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FACTORS AFFECTING VITAMIN C CONTENTS OF CAMEL MILK

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ABSTRACT

The objective of this study was to assess vitamin C contents of camel milk in relation to season and stage of lactation. Milk samples were collected from Anafi camels in Butana region, Sudan. The mean ascorbic acid contents during dry and rainy seasons were 41.0±3.70, and 33.0±4.00 mg/l, respectively. There was a trend of increase in the vitamin C content with the advancement of lactation from 40.10 during the first three months to 44.40 mg/l at 290-360 days of lactation. The increase during summer season and with the advancement of stages of lactation could not be justified, and may be related to the unique glucose metabolism of camel.

Key words: Camel, milk, season, stage of lactation, vitamin C

Vitamin C is a six-carbon lactone synthesised from glucose in the liver and kidney in animals, birds and reptiles (Drouin *et al,* 2011); humans and primates lack the terminal enzyme in the biosynthetic pathway of ascorbic acid, l-gulonolactone oxidase (Nishikimi *et al,* 1994). Camel milk is recommended as a nutriceutical and functional food (Aludatt *et al,* 2012); partly this is because of its richness in vitamin C (Farah, 1993; Farah *et al,* 1993).

The variation of vitamin C content in camel plasma and organs has been studied recently (Mohamed, 2002) and the physiological variation in milk was reported in several references (Metawie *et al,* 2000; Mohamed *et al,* 2005). The present study aims to analyse the vitamin C content in milk of Anafi breeds of camel in Sudan (Gillespie, 1962) in relation to season and stage of lactation.

Materials and Methods

Camel milk was collected from 88 camels in Butana region, Sudan during dry (January-May) and rainy (July-September) seasons. Another 58 camels were followed at different stages of lactation as from delivery to 360 days of lactation. The camels were hand-milked, and milk samples were put on ice and transported to the laboratory. Samples of milk were prepared and analysed 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. Group differences were identified using Duncan's multiple comparison Test. The main aim of this investigation was to study the variation of milk vitamin C concentrations with season and stage of lactation.

Results and Discussion

The study revealed a lower vitamin C content during the rainy season (Table 1). The real cause for such variation is unknown but may be related to internal mechanism such as higher glucose in the blood of camel as compared to ruminants (Elmahdi *et al,* 1997). In line with our findings, Konuspayeva *et al* (2011) indicated that the summer milk was richer (227±110 mg/l) than in autumn (180±62 mg/l) and winter (157±58 mg/l). However, it is clear that differences in analytical methods from HPLC to routine biochemistry may be a determining factor in our results compared with that of Kazakhstan breeds of camel. Similar seasonal variations were reported in human milk; with summer milk under conditions of the study usually had more ascorbic acid than spring and fall milk (Tifrea and Titan, 2011). The vitamin C content of mother milk varied with the season, being

Table 1. The effects of season on vitamin C in Sudanese camel.

Season	Contents (mg/l)
Dry	$41.0^{a} \pm 3.70$
Rainy	$33.0^{b} \pm 4.00$

Means on the same column having different superscripts are significantly different at $P < 0.05$.

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higher in summer (3.9±1.05 mg/100 ml) than in winter (3.02± 2.01 mg/100 ml) (Tawfeek *et al,* 2002). The stability of ascorbic acid against oxidation was greater in summer than in winter milk (Trout *et al,* 1939).

In our work, Anafi camels showed lower values of ascorbic acid in all observed stages of lactation (Table 2). Similar reports were reported in Arabi camel, the main milk producer of camel breeds in Sudan, showing higher levels at 180 days in lactation than for those earlier in lactation (Mohamed *et al,* 2005). In cows, breed related variations were also reported (Woessnee *et al,* 1939).

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

Days of lactation	Contents (mg/l)
6-89	$40.10^{a} \pm 3.00$
90-179	$40.00^{a} \pm 2.98$
180-269	$42.30^{b} \pm 4.00$
270-360	$44.40^{c} \pm 3.90$

Means on the same column having different superscripts are significantly different at $P < 0.05$

A high level of vitamin C in camel milk is well known (El-Hatmi *et al,* 2006) compared to cow milk (Saini *et al,* 2007). Heating of camel milk at 63, 80, 90 and 100°C for 30 min results in a loss of vitamin C content of about 27, 41, 53 and 67%, respectively (Mehaia, 1994).

In conclusion, the exact cause of higher vitamin C during dry hot season could not be ascertained. However, these variations may be related to its unique glucose metabolism in camel compared to other ruminants but needs further valiadation.

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