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Milk Composition of Dromedary Camels (*Camelus dromedarius*): Nutritional Effects and Correlation to Corresponding Blood Parameters

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Abstract: This study has been conducted in order to study the possible correlations between the nutritional value of plants selected by camels during the dry and green season and the corresponding blood and milk composition of the dromedary camels. The study has been conducted on 50 indigenous Arabian camels of different age and kept under natural range in Southern Darfur. The dromedary camels selected plants with significantly ($p<0.05$) higher crude protein content during the dry season and kept the serum albumin concentration and milk protein content at the same levels as those observed during the green season. However, the significantly ($p<0.05$) higher lipogenic content (ether extract + crude fiber) of the plant selected during the dry season resulted in significantly ($p<0.05$) higher serum triacylglycerides concentration and significantly ($p<0.05$) higher milk fat content compared to that of the green season. Although, the camels selected plants with significantly ($p<0.05$) higher nitrogen free extract content during the dry season, the plasma glucose level and the milk lactose content were significantly ($p<0.05$) reduced compared to that of the green season. The significantly ($p<0.05$) lower ach content of the plants selected during the dry season resulted in significantly lower serum calcium + phosphorus concentration, but did not reflect on the ash content of the milk. The results indicate that despite camels selectivity and unique adaptation to arid conditions, the milk lactose-and fat content were affected by the nutritional scarcity during the dry season. Therefore, it could be beneficial to provide energy-rich feed supplemented with calcium and phosphorus to camels kept under dry tropical conditions.

Key words: Camel, milk, blood, nutrition, season

INTRODUCTION

Since pasture productivity is marginal and forage yields are highly variable, camels due to their unique adaptation to hot and arid environments are the only reliable milk producers (Schwartz and Dioli, 1992).

The changes in diet composition and grazing conditions resulted in a rapid change in milk composition, but the relationship between feed constituents and milk composition is complex; however there was a highly positive correlation between the milk fat content and blood levels of triacylglycerols and glucose in dairy goats (Khaled *et al*., 1999). The daily milk yield of camels was reported to be about 5-10 L under optimum feeding conditions compared to only 3-4 L under poor feeding conditions (Knoess, 1976).

The water content of camel milk is of important value for young calves and especially for humans living in drought areas. The moisture percentage of camel milk is 84% under water availability conditions; however, when water is restricted at high environmental temperature, the moisture content of milk was reported to increase to a level of 90% (Yas, 1997). Moreover, Yagil and Etzion (1980) investigated camels milk composition under *ad libitum* and restricted drinking water situations. They reported that under *ad libitum* watering, the moisture, lactose and ash contents were 85.7, 4.6 and 0.6%, respectively, while under restricted drinking water situations lactose and ash contents declined to 2.9 and 0.35%, respectively, while the moisture content was increased to 91.2%.

Milk yield depends on the number of milking times, the feed intake, the climate and the frequency of watering. Estimates of lactation length varied from 9 to 18 month and the total lactation yields from about 800 to 3600 L with a daily yield of 2.8-11.0 L (Wilson, 1984). It has been demonstrated that she-camels maintained on natural grazing lands and milked twice a day, yielded a daily average of 7 to 13 kg in Ethiopia (Knoess, 1979). The daily milk yield was reported to be higher in camels maintained

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on improved irrigated pasture in India from 2.5-6.5 to 15 kg (Gohl, 1979). Milk fat content was also reported to differ from that of other animals and when left standing, fat is distributed as small globules throughout the camel milk (Yagil and Etizion, 1980). Recently, Baidar-khan and Iqbal (2001) studied the Bactrian camels milk composition and reported moisture, dry matter, fat, protein, lactose and ash content of 86.3-88.5, 8.9-14.3, 2.9-5.5, 2.5-4.5, 2.9-5.8 and 0.35-0.95%, respectively. Camels milk yield during the dry season was reported to be about half of the yield during the rainy season. This was attributed to the lack of feed during the dry season (Lakosa and Shokin, 1964).

The primary precursors of milk constituents are free amino acids, glucose, acetate, fatty acids and triacylglycerols, from which milk protein, lactose and fat are produced. Limiting any of these precursors will reduce milk production and change its composition (Jelinek *et al*., 1996). Therefore it was the intention of this study to investigate reflection of the seasonal variations in pasture quality on the milk composition of dromedary camels.

MATERIALS AND METHODS

Study background: The study has been conducted on 50 indigenous Arabian camels of different age and kept under natural range in Southern Darfur state [Latitudes 8° and 13° North, Longitudes 22° and 28° East]. It was conducted both during the dry season (March-May 2003) on camels summer habitat (Masaif) and during green the season (August-September 2003) on camels autumn habitat (Makharif). The camel herds were naturally ranging and have had no feed supplementation except the provision of common salt (NaCl), where approximately 1 pound of salt was added to 20 L of water during the dry season as a traditional practice of nomads during this season. The camels have had access to water every 5-9 days during the dry season, while water was available *ad libitum* during the green season. Samples of parts of trees, bushes and grasses browsed or grazed by camels were collected during both dry and green season. The samples were air dried and kept in clean small plastic bags for subsequent analysis. Milk samples were collected randomly from apparently healthy she-camels of different age groups. The milk samples were kept at -20°C for subsequent analysis. A total number of 50 milk samples were collected, half of which were collected during the dry season while the other half were collected during the green season.

Plants analysis: Plants dry matter content, ether extract using Soxhlet apparatus, crude protein content using Kjeldahl method, crude fiber content and ash content were determined according to the method of AOAC (1984). Nitrogen free extract was calculated by subtracting Ether Extract (EE), Crude Protein (CP), Crude Fiber (CF) and ash from Dry Matter (DM).

Milk analysis: Milk moisture and dry matter contents were determined by forced draft oven method, milk fat content was determined using Gerber method, milk total protein content was determined using Kjeldahl method and milk ash was determined by gravimetric method (Marshall, 1993). Milk lactose content was calculated by subtracting protein, fat and ash contents from the Dry Matter (DM).

Statistical analysis: The data obtained from milk and plants samples collected during both seasons have been subjected to standard methods of statistical analysis. The statistical analysis was performed using windows based SPSS (1999, Version 10.01). The analysis of variance (ANOVA) test was used to evaluate the effects of season on the composition of plants parts that were browsed or grazed by camels and their subsequent effect on blood and milk composition of lactating camels.

RESULTS

The dromedary camels selected plants with significantly ($p<0.05$) higher crude protein content during the dry season compared to the green season (6.79±0.12 vs. 4.90±0.34%) and rendered the serum albumin concentration (3.17±0.05 g dL^{-1}) and milk protein content (35.7±0.6 g L^{-1}) at the same levels as those observed during the green season (3.09±0.05 and 35.5±0.4 g L^{-1}, respectively) (Table 1).

The dromedary camels have also selected plants with significantly ($p<0.05$) higher lipogenic content (ether extract + crude fiber) during the dry season compared to the green season (15.2±0.54 vs. 13.64±0.33%) and have showed significantly ($p<0.05$) higher serum triacylglycerides concentration (34.24±1.55 mg dL^{-1}) and milk fat content (34.1±0.4 g L^{-1}) compared to that of the green season (26.71±1.51 mg dL^{-1} and 31.2±0.2 g L^{-1}, respectively) (Table 2).

Although, the camels selected plants with significantly ($p<0.05$) higher nitrogen free extract content during the dry season compared to the green season (68.04±0.46 vs. 65.25±0.74%), the plasma glucose level (59.57±2.39 mmol L^{-1}) and the milk lactose content (29.2±3.1 g L^{-1}) were significantly ($p<0.05$) reduced compared to that of the green season (86.57±2.33 mmol L^{-1} and 43.1±2.7 g L^{-1}, respectively) (Table 3).

Table 1: Interaction between Crude Protein (CP) content of the plants selected by dromedary camels, serum albumin concentration and milk protein content of dromedary camels (Mean±SE)

Season	Plants CP (g kg^{-1} DM)	Serum albumin (g dL^{-1})	Milk protein (g L^{-1})
Dry	06.79±0.12[a]	03.17±0.05[a]	35.70±0.60[a]
Green	04.90±0.34[b]	03.09±0.05[a]	35.50±0.40[a]

Means within the same column bearing different superscripts are significantly different at $p<0.05$

Table 2: Interaction between the sum of Ether Extract (EE) and Crude Fibre (CF) contents (lipogenic content) of the plants selected by dromedary camels, serum triglycerides concentration and milk fat content of dromedary camels (Mean±SE)

Season	Plants EE + CF (g kg^{-1} DM)	Serum triglycerides (mg dL^{-1})	Milk fat (g L^{-1})
Dry	15.20±0.54[a]	34.24±1.55[a]	34.10±0.40[a]
Green	13.64±0.33[b]	26.71±1.51[b]	31.20±0.20[b]

Means within the same column bearing different superscripts are significantly different at $p<0.05$

Table 3: Interaction between Nitrogen Free Extract (NFE) content of the plants selected by dromedary camels, plasma glucose concentration and milk lactose content of dromedary camels (Mean±SE)

Season	Plants NFE (g kg^{-1} DM)	Plasma glucose (mmol L^{-1})	Milk lactose (g L^{-1})
Dry	68.04±0.46[a]	03.31±0.13[a]	29.20±03.10[a]
Green	65.25±0.74[b]	04.81±0.13[b]	43.10±02.70[b]

Means within the same column bearing different superscripts are significantly different at $p<0.05$

Table 4: Interaction between ash content of the plants selected by dromedary camels, sum of the serum calcium (Ca) and phosphorus (P) concentrations and milk ash content of dromedary camels (mean±SE)

Season	Plants ash (g kg^{-1} DM)	Serum Ca + P (mmol L^{-1})	Milk ash (g L^{-1})
Dry	04.82±0.08[a]	14.12±0.19[a]	06.7±0.30[a]
Green	11.39±0.53[b]	16.08±0.18[b]	06.7±0.30[a]

Means within the same column bearing different superscripts are significantly different at $p<0.05$

The significantly ($p<0.05$) lower ach content of the plants selected by dromedary camels during the dry season compared to the green season (4.82±0.08 vs. 11.39±0.53%) resulted in significantly lower serum calcium + phosphorus concentration (14. 12±0.19 vs. 16.08±0.18 mg dL^{-1}), but did not reflect on the ash content of the milk (6.7±0.3 vs. 6.7±0.3 g L^{-1}) (Table 4).

DISCUSSION

This study has been conducted to monitor the seasonal variations in the nutritional value of forages species selected by dromedary camels and their possible correlation to the corresponding blood parameters and milk composition of she-camels kept under traditional nomadic system.

In the present study, the dromedary camels selected plants with higher crude protein content during the dry season and manage to keep the serum albumin concentration and the milk protein content at the same levels as compared to the green season (Table 1) The overall mean value of serum albumin obtained in the present study is within the range reported for camels in the Sudan (Abdelgadir *et al*., 1984).

However, seasonal variations in the nutritional value of the plants selected by camels have influenced the serum triacylglycerides and plasma glucose concentrations and consequently affected the fat-and lactose contents of the milk of she-camels (Table 2 and 3). The observed increase in milk fat content during the dry season could be related to the reduced feed intake and the consequent elevation of the serum triacylglycerides concentration (Amin *et al*., 2007b), since triglycerides are known to provide the metabolic fuel for most tissues when the animal has energy deficit (Beitz, 1993). Moreover, it has been reported that reduced glucose metabolism is reflected on the output of free fatty acids (Mayes and Bothman, 2003). The observed increase in milk fat content during the dry season could also be related to the decreased milk yield. In the dry season, the camel milk yield was reported to be about half of the rainy season (Lakosa and Shokin, 1964; Knoess *et al*., 1986). Moreover, Sheriha (1986) reported a negative correlation between milk yield and fat content in camels.

The observed decrease in milk lactose content during the dry season despite the higher content of nitrogen free extract in the plants selected by dromedary camels during this season could be attributed to the reduced feed intake and the consequent decrease in the concentration of plasma glucose (Amin *et al*., 2007b). Food deprivation was reported to decrease plasma glucose level in monogastric mammals and ruminants (Evans, 1971; Rule *et al*., 1985). Moreover, Martin (1993) reported a negative correlation between the lactose and fat contents with advanced lactation. The milk fat and lactose contents obtained in the present study are within the range reported by Baider-khan and Iqbal (2001).

On the other hand seasonal variation in the ash content of plants selected by the dromedary camels have decreased the serum levels of calcium and phosphorus but did not show significant effect on milk ash content (Table 4). This could be attributed to the mobilization of minerals to meet the requirements of milk synthesis during the dry season, where the available plants have lower ash content (Amin *et al*., 2007a). Moreover, it has been reported that animals kept under natural range grazing could obtain their phosphorus requirement during the wet-but not during the dry season (Wilson, 1984; Elmi, 1989).

CONCLUSIONS

The results obtained in this study indicate that seasonal variation in the nutritional value of the plant selected by dromedary camels could have a significant influence on milk composition. Despite camel's selectivity and unique adaptation to arid conditions, the milk lactose- and fat content were affected by the nutritional scarcity during the dry season. Therefore, it could be beneficial to provide energy-rich feed supplemented with calcium and phosphorus to camels kept under dry tropical conditions.

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