Chapter 4

Ascorbic Acid Concentrations in Milk from Sudanese Camels

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Abstract

The present study in Sudanese camels was done to describe the associations between vitamin C concentrations in milk, and either breed, stage of lactation, parity or the presence of mastitis. Arabi camels had higher ascorbic acid levels in milk than did either Anafi or Bishari camels. Milk ascorbic acid levels were higher for camels more than 180 days in lactation than for those earlier in lactation. Multiparous versus primiparous camels had higher ascorbic acid concentrations in their milk. The ascorbic acid content of colostrum was higher than that of milk. Mastitis was associated with a decrease in the ascorbic acid content of both milk and blood plasma.

Introduction

Vitamin C status of animals may be a determinant of their disease resistance (FIELD et al. 2002). We have described vitamin C concentrations in plasma and leukocytes of Sudanese camels in relation to characteristics such as breed, sex, sexual activity and season (MOHAMED and BEYNEN 2002a) and parasite infections (MOHAMED and BEYNEN 2002b). Vitamin C concentrations in plasma and leukocytes were found to be higher in lactating camels than in their dry counterparts (MOHAMED et al. 2002). There are reports on the vitamin C content of camel milk (FARAH et al. 1992; KNOESS 1977; MEHAIA and AL-KAHNAL 1989), but there was no information on the ascorbic acid content of camel milk in relation to the stage of lactation. Thus, in this study vitamin C levels were measured in colostrum and in milk from camels up to 360 days in lactation. Parasite infections (MOHAMED and BEYNEN 2002b) and brucellosis (MOHAMED et al. 2002) were associated with low vitamin C status of Sudanese camels. In this study on ascorbic acid in camel milk we also addressed the question whether mastitis affects vitamin C status.

Materials and Methods

In this study, a total of 2586 camels (*Camelus dromedarius*) from 15 herds of the Lahawiyin tribe were used. The first author was familiar with the camel owners and belongs to the same tribe. Animals were allowed to graze in the centre of Butana, Sudan during the rainy season and they migrated to the Elshowak region during the dry season. The camels were mainly fed on natural vegetation, but during the dry season dietary supplements consisted of sorghum stalk and sesame cakes.

To assess the relation between breed and ascorbic acid in colostrum, samples were taken from Arabi, Anafi and Bishari camels at 4 or 5 days after parturition. The animals were of different parities. Milk samples were taken from the same, ear-tagged animals when they were 4-5 months in lactation. Blood samples were taken at the same time as the milk samples. Blood samples were taken from primiparous Arabi camels in the dry state and another group was followed throughout lactation while milk and blood samples were taken at different stages. The animals were ear-tagged for identification. Another group of camels was used to determine the influence of parity. On the basis of information of the owners, the animals were classified as primi- or multiparous.

One thousand primi- or multiparous, lactating Arabi camels that were 6-9 months in lactation were checked for the presence of mastitis using the California Mastitis Test.

Positive camels were verified to have clinical signs such as redness and increased temperature of the udder in acute cases and fibrosis in chronic cases. Blood and milk samples were taken for ascorbic acid analysis.

All samples were taken during the rainy season (July-September). Blood was taken from the jugular vein while the animals were in the fed state. Blood samples were kept on ice and centrifuged at 4 ^{0}C. The camels were milked by hand. Milk samples were put on ice and transported to the laboratory. Samples of plasma and milk were prepared and analyzed for ascorbic acid as described previously (BEHRENS and MADERE 1987).

It was assumed that possible confounding factors would not affect interpretation of the results because either the same animals were followed and/or sample size was large. To identify group differences, Duncan's multiple comparison test or Student's t-test was used. The level of statistical significance was pre-set at $P<0.05$.

Results

As shown in Table 1, significant breed differences were observed for colostrum and milk L-ascorbic acid contents.

Table 1. Colostrum, milk and plasma L-ascorbic acid levels in three breeds of camels

	Breed		
	Arabi (n=219)	Anafi (n=204)	Bishari (n=197)
Plasma (mg/l)	5.53 ± 1.41^a	4.42 ± 1.22^b	3.21 ± 1.00^c
Colostrum (mg/l)	54.8 ± 6.7^a	44.5 ± 5.9^b	42.3 ± 6.1^c
Milk (mg/l)	47.8 ± 5.3^a	40.9 ± 4.0^b	39.1 ± 3.7^c

Data presented as means ± SD. Means in the same row having a different superscript are significantly different (P<0.05).

Arabi camels had the highest concentrations. Plasma ascorbic acid also was highest in the Arabi camels. Table 2 shows a significant effect of stage of lactation on milk vitamin C levels.

Table 2. Milk and plasma ascorbic acid levels as affected by the stage of lactation in primiparous Arabi camels

	Stage of lactation, days				
	Dry (n=230)	6-89 (n=310)	90-179 (n=221)	180-269 (n=200)	270-360 (n=233)
Plasma (mg/l)	$3.98^{a} \pm 0.81$	$3.91^{a} \pm 0.87$	$4.10^{a} \pm 0.99$	$4.40^{b} \pm 1.09$	$4.94^{b} \pm 1.18$
Milk (mg/l)	-	$44.2^{a} \pm 4.2$	$44.2^{a} \pm 3.9$	$46.7^{b} \pm 4.0$	$48.4^{b} \pm 3.8$

Data presented as means ± SD. Means in the same row having a different superscript are significantly different (P < 0.05).

The levels were higher after 180 days in lactation than before. Plasma ascorbic acid concentrations showed the same trend. Table 3 shows that multiparous versus primiparous female camels had similar plasma ascorbic acid concentrations, but had significantly higher concentrations in milk.

Table 3. Milk and plasma ascorbic acid levels as affected by parity in Arabi camels

	Primiparous (n=171)	Multiparous (n=255)
Plasma (mg/l)	4.44 ± 0.91	4.35 ± 0.89
Milk (mg/l)	44.9 ± 5.8	46.3 ± 4.7^{a}

Means ± SD. [a] Significantly different from primiparous animals (P<0.05).

Udder condition markedly affected milk and plasma vitamin C concentrations. Table 4 shows that mastitis was significantly associated with reduced ascorbic acid levels.

Table 4. Plasma and milk ascorbic acid levels as affected by mastitis in Arabi camels

	Healthy (n=510)	Mastitis (n=490)
Plasma (mg/l)	4.43 ± 1.01	2.71 ± 0.91^{a}
Milk (mg/l)	47.4 ± 5.2	26.8 ± 4.4^{a}

Means ± SD. [a] Significantly different from healthy animals (P<0.05).

Discussion

Milk production of camels may vary between 1800 and 12700 kg for a lactation period between 9 and 18 months. As to milk production by camels, BACHMANN and SCHULTHESS (1987) have studied the effect of breed, KARUE (1994) has investigated the effect of stage of lactation on daily production and FIELD (1979) has reported the effect of parity. The present study shows that milk concentrations of ascorbic acid are on average 44.2 mg/l before 180 days in lactation and 47.6 mg/l thereafter. The present values for milk vitamin C are higher than those reported by FARAH et al. (1992), who obtained a mean value of 37 mg/l in indigenous Kenyan camels. For Saudi breeds of camels, SAWAYA et al. (1984), using only 11 camels, found a mean value of 24 mg/l. KNOESS (1977), MEHAIA and AL-KAHNAL (1989) and KON (1959) have reported similar low levels.

Ascorbic acid concentrations were found to be on average 10 % higher in colostrum than in milk obtained at 4-5 months after parturition. HIDIROGLOU et al. (1995) obtained a level of 16 mg/l in colostrum and 8 mg/l in milk of Canadian Holstein cows. It would appear that newborn camel and dairy calves depend on colostrum as a source of vitamin C. There is evidence that vitamin C stimulates the immune response in calves (CUMMINS and BRUNNER 1989). WITNAH and RIDDELL (1977) also reported low ascorbic acid concentrations in cow milk. From a metabolic point of view, it is interesting to study the species difference.

The incidence of mastitis in the 1000 Arabi camels was found to be 51%. This figure is similar to that reported by ABDURAHMAN et al. (1995) showing in a field survey using 170 camels that the incidence of mastitis was 43.5%. It is clear that udder condition markedly affected the vitamin C content of both milk and blood plasma from camels. This finding is in contrast to recent data obtained in cows (SANTOS et al. 2001). In any event, in camels mastitis may lower vitamin C status as has been shown for other types of infection (MOHAMED and BEYNEN 2002b; MOHAMED et al. 2002).

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