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Influence of Some Factors on Composition of Dromedary Camel Milk in Sudan

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ABSTRACT

The present study was carried out to investigate the impact of management systems, breeds, parity and stage of lactation on milk composition of Sudanese Arabi camels. Samples of camel milk were collected from 120 healthy she-camels from three different indigenous breeds (Kenani, Nefidia and Butana) in two different management systems (traditional nomadic system and semi intensive system). The milk samples were from camel of 5 parity numbers (1-5 parities) and 4 lactation stages. The highest significant percentages of camel milk fat, protein, lactose, total solids (TS) and solids non fat (SNF) were recorded for the camel in the traditional nomadic system (Nefidia and Butana) followed by the semi intensive system (Kenana breed). Moreover, the mean protein, lactose, TS and SNF values of camel milk were significantly higher during the first stage of lactation, while the mean for fat was significantly high during the third stage of lactation. Fat, protein, lactose, TS and SNF values of camel milk were higher in the fifth parity. Camel reared in the traditional nomadic system (Nefidia and Butana breed) and semi intensive system (Kenana breed) had significantly high content of milk fat compared to their counterparts. However, non significant differences in fat percentage during the fourth parity were observed. The TS and SNF of camel milk were significantly high at the first stage of lactation in comparison with the second and fourth ones. The results indicated that variations in chemical composition of camel milk were mainly attributed to factors such as management systems, breed, parity number and stage of lactation.
Keywords: Management systems, chemical composition, camel milk.

INTRODUCTION

Dromedary camels (*Camelus dromedarius*) can survive and produce considerable amount of milk during recurrent and prolonged hot and dry environment (Bekele *et al*., 2011). Camel milk is considered one of the most valuable food sources for nomadic people in arid and semi arid areas and has been consumed for centuries due to its nutritional values and medicinal properties (Kenzhebulat *et al*., 2000; El Zubeir and Nour 2006; Farah *et al.*, 2007; Lorenzen *et al*., 2011). It is considered to have anti-cancer (Magjeed, 2005) and anti-diabetic (Agrawel *et al*., 2003; Agrawel *et al*., 2005) properties. The high content of unsaturated fatty acids of the camel milk may enhance its overall nutritional quality (Karray *et al*., 2005; Konuspayeva *et al*., 2008; Ayadi *et al*., 2009).

Camel milk composition was found to be less stable than other species such as bovine. Previous findings pointed out that the variation in camel milk composition could be attributed to many factors such as analytical measurement procedures, geographical locations, feeding conditions, type of samples and breeds in addition to other factors including milking frequency, stage of lactation and parity numbers (Iqbal *et al*., 2001; Faye *et al*., 2008; Ayadi *et al*., 2009; Al-Haj and Al-Kanhal, 2010; Hammadi *et al*., 2010; Aljumaah *et al*., 2011). However, geographical origin and seasonal variations were found to be the most effective factors on camel milk constituents and chemical composition in production systems (Shuiep *et al*., 2008). The mean values of camel milk composition (%) reported over the past 30 years were: 3.5±0.1; 3.1±0.5; 4.4±0.7; 0.97±0.07 and 11.9±1.5 for fat, protein, lactose, ash, and total solids, respectively (Al-Haj and Al-Kanhal, 2010).

The camel population in Sudan is about 4.623 millions heads of different indigenous breeds (MARF, 2011). Indigenous camels in Sudan can be classified into different ecotypes or breeds including: Kenani, Butana, Lahawee and others (Wathig *et al*., 2007). Three major production systems: traditional nomadic, semi nomadic and semi intensive systems are practiced in Sudan (Shuiep *et al*., 2008; Ishag and Ahmed, 2011; Eisa and Mustafa, 2011). The composition of camels' milk had been studied under different conditions (El-Amin and Wilcox, 1992; Mehaia *et al*., 1995; Babiker and El Zubeir, 2014). However, there is limited information about the factors affecting milk composition of camels in Sudan. Therefore, the aim of this study was to investigate the effects of management systems, breed, parity number and stages of lactation on the camel milk composition of Sudanese Arabi camel.

MATERIALS AND METHODS

Collection of milk samples

Camel milk samples were collected from three different areas in central Sudan (Sinnar; Moya mountain, and Gezira State; Al Neb; Al Butana) and Khartoum State (Khartoum North locality and Eastern Nile locality), during July 2013 to August 2013. A total of 120 milk samples were collected from 120 healthy she-camels of three indigenous breeds; Kenani and Nefidia and Butana in traditional nomadic system and semi intensive system, respectively. In total 120 bulk milk samples (40 samples/system) were collected in dry clean bottles (60 ml). The samples were labelled and transferred in an icebox to the Dairy Chemistry laboratory of the Faculty of Animal Production, University of Khartoum for the chemical analysis. According to parity, the collected samples were divided into five categories; first, second, third, fourth and fifth. The stage of lactation was also divided into four stages; first (from birth to 3 months), second (from 4 to 6 months), third (from 7 to 9 months) and fourth (from 10 to the end of lactation) stages.

Management systems of camel

In traditional nomadic system, the camels spend all the time in the pasture with restricted access to water. In semi intensive system, the entire herd was kept in pens all the year, and the daily ration consists of a mixture of groundnut cake, *Sorghum biocolor* (Feterita) and *Sorghum biocolor* (Abu70) in addition to continuous water supply. In traditional nomadic system, camels were hand milked three times a day (6:30 am, 1:00 pm and 7:00 pm) and in semi intensive system the camels were hand milked three times (6:00 am, 1:30 pm and 7:00 pm).

Chemical analysis

Each milk samples was analysed for the content fat, protein, solids not fat, total solids, lactose content and density. The content of milk components were measured twice using Lactoscan milk Analyzer (Milkotronic LTD, Europe) according to the manufacturer's instructions.

Statistical analysis

The data were analysed using the General Linear Model (GLM) procedure in SPSS (Statistical Package for Social Sciences, v.17). Differences between means were separated by Duncan's Multiple Range Test (DMRT) when the significant differences existed.

RESULTS AND DISCUSSION

Results revealed that camel milk composition was significantly ($P<0.05$) affected by the management systems (Table 1, 2 and 3). The highest percentage of fat (4.59), protein (3.53), lactose (4.81), total solids (13.62) and SNF (8.99) were recorded in milk of camel kept in the traditional nomadic system (Nefidia breed). In contrast, these components showed the lowest values in milk of camel kept under the traditional nomadic system (Butana breed). The fat content was higher in milk of camel managed under the traditional nomadic system (Nefidia breed) than semi intensive system (Kenana breed) and traditional nomadic (Butana breed) management systems (4.59% vs. 4.20% and 3.36% respectively). The lower values of camel milk fat content found in the traditional nomadic (Butana breed) system might be due to lack nutrient supplements in comparison to those in the semi intensive system. The fat percentage of Nefidia camel milk recorded the highest value (4.59%) than Kenana and Butana camel milk. Konuspayeva *et al*. (2009), Al-Haj and Al-Kanhal (2010); Babiker and El Zubeir (2014) reported that camel milk composition was influenced by regional differences including feeding conditions. These results partly agreed with those reported previously in Bedouin camels under semi nomadic system (Guliye *et al*., 2000). On the other hand, the obtained results disagreed with the results reported by Haddadin *et al*. (2008) where the milk composition in camels was found to be independent of the grazing system. Variations observed in camel milk composition could be attributed to several factors including management systems (Bekele *et al*., 2008; Shuiep *et al*., 2008; Riyadh *et al*., 2012; Babiker and El Zubeir, 2014), geographical locations, feeding conditions (Khaskheli *et al*., 2005; Bekele *et al*., 2008), seasons (Shuiep *et al*., 2008; Haddadin *et al*., 2008 and Riyadh *et al*., 2012), stage of lactation and calving number (El-Amin *et al*., 2006; Zeleke, 2007; Riyadh *et al*., 2012).

Significant differences among the three studied breeds in the chemical composition of camel milk were observed (Table 1, 2 and 3). This result agreed with those of other researchers (Alshaikh and Salah, 1994; Gaili *et al*., 2000; Khaskheli *et al*., 2005; Konuspayeva *et al*., 2009; Ereifej *et al*., 2011; Babiker and El Zubeir (2014) who reported that camel milk components were significantly affected by breed of lactating camels. The Nefidia camel's milk had the highest contentsof protein, lactose, TS and SNF (3.53%, 4.81%, 13.62% and 8.99%, respectively). These results are consistent with those of Babiker and El Zubeir (2014) who found similarities between camel milk components of Kenani and Anafi but reported differences in these components between these two camel breeds.

Table 1: Means± S.E of camel milk components (%) as influenced by Semi-intensive system, Kenana breed, Parity order and stages of lactation

Parity Number	Stages of Lactation/ Month	Fat	Protein	Lactose	T. S	SNF	Density (mg/dl)
(1-2)	(1-2)	3.60^a±0.19	3.34^a±0.05	4.60^a±0.06	12.19^a±0.25	8.65^a±0.13	1.030^a±0.001
	(4-6)	3.79^a±0.38	3.23^a±0.09	4.43^a±0.12	12.17^a±0.49	8.29^a±0.25	1.029^a±0.003
	(7-9)	5.32^a±0.25	3.22^a±0.06	4.34^a±0.08	13.48^a±0.33	8.20^a±0.17	1.027^a±0.002
	(≤10)	4.51^a±0.36	3.27^a±0.09	4.45^a±0.11	12.92^a±0.47	8.41^a±0.24	1.028^a±0.002
3	(1-2)	4.74^a±0.41	3.27^a±0.09	4.43^a±0.13	13.07^a±0.54	8.34^a±0.28	1.028^a±0.003
	(4-6)	3.78^a±0.24	3.20^a±0.06	4.39^a±0.08	11.99^a±0.31	8.22^a±0.16	1.028^a±0.002
	(7-9)	3.44^a±0.41	3.04^a±0.09	4.18^a±0.13	11.35^a±0.54	7.82^a±0.28	1.047^a±0.003
	(≤10)	4.44^a±0.32	3.39^a±0.08	4.62^a±0.10	13.11^a±0.42	8.67^a±0.21	1.030^a±0.002
4	(1-2)	6.25^a±0.41	3.29^a±0.09	4.38^a±0.13	14.46^a±0.54	8.30^a±0.28	1.027^a±0.003
	(4-6)	3.20^a±0.72	3.13^a±0.17	4.35^a±0.23	11.31^a±0.93	8.11^a±0.48	1.028^a±0.005
	(7-9)	3.14^a±0.51	3.26^a±0.12	4.50^a±0.16	11.54^a±0.66	8.40^a±0.34	1.029^a±0.004
	(≤10)	3.87^a±0.72	3.63^a±0.17	4.98^a±0.23	13.19^a±0.93	9.31^a±0.48	1.032^a±0.005
5	(1-2)	2.15^b±0.69	2.10^b±0.14	3.59^b±0.27	9.99^b±0.69	7.39^b±0.59	1.015^b±0.001
	(4-6)	5.52^a±0.72	3.34^a±0.17	4.49^a±0.23	14.00^a±0.93	8.49^a±0.48	1.028^a±0.005
	(7-9)	3.33^a±0.72	3.28^a±0.17	4.54^a±0.23	11.80^a±0.93	8.47^a±0.48	1.030^a±0.005
	(≤10)	2.10^b±0.69	2.50^b±0.14	3.30^b±0.27	8.89^b±0.69	7.10^b±0.59	1.014^b±0.001

$^{a-b}$ Means with different letters in the same superscript are significantly different at (p≤0.05)

Table 2 showed the effect of traditional nomadic system on Butana breed, parity number and stages of lactation on camel milk constituents. Results showed significantly (P<0.05) differences in fat, protein, lactose, TS and SNF of camel milk in the different parities. Where camel in the first stage of lactation revealed high mean values protein, lactose, TS and SNF percentages for milk (3.49±0.03, 4.77±0.04, 13.14±0.16 and 8.97±0.07%, respectively). Meanwhile, the mean values of milk constituents were lower in the subsequent parity.

Table 2: Means± S.E of camel milk components (%) as influenced by Traditional Nomadic system, Arabi (Butana) breed, parity order and stages of lactation

Parity Number	Stages of Lactation /Month	Fat	Protein	Lactose	T. S	SNF	Density (mg/dl)
(1-2)	(1-3)	3.89^a±0.36	3.28^a±0.09	4.54^a±0.11	11.83^a±0.47	8.45^a±0.24	1.029^a±0.002
	(4-6)	2.08^b±0.27	1.99^b±0.07	3.69^b±0.23	8.59^b±0.36	6.59^b±0.39	1.019^b±0.001
	(7-9)	2.13^b±0.27	2.00^b±0.07	3.59^b±0.23	8.25^b±0.36	6.31^b±0.39	1.018^b±0.001
	(≤10)	3.48^a±0.36	2.96^a±0.09	4.07^a±0.11	11.12^a±0.47	7.61^a±0.24	1.027^a±0.002
3	(1-3)	3.89^a±0.29	3.53^a±0.07	4.85^a±0.09	13.06^a±0.38	9.18^a±0.20	1.032^a±0.002
	(4-6)	2.55^a±0.41	3.33^a±0.09	4.64^a±0.13	11.17^a±0.54	8.62^a±0.28	1.031^a±0.003
	(7-9)	2.63^a±0.41	3.21^a±0.09	4.48^a±0.13	10.94^a±0.54	8.31^a±0.28	1.029^a±0.002
	(≤10)	3.22^a±0.29	2.88^a±0.07	3.90^a±0.09	10.16^a±0.38	7.40^a±0.20	1.025^a±0.003
4	(1-3)	2.98^a±0.51	4.16^a±0.12	5.79^a±0.16	13.28^a±0.66	10.78^a±0.34	1.038^a±0.004
	(4-6)	1.29^b±0.42	2.56^b±0.06	3.89^b±0.26	9.29^b±0.66	7.01^b±0.21	1.020^b±0.001
	(7-9)	1.22^b±0.39	2.40^b±0.06	3.70^b±0.23	9.10^b±0.38	6.59^b±0.19	1.021^b±0.001
	(≤10)	3.05^a±0.29	3.14^a±0.07	4.33^a±0.09	11.13^a±0.38	8.08^a±0.20	1.028^a±0.002
5	(1-3)	4.28^a±0.72	4.21^a±0.17	5.78^a±0.23	15.10^a±0.93	10.82^a±0.48	1.038^a±0.005
	(4-6)	3.45^a±0.72	3.67^a±0.17	5.07^a±0.23	12.92^a±0.93	9.47^a±0.48	1.033^a±0.005
	(7-9)	3.72^a±0.41	3.20^a±0.09	4.39^a±0.13	11.93^a±0.54	8.21^a±0.28	1.028^a±0.003
	(≤10)	5.13^a±0.72	3.71^a±0.17	5.04^a±0.23	14.62^a±0.93	9.48^a±0.48	1.032^a±0.005

$^{a-b}$ Means with different letters in the same superscript are significantly different at (p≤0.05)

However, no significant differences in the camel milk constituents during the first, second and third stages of lactation were found. In the fourth stage of lactation, milk constituents were significantly decreased. Similarly the data revealed non significant differences in fat content of camel milk with the variation in the parity order, however there was a slight decreased in the fat content in the first (4.27±0.12%) and fifth parity (4.29±0.22%). In contrast, Zeleke (2007) mentioned that the effect of parity on fat content of camel milk was significant. The camel milk in the fifth parity had the highest fat content (4.29±0.22%). The highest level of lactose was observed in the fifth parity (4.79±0.08%). This result is concordant with those of Zeleke (2007); Riyadh *et al*. (2012) who reported that the highest lactose content in camel milk was recorded in the first stage of lactation. This observation probably explains the common understanding among camel milk producers that camel milk is sweeter during first lactation than other subsequent lactations (Riyadh *et al*., 2012).

Table 3: Means± S.E of camel milk components (%) as influenced by Traditional Nomadic system, Arabi (Nefidia) breed, parity order and stage of lactation

Parity Number	Stages of Lactation/Month	Fat	Protein	Lactose	T. S	SNF	Density (mg/dl)
(1-2)	(1-3)	$5.18^a±0.41$	$3.49^a±0.09$	$4.71^a±0.13$	$14.08^a±0.54$	$8.90^a±0.28$	$1.034^a±0.003$
	(4-6)	$4.94^a±0.29$	$3.66^a±0.07$	$4.97^a±0.09$	$14.23^a±0.38$	$9.34^a±0.20$	$1.034^a±0.002$
	(7-9)	$4.52^a±0.41$	$3.60^a±0.09$	$4.90^a±0.13$	$13.73^a±0.54$	$9.21^a±0.28$	$1.031^a±0.003$
	(≤10)	$4.93^a±0.72$	$3.80^a±0.17$	$5.17^a±0.23$	$14.64^a±0.93$	$9.71^a±0.48$	$1.031^a±0.005$
3	(1-3)	$4.78^a±0.29$	$3.54^a±0.07$	$4.83^a±0.09$	$13.85^a±0.38$	$9.08^a±0.20$	$1.031^a±0.002$
	(4-6)	$4.56^a±0.29$	$3.42^a±0.07$	$4.67^a±0.09$	$13.31^a±0.38$	$8.75^a±0.20$	$1.030^a±0.002$
	(7-9)	$4.02^a±0.41$	$3.34^a±0.09$	$4.57^a±0.13$	$12.59^a±0.54$	$8.57^a±0.28$	$1.030^a±0.003$
	(≤10)	$3.99^a±0.32$	$3.67^a±0.08$	$5.04^a±0.10$	$13.42^a±0.42$	$9.44^a±0.21$	$1.033^a±0.002$
4	(1-3)	4.54a±0.29	3.75a±0.07	5.11a±0.09	14.12a±0.38	9.58a±0.20	$1.033^a±0.002$
	(4-6)	$3.79^a±0.32$	$3.09^a±0.08$	$4.24^a±0.10$	$11.72^a±0.42$	$7.94^a±0.22$	$1.027^a±0.002$
	(7-9)	$5.12^a±0.25$	$3.56^a±0.06$	$4.82^a±0.08$	$14.16^a±0.33$	$8.71^a±0.17$	$1.031^a±0.002$
	(≤10)	$2.10^b±0.24$	$2.29^b±0.09$	$3.79^b±0.10$	$10.12^b±0.31$	$6.90^b±0.25$	$1.022^b±0.001$
5	(1-3)	$3.10^b±0.41$	$2.10^b±0.09$	$3.69^b±0.13$	$10.39^b±0.54$	$6.90^b±0.48$	$1.022^b±0.001$
	(4-6)	$4.07^a±0.51$	$3.69^a±0.12$	$5.07^a±0.16$	$13.54^a±0.66$	$9.48^a±0.43$	$1.033^a±0.004$
	(7-9)	$4.90^a±0.41$	$3.45^a±0.09$	$4.68^a±0.13$	$13.71^a±0.54$	$8.81^a±0.28$	$1.027^a±0.003$
	(≤10)	$3.00^b±0.51$	$2.26^b±0.12$	$3.59^b±0.16$	$10.00^b±0.66$	$7.00^b±0.56$	$1.021^b±0.002$

[a-b] Means with different letters in the same superscript are significantly different at ($p≤0.05$)

Camel milk composition was affected significantly ($P<0.05$) by stages of lactation. The protein, lactose, TS and SNF content of camel milk were higher during the first and third stage of lactation (Table 1 and Table 3). The obtained results followed the same trend reported by Alshaikh and Salah (1994), Haddadin *et al*. (2008); Zeleke (2007) who found that values of fat, protein and total solids were highest during the first 6 months of lactation. Camel milk constituents were lower during the second and fourth stage of lactation (Table 2), this may be due to the increase in the milk water content during the last stage of lactation (Riyadh *et al*., 2012). These results confirm those of Gaili *et al*. (2000); Zeleke (2007) who demonstrated that total solids of camel milk decreased from 11.7% in the first stage of lactation to 10.1% by the end of lactation and that fat content of camel milk was gradually decreased with the progress of the stage of lactation.

CONCLUSION

The present study emphasized that the variations in camel milk chemical composition could be attributed to more factors such as production systems, breed, parity number and stages of lactation. The performance of she camels at traditional nomadic system was better in comparison to the other system (semi-intensive). For the future studies, more research conducted to delineate management systems for the camel to in order to improve the milk chemical composition.

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