

**SHORT NOTE [NOTA CORTA]**

**INFLUENCE OF SEASON AND MANAGEMENT ON COMPOSITION OF  
RAW CAMEL (*Camelus dromedarius*) MILK IN KHARTOUM STATE, SUDAN**

**[INFLUENCIA DE LA ESTACIÓN Y MANEJO SOBRE LA COMPOSICIÓN  
DE LA LECHE DE CAMELLO (*Camelus dromedarius*) EN KHARTOUM,  
SUDAN]**

**E.S. Shuiep<sup>1,2</sup>, I.E.M. El Zubeir<sup>2\*</sup>, O.A.O. El Owni<sup>2</sup> H.H. Musa<sup>1,3</sup>**

<sup>1</sup>Dept. Animal Production. Fac. Veterinary Science. University of Nyala. Nyala.  
Southern Darfur State. Sudan. E-mail: tahirr13@yahoo.com

<sup>2</sup>Dept. Dairy Production. Fac. Animal Production. University of Khartoum.  
Khartoum North, 13314, Sudan, E-mail: ibtisammohamed@hotmail.com

<sup>3</sup>College of Animal Science and Technology, Yangzhou University,  
Yangzhou 225009. China. E-mail: hassan\_hm30@yahoo.com

\* Corresponding author

**SUMMARY**

The influence of seasons (winter and summer) on chemical composition of raw camel milk within two management systems in two different locations around Khartoum State, Sudan was investigated. Camel milk samples (n=112) were collected from Eastern Nile (semi-intensive system) and Western Omdurman (traditional system) using the same procedure for milk sampling. The two locations were approximately of 100 Km distance apart. Titratable acidity and major components of milk were determined. Total solids, lactose and titratable acidity were higher in Eastern Nile samples ( $P \leq 0.05$ ), while fat was higher in Western Omdurman ( $P \leq 0.01$ ). Non-significant differences were obtained between locations in ash and protein content. Summer samples revealed significantly higher protein content and titratable acidity in Eastern Nile, whereas in winter all components were higher than those examined in summer in both locations. The high water content in summer samples negatively affected camel milk components compared to winter samples. The influence of season was higher than that reported for management. Feeding of high energy diets and protein concentrates has effect of negative value on fat content and positive value on protein content of camel milk, respectively.

**Keywords:** camel milk, chemical composition, seasonal influence, Sudan

**RESUMEN**

Se estudió la influencia de la estación (invierno y verano) sobre la composición química de la leche de camello en dos sistemas de manejo y dos localidades de Khartoum, Sudán. Las muestras de leche (n=112) se colectaron de la región Oriental del Nilo (sistema semi intensivo) y la región Occidental de Omdurman (sistema tradicional), las cuales se encuentran separadas por aprox. 100 km. La acidez y componentes mayores de la leche fueron determinados. Los sólidos totales, lactosa y acidez fueron mayores ( $P \leq 0.05$ ) en el Nilo Oriental, mientras que la grasa fue mayor en Omdurman Occidental ( $P \leq 0.01$ ). No se encontraron diferencias en el contenido de cenizas y proteína. Las muestras del verano fueron más altas en proteína y acidez en el Nilo Oriental, mientras que durante el invierno todos los componentes fueron mayores en ambas localidades en comparación con el verano. El efecto de la estación del año fue mayor que el efecto de manejo. Alimentar con dietas altas en energía y proteína tuvo un efecto negativo en el contenido de grasa y positivo en el contenido de proteína de la leche de camello.

**Palabras clave:** Leche de camello, composición química, época, Sudán.

**INTRODUCTION**

The camel population in Sudan was estimated at 3.724 million head according to the Ministry of Animal Resource and Fisheries (MOARF, 2004). The majority

of this number is kept by migratory pastoralists "Abbala" in arid and semi arid zones of Sudan, where camel pastoralists prevail with limited resources in subsistence production systems. The mobility is the primary means by which *Abbala* compensate for the

spare resource (Schwartz and Dioli, 1992). However, some herders around Khartoum State keep not more than three “*Nagas*” (she camel) with dairy cattle in their farms as milk producer, mostly, for special family use.

Camels’ milk is a complex mixture of fat, protein, lactose, minerals and vitamins (Schwartz and Dioli, 1992) and miscellaneous constituents dispersed in water. Various authors described camel milk composition and characteristics in different production systems and have published the special properties of camel milk and outlined that the components of camel milk are considerably different from those of ruminants (Elamin, 1979; Elamin and Wilox, 1992; Schwartz, 1992; Dell’Orto *et al.*, 2001; Wang’ang’a, 2002; Younan, 2002 El Hag *et al.*, 2003; Nabag *et al.*, 2006). The general composition of camel milk varies in various parts of the world with a range of 3.5 to 4.5% protein, 3.4 to 5.6% lactose, 3.07 to 5.50% fat, 0.7 to 0.95% ash and 12.1 to 15% total solids (Gnan and Sheriha, 1986). These wide variations in the constituents of milk were attributed to some factors such as age, number of calving, management, stage of lactation, the sampling technique used (Abu-Lehia, 1987 and Alshaikh and Salah, 1994) and feed quality (Parraguez *et al.*, 2003). The most important factor in camel milk for peoples living in dry zone is its water content (Wilson, 1998). Yagil (1982) declared that young camel and human livings in dry areas are in need of fluids to maintain homeostasis and thermoregulation. The pastoralists usually rely on camel milk through out the year (Bakheit, 1999; Iqbal, 2002) and it may contribute up to 50% of their food (Chabeda, 2002).

Seasonal variation effect on milk production in different species in tropical and sub tropical zones are recognized. Concerning camels, large seasonal variations in total solids and fat were reported from Jordan with maxima in mid-winter and minima in August (Haddadin *et al.*, 2007).

*Nagas* unlike other milk-producing animals, can thrive under extreme hostile conditions of temperature, drought and lack of pasture, and still produce milk under traditional management system (Yagil and Etzion, 1980). Evidences in ruminants has demonstrated that milk composition is strongly influenced by feeding conditions (Sampelayo *et al.*, 1998) and it is suggested that when animals are breeding in environments quite different from that considered natural for them, a difference in milk composition may be found. Moreover, Bekele *et al.* (2002) concluded that if camel had been kept under better management conditions milk production would be better.

The objectives of this study are to determine the

chemical composition of camel milk in both traditional and semi-intensive management systems, and to investigate the influence of seasonal changes in temperature, water availability and feed quality on the composition of camels’ milk.

## MATERIALS AND METHODS

### Source of samples

This study was carried out in Khartoum State, Sudan. 112 samples of raw camel milk were collected from 112 *Nagas* in Eastern Nile and Western Omdurman, (n=56 /location) during two seasons, winter (December 2004– February 2005) and summer (April– June 2005) (n=28 /season). Different management system is practiced in each location. In Eastern Nile, where semi-intensive system is practiced, transhumance camel owners keep one or more *Naga* in dairy farms with cattle. Traditional management is the system of practice in Western Omdurman, where *Abbala* use natural pasture.

### Animals

*Nagas* (n=112) investigated in this study were a costumed to twice milking a day, early morning and evening. Each *Naga* was subjected to sampling once during this study, because it was not possible to find the transhumance in the same place during the different seasons. The samples taken during summer are from early lactation and those collected during winter are from mid or late lactation.

### Feeding of the animals

In Eastern Nile *Nagas* are kept in dairy farms under semi-intensive system management with relatively good water supply and feeding conditions. Protein concentrates (ground nut cake) and high energy diet (molasses base diet) that provided to dairy cows is available to *Nagas* also. While in Western Omdurman area, natural grazing is used among *Abbala* who practice traditional movement searching for natural pastures under scarce cater conditions.

### Collection of camel milk samples

Samples were collected from bulk milk of single *Naga* from early morning milking in dry clean bottles (200 ml) after thoroughly mixing. The samples were immediately labeled and transferred in an icebox to the laboratory within maximum 3 hrs.

### Chemical analysis:

Proximate analysis was used in duplicate according to the procedure out lined by Bradley *et al.* (1992) to determine the titratable acidity and the principal

chemical components of milk. Percentage of total solids was determined gravimetrically after drying in a forced-draft oven at 105°C until a steady weight was achieved, ash content was measured gravimetrically by burning away the organic matter in muffle furnace at 500°C, fat was determined by Gerber's method and Kjeldahl method was used to determine the nitrogen content. A nitrogen conversion factor of 6.38 was used for calculation of protein contents of milk samples. Lactose content was determined by the difference of total solids minus other solid components.

### Statistical analysis:

The data of the present study was statistically analyzed using SPSS software (Statistical Package for Social Sciences, v. 10). Mean separation was carried out using paired Student t- test.

## RESULTS AND DISCUSSION

The average total solids content of camel milk samples collected during this study from Khartoum State were found to be 9.56± 0.88% and 9.41± 0.93% from Eastern Nile (semi-intensive) and Omdurman (traditional system), respectively (Table 1). This result was lower than that reported by Knoess (1976), Farah and Ruegg (1989), El-Amin et al. (2006) and Nabag et al. (2006). However, it was similar to that cited by Mehaia et al. (1995).

The data presented in Table 1 reveal significant differences ( $P \leq 0.05$ ) for total solids content of camel milk between locations. This may be due to the different management systems and variation in quality and quantity of feed available between the locations. Compared to Western Omdurman, Eastern Nile samples were low in total solids contents, which might be due to water availability in Eastern Nile, while in Western Omdurman camels usually drink once a week in summer and once a month in winter as reported by Musa et al. (2006). This is supporting evidence reported by Yagil (1982). Highly significant differences ( $P \leq 0.01$ ) were obtained when comparing the two seasons as shown in Table 2. This might be attributed to the reason that camel during hot seasons provides milk with lower total solids because the calves need more fluids (Yagil and Etzion, 1980). This may occur by the alternations in some component particularly lactose, fat and protein (Yagil, 1982).

The ash content of camel milk samples collected from the two locations were similar, while those collected during summer revealed lower ash content in comparison to those collected during winter (Table 2). This agrees with Yagil (1982) who reported that dehydrated camel's milk usually related to low ash content.

Table 1. The composition of raw camel milk (mean ± SD) obtained from two locations in Khartoum State, Sudan

Location	Total solids %	Ash%	Fat%	Protein%	Lactose%	Titrateable Acidity%
Eastern Nile	9.56± 0.88	0.73±11	2.64±40	2.93±0.29	3.12±0.81	0.15±0.02
Western Omdurman	9.41±0.93	0.73±12	2.85±0.48	2.94±0.41	2.90±0.62	0.14±0.02
Significance	*	ns	**	ns	*	**

<sup>ns</sup> No significant differences

\* Significant differences at  $P \leq 0.05$

\*\* Significant differences at  $p \leq 0.01$

Table 2. The composition (mean ± SD) of raw camel milk samples collected from Eastern Nile and Omdurman during winter (W) and summer (S) in Khartoum State, Sudan.

Season	Total Solids%		Ash%		Fat%		Protein%		Lactose%		Acidity%	
	W	S	W	S	W	S	W	S	W	S	W	S
Eastern Nile	10.20 <sup>a</sup> ±0.66	8.92 <sup>b</sup> ±0.46	0.80 <sup>a</sup> ±0.09	0.66 ±0.07 <sup>b</sup>	2.80 <sup>a</sup> ±0.26	2.49 <sup>b</sup> ±0.46	2.88 <sup>b</sup> ±0.35	3.27 <sup>a</sup> ±0.50	3.73 <sup>a</sup> ±0.59	2.50 <sup>b</sup> ±0.46	0.12 <sup>b</sup> ±0.01	0.17 <sup>a</sup> ±0.07
Western Omdurman	10.47 <sup>a</sup> ±0.54	8.65 <sup>b</sup> ±0.62	0.80 <sup>a</sup> ±0.10	0.66 ±0.10 <sup>b</sup>	3.18 <sup>a</sup> ±0.33	2.53 <sup>b</sup> ±0.36	2.97 <sup>a</sup> ±0.21	2.90 <sup>b</sup> ±0.55	3.22 <sup>a</sup> ±0.43	2.57 <sup>b</sup> ±0.63	0.13 <sup>b</sup> ±0.01	0.15 <sup>a</sup> ±0.02
Mean	10.18 <sup>a</sup> ±0.56	8.79 <sup>b</sup> ±0.59	0.80 <sup>a</sup> ±0.01	0.66 <sup>b</sup> ±0.01	3.00 <sup>a</sup> ±0.35	2.51 <sup>b</sup> ±0.41	2.93 <sup>b</sup> ±0.29	3.09 <sup>a</sup> ±0.55	3.47 <sup>*</sup> ±0.57	2.54 <sup>b</sup> ±0.46	0.14 <sup>b</sup> ±0.01	0.16 <sup>a</sup> ±0.02

\* Indicate significant differences ( $p \leq 0.05$ ) in the same column (between locations)

Similar superscript letter indicate significant differences ( $p \leq 0.05$ ) between seasons

Lower mean fat content was found for the camel milk samples collected from Eastern Nile compared to that collected from Western Omdurman (Table 1). This finding showed highly significant difference ( $P \leq 0.01$ ) between the two locations. This agreed with Parraguez *et al.* (2003) who mentioned that when energy is supplemented by concentrate diet, this results in a decrease in milk fat content. On the other hand, the mean fat content of camel milk during winter was found to be significantly ( $P \leq 0.05$ ) higher than that reported during summer. This could be explained by seasonal changes that affect the quality of feed especially in Western Omdurman (El Zubeir and Nour, 2006). Moreover, it is known that total energy intake is directly related to fat content. Similarly, the hydration status of the camels during summer could be another reason as stated before by Yagil (1982). Moreover, summer samples in Western Omdurman revealed lower fat content compared to that of winter. Although camels in Eastern Nile always have high protein rations in dairy cattle farms, the protein content of their milk was similar to that obtained from Western Omdurman. This could be explained by that camels are well selective browsers. Protein content of camel milk samples collected from Eastern Nile during summer was significantly ( $P \leq 0.05$ ) higher when compared to that collected in Western Omdurman. This might be due to the protein rich diet, which is resulted in production of milk rich in protein (Parraguez *et al.*, 2003). During winter season the mean protein content of camel milk was found to be lower than that estimated during summer. The higher protein estimated during summer may be due to availability of good pasture as it rains during summer. Also it may be due to individual variations (Yagil and Etzion, 1980), stage of lactation and/ or parity number (El-Amin *et al.*, 2006). The availability of water in Eastern Nile could be another reason.

During winter season the average lactose content of camel milk was found to be significantly higher than that collected during summer season. Lactose content of Western Omdurman samples was lower than that reported for Eastern Nile, which could be explained by the daily exercise for the animals to obtain the daily feed beside the continuous mobility, this supporting Parraguez *et al.* (2003).

The mean titratable acidity in Eastern Nile samples was found to be higher than that of Western Omdurman samples (Table 1) with highly significant differences ( $P \leq 0.01$ ). This might be due to the presence of some bacteria (Data not shown). It might also be due relatively long transportation time from milking to analysis. Highly significant differences ( $P \leq 0.01$ ) were obtained when comparing winter and summer mean titratable acidity of camel milk. The high titratable acidity is related to high temperature (Yagil and Etzion, 1980). Moreover, the increase in

titratable acidity during summer may be due to bacterial acidification (Mohamed *et al.*, 1999 and Simon and Hasen, 2001).

## CONCLUSION

Season strongly affects camel milk composition through heat stress, feed available quality and water availability by affecting the total solids of milk and this directly affects the other components.

## ACKNOWLEDGEMENT

The authors would like to thank Islamic Development Bank (Jeddah) and Ministry of Higher Education and Scientific Research (Sudan) for the financial support. We would also like to thank the camel herders who allowed collecting samples from their herds

## REFERENCES

- Abu-Lehia, I.H. 1987. Composition of camel milk. *Milchwissenschaft* 42: 368–371.
- Alshaikh, M.A., Salah, M.S. 1994. Effect of milking interval on secretion rate and composition of camel milk in late lactation. *Journal of Dairy Research*, 61: 451–456.
- Bakheit, S.A. 1999. Studies on milk production and composition of camel's milk (*Camelus dromedarius*) under nomadic system. M. Sc. Thesis U. of K., Sudan.
- Bekele, T., Zeleke, M., Baars, R.M.T. 2002. Milk production performance of one humped camel (*Camelus dromedarius*) under pastoral management in semi- arid eastern Ethiopia. *Livestock Production Science*, 76: 37- 44.
- Bradley, R.L., Arnold, E.J.R., Barbano, D.M., Semerad, R.G., Smith, D.E., Viries, B.K. 1992. Chemical and physical methods. In: Marshall, T. R. (Ed). *The Standard Methods for the Examination of Dairy Products*. American Public Health Association, Washington, DC., USA.
- Chabeda, E.O. 2002 The past, present and future extension on camel production in Kenya. In: *Proceedings of the 8th Kenya Camel Forum*. 12th -15th March, Kajiado District, Kenya.
- Dell'Orto, V., Cattaneo, D., Beretta, E., Baldi, A., Savoini, G. 2001. Effect of trace element supplementation on milk yield and composition in camel. *International Dairy Journal*, 10:873- 879.

- El-Amin, E.B., El Owni, O.A.O., El Zubier Ibtisam, E.M. 2006. Effect of parity number, lactation stage and season on camel milk composition in Khartoum State, Sudan. Proceedings of the International Scientific Conference on Camel. Part IV: 2173- 2183. Qassim University, Saudia Arabia, 9-11 May 2006.
- Elamin, F.M. 1979. The Dromedary of the Sudan. In: The Camelid an all-purpose animal. Proceedings of the Khartoum Workshop on Camels, Cockrill, W. R. (Ed.), Motala, Grafediska, Sweden.
- Elamin, F.M., Wilox, C.J. 1992. Milk composition of Majaheim camel. Journal of Dairy Science, 75: 3155- 3157.
- El Hag, F.M., Sabiel, S.A., Abu Nikhaila, A.M., Ahmed, M.E., Ahmed, M.M. 2003. Camels (*Camelus dromedarius*) under pastoral system in north Kordofan, Sudan: Seasonal and parity effect on camel milk yield and composition. Nomadic People, 6(2): 24- 32.
- El Zubeir, I.E.M., Nour, E.M. 2006. Studies on some camel management practices and constrains in pre- urban areas of Khartoum State, Sudan. International Journal of Dairy Science, 1: 104- 112.
- Farah, Z., Ruegg, M.W. 1989. The size distribution of casein micelles in camel milk. Food Microstructure, 8: 211- 216.
- Gnan, S.O., Sheriha, A.M 1986. Composition of Libyan camel's milk. Australian Journal of Dairy Technology. 41: 33-35.
- Haddadin, M.S., Gammoh, S.I., Robinson, R.K. 2007. Seasonal variations in the chemical composition of camel milk in Jordan. Journal of Dairy Research, doi: 10.1017/S0022029907002750, (in press).
- Iqbal, A. 2002. A socioeconomic profile of camel in Pakistan with special emphasis on management and production aspect. In: International Workshop on Camel Research and Development- Formulating a Research Agenda for the Next Decade. 9<sup>th</sup>- 12<sup>th</sup> December. Wad Medani, Sudan. pp. 45- 50.
- Knoess, K. 1976. Assignment Report on Animal Production in the Middle Awash Valley. FAO. Rome, Italy.
- Mehaia, M.A., Hablas, M.A., Abdel- Rahman, K.M., El Mougy, S.A. 1995. Milk composition of Majaheim, Wadha and Hamra camels in Saudi Arabia. Food Chemistry, 52: 115- 122.
- MOARF 2004. Estimates of animal population 2000-2004. Sudanese Ministry of Animal Resources and Fisheries. Annual report.
- Mohamed, I.E.M., El Owni, O.A.O., Mohamed, G.E. 1999. Effect of mastitis on milk quality of Friesian cows in Khartoum State. Indian Journal of Animal Sciences, 69: 733- 735.
- Musa, H.H., Shuiep, E.S., El Zubier, I.E.M. 2006. Camel husbandry among pastoralists in Darfur in Western Sudan. Nomadic People, 10: 101-106.
- Nabag, M.G., Alatti Khadiga, A., El Zubier Ibtisam, E.M. 2006a. Milk composition of camels and goats grazing in extensive pasture of Butana area in Sudan. Proceedings of the International Scientific Conference on Camel. Part IV: 2173- 2183. Qassim University, Saudia Arabia, 9- 11 May 2006.
- Parraguez, V.H., Thenot, M., Latorre, E., Ferrando, G., Raggi, L.A. 2003. Milk composition in alpaca (*Lama pacos*): comparative study in two regions of Chile. Archivos de Zootecnia. 52: 431- 439.
- Sampelayo, M.R., Perez, L., Boza, J., Amigo, L. 1998. Forage of different physical forms in the diets of lactating Granadina goats: nutrient digestibility and milk production and composition. Journal of Dairy Science, 81: 492- 498.
- Schwartz, H.J. 1992. Introduction: The Camel (*C. dromedarius*) in East Africa. In: The One Humped Camel in Eastern Africa: A Pictorial Guide to Diseases, Health Care and Management. Schwartz, H. J. and Dioli, M. (Ed). pp: 1- 9. Verla Josef Margraf Scientific Books.
- Schwartz, H.J., Dioli, M. 1992. The One Humped Camel in Eastern Africa: A Pictorial Guide to Disease, Health Care and Management. Verla Josef Margraf. Scientific Books.
- Simon, M., Hasen, A.P. 2001. Effect of dairy packing materials on the shelf life and flavor of ultra pasteurized milk. Journal of Dairy Science, 84:784- 791.

Shuiep *et al.*, 2008

Wang'ang'a, H.W. 2002. Provincial livestock production office North Eastern province report on the ship of the desert. In: Proceedings of the 8<sup>th</sup> Kenya Camel Forum. 12<sup>th</sup> -15<sup>th</sup> March, Kajiado District, Kenya. pp: 37- 39.

Wilson, R.T. 1998. Camels. CTA series, Mac Millan Educational Press Ltd, London, UK. pp: 120-124.

Yagil, R. 1982. Camels and Camel Milk. FAO Animal

Production and Health Paper No. 26. Rome, Italy.

Yagil, R., Etzion, Z. 1980. Effect of drought conditions on the quality of camel milk. Journal of Dairy Research, 47:159- 162.

Younan M 2002 Lack of treatment concept of camels. Proceedings of the 8<sup>th</sup> Kenya Camel Forum. 12<sup>th</sup> -15<sup>th</sup> March, Kajiado District, Kenya. pp: 76- 77.

*Submitted November 18, 2006 – Accepted October 04, 2007*  
*Revised received January 22, 2008*