Variability of vitamin C content in camel milk from Kazakhstan

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Abstract

In order to study the variability of vitamin C content in camel milk in Kazakhstan, 42 milk samples from Bactrian, 73 dromedary, 19 hybrids, 22 mixed farms and 24 undetermined species were collected. The sampling included four regions at four seasons within a year. In the whole sample, the mean value was 150.4± 105 mg/L (15-435 mg/L). The vitamin C content varied significantly according to the sampling place, with a higher value in Atyraou (175 ± 118 mg/L) compared to Almaty (161 ± 96 mg/L) and Chymkent (157 ± 109 mg/L), and quite a bit lower at Aralsk (80 ± 61 mg/L). Milk from the Bactrian camel was richer (169 ± 110 mg/L) than the dromedary (146 ± 93 mg/L) or hybrid (133 ± 129 mg/L). The seasonal variation was similar for all species. In winter dromedary milk was richer than Bactrian milk – the reverse to other seasons. The values for hybrid milk were intermediate between dromedary and Bactrian all year. On the whole, summer milk was richer (227 ± 110 mg/L) than autumn (180 ± 62 mg/L) and winter (157 ± 58 mg/L). The spring milk contained lower vitamin C concentration (75 ± 59 mg/L). All during the lactation period, vitamin C concentration in the dromedary camel varied from 48 to 256 mg/L (mean=184) and tended to increase during the lactation period. The colostrum contained less vitamin C than milk.

Keywords: Dromedary, Bactrian, hybrid, milk, vitamin C, Kazakhstan

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Introduction

Camel milk is well known for its richness in vitamin C (Farah, 1993). Normal reported values are between three and ten times higher than in cow milk (Faye, 1997). This high value contributes to a consideration that camel milk has a stimulating effect on the human immune system, provides sufficient vitamin C for people living in the desert, and presents normal acidity unfavourable for bacteria growth, allowing milk preservation in the harsh conditions of the arid lands at ambient temperature for several hours. The variation of vitamin C content in camel plasma and organs has been studied recently (Elkhidir, 2002) and the physiological variation in milk was reported in several references (Metawie et al., 2000; Mohamed et al., 2005). But no data involved the Bactrian camel (double-humped) and wide regional variation. The present study aims to analyse the variability in vitamin C content in camel milk, taking in such variation factors as geographical origin, season and species in Kazakhstan where dromedaries cohabit with Bactrian camel and their hybrids.

Material and methods

Sampling procedure

To obtain maximum variability, the camel milk was sampled from four different regions at extreme points of Kazakhstan: Almaty, Atyrau, Aralsk and Shymkent (the maximum distance between the different points was more than 3,500 km) and during four seasons of the year. In total, 180 milk samples were collected. The raw milk samples were collected at milking time in Bactrian (n=42), Dromedary (n=73), and hybrid (n=19) animals. In some cases samples were collected from different species after the whole milking (n=22; hereafter referred to as 'mixed milk'). In 24 cases the vitamin C determination involved fermented milk from mixed milk (hereafter referred to as '*shubat*', local name of fermented milk). Seven samples were from unknown origin regarding species.

Bactrian camel's milk samples were from three different Kazakh types named *uralobukeevskii*, *kyzylordinskii* and *yuzhnokazakhstanskii* (Terenytev, 1975; Konuspayeva and Faye, 2004). Milk samples from Dromedary camels were from the Turkmen Arvana breed. Hybrid samples involved F1 or F2 crossbred animals. Milk samples collected before eight days after parturition were called colostrum. The colostrum originated from the Almaty region; samples were collected from six Dromedaries in the spring only (i.e., at the main calving period for this area, from January to April). Shubat samples were collected like the 'mixed milk' samples by region and season (Table 1).

Table 1. Camel raw milk sampling design by region x species x season

Source	Almaty (n=64)				Atyrau (n=16)			
	winter	spring	summer	autumn	winter	spring	summer	autumn
Bactrian	0	4	4	2	0	2	1	1
Dromedary	4	20	20	4	0	2	1	0
Hybrid	0	0	0	0	0	4	2	0
Mix milk	0	0	0	0	0	1	0	1
Shubat	1	1	1	2	0	1	0	0
Unknown	0	1	0	0	0	0	0	0
	Aralsk (n=38)				Shymkent (n=69)			
	winter	spring	summer	autumn	winter	spring	summer	autumn
Bactrian	3	6	7	6	0	3	2	1
Dromedary	0	2	1	1	2	4	6	6
Hybrid	0	1	0	0	1	5	5	1
Mix milk	0	2	1	1	1	7	6	2
Shubat	0	3	2	2	0	4	5	2
Unknown	0	0	0	0	0	6	0	0
Total	187							

There were 88 samples collected during the lactation period. This information was used to assess the physiological change in vitamin C concentration in milk.

Laboratory and statistical analysis

Vitamin C was quantified on fresh milk by the colorimetric method using 2.6 di-chlorophenolindophenol (2.6-DIPh) (Dabrowski and Hinterleitner, 1989). Each analysis

was done in triplicate. The results were expressed in mg/L on wet basis.

A linear model tested vitamin C concentrations as a dependant variable. The tested variation factors were the region (Reg), the species (Spec), the season (Seas) and their interactions. The limit of signification level for variance analysis was 0.05. The results are presented as mean plus/minus standard error. As the variances were not homogeneous, data were log transformed in order to get normal distribution of the values. Separate analyses were achieved for raw camel milk and shubat. The statistic freeware 'R' (Ihaka and Gentleman, 1996) was used for all statistical analyses.

Results

Raw milk and colostrum

The vitamin C concentration in raw camel milk varied from 15 to 435 mg/L, i.e. variability from 1 to 29 with an average of 150.4 ± 105 mg/L. A regional variation ($p<0.05$) was observed with higher concentration in Atyraou (175 ± 118 mg/L) in the western part of the country compared to Almaty (161 ± 96 mg/L) and Chymkent (157 ± 109 mg/L) and quite lower at Aralsk (80 ± 61 mg/L). Milk from Bactrian was richer (169 ± 110 mg/L) than dromedary milk (146 ± 93 mg/L) or hybrid (133 ± 129 mg/L). Within region, the variability could be higher: for example, in Almaty region, 201 mg/L on average in Bactrian compared to 149 mg/L in dromedary.

The seasonal variation was similar for all the species. In winter, dromedary milk was richer than Bactrian milk reverse to other seasons ($P<0.001$). The values for hybrid milk were intermediate between dromedary and Bactrian all over the year. As the whole, the summer milk was richer (227 ± 110 mg/L) than in autumn (180 ± 62 mg/L) and winter (157 ± 58 mg/L). The spring milk contained lower vitamin C concentration (75 ± 59 mg/L) (Figure 1).

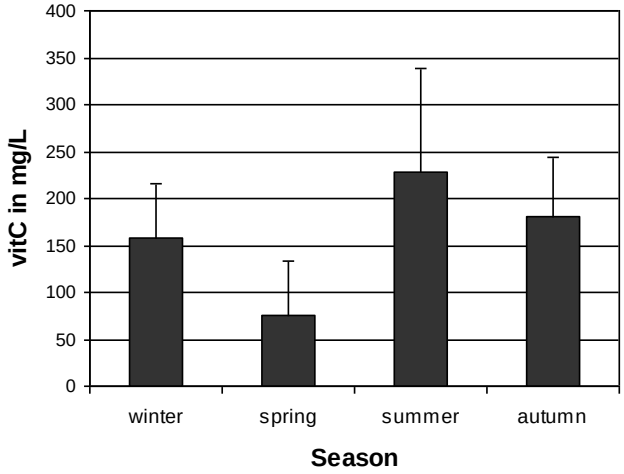

Figure 1. Seasonal change of the vitamin C content in raw camel milk from Kazakhstan

All over the lactation period, vitamin C concentration in dromedary camel varied from 25 to 256 mg/L (mean=184) and tended to increase according to physiological stage with an abrupt rise between week 5 and 7. A slight decrease was observed at week 14 (lactation peak) and the maximum was observed at week 31, i.e., according to calving season, in summer time (Figure 2). The colostrum contained less vitamin C than milk (21 and 165 mg/L on average respectively).

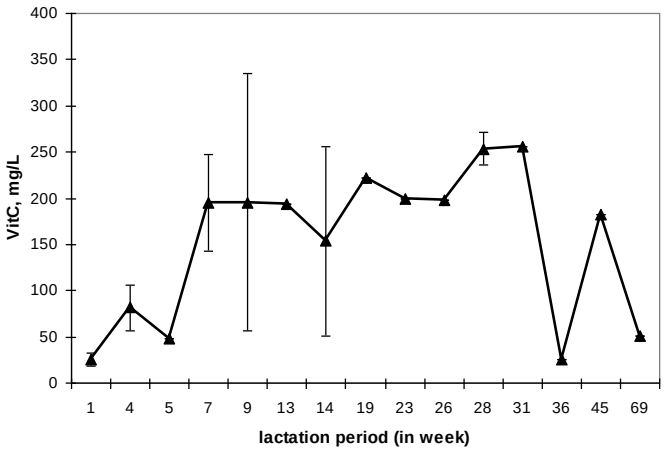

Figure 2. Change in vitamin C concentration in camel raw milk at the lactation period

Shubat

Vitamin C in *shubat* is comparable to vitamin C content of raw milk (160 ± 110 mg/L). Similar seasonal and regional changes were observed. The vitamin C content in *shubat* was quite comparable to raw milk composition.

Discussion

The high level of vitamin C in camel milk is well known (Farah et al., 1994; El-Hatmi et al., 2006), especially compared to cow milk (Saini et al., 2007). It plays a major part in the medicinal reputation of camel milk (Mal., 2000; Konuspayeva et al., 2004). The reported range of 25-60 mg/L (Farah, 1993) and the average of 37.4 mg/L (Farah et al., 1994) or 44 mg/L (Mohamed et al., 2005) were lower than our results in both species. Ascorbic acid is highly unstable (especially with temperature change). In our study vitamin C was determined in fresh milk, whereas the other authors (Farah et al., 1994; Mohamed et al., 2005) had analysed frozen milk. Therefore, the observed differences in vitamin C milk concentration could be partly explained by the analytical conditions, and probably also by the analytical methods used. Moreover, the floristic composition of the steppe was quite different from that of the rangelands in Africa. Elsewhere, the large camelids in Kazakhstan are under the influence of a very cold climate in winter and a very hot summer. Consequently, the nutritive value and the composition of the diet were quite variable between seasons, which helps to explain the high variability in milk composition (Konuspayeva et al., 2008). The significant differences in vitamin C content observed in our study were supported by the sampling procedure, which was expected to maximise the variability. The sampled regions were quite at opposite ends of the country (with a distance of more than 3000 km between Atyraou and Almaty for example); all seasons and large camelid species and breeds were included.

A genetic variability was already reported. On a total of 2586 camels, ascorbic acid concentration differed significantly between Sudanese camel breeds: Arabi camels had higher ascorbic acid levels in milk than did either Anafi or Bishari camels (Mohamed et al., 2005). In a study aiming to identify the milk parameters discriminating dromedary and Bactrian (Faye et al., 2008), the acidity of camel milk was a discriminant parameter. The storage and transport conditions of the milk samples were identical for the two species, notably because their cohabitation in the same areas was common. So, the difference in acidity could most probably be attributed to the intrinsic property of the milk. Partly, this difference was attributed to the vitamin C in higher concentration in Bactrian milk.

A seasonal variation of vitamin C concentration in camel milk was underlined in Jordan (Haddadin et al., 2008). But the main studied variation was the lactation stage. The increase of vitamin C concentration during lactation was reported by Mohamed et al. (2005), contrary to Sahani et al. (1998), who reported a higher content of vitamin C in milk at the early phase of lactation. Some references also reported an age effect, with higher vitamin C concentration in multiparous milk compared to primiparous (Mohamed et al., 2005). In young camel the vitamin C increased significantly from the first to the 8th month (Metawie et al., 2000). The ascorbic acid content of colostrum was higher than that of milk, according to Mohamed et al., (2005) but the reverse observation was reported by Stahl et al., (2005).

The heat treatment of camel milk as pasteurisation had a little effect on vitamin C concentration, with a slight but significant decrease from 40.9 mg/dl to 38.4 mg/dl (Wernery et al., 2005).

References

Dabrowski K., Hinterleitner S., 1989. Applications of a simultaneous assay of

ascorbic acid, dehydroascorbic acid and ascorbic sulphate in biological materials, Analyst, 114, 83-87.

El-Hatmi H., Khorchani T., Attia H., 2006. Characterization and composition of camel's (*Camelus dromedarius*) colostrum and milk, Microbiol. Hyg. Alim. 18, 13-17.

Elkhidir H. H., 2002. Vitamin C status in Sudanese camels. PhD thesis. Utrecht Univ., 98 p.

Farah, Z., 1993. Composition and characteristics of camel milk. J. Dairy Res., 60, 603-626.

Farah Z., Rettenmaier R., Atkins D., 1994. Vitamin content of camel milk. Int. J. Vit. Nutr. Res. 62, 30-33.

Faye B., 1997. Guide de l'élevage du dromadaire. Ed. Sanofi, Libourne, France, 126 pp.

Faye B., Konuspayeva G., Messad S., Loiseau G., 2008. Discriminant milk components of Bactrian camel *(Camelus bactrianus),* dromedary *(Camelus dromedarius*) and hybrids. Dairy Sci. Technol., 88, 607-617.

Haddadin M., Gammoh S., Robinson R., 2008. Seasonal variations in the chemical composition of camel milk in Jordan. J. Dairy Res., 75, 8-12.

Ihaka R., Gentleman R., 1996. A language for data analysis and graphics. J. Comput. Graph., 5, 299-314.

Konuspayeva G., Faye B., 2004. A better knowledge of milk quality parameters: A preliminary step for improving the camel milk market opportunity in a transition economy – The case of Kazakhstan, pp. 28–36 in Proc. Intl. Conf. 'Saving the Camel

and Peoples' Livelihoods,' LPPS publ., Sadri, Rajasthan, India, Nov. 23–25, 2004.

Konuspayeva G., Loiseau G. Faye B., 2004. La plus-value « santé » du lait de chamelle cru et fermenté : l'expérience du Kazakhstan. Renc. Rech. Ruminants, 11, 47-50.

Konuspayeva G., Faye B., Loiseau G., Ivashchenko A., 2008. Analysis of camel milk in Kazakhstan. Review of the Al-Farabi University, Biological serie, 1(36), 40-43.

Mal, 2000. Chemical composition and vitamin C content of milk in Indian camels managed under farm conditions. Indian Vet J., 77, 695-696.

Metawie R.A., Mohamed O.M., El Bagoury A.M., Ezzo O.H., 2000. Some haematological and serum biochemical changes in camel calves during the first 8 months of age. Egypt. J. Agric. Res, 78, 1311-1321.

Mohamed H.E., Mousa H.M., Beynen A.C., 2005. Ascorbic acid concentrations in milk from Sudanese camels, J. Anim. Physiol. and Anim. Nut. 89, 35-37.

Sahani, M.S., Rathinasabapathy, M., Gorakhmal, Khanna, N.D., 1998. Milking technique and other factors affecting milk production potential in different breeds of camels under farm conditions. Indian Journal of Animal Sciences, 68, 254-256.

Saini, N., Bhati, A.K., Singh, N., Tuteja, F.C., 2007. Trace mineral and vitamin C content of camel milk: A comparative study. Vet. Practioner, 8, 20-21.

Stahl, T., Sallmann, H.P., Duehlmeier, R., Wernery, U., 2006. Selected vitamins and fatty acid patterns in dromedary milk and colostrum, J. Camel Pract. Res, 13, 53-57.

Terentyev, C.M. 1975. Camel farming (in Russian). Kolos, Moscow, Russia.

Wernery U., Johnson, B., Abraham, A. 2005 The effect of short-term heat treatment on vitamin C concentrations in camel milk, Milchwissenschaft, 60, 266-267.