Short communication

Variations in some macro minerals of camel milk as affected by management system, parity orders and stages of lactation

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Abstract

This study was carried out using camel milk samples from three regions with two different husbandry systems in Sudan. These systems are: intensive in Khartoum North (Khartoum State) and traditional nomadic in Moya Mountain (Sennar State) and Tamboul (Gezira State). Camel milk samples (25, 23 and 21, respectively) were collected and examined to determine some macro minerals (calcium, sodium, potassium and phosphorus). The results showed significant ($P \leq 0.05$) differences between management systems and stages of lactation in calcium, sodium and potassium. The phosphorus content in camel milk was affected significantly ($P \leq 0.05$) by the variation of the management systems but not by the stages of lactation. The content of Na was affected significantly ($P \leq 0.05$) by parity orders. I In conclusion, management system was the main factor affecting the mineral content of camel milk. Moreover, she camels that grazed in nomadic system in the Moya Mountain area produced milk with a richer mineral content compared to those in other systems.

Keywords: Camel milk, macro minerals, management systems, stages of lactation, parity order.

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Introduction

Camel milk provides a limited amount of minerals (Aludatt et al., 2010). The total content of minerals is usually expressed as total ash. This amount varies from 0.6% to 0.9% with the average value of 0.79 ± 0.07% (Konuspayeva et al., 2009; Musaad et al., 2013). Variations in mineral content were attributed to breed differences, feeding, analytical procedures (Mehaia et al., 1995) and water intake (Haddadin et al., 2008). Sheiup et al. (2008) found that the ash content of camel milk samples collected from the traditional and semi intensive system were similar (0.073±0.12% and 0.073±0.14%, respectively). In contrast, Riyadh et al. (2012) reported lower values of ash for camel milk samples obtained in the nomadic system compared to in the semi nomadic and settled system. They also reported that the Na:K ratio was affected by production systems. Furthermore, Mehaia et al. (1995) reported that the presence of Na, K and Cu in camel milk were higher than in bovine milk.

In Sudan, the predominant system for keeping camels is the extensive system (El Zubeir and Nour, 2006; Musa et al., 2006). Despite this, are currently four other camel management systems: the traditional nomadic system, transhumance or semi-nomadic system, sedentary or semi-sedentary system and the intensive system (Dowelmadina et al., 2015). It was observed that improved husbandry practices and management oriented towards milk production in the semi intensive system has positively influenced the compositional quality of camel milk in Sudan (Babiker and El Zubeir, 2014; Shuiep et al., 2014). Although the performance of milk gross chemical composition of she camels kept in traditional nomadic system was better than those in semi-intensive (Dowelmadina et al., 2014), little work was done concerning the minerals content in different production systems. This study was aimed to determine the impacts of management systems, parity order and stage of lactation on the contents of Ca, Na, K and P in camel milk.

Materials and methods

Source of samples

This study was carried out during the period from June to July 2013. Sixty-nine healthy she camels at different parity numbers (first, second, third, fourth and fifth parity) and stages of lactation (early, medium and late) from three different breeds of camel (Kenani at Khartoum North, Nefidia at Moya Mountain and Lahawi at Tamboul area) kept under two different management systems (intensive system and nomadic system) were selected for milk sampling. Milk samples were collected from individual camels in sterile bottles (50 ml). Each sample was immediately labeled, kept on ice and transferred the laboratory at the Department of Dairy Production, Faculty of Animal Production, University of Khartoum for analysis.

The milk samples were analysed to determine ash contents and ash constituent of Ca, Na, K and P.

Determination of ash

Twenty ml of each milk sample was weighted into a suitable clean and dry crucible and evaporated to dryness on a steam bath. The crucibles were placed in a muffle furnace at 500 – 525 $^{\circ}$C for three hours and were then subsequently cooled. Ash of each sample was dissolved in 5 ml of hydrochloric acid and filtered into a 100 volumetric flask. The residue was dissolved in distilled water and diluted to 100 volumes. The ash solution resulted from samples was used to determine the mineral (Ca, Na, K and P) content in camel milk.

Determination of Ca

Calcium content was determined in accordance to the Chapman and Pratt (1961) titration method. Five ml of ash extract solution was poured into a 50 ml conical flask. The volume was completed to 25 ml by the addition of distilled water and 50mg of muroxide indicator. 3 to 5 drops of sodium hydroxide were then added and the mixture was titrated against 0.01N (EDTA). After calibration, the solution changed colour from pink to purple. The calcium content was calculated according to Chapman and Pratt (1961).

Determination of Na and K

Na and K were determined from the ash extract using the Flame photometer (EEL 12700, England) in accordance with the accompanied technical method.

Determination of P

Phosphorus was determined by spectrophotometer (UV mini 1240, Shimadzo, Japan). The phosphorus content of milk samples was carried out using vanadate-molybdate yellow calorimetric method of Chapman and Pratt (1961).

Data arrangement and statistical analysis

The management systems and breeds were divided in three treatments for analysis:

i) Intensive system/Kenani breed at Khartoum North

ii) Nomadic system/Nefidia breed at Moya Mountain

iii) Nomadic system/Lahawi breed at Tamboul area.

The parity numbers were divided into three parity orders for analysis: first and second parity; order; third parity order; fourth and fifth parity order.

The stages of lactation were divided into three stages for analysis: early stage (1-4 months); medium stage (5-8 months) and late stage (more than 9 months. ANOVA tables were computed with general linear model (Univariate) and the means were separated using Duncan Multiple Range Test (DMRT). IPM SPSS software version 22; SPSS Inc., Chicago, USA (2013) was used.

Results and discussion

Effect of management systems on mineral content of camel milk

Significant differences (*P*≤0.05) in Ca, Na, K and P contents of camel milk between the different management systems were observed (Table 1). These findings were in line with El-Amin et al. (2006) and Nabag et al. (2006) who mentioned that the concentration of major mineral indicated a wide range of variations. The highest means of calcium (151.17 mg/100 g) and phosphorous (100.25 mg/100 g) were recorded for milk of the camels in intensive (Khartoum) and traditional nomadic (Moya Mountain) systems. However, Riyadh et al. (2012) mentioned that the highest value of Ca in camel milk was found in the semi-nomadic system. The main reasons for this could be availability of water *at Libdium* (Babiker and El Zubeir, 2014) in the intensive system and availability of natural running water and green grasses at Moya Mountain (Dowelmadina et al., 2014). This also corroborates with Haddadin et al. (2008) who attributed variations of minerals content of camel milk to water intake. Furthermore, this study demonstrated that there were variations between mineral contents from the two production systems (Moya Mountain; Sennar State and Tamboul; Gezira State). The geographical origin was reported to be one of the effective factors that influenced the composition of camel milk (Konuspayeva et al., 2009). The present results is in agreement with Aludatt et al. (2010) who reported regional differences in mineral contents in camel milk in Jordan. Moreover, different breeds were reared at different production systems. It was stated previously that the variations in mineral content were attributed to breed differences, feeding procedures and analytical procedures (Mehaia et al., 1995). Additionally, the highest means of sodium (201.48mg/100g) and potassium (228.19mg/100g) were recorded for milk of the camels in traditional nomadic (Tamboul) systems.

Table 1. Effect of management systems on mineral content of camel milk.

Management system/ Breed	**Macro-mineral content of camel milk*(mg/100 g)**			
	Ca	Na	K	P
Intensive/ Kenani	151.17^{a}±3.3	130.31^{b}±8.6	202.98^{b}±8.3	95.3^{ab}±6.5
Nomadic/ Nefidia	146.09^{a}±3.8	143.29^{b}±10.1	214.45^{ab}±9.7	100.25^{a}±7.5
Nomadic/ Lahawi	131.05^{b}±3.9	201.48^{a}±10.9	228.19^{a}±10.5	79.86^{b}±7.3

*Mean ± S.E.; $^{a, b}$ Means in the same column followed by different superscript letters are different (P<0.05); Ca: Calcium; Na: Sodium; K: Potassium; P: Phosphorus.

Conversely, the lowest content of calcium (131.05mg/100g) and phosphorous (79.86mg/100g) were recorded for camel milk collected from traditional nomadic (Tamboul). Meanwhile, the lowest means of sodium (130.31mg/100g) and potassium (202.98mg/100g) were recorded for camel milk collected from intensive systems (Khartoum). These findings agreed with Riyadh et al. (2012), who mentioned that management systems is one of the factors that mainly attribute to variations of mineral contents in camel milk. Dromedary milk revealed mean values of calcium of 114 -13 mg 100 g_1, potassium of 156 - 38 mg 100 g_1 and sodium of 59 - 16 mg 100 g_1 (Al Haj and Al Kanhal). This could also be due to the feeding behaviour of camels consuming natural vegetation, such as Atriplex and Acacia, which usually contain high levels of salt.

Effect of parity orders on mineral content of camel milk

Significant ($P \leq 0.05$) differences in sodium content of camel milk as affected by parity orders were reported (Table 2). No significant differences were obtained in the mineral content (Ca, K and P) of milk from she camels at different parity orders. Similarly, previous reports showed variations of camel milk due to parity number, and calving number (El-Amin et al. 2006); However, Riyadh et al. (2012) reported that parity numbers showed variations on minerals content in camel milk. The highest mean of Ca (144.6mg/100g) and K (226.8mg/100g) were recorded during the third parity. Meanwhile, the highest mean of Na (170.4mg/100g) and P (97.1mg/100g) were recorded during the parity orders of fourth + fifth and first + second, respectively. Similarly, Elnour and Bakheit (2012) found that the Ca content in camel milk from nomadic system in North Kordofan State decreased from first parity to fifth parity. Meanwhile the Na, K and P increased from first parity to fifth parity.

Effect of stages of lactation on mineral content of camel milk

Significant ($P \leq 0.05$) differences in the average content of calcium, sodium and potassium in camel milk were observed throughout the different stages of lactation (table 3). Non-significant differences of camel milk at different stages of lactation in the average of phosphorus content were found. The present results supported Riyadh et al. (2012), who reported that the stages of lactation were one of the contributing factors to variations of minerals content in camel milk. She-camels in the medium stage of lactation showed the highest average content of calcium (147.3 mg/100 g), potassium (226.6 mg/100 g) and phosphorus (96.4 mg/100 g) in their milk. Meanwhile, the highest average of sodium (202.1 mg/100 g) in camel milk was recorded during the late stage of lactation. Despite this, Yagoob and Nawaz (2007) found that the average of calcium was 138 mg/100 g and phosphorus was 0.5 mg/100 g for Pakistani camel milk.

Table 2. Effect of parity order on mineral content of camel milk.

Parity order	Macro-mineral content of camel milk* (mg/100 g)			
	Ca	Na	K	P
First + Second	$142.5^{a}±3.4$	$139.7^{b}±8.9$	$207.8^{a}±8.6$	$97.1^{a}±6.7$
Third	$144.6^{a}±3.6$	$154.4^{ab}±9.6$	$226.8^{a}±9.2$	$86.3^{a}±7.3$
Fourth + Fifth	$142.8^{a}±3.0$	$170.4^{a}±7.9$	$211.0^{a}±7.7$	$92.3^{a}±6.0$

*Mean ± S.E; $^{a,\ b}$ Means in the same column followed by different superscript letters are different (P<0.05); Ca: Calcium; Na: Sodium; K: Potassium; P: Phosphorus.

Table 3. Effect of the stage of lactation on mineral content of camel milk.

Stage of lactation (months)	Macro-minerals content of camel milk* (mg/100 g)			
	Ca	Na	K	P
Early lactation (1-4)	$144.8^{ab} ± 3.1$	$131.9^{b} ± 8.3$	$196.1^{b} ± 7.9$	$87.3^{a} ± 5.8$
Mid lactation (5-8)	$147.3^{a}±3.6$	$144.0^{b}±9.9$	$226.6^{a}±9.5$	$96.4^{a}±7.0$
Late lactation (≥9)	$136.0^{b}±4.3$	$202.1\ ^{a}±11.3$	$223.7^{a}±10.9$	$94.5^{a}±8.7$

*Mean ± S.E; $^{a,\ b}$ Means in the same column followed by different superscript letters are different (P<0.05); Ca: Calcium; Na: Sodium; K: Potassium; P: Phosphorus.

Conclusion

The present study showed variations of macro mineral content in camel milk as affected by management systems, parity orders and stages of lactation. Mineral content of camel milk samples obtained from the intensive system in Khartoum and nomadic system in Moya Mountain and Butana area revealed highly significant variations between these systems in the content of calcium, sodium, potassium and phosphorous. Additionally, the parity orders and stages of lactation showed variations in the mineral content of camel milk.

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