of milk from the camel *(Camelus dromedarius)*. A wide variation was observed in the components of raw camel milk. The average contents of physical parameters were 6.70 for pH, 0.19 % acidity, 1.029 specific gravity. The chemical components were 11.30 % total solids, 4.40 % fat, 8.12 % solids not fat, 2.91 % protein, 3.18 % lactose and 0.90 % ash.

The highest level of glutamic acid was detected in camel milk, while it had a lower ratio of lysine than that of cow milk. There were noticeably higher levels of proline, aspartic, therionine, valine and leucine, respectively, while a lower values of cystine and methionine in camel milk.

Gas liquid chromatography analysis of camel milk fat indicated that the short chain-fatty acids (C_4-C_{12}) were present in very low percentages, while the concentration of long chain-fatty acids were high such as saturated fatty acids (C_{14}, C_{16} and C_{18}) and polyunsaturated fatty acids (mainly $C_{18:1}$). Also, the fatty acids in camel milk showed a higher degree of unsaturation, with especially relative high quantities of the essential fatty acids like linolenic ($C_{18:3}$) and linoleic ($C_{18:2}$) acids.

Keywords: Camel, milk, physico-chemical composition, total amino acids, fatty acids.

INTRODUCTION

The camel is among the animals mentioned in the Quran as a miracle of God (Deurasech, 2005). It is common practice to let camels to eat certain plants in order to use the milk for medicinal purpose (Yagil, 1986).

The *camelidae* originated in North America where the earliest fossil remains of *camelidae* have been found. The genus *camelus* migrated from North America in the late Tertiary across the existing land bridge to Asia and Africa. The term dromedary is derived from the Greek 'Dromados' which means runner or 'droma'- running and in the strict sense is used for riding camels. The name 'Bactrian' for the two-humped camel refers to the area (Baktria) in North Afghanistan where this type of camel is thought to have originated (Simpson, 1945; Zeuner, 1963).

There are different species of camels belonging to the genus camelus, the one-humped dromedary camel (*Camelus dromedarius*) and the two-humped bactrian camel (*Camelus bactrianus*) (Sawaya *et al.,* 1984).

According to FAO statistics (Global Livestock Production and Health Atlas - GLIPHA, 2006) the world population of camels is about 20 million animals, mainly in arid zones, of which 15 million camels live in Africa and 5 million in Asia (GLIPHA, 2006). In 2001, the total camel population was 19 million of which 17 million were dromedaries (*C. dromedarius*) and 2 million were Bactrian camels (*C. bactrianus*). In most countries, the camel population is increasing after a period of decreasing number due to the introduction of modern transport facilities. Dromedaries are mainly used for milk production, whereas the bactrians are mainly used for working and wool production (Farah, 2004).

In many arid regions of Africa camels play a central role in supplying the desert dwellers with milk of high nutritional quality and meat under extremely hostile conditions of temperature, drought and lack of pasture. Milk yields per day range from 3.5 kg per animal under desert conditions up 18 kg in irrigated areas. With progressing urbanization camel's milk is commercialized and emerges on the informal markets of the growing suburbs (Yagil and Etzion, 1980; Farah, 1996 and 2004).

Camel milk is normally drunk fresh, consumed when slightly sour or strongly soured, is usually an acquired taste or used to produce yoghurt or cheese particularly in countries where large camel populations are found.

The fact that it is mainly consumed in its raw state (boiling of the milk is not common as it is known to remove its "goodness"), the high ambient temperature and the lack of refrigeration facilities in many arid areas are the main reasons for hygienic problems (Radwan *et al.*, 1992; Semereab and Molla 2001). It has also a number of medicinal uses, the inherent ability to provide milk in times of drought, can be utilized to provide much needed food for children who would otherwise succumb to malnutrition and even food aid which is not suitable for them. Bedouin of the Sinai Peninsula were treated their diabetes by drinking camel's milk, there were even cases of juvenile diabetes being stabilized on camel's milk when insulin treatment had failed. Another side effect of camel's milk known to the Bedouin to relive his chronic fatigue, improve sexual prowess and liver cirrhosis (Yagil *et al.*, 1994). Beg *et al.*, (1986) found that one of the camel's milk proteins is similar to insulin. Also, raw camel milk had effect in type 1 diabetic patients (Agrawal *et al.*, 2005).

In several parts of the world, there are many folklore stories told by camel herders describing the use of camel's milk for medicinal purposes or as a health food, especially for dropsy, jaundice and conditions affecting the lungs and spleen (Yagil, 1982; Knoess *et al.*, 1986).

Camel's milk has unique biological values as well as antibacterial and antiviral properties due to its higher content of immunity factors (El-Agamy *et al.*, 1992; El-Agamy, 2000), which conform to previous data that camel's milk destroys *Mycobacterium tuberculosis* (Donchenko *et al.*, 1975; Ilse, 2004). Furthermore, camel's milk also had a beneficial action on chronic liver patients in Asia (Sharmanov *et al.*, 1978). It is estimated that worldwide there are 145 million malnourished children and from 4 to 5 million deaths due to diarrhoea each year (UNICEF, 1992), therefore it is used as a supplement to mother's milk or a an alternative to formula in order to provide a nutritious fresh milk in areas prone to diarrhoea due to bad hygienic conditions. Also, It can be considered a strong viral inhibitor to human rotavirus, which represents the main diarrhea-causing agent in infants (El-Agamy and Nawar, 2004).

Although the composition of camel milk has been studied in various parts of the world (Ohri and Joshi, 1961; (El-Bahey, 1962; Rao *et al.*, 1970; Knoess, 1977; Yagil and Etzion 1980; El-Agamy, (1983);

Sawaya *et al.*, 1984; Abu-Lehia, 1987; Hassan *et al.*, 1987; Yagil, 1987; Mehaia and Al-Kanhal 1989; Bayoumi, 1990; Hafiz and Hamzawi, 1991; El-Amin and Wilcox 1992; Farag and Kebary 1992; Al-Kanhal, 1993; Farah, 1993; Merin *et al.*, 2001). However, available information on camel milk is limited in Egypt, especially amino acids and fatty acids composition. Therefore, the present investigation was undertaken to study some physical, principal chemical composition, amino acids and fatty acids analysis of camel milk.

MATERIALS AND METHODS

Twenty individual samples of milk were collected from a herd of lactating dairy camels (*Camelus dromedarius*) at random in Berkash Village Market, Giza governorate, during the period January and February 2008. Five individual samples of cow's milk were obtained from private farm in West Omrania, Giza. Milk samples were collected in cleaned sample bottles and brought to the laboratory of Dairy Department, National research Centre for analysis and stored at -20°C until analysis.

Some physical parameters were measured as follows: pH by a digital pH meter (HANNA Instruments, pH 211, Microprocessor) and specific gravity at 20 °C gravimetrically using a hydrometer. Chemical composition of milk samples were analysed for titratable acidity, total solids (TS), total protein (TP), fat and ash contents according the methods of Ling, (1963). While lactose content was determined colorimetrically using the phenol-sulphoric acid method according to Barentt and Abd El-Tawab, (1957). The average of duplicate replicates was taken for each sample.

The analysis of amino acids was performed by analytical High Performance Liquid Chromatography (HPLC) method according to Millipore co-operative (1987). The apparatus used is Waters 600E Multisolvent Delivery System, Pico Tag analysis column, Waters 484 Detector and Workstation with Millennium Chromatography Manager software. The analysis was carried out using a gradient of Pico-Tag solvent A and B at 40 °C and flow rate 1 ml/min. The separated PTC-amino acids were detected at 254 nm wavelength. Before injecting the sample, the instrument was calibrated by two injections of the standards.

Analyses of fatty acids composition:

The analyses of fatty acids was carried out by defatting milk samples were defatted by centrifugation at 4000 rpm for 30 min. Methyl esters of fatty acids were prepared using the method of IVOOC, (1991), where about 0.1 g of fat was dissolved in 2 ml hexan and then 0.4 ml KOH in anhydrous methanol was added, mixture was treans-esterfied with cold phenol solution of potassium hydroxide. After 3 min, 3 ml water was added, the organic layer, separated by centrifugation, was dried by anhydrous sodium sulfate, and concentrated with N_2 stream to around 0.5 ml for GLC analysis of fatty acid methylesters.

Fatty acid methylesters were directly injected into Agilent 6890 series gas liquid chromatography (GLC) apparatus, provide with a DB-23 capillary column (60 m x 0.32 mm x 0.25 μm). Carrier gas was N_2 with flow rate 3 ml/min, splitting ratio of 1:50, H_2 flow rate 40 ml/min and flow rate 450 ml/min. The injector temperature was 230°C and that of FID detector was 250°C. The temperature setting was as follows: 150-170°C at 10°C/ min, then 170-192°C at 5°C/min (holding 5 min and then 192-220°C during 10 min (holding 3 min).

The peaks (fatty acids) were identified by comparison of retention time obtained with known standards and were expressed as percentage of total fatty acids. The proportions of the individual acids were calculated from the ratio of their peak area to the total area of all the observed acids.

RESULTS AND DISCUSSION

Changes in the physico-chemical parameters and composition (pH, acidity, specific gravity, total solids, total protein, fat, lactose and ash) of camel and cow milks with comparison to different previous data of camel and cow milks are shown in Table (1).

Camel milk has a very white opaque colour, a faintly sweetish odor and a sweet but sharp taste, but sometimes can also be salty. It is thinner than cow or buffalo milk. Similar data were in accordance with that of **Ohri and** Joshi (1961); Abdurahman, (1996). Also, (Farah, 1996) decided that these changes in taste were caused by the type of fodder and availability of drinking water.

The pH values of fresh camel milk ranged from 6.55 to 6.87 with an average value of 6.70, which is relatively similar to that reported value 6.77 by Khaskheli *et al.,* (2005), and value 6.6 by (El-Bahay, 1962; Field *et al.*, 1997), also, slightly higher when compared to our cow milk (6.6), and values (6.5-6.7) by FAO (1982). While higher than those reported by Sawaya *et al.,* (1984); Hassan *et al.,* (1987); Ahmed, (1990); Farag and Kebary (1992) (6.49, 6.41, 6.53 and 6.39 respectively), and with those of Gnan and Sheriha, 1986), who reported that the values between 6.2 and 6.8.

However, the acidity of milk mainly reflects temperature of milk after collection, husbandry techniques and marketing practices. The acidity in terms of lactic acid content varied between 0.15 to 0.22 % with an average of 0.19%. These results are higher than those reported by Hassan *et al.,* (1987); Ahmed, (1990); El-Amin and Wilcox, (1992); Farag and Kebary (1992) (0.16, 0.13, 0.15 and 0.17% respectively). But Rodriguez *et al.,* (1985) reported 0.14 and 0.I5 for Jerseys and Holsteins. Both these values are lower than those of cows' milk (El-Bahay, 1962; Rao *et al.,* 1970; Sawaya *et al.,* 1984). It is worth mentioning that the acidity of camel milk is still of particular importance in determining the freshness and keeping quality of camel milk. Ohri & Joshi (1961) found that the acidity of camel milk 2 h after milking was low (0.03 %) and increased to 0.14 % in 6 h. They also reported that camel milk soured in 8 h when kept at 30°C compared with cow's milk, which soured within 3 h at the same temperature. Differences in hygiene of the actual milking and in the total microbial count and its activity in milk could account for the differences in the increase in acidity.

Specific gravity (density) is dependent on temperature at the time of measurement and composition of material, especially fat content. Table (1) revealed the average of specific gravity of camel milk is 1.029. This finding is in agreement with those reported by Hassan *et al.,* (1987); Ahmed (1990). While it is relatively lower than those reported by Farag & Kebary (1992); Khaskheli *et al.,* (2005), also, it is lower than cow milk in our study (1.037), which is corresponding with Birgitte *et al.,* (2004), who mentioned that the mean value of specific gravity for cow was 1.038.

The total solids content of camel milk varied between 8.96 to 12.10 % with an average of 11.30 %. These results were higher than those of El-Bahay, (1962); Hassan *et al.,* (1987) (10.94 and 10.12% respectively), but lower than those by El-Agamy, (1983); Farag and Kebary (1992); Zhang *et al.,* (2005); Kamal *et al.,* (2007); Haddadin *et al.,* (2008) (13.10, 12.36, 14.31, 15.06 and 12.3 % respectively), also, lower when compared to our cow milk (11.91%). FAO, (1982) and Ahmed, (1990) reported similar fluctuations (84 to 93 g/100g) in the moisture content of camel milk which is inversely proportional to TS content. One of the reasons they reported was hot summer, during which the camel secretes highly diluted milk with low fat. This could be the natural phenomena by which the camel young ones are supplied with sufficient nutritional value and water for a superb adaptation in a desert environment. Secondly, water content of fodder would also affect water content of milk. It has been clearly demonstrated that experiments which restricted drinking-water caused an increase in water content and a subsequent decrease in total solids (Yagil and Etzion 1980; Yagil, 1986). Seasonal climatic variations, water and feed availability had a similar effect (Knoess *et al.,* 1986).

Relative similar data of fat contents were recorded by El-Agamy, (1983); Haddadin *et al.,* (2008) and is lower than that of El-Bahay, (1962); Hassan *et al.,* (1987); Farag and Kebary (1992); Zhang *et al.,* (2005); Kamal *et al.,* (2007), also is lower when compared to our cow milk (3.6%) and that of many cattle breeds (Atherton and Newlander 1977). This difference could reflect species differences and feeding conditions. Generally, estimates of fat percentages of camel milk vary with season (Knoess *et al.,* 1986), stage of lactation (El-Amin, 1979) and pregnancy (Rodriguez *et al.,* (1985). The results of fat contents were similar to those of reported by (FAO, 1982) according to which, the hydration status of the animal as well as the type of forage eaten would also affect the fat content of the milk.

Content of the mean calculated solids not fat (SNF) of camel milk (8.12 %) was appreciably approximately near to cow milk (8.31 %) in our study. These data were higher than those reported by El-Agamy, (1983); Farag and Kebary (1992); Zhang *et al.,* (2005); Kamal *et al.,* (2007). Also, lower than applied to El-Bahay, (1962); Hassan *et al.,* (1987).

The total protein content of camel milk was between 2.13 and 3.20 with an average of 2.91 %. It could be stressed that protein content of the feed as well as water intake had directly affected the protein quality of milk (FAO, 1982). Relative similar data of protein were observed by Sawaya *et al.,* (1984); Hassan *et al.,* (1987); Haddadin *et al.,* (2008), but lower than those by El-Bahay, (1962); Mukasa-Mugerwa, (1981); El-Agamy, (1983); Farag and Kebary (1992); Zhang *et al.*, (2005); Kamal *et al.*, (2007). Also, slightly lower comparing to our cow milk (3.35 %).

Average of lactose percentage in our study (4.40%) was similar to that reported by Knoess, (1977); Farag and Kebary (1992) and higher than that of El-Bahay, (1962); Hassan *et al.*, (1987); Haddadin *et al.*, (2008), but was lower than those of Mukasa-Mugerwa, (1981); El-Agamy, (1983); Sawaya *et al.*, (1984); Kamal *et al.*, (2007). This wide variation could be attributed to the variable chemical composition of the individual milk (Aou-Lehia, 1990). Also, this change in lactose concentration would account for the milk being described sometimes as sweet and other times as bitter (Farah, 1996).

Table (1): Physico-chemical parameters and composition of camel's milk compared with cow's milk.

Parameter	Present Study *		Previous studies					
			Camel milk					
	Camel milk	Cow milk	El-Bahay (1962)	El-Agamy (1983)	Hassan *et al.*, (1987)	Farag & Kebary (1992)	Zhang *et al.*, (2005)	Kamal *et al.*, (2007)
pH	6.70	6.60	6.60	-	6.41	6.39	-	-
Acidity (%)	0.19	0.17	-	-	0.16	0.17	-	-
Specific gravity	1.029	1.037	1.030	-	1.028	1.034	-	-
Total solids %	11.30	11.91	10.12	13.10	10.94	12.36	14.31	15.06
Fat (%)	3.18	3.60	3.80	2.90	3.50	3.90	5.65	3.78
SNF (%)	8.12	8.31	6.32	10.20	7.44	8.46	8.66	11.28
Total protein %	2.91	3.35	3.50	3.70	2.49	3.10	3.55	3.30
Lactose (%)	4.40	4.40	3.90	5.80	3.87	4.47	4.24	5.85
Ash (%)	0.90	0.70	0.80	0.70	0.81	0.80	0.87	0.70

*: The average of duplicate was taken for each sample.

Ash content of camel milk was observed to vary in between 0.75 to 0.97% and average of 0.90%. These results were higher than those reported by different workers i.e. in between 0.70 to 0.83% (El-Bahay, 1962; Knoess, 1982; El-Agamy, 1983; Hassan *et al.*, (1987); Ahmed, 1990; El-Amin and Wilcox, 1992; Farag and Kebary 1992); Kamal *et al.*, (2007); Haddadin *et al.*, (2008), also, higher when compared to our cow milk (0.7%). The variations in ash of the various studies reflect many genetic and environmental factors. El-Amin, (1979) suggesting that depending on yields. Finally the ash content is given with 0.7 to 1.2% (Gnan and Sheriha 1986; Merin *et al.*, 1998) which can be compared with the ash content in milk of cows, goats and sheep (Farah, 2004).

The composition of camel milk can be partly attributed to the inherited capabilities of the animals, but the stage of lactation, age, and the number of calving also play a role. Of special significance to the quality of the produced milk are the feed as well as water quantity and quality (FAO/WHO/OIE 1992).

In general the data showed a wide variation in the physico-chemical properties of camel milk. The results obtained were in agreement with studies of Ahmed, (1990); Larpson, (1990). Also, the composition of camel milk varies in different parts of the world with arrange of 3.5 to 4.5% protein, 3.4 to 5.6% lactose, 3.07 to 5.50% fat, 0.7 to 0.95% ash and 12.1 to 15% TS

(Gnan and Sheriha 1986). This wide variation in the constituents of milk may be attributed to factors such as breed, age, the number of calving, nutrition, management, the stage of lactation and the sampling technique used (Abu-Lehia, 1987; Alshaikh and Salah 1994). In addition, the feed and water quality and quantity available to the animals also play an important role (FAO, 1982).

Total amino acids composition of camel milk proteins compared with that of cow milk are presented in Table (2). Overall, the amino acid composition of camel milk proteins appears to be generally similar to that of cow milk proteins.

The highest level of glutamic acid (13.29 g/100g protein) was detected in camel milk, similar trend was noticed to that of cow milk and this result is in line with Taha and Kielwein (1990). While camel milk had a lower ratio of lysine than that of cow milk, similar data was applied with results obtained by Ahmed, (1990).

In addition, there were noticeably higher levels of proline, aspartic, therionine, valine and leucine, while a lower values of cystine and methionine which may be due to the effect of heat treatments of camel milk samples , namely, 11.1, 8.24, 7.84, 7.57 and 7.27 g/100g protein, respectively. While the results show that the cystine and methionine are present at low level (0.53 and 2.09 g/100g protein) in camel milk, respectively, that the same trend of cow milk. This ratio is almost lower in camel milk than in cow milk. This trend is in agreement with that reported by (Sawya *et al.*, 1984; Mehaia and Al-Kahnal 1989). Also, high level of arginine (5.22 g/100g protein) was found in camel milk comparing to cow milk (3.7 and 3.3 g/100g protein) which described by both Renner, (1991); Guo *et al.*, (2006), respectively. This observing is comparable with published data (Sawya *et al.*, 1984; Mehaia and Al-Kahnal 1989; El-Agamy and Nawar 2000). The ratios of essential to non-essential amino acids are quite close to both type milks (El-Agamy and Nawar 2000).

Differences in the amino acid contents of different animal milks were attributed to be accompanied by differences in total protein contents. All reported data reveal that camel milk proteins have the satisfactory quality balance of essential amino acids equaling or exceeding the FAO/WHO/UNU requirements (1985) for each amino acid, therefore, it has the adequate nutritive values for human diets.

Table (2): Total amino acid concentrations of camel's milk compared with cow's milk.

Amino acid (g/100 g protein)	Camel			Cow	
	Present Study*	Sawya *et al.*, (1984)	Mehaia *et al.*, (1989)	Renner, (1991)	Guo *et al.*, (2006)
Essential					
Arginine	5.22	3.9	3.8	3.7	3.3
Histidine	2.05	2.5	2.7	2.8	3.0
Iso Leucine	5.28	5.4	5.0	6.4	4.2
Leucine	7.27	10.4	9.5	10.4	8.7
Lysine	5.32	7.0	7.1	8.3	8.1
Methionine	2.09	2.5	3.6	2.7	1.8
Phenylalanine	3.57	4.6	5.6	5.2	4.8
Theronine	7.84	5.2	4.3	5.1	4.5
Tryptophan	-	1.2	-	1.4	1.5
Valine	7.57	6.1	6.9	6.8	4.8
Non-essential					
Alanine	6.36	2.8	2.7	3.5	3.0
Aspartic	8.24	7.6	6.4	7.9	7.8
Cystine	0.53	1.0	0.6	0.7	0.6
Glycine	5.05	1.7	1.3	2.1	1.8
Glutamic	13.29	23.9	19.5	21.8	23.2
Proline	11.1	11.1	11.1	10.0	9.6
Serine	6.99	5.8	4.2	5.6	4.8
Tyrosine	3.63	4.5	4.0	5.3	4.5
Essential amino acids	*46.21*	*48.80*	*48.50*	*52.80*	*44.70*
Non-essential amino acids	*55.19*	*58.40*	*49.80*	*56.90*	*55.30*
Essential / non- essential	*0.84*	*0.84*	*0.97*	*0.93*	*0.81*
Cystine / methionin	*0.25*	*0.40*	*0.17*	*0.26*	*0.33*

***: The average of three individual samples.**

Milk fat is one of the most palatable food components known to man. In the form of milk and various dairy products, and as an ingredient in cookery, it is widely consumed by all age groups.

Permanent attention of both dairy industry and nutritionists has been paid to milk fat composition. Fatty acids are the most important components of lipids, thus research dealing with milk fat has been focused mainly on fatty acids content and composition.

Changes in the fatty acid composition of camel's milk fat in comparison with different previous data of camel and cow milk's fat, also data on the groups of the fatty acids, namely saturated (SAFAs), monounsaturated (MUFAs), polyunsaturated (PUFAs) and all unsaturated (USFAs) are given in Table (3).

There were some variations in the fatty acid content of camel milk, the level of short-chain fatty acids (C_4-C_{12}) were present in very small amounts and the predominant saturated fatty acids were C_{14}, C_{16} and C_{18}. Also, it has higher proportions of unsaturated fatty acids compared with cow milk, which may be the main reason for the waxy texture of camel milk fat, this result identically with those mentioned by Hagrass *et al.,* (1987). There was a considerable level of polyunsaturated fatty acids (mainly $C_{18:1}$ is the most abundant) in camel's milk fat.

Short chain fatty acids (C_4-C_8) of camel milk have been reported to be in the range 0.23 to 0.99 with an average 1.60 %, which were considerably lower than that of bovine milk (Abu-Lehia, 1989; Farah *et al.*, 1989; Farag and Kebary 1992; Farah, 1993; Attia *et al.*, 2000; Gorban and Izzeldin 2001; Alhadrami, 2003; Zhang *et al.,* 2005). Also, even-numbered saturated fatty acids (C_{12}-C_{18}) in camel milk accounted for 47.27 % of total fatty acids with C_{16}, C_{18} and C_{14} as the major components (26.18, 10.79 and 10.30 % respectively). These results are similar to those of dromedary camel milk reported in the literature (Sawaya *et al.*, 1984; Abu-Lehia, 1989; Gorban and Izzeldin 2001; Zhang *et al.*, 2005; Haddadin *et al.*, 2008; Kamal and Salama 2008). On the other hand, polyunsaturated fatty acids ($C_{18:1}$-$C_{18:3}$) in camel milk accounted for 34.54 % of total fatty acids, mainly $C_{18:1}$ (25.75 %). As compared with bovine milk fat, it was found that the oleic acid ($C_{18:1}$), the most abundant unsaturated fatty acids, is present at a higher amount in camel milk fat (Farah *et al.*, 1989; Farag and Kebary 1992; Attia *et al.*,2000; Gorban and Izzeldin 2001) but lower amount than that of Abu-Lehia (1989) for cow (29%), or that the proportion is practically the same in dromedary and bovine milk fat (Hagrass *et al.,* 1987; Abu-Lehia 1989; Zhang *et al.,* 2005; Kamal and Salama 2008) .

According to Gnan and Sheriha (1986) camel's milk fat contained relatively high levels of polyunsaturated acids, which are essential for human nutrition especially linolenic ($C_{18:3}$) and linoleic ($C_{18:2}$) acids.

In addition, SAFAs accounted for 57.56 % of the total, this proportion is the same, 57.718% in dromedary milk fat (Farag and Kebary 1992), and was in higher than those of Gorban and Izzeldin (1999) (52 %), but lower than reported by Czech *et al.,* (2005) decided the fat of cows (Czech Pied and Holstein) were 60.78 and 63.62 % of total acids respectively. Mean MUFAs contents (33.66 %) and total levels of all the unsaturated acids (MUFAs and PUFAs) were (33.66 and 8.79%) elevated in the camel milk fat.

Thus, these differences can be partially explained by different several factors that affect on the fatty acid composition of camel milk include breed, feeding, composition of dietary fat, dietary protein, seasonality and region, and stage of lactation (Palmquist *et al.,* 1993; Gorban and Izzeldin 2001).

Table (3): Fatty acids composition of camel's milk fat compared with cow's milk.

Fatty acid (%)	Camel milk fat				Cow milk fat		
	Present Study*	Hagrass *et al.*, (1987)	Farag & Kebary (1992)	Attia *et al.*, (2000)	Abu-Lehia, (1989)	Attia *et al.*, (2000)	Zhang *et al.*, (2005), two breeds
Saturated:							
C 4.0 Butyric	0.80	1.26	0.440	0.60	3.50	2.60	1.41, 1.44
C 6.0 Caproic	0.52	1.24	0.623	0.22	2.40	1.65	1.27, 1.50
C 8.0 Caprylic	0.29	1.97	0.031	0.21	1.40	1.12	1.02, 1.26
C 10:0 Capric	0.72	3.21	0.081	0.25	2.10	2.75	2.69, 3.30
C 12:0 Lauric	1.92	3.86	0.535	1.19	3.10	3.89	3.54, 4.00
C 14:0 Myristic	10.30	13.30	11.948	13.11	10.40	13.05	12.81, 12.55
C 16:0 Palmitic	26.18	40.88	30.453	31.45	26.60	38.59	33.19, 32.99
C 15:0 Peutadecanoic	-	-	2.664	0.10		1.50	
C 17:0 Margaric	1.01	-	1.247	-	1.62	-	-
C 18:0 Stearic	10.79	5.54	8.523	16.12	7.86	8.65	2.61, 4.45
C 20:0 Arachidic	5.03	-	-	0.49	0.11	0.49	0.25, 0.22
Monounsaturated:							
C 14:1 Myristoleic	-	0.62	1.129	0.70		1.7	
C 15:1	-	-	0.205	-		-	
C 16:1 Palmitoleic	7.21	1.43	9.100	11.62	1.70	2.30	2.04, 2.20
C 17:1 Margaroleic	0.70	-	1.116	-	-	-	-
C 18:1 Oleic	25.75	26.08	16.447	20.70	29.00	20.52	23.60, 25.54
Polyunsaturated:							
C 18:2 Linoleic	4.03	0.49	1.035	1.19	3.20	1.92	3.92, 3.64
C 18:3 Linolenic	4.76	-	1.690	1.33	1.10	1.34	0.78, 0.72
SAFAs [1]	57.56	71.38	-	57.718	-	-	60.78, 63.62
MUFAs [2]	33.66	28.13	-	-	-	-	27.64, 25.76
PUFAs [3]	8.79	-	-	-	-	-	6.76, 6.35
USFAs [4]	42.45	28.63	29.074	29.074	-	-	34.31, 32.11
US/SA [5]	0.74	-	-	0.56	-	-	-

1 *: The average of three individual samples.
2: Saturated fatty acids, 3: Monounsaturated fatty acids, 4: Polyunsaturated fatty acids, 5: Total unsaturated fatty acids, 6: US/SA: Unsaturated /Saturated

Conclusions:

Camel milk was shown to be poor in fat and rich in lactose, which is more similar to human milk than to other mammalian milk. It is normally drunk fresh or sour case, heavy and sweet.

A wide variation was observed in the physico-chemical characteristics of camel milk. This is mainly due to several factors such as the different regions, the analyzed samples of individuals or bulk, the analytical procedure used, lactation period, animal breeding and feeding regimen.

In spite of the economic and ecological advantages the virtues of the camel are almost unknown outside the communities where it is used and until now it has received less attention than other domestic animals.

The result could contribute to the overall knowledge of camel as food source, but much still needs to be learned if efficient improvement programmers are to be initiated. For example, if camels are reared under same environment as buffalo, there is no doubt it will produce milk of high quality.

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الخواص الفيزوكيميائية والحيوية للبن الجمال

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تم تجميع عينات لبن النوق (الإبل) والأبقار من المزارع الخاصة الموجودة فى سوق برقاش ، العمرانية الغربية على الترتيب – الجيزة. وقد تم دراسة بعض الخواص الطبيعية مثل قياس رقم الأس الهيدروجينى ، الوزن النوعى ، تقدير نسبة الحموضة ، كما تم أيضاً دراسة الخواص الكيمائية من حيث تقدير المكونات الأساسية للبن مثل الجوامد الكلية ، الدهن ، الجوامد اللبنية اللادهنية ، البروتين الكلي ، سكر اللاكتوز، وكذلك محتواها من الرماد فى كلا النوعين ، بينما تم دراسة مكونات الأحماض الأمينية ، والأحماض الدهنية في عينات لبن الجمال.

وأوضحت النتائج أن محتوى الجوامد الكلية فى لبن الجمال أقل نسبياً عن مثيلتها فى لبن الأبقار، بينما على العكس من ذلك حيث إرتفاع نسبة البروتين الكلى والدهن فى لبن الأبقار ، كما تميز لبن النوق بإرتفاع سكر اللاكتوز عنه فى لبن الأبقار.

وبالنسبة لدراسة محتوى الأحماض الأمينية الكلية في لبن الجمال بإستخدام طريقة HPLC ، حيث أظهرت النتائج أن بروتينات لبن الجمال تتميز بإرتفاع محتواها من حامض الجلوتاميك ، وإنخفاض نسبة الليسين عنه فى لبن الابقار. وكذلك إحتوائه على نسب مرتفعة من البرولين ، الأسبارتك ، السريونين ، الفالين ، الليوسين على الترتيب ، بينما على العكس من ذلك حيث يحتوى على نسبة أقل من السيستين ، الميثيونين.

أما بالنسبة لدراسة محتوى الأحماض الدهنية في دهن لبن الجمال بإستخدام طريقة GLC ، فإنه يتميز بإنخفاض نسبة الأحماض قصيرة السلسلة (C_4-C_{12}) عنه فى لبن الأبقار، بينما كانت نسبة الأحماض طويلة السلسلة مرتفعة خصوصاً فى الأحماض الدهنية المشبعة (C_{14}, C_{16}, C_{18}) والأحماض الدهنية الغير مشبعة حيث كان السائد هو ($C_{18:1}$).