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Camel milk
Vitamin A
Vitamin B_2
Vitamin E
Vitamin C

Vitamin Content of Camel Milk

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Summary: The content of vitamin C, *vitamin B_2 and fat-soluble vitamins E and A in camel milk was studied. The milk samples were collected from 20 individual camels (Camelus dromedarius) in two different occasions. The study showed that camel milk contains considerably less vitamin A and B2 than cow milk while the content of vitamin E was about the same level. The level of vitamin* C *was in average three times higher than that of cow milk.*

Introduction

According to FAO Statistics there are 17 million camels (Camel us dromedarius) in the world, of which 12.2 million are in Africa and 4.8 million in Asia [1]. The camel is an important source of milk. Indeed, in some countries hosting large camel populations, camel milk is one of the main components of the human diet. Milk production varying between 1800 and 12700 kg during a lactations period between 9 and 18 months has been reported [2]. Available information concerning camel milk is mainly limited to data on gross composition. Information on the nutritional quality of camel milk, especially on important minor constituents, such as vitamins, is scarce. The present investigation was undertaken to study the content of the water soluble vitamins C, B_2 and some fat soluble vitamins A and E in camel milk.

Material and Methods

Milk samples: Camel milk samples were taken at 01 Maisor Camel Farm, which is situated just North of the Equator in Kenya's Laikipia District and at an altitude of between 1767 and 1889 m above sea level. The animals of indigenous breed (Camelus dromedarius) were fed all year around exclusively by grazing. The milk samples were collected from 20 individual camels in two different occasions. The samples were kept refrigerated at 4°C and transported to our laboratory within 24 hours. Prior to refrigeration, all the samples for vitamin C determination were stabilised with 10% metaphosphoric acid. Upon arrival, the milk samples were stored at -20°C until analysis.

Analytical methods: Both retinol and α-tocopherol were determined on the same sample extract on the milk specimen after saponification, but with different HPLC conditions.

The deep frozen milk samples were warmed to about 35°C and mixed to obtain homogeneous distribution of milk fat. In 30 ml centrifuge tubes with stoppers 5g of milk were mixed with 6 ml of ethanol abs. and 200 mg of ascorbic acid. The tubes were heated to 80°C in a water bath for 5 min. under N2 and stirred using a magnetic stirrer. Then I ml of NaOH, 12.5 M was added and the mixture saponified for 20 minutes. After cooled to room temperature, the saponification mixture was extracted with a mixture of 10 ml n-hexane and toluene 1:1 by shaking mechanically during 10 minutes at a frequency of250 strokes/min. 6 ml of H_2O dest. were added, the tubes inverted several times and centrifuged. The clear organic phase was subjected to HPLC separations.
Retinol was determined under the following HPLC condition:

Column:	Hibar RT (125-4 mm)
Stationary phase:	LiChrosorb Si 60, 51lm, combined with LiChro-CART 4-4 mm as pre-column (MERCK)
Mobile phase:	2.5070 i-propanol in n-hexane
Flow:	1.3 ml/min.
Pressure:	approx. 32 bar
Injection:	Automatic, autosampler WISP 712^(WATERS) 20-80 III
Injection volume:	Spectrofluorometer 650-10 LC (PERKIN-ELMER), excitation 330 nm, emission 408 nm
Integrator:	SPECTRA-PHYSICS SP 4270
Calculation:	External standard method, peak area
Standard:	O.4µg of retinol/ml n-hexane containing 0.02070 butyl-hydroxy-toluene (BHT) as antioxidant
Retention time:	4.4 min.
Run time/sample:	10 min.

α-tocopherol was determined under the following HPLC condition:

Column:	Hibar RT (125-4 mm)
Stationary phase:	LiChrosorb Si 60, 5 11m, combined with gard column 20-4 mm Si 60, 5 11m (STAGROMA WALLISELLEN, SWITZERLAND)
Mobile phase:	3070, l,4-dioxane in n-hexane
Flow:	1.6 ml/min.
Pressure:	approx. 50 bar
Injector:	Automatic, autosampler WISP 712^(WATERS)
Injection:	20-80 III
Injection volume:	Spectrofluorometer 650-10 LC (PERKIN-ELMER), excitation 295 nm, emission 330 nm
Integrator:	SPECTRA-PHYSICS SP 4270
Calculation:	External standard method, peak area
Standard:	I µg of dl-α-tocopherol/ml n-hexane containing 0.01070 BHT as antioxidant
Retention time:	4.7 min..
Run time/sample:	15 min

The concentration of vitamin B_2 (riboflavin) was estimated by taking advantage of the strong fluorescence of the vitamin. To hydrolyse FAD and protein bindings trichloracetic acid was used as described by RETTENMAIER *et al [3].*

Vitamin C (ascorbic acid) was measured fluorometrically after it has been oxidized with iodine to dehydroascorbic acid, which is then coden sed with orthophenylenediamine to form a fluorescent quinoxaline. Essentially the same method as described by BRUBACHER and VUILLEUMIER [4] for plasma vitamin C was followed. However, the stabilisation of the vitamin in milk was performed by diluting I volume of milk with I volume of metaphosphoric acid 10070 (w/v).

Results and Discussion

The coefficient of variation (CV) calculated on 20 double determinations were found to be ±4.45OJo for retinol and ±4.05% for α-tocopherol. For riboflavin and ascorbic acid, CV was found to be ± 2.83% and ± 1.22% (10 double determinations) respectively.

Recoveries of added dl-α-tocopherol and riboflavin were 98.1% ±5.7, n=5 and 94.7% ± 3.4, n = 6 respectively. The results obtained using the above described method

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for vitamin A and E correspond with those of a method which includes exhaustive extraction [5]. However, in cases of very low vitamin A levels (e.g. 0.05 µg/g) exhaustive extraction led to slightly lower vitamin A values (max. 15%). This might be due to losses during concentration of the large volume associated with the repeated extraction steps.

The table shows the vitamin content of 20 individual samples of camel milk as well as the corresponding values in cow milk [6]. The mean values of the vitamins A, B2, E and Care 0.1,0.57,0.56 and 37.4 mg/l respectively.

Comprehensive information on vitamin content in milk of the dromedary type camel is not available. The only published work comparable with our findings is the

Table: Vitamin content of camel milk (Figures in parenthesis are the values for cow milk)

Sample No.	Vitamin in mg/I A	B_2	E	C
1	0.14	0.69	0.39	34.0
2	0.11	0.55	0.49	32.6
3	0.11	0.72	0.60	33.5
4	0.05	0.56	0.21	39.5
5	0.08	0.45	0.27	32.3
6	0.11	0.56	0.64	34.5
7	0.09	0.76	0.48	41.5
8	0.11	0.45	0.36	35.0
9	0.07	0.56	0.40	36.6
10	0.12	0.44	0.56	32.5
11	0.13	0.78	0.91	36.0
12	0.09	0.56	0.57	35.7
13	0.07	0.59	0.40	61.1
14	0.07	0.69	0.91	26.2
15	-		-	47.0
16	0.08	0.46	0.53	31.6
17	0.12	0.53	0.75	37.3
18	0.12	0.43	0.69	35.2
19	0.09	0.52	0.72	47.0
20	0.08	0.58	0.73	
Mean	0.10 (0.27)	0.57 (1.56)	0.56 (0.60)	37.4 (11.0)
Range	0.05-0.14 (0.17-0.38)	0.43-0.78 1.16-2.02)	0.21-0.91 (0.2-1.0)	26.2-61.1 (3-23)

report of SAWAYA *el al* [7] who studied the vitamin content of II Saudi dromedaries and found mean values of 0.15,0.42 and 24 mg/kg for vitamin A, 8_2 and C respectively. No data on the content of vitamin E is given in the report. From the results of the present investigation it can be concluded that camel milk contains less vitamin A and 8_2 than cow milk while the content of vitamin E is about the same level. The level of vitamin C is in average three times higher than that of cow milk. The availability of a relatively fair amount of vitamin C (average 37.4 mg/l) in camel milk is of significant relevance from the nutritional standpoint in the arid areas where fruits and vegetables containing vitamin C are scarce.

References

1. FAO Production Yearbook, FAO Rome (1978).
2. YAGIL, R. (1982) Camel Milk, FAO Production and Health Paper 26,9.
3. RETTENMAIER, R. and VUILLEUMIER, J. P. (1983) A simple Method for the Determination of Riboflavin in Human Milk, Internal. J. Vit. Nutr. Res. 53, 32-35.
4. BRUBACHER, G. and VUILLEUMIER, J. P. (1974) Vitamin C, in Clinical Biochemistry, Principles and Methods (Curtius, H. Ch., Roth, M., eds.), Vo. II, pp. 989-997, Walter de Gruyter, Berlin, New York.
5. DOSTÁLOVÁ, L., SALMENPERA, L., VÁCLAVINKOVÁ, V., HEINZ-ERIAN, P. and SCHUEP, W. (1988) Vitamins and Minerals, in Pregnancy and Lactation (Berger, H., ed.), Nestle Nutrition Workshop Series, Vol. 16, Nestlé Ltd., Vevey-Raven Press, Ltd., New York.
6. Ciba-Geigy AG (1977) Wissenschaftl. Tabellen, p. 211, Ciba-Geigy AG, Basel.
7. SAWAYA, W. N., KHALIL, J. K., AL-SHALAHAT, A. and AL-MOHAMMED, H. (1984), Chemical Composition and Nutritional Quality of Camel Milk, J. of Food Sci. 49, 744-747.

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