Vol 18 No 2, p 273-276

MINERAL, VITAMIN AND FATTY ACID CONTENTS IN THE CAMEL MILK OF DROMEDARIES IN THE ANXI GANSU CHINA

S.Y. Wang[1,4], J.P. Liang[3], W.J. Shao[2] and H. Wen[2]

[1]Department of Biology Physics, Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China, [2]Department of Animal Medicine, Gansu Agricultural University, Lanzhou 730070, China, [3]Lanzhou Institute of Animal & Veterinary Pharmaceutics Sciences, Chinese Academy of Agricultural Sciences, Lanzhou 730050, China
[4]Lanzhou University, Lanzhou 730070, China

ABSTRACT

Mineral, vitamin and fatty acid contents in the milk of dromedaries of the Anxi, Gansu, China were test and compared to others milk from cows, goats and human. Calcium, Magnesium and Iron content in camel milk were highest than others milk. The present results confirm that Vitamin C content in camel milk (33.6-40.03 mg/l) are 3-5 times higher that vitamin C content of cow milk (10.42±5.6 mg/l). The content Vitamin E were similar in camel milk (126.9±26.2 mg/l) and human milk (121.69±15.2 mg/l), and vitamin E in fresh cow milk were highest (161.0±23.7 mg/l). Unsaturated FA in camel milk (65.02g/100g FA) were highest than the cow milk (40.76g/100g), goat milk (40.23g/100g), human milk (58.17g/100g) ($p<0.001$), and C18:3 in camel milk (5.12±0.21g/100g) was significantly higher than the cow milk (0.38g/100g), goat milk (0.34 g/100g), human milk (2.96g/100g) ($p<0.001$).

Key words: Anxi China, camel milk, fatty acid, mineral, vitamin

Camel's milk is an important nutritional food and a source of income for breeders in arid and semi-arid zone. Camel milk and milk products are gaining an escalated popularity and more acceptance for human consumption in many countries (Wernery, 2006). Camel produces more milk (8-10 kg/day)than cow (5-6kg/day) in Kenya (Karne, 1998). Camels can *maintain* lactation to 16-18 months with a highest average milk yield during the first 6 months (Wernery *et al,* 2004). It may be used alone as food for children, patients and elderly people. It was found that camel milk is rich in anti-protease inhibitors, vitamin C, insulin, potassium and iron while low in fat and cholesterol (Kappeler *et al,* 1998; Shehadeh *et al,* 2001; Tefera and Gebreah, 2004).

In recent years, the camel milk has been used for treatment of malnutrition, jaundice, anaemia, asthma, ulcers, milk allergy, lactase deficiency etc (Agarwal *et al,* 2005; Shiller,1990; Elsayed *et al,* 1992; Gorban and lzzeldin, 2001; and Guliyed *et al,* 2002) Camel milk is found safe and efficacious in improving long-term glycaemia control, and in the reduction of insulin requirement in diabetes patients (Agrawal *et al,* 2005 and Wang *et al,* 2009).

The purpose of the present study was to estimate the minerals (potassium, calcium, sodium, magnesium, iron, zinc, copper), vitamins (C, E) and fatty acids in dromedary camel milk in Anxi, Gansu, China and to compare with those of other milk from cows, goats and human.

Materials and Methods

Milk sample

Raw camel milk was collected from 2 herds of 50 females dromedary camel in the village of Suoyang, Anxi, Gansu, China. Herds were bred according to the semi-intensive system. They went to the pasture during the day and they were fed barley in the evening (2.5kg/animals). These were milked manually twice a day in the morning and evening. The goat's milk was collected in Yongdeng, Lanzhou, China. The cow milk came from Dairy farm of Dawa mountain, Lanzhou, China. The human milk was provided by volunteers of March lactation age. The milk was collected immediately, cooled and stored in refrigerator at 4°C. These samples were carried out to the laboratory for analyses.

Sample measurements

The main trace mineral elements (K, Ca, Na, Mg, Fe, Zn, Cu) were determined after separation of milk by atomic absorption spectrophotometer (Hitachi

SEND REPRINT REQUEST TO J.P. LIANG email: liangjp100@sina.com; wangsy@impcas.ac.cn

180-80 polarised Zeeman, Japan) according to the classical method of Bellanger and Lamand (1975). The samples were digested for destroying proteins and amino acids in order to separate the minerals linked to proteins. The concept is to mix in the Kjeldahl flask in a microwave digestor, 2ml milk, 15ml nitric acid (HNO^3, AR), then 3ml perchloric acid ($HClO^4$, AR). After milk digestion, the sample was poured in sterile tube, then exported to Analysis Centre of Lanzhou Institute of Animal and Veterinary Pharmaceutics Sciences, CAAS for determining the minerals.

Vitamin C and E were analysed with the High Performance Liquid Chromatography (HPLC) system (Varian, USA). The analysis of 2 elements was carried out according to the methods of Lee *et al* (1997) and Anonym (1997). In order to keep the steady state of vitamin C and E in the process of determination, this aqueous solution of oxalic acid was used as mobile phase (concentration of 0.1%).

Milk (2ml) and benzene petroleum ether (v:v=1:1, 2ml) were added in the test tube, then ethanol was added unit the mixture clarified. FA in 1ml of supernatant were methylated with 2ml of 0.4 mol/ml sodium methylated at 50 for 30 min (Christie *et al,* 2001).

Fatty acid (FA) methyl esters were separated on a 2m×3mm stainless steel column (Shimadzu, Japan). Samples were injected (1µl methyl esters) by auto-sampler into a Shimadzu-GC 2010 gas chromatograph equipped with a flame ionisation detector. The injector temperature was maintained at 250 and the detector temperature was maintained at 250. Satisfactory separation of FA was as described in Loor *et al* (2005). The composition of fatty acid in milk was identificated by Chromatography mass spectrometry equipped with a G1701BA- ChemStation. The analysis of FA in milk were provided by Analysis Centre of Lanzhou University.

Statistical analysis

Data of experiment were analysed using SPSS statistical package program (2000). The paired Student's test was used to study the differences between groups, data are expressed as mean±SD.

Results

All the results are expressed in µg/1000ml. The average values of the main trace element are given in Table 1. There were a statistically significant difference found when compared with cow milk, goat's milk and human milk in K, Ca, Na, Mg and Fe (Table 1), and these content in camel milk were highest than others milk except goat's milk in magnesium (99.54). There were no significant variance in Zn of 4 milk samples. K and Cu in camel milk were least than cow milk, goat's milk and human milk (Table 1).

Vitamin C in camel milk was highest than cow milk, goats milk and human milk. There were significant variation in Vitamin C between fresh camel's milk and camel's milk (Table 2). Vitamin E in camel milk was statistically significant as compared with other milk. Vitamin E in fresh cow milk was highest. There was no significant variation in Vitamin E between fresh camel's milk and camel's milk (Table 2).

The fatty acids, *viz* C12:0, C13:0 and C14:0 in camel milk were significantly lower than the cow, goat milk, human milk ($p < 0.001$) (Table 3). There was no statistically significant different in C14:1 from camel milk, goat's milk and human milk. C15:0 did not significantly varied in cow milk and goat milk however, it was detected in human milk. C16: 0 had

Table 1. Mean values of trace elements in milk from camels, cow, goats and human (in µg/1000ml)

Groups	K	Ca	Na	Mg	Fe	Zn	Cu
Camel milk (n=10)	1348.33±65.78	60.75± 9.67	631.88± 67.23	84.67± 7.87	43.50± 4,67	1.58± 0.27	0.54± 0.09
Cow milk (n=10)	1464.17± 43.48	45.59±7.46**	355.75±37.36**	73.97±8.39**	8.10±1.34**	1.60± 0.09	0.72± 0.03
Goat's milk (n=8)	1757.67±67.78**	46.92±5.73**	325.63±39.57**	99.54±8.91*	5.82±1.21**	1.6± 0.18	1.36±0.06**
Human milk (n=4)	401.25±54.87**	39.67±4.52**	145.60±19.37**	8.85±2.45**	28.43±1.09**	1.56± 0.89	1.46±0.02**

* $p < 0.05$, ** at $p < 0.001$ in comparison to camel milk group.

Table 2. Vitamin C and E content of camel cow, goat's and human milk (mg/l).

	Camel's milk n=10	Fresh camel's milk n=10	Fresh cow milk n=10	Fresh goat's milk n=8	Fresh human milk n=4
Vitamin C	33.6±9.8	40.03±13.2**	10.42±5.6**	20.98±9.6*	6.93±7.8**
Vitamin E	126.9±26.2	128.2±37.3	161.0±23.7**	86.4±10.2**	121.69±15.2

**$p < 0.05$, ** at $p < 0.001$ in comparison to fresh camel milk group.

similar content in camel milk (19.83) and human milk, (19.88), while these were all lower than cow milk (34.21) and goat milk (29.49). C16:1 in camel milk (10.53) was significantly higher than cow milk (0.68) and goat milk (1.06) not detected in human milk ($p < 0.001$, Table 3). C18:0 and C18:1 showed no significant variance in 4 sample milk. C18:2 in camel milk was significantly higher than the cow milk and goat milk($p < 0.001$) and C18:2 in human milk was highest. C18:3 in camel milk was significantly higher than the milk, goat milk, human milk (Table 2) ($p < 0.001$) (Table 3). Unsaturated FA in camel milk (65.02) were highest than the cow milk (40.76), goat milk (40.23), human milk (58.17) ($p < 0.001$) (Fig 1).

Discussion

The present study was performed to analyse important composition of camel milk in comparison to cow milk, goat's milk and human milk in order to develop new uses for camel milk.

A significant difference was observed in the main trace elements (K, Ca, Na, Mg, Fe, Cu) of camel milk compared with goat, cow and human milk. Calcium, magnesium and iron content in camel milk were highest than those of other milk concerned, and it can be used as the main source of these main trace elements. The concentrations of copper and iron in dromedaries of Anxi, China were lower than that in dromedaries of the Arabian Peninsula (Wernery *et al,* 2002). The main trace element values were lower than these report by Farah (1996) and Kappeler *et al* (1998).

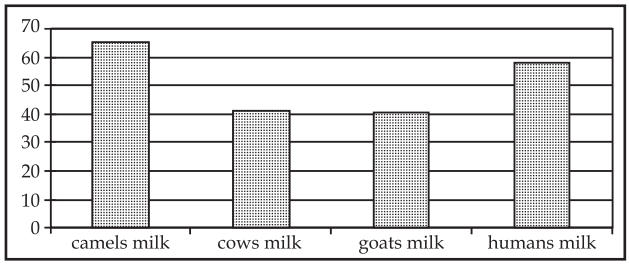

Fig 1. Percentage of unsaturated fatty acids in four samples of milk.

Results of present study showed that the highest contents of vitamin C in camel milk was 3 times higher that vitamin C content of cow milk and 2 times higher that goat's milk. Vitamin C content in camel milk was 35.6 mg/l in some studies (Stahl *et al*, 2006; Wernery *et al,* 2009) which was similar to the observation of present study (33.6-40.03 mg/l). In the present study vitamin C values in camel milk were 3-4 times higher that cow milk which was in consonance to the findings of Farah (1992, 1993).

The vitamin E content were similar in camel and human milk. The vitamin E values in camel milk was similar to in levels in camel blood (Wernery *et al,* 2009) whereas the values were higher than those reported by Farah (1996) and Kappeler *et al* (1998).

Vitamin C, a strong antioxidant, is essential for brain function and growth, and protects against respiratory ailments. The content of vitamin C was remarkably higher than in cow milk. The high concentration of vitamin C was the most prominent factor of camel milk. Camel milk is often the only

Table 3. Fatty acid composition of camel milk, cow milk, goat's milk and human milk (g/100g FA).

Fatty acid	(sample)			
	Camel milk (n=10)	Cow milk (n=10)	Goat's milk (n=8)	Human milk (n=4)
C12:0	0.36±0.01	1.60±0.02**	2.93±0.03**	2.90±0.01**
C13:0	0.72±0.05	3.81±0.06**	9.13±0.16**	0.10±0.01**
C14:0	1.87±0.06	4.08±0.06**	4.13±0.10**	7.20±0.17**
C14:1	11.78±0.3	14.78±0.27**	10.77±0.31	11.24±0.33
C15:0	1.07±0.89	1.25±0.06	1.06±0.04	0
C16:0	19.83±0.27	34.21±0.09**	29.47±0.56**	19.88±0.77
C16:1	10.53±0.48	0.68±0.01**	1.06±0.98**	0
C18:0	9.67±0.05	10.19±0.16	9.73±0.41	10.87±0.19*
C18:1	25.76±0.30	22.47 ±0.09*	25.32±0.41	24.73±0.28
C18:2	11.86±0.07	2.25±0.06**	2.69±0.31**	19.24±0.29**
C18:3	5.12±0.21	0.38±0.07**	0.34±0.03**	2.96±0.02**
Saturated FA	33.48	55.15**	56.33**	41.05**
Unsaturated FA	65.02	40.76**	40.23**	58.17**

Saturated FA: C12:0+C13:0+C14:0+C15:0+C16:0+C18:0 Unsaturated FA: C14:1+C16:1+C18:1+C18:2+C18:3

* $p < 0.05$, ** $p < 0.001$ in comparison to camel milk group.

source of vitamin C since fruits and vegetable are scarce in the desert.

The fatty acid composition of milk is one of the important aspects linked to the discussion on the health effect of milk and milk products (Wahle and Heyes, 2002). We observed that C12:0 and C13:0 were lower than cow and goat's milk, which was in consonance to the findings of Stahl *et al* (2005) that camel contains much higher concentration of long –chain fatty acids (C14-C18) than short-chained fatty acids (C<14). The fraction of unsaturated fatty acids in the fatty acid pattern of camel milk (65.02%) were higher as compared to reports of Stahl *et al* (2006) (49.5), Gorban and Lzzeldin (2001) (30.2%) and Farah *et al* (1998) (35%). The higher content of C18: 3 of camel milk (5.12%) were comparable to cow milk (0.38%, P<0.001). In the present study, the fraction of unsaturated fatty acids in the fatty acid pattern of cow milk (40.76%) and the content of C18:3 of cow milk (0.38%) were in consonance to their findings (42.1% and 0.3% respectively), while the content of C18:3 of camel milk (5.12%) was remarkably higher than their study.

Unsaturated fatty acids (30-35g/100g total milk fatty acids) are inversely associated to diabetes risk (Mann, 2002), and milk also contains beneficial minor components such as conjugated linoleic acid which plays an important role in prevention and treatment of diabetes (Schrezenmeir and Jagla, 2002 and Wang *et al*, 2009).

Acknowledgements

We are grateful to Lanzhou Institute of Animal and Veterinary Pharmaceutics Sciences, Chinese Academy of Agricultural Sciences and Analysis Centre of Lanzhou University for detection and analysis for our study. We also thank Gansu Hualong Agricultural Development Corporation for providing camel milk and financial support for our study.

References

Agrawal RP, Beniwal R, Sharma S, Kochar DK, Tuteja FC, Ghorui SK, and Sahani SM (2005). Effect of raw camel milk in type 2 diabetes patients: 1 year randomised study. Journal of Camel Practice and Research 12(1):27-31.

Anonym (1997). Mineralstoffe, Spurenelemente and Vitamine –Klinische Aspeket und Chemische Analyse, Verlag Bertelsmann Bulletin 68:1103-1119.

Bellanger J and Lamand M (1975). Method de dosage du cuivre et du zinc plasmatique. Bull. Tech. CRZV. Theix Inra 20:53-54.

Elsayed E, Roger R, Amin I, Claude C and Robert A (1992). Antibacterial and antiviral activity of camel milk protective protein. Journal of Dairy Science 59(2):169-175.

Farah Z (1996). Composition and characteristics of camel milk. Journal of Dairy Research 60:603-626.

Guliyed AY, Creveld C and Yagil (2002). Detection of subclinical mastitis in dromedary camels. Tropical Animal Health and Production 34(2):95-104.

Gorban AM and Lzzeldin OM (2001). Fatty acids and lipids of camel milk and colostrums [J]. International Journal of Food Science and Nutrition 52(3):283-287.

Kappeler S, Zakaria F and Zdenco P (1998). Sequence analysis of camels milk casein. Journal of Dairy Research 65(3):209-222.

Karen CN (1998). The dairy characteristics of the Kenyan camel. In: Dromedaires et Chameaux Laitiers. Ed. P. Bonnet, Actes du colloque, 24-26 Octoble 1994, Nouakchott. Mauritanie.

Lee W, Roberts SM and Labbe RE (1997). Clinical Chemistry 43:154-157.

Loor JJ, Ferlay A, Ollier A, Ueda K, Doreau M and Chilliard Y (2005). High-Concentrate Diets and Polyunsaturated Oils Alter Trans and Conjugated Isomers in Bovine Rumen, Blood, and Milk. Journal of Dairy Science 8(11):3986-3999

Shehadeh N Gelertner L, Blazer S, Perlman R Solovachik L and Etzioni A (2001). Importance of insulin content in infant diet: suggestion for a new infant formula. Acta Paediaty 90(1):93-95.

Shiller C (1990). Future development in biotechnology and bioengineering: Microorganisms and enzymes. International Dairy Congress, Montreal press. pp 23-40.

Stahl T, Sallmann HP, Duehlmeier R and Wernery U (2006). Selected vitamins and fatty acid patterns in dromedary milk and colostrums. Journal of Camel Practice and Research 13(1):53-57.

Tefera M and Gebreah F (2004). A study on the productivity and diseases of camel in Eastern Ethiopia. Tropical Animal Health and Production 34(5):365-374.

Wang S Y, Li.ang J P, Song N N, Shao WJ and Wen Hong (2009). Effect of raw camel milk in type 2 diabetes animals model and patients: ten months's randomised study [J]. Journal of Camel Practice and Research 16(1):107-113.

Wernery U, Abraham AA, Jyothi T, Ali Abubakar and George RM (2009). Mineral and vitamin contents in the blood of racing dromedaries in the United Arab Emirates. Journal of Camel Practice and Research 16(1):30-40.

Wernery U (2006). Camel milk, the white gold of the desert. Journal of Camel Practice and Research 13(1):15-26.

Wernery U, Juhas J and Nagy P (2004). Milk yield performance of dromedaries with an automatic bucket milking machine. Journal of Camel Practice and Research 11(1): 51-57.

Wernery U, Ali M, Kinne J, Abraham AA and Wernery R (2002). Copper deficiency: A predisposing factor to septicaemia in dromedary calves. Journal of Camel Practice and Research 9(1):1-4.