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Research Article

Effect of Parity Orders on the Chemical Composition of Camel Milk from Different Production System in Khartoum State, Sudan

Mohamed MEM and Ibtisam EM El Zubeir*

Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Sudan

Abstract

This study was carried out on 42 camel milk samples collected from 42 lactating she camels at the second and third parties in different stages of lactations. The camels were reared in grazing range, closed and semi-closed farms in and around Khartoum State (14 samples were collected from each farm). The aim was to study the effect of parity order and management system on the chemical composition of camel milk.

The current study revealed that the effect of management systems on the camel milk composition was highly significant (P<0.001) and the highest percentage of total solids, fat, protein, lactose and density were recorded for the samples collected from semi-closed farm and grazing range (14.47% vs. 14.89%, 5.07% vs. 5.59%, 3.67% vs. 3.65%, 5.01% vs. 4.90% and 1.033 mg/cm^3 vs. 1.032 mg/cm^3, respectively).

The data showed that parity orders was significantly (P<0.05) affected the camel milk composition, and the samples from she camels at the second parity revealed 14.44% total solids, 5.25% fat, 3.60% protein, 4.88% lactose and 1.032 mg/cm^3 density, compared to those found for she camels at the third parity (13.46% total solids, 4.69% fat, 3.46%protein, 4.69% lactose and 1.031 mg/cm^3 density). The study concluded that the management system and parity orders have significant impact on camel milk composition.

***Corresponding author:** I E M El Zubeir, Department of Dairy Production, Faculty of Animal Production, University of Khartoum, P. O. Box 321, Khartoum North, Sudan, Tel: +249 912251610; E-mail: Ibtisamelzubeir17@gtmail.com

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Introduction

More than 60% of the dromedary camel population is concentrated in the arid areas of North East African countries; Somalia, Sudan, Ethiopia and Kenya [1].Sudan is rated as the second highest in owning camels in the world, according to the Ministry of Animal Resources and Fisheries [2], the camel population in Sudan was estimated at 4.8 million head. The four main camel management production systems in Sudan include traditional nomadic system, transhumance or semi-nomadic system, sedentary or semi-sedentary system and the intensive system [3]. Camel milk represents the main source of protein especially for the nomads during their migration and is used mainly to secure the family needs in most of camel rearing societies [4]. Most of camel milk produced in Sudan is consumed as fresh or traditional fermented products [5].

Production and management systems are found to affect camel milk composition [6-13]. Similarly many authors reported on the effect of parity order and calving number as a contributing factors of the variation of camel milk [7,8,11,14]. The feeding conditions on camel milk contents have also been highlighted [7,12,13-17].

Feed and availability of water can affect the chemical composition of camel milk, which contains 2.9 to 5.5 % fat, 2.5 to 4.5% proteins, 2.9 to 5.8% lactose, 0.35 to 0.90% ashes, 86.3 to 88.5% water and 8.9 to 14.3% solid non fat [18]. It was shown that the average composition of camel milk from two locations in Khartoum State, Sudan were 9.56±0.88% and 9.41±0.93%, 0.73±0.11% and 0.73±12%, 2.64±40% and 2.85±0.48%, 2.93±0.290% and 2.94±0.41%, 3.12±0.81% and 2.90±0.62%, and 0.15±0.02% and 0.14±0.02% total solids, ash, fat, protein, lactose and titratable acidity respectively [12]. The fat (4.59%), protein (3.53%), lactose (4.81%), total solids (13.62%) and SNF (8.99%) were higher in milk of Nefidia camel that kept in the traditional nomadic system in Sennar State [7]. The camel milk composition was significantly (P<0.05) affected by the husbandry practices. The highest means of fat (4.05±1.5%), SNF (8.78±0.74%), protein (3.41±0.3%) and lactose (4.67±0.42%) were recorded for the camels kept at semi-intensive farming system in comparison with the other two investigated farming systems [6]. However the highest means of fat (4.63 %), SNF (9.35 %), total solids (14.24 %), protein (3.65 %), lactose (4.98 %) and density (1.033 gm/cm^3) were found in traditional nomadic system in Sennar State in comparison with the other two systems. Whereas the least camel milk fat (3.20 %), SNF (8.04 %), total solids (11.23 %), protein (3.11 %), lactose (4.29 %) and density (1.028 gm/cm^3) were recorded in traditional nomadic system in Gezira State [9] The mean parentages 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 [19].

Regardless of the available data about camel milk chemical composition, still the contributed factors that interfere to vitiations in the chemical composition of camel milk have to be studied due to the contradicted findings. Moreover the special properties of camel milk and the variations reported on its constituents in addition to the several medicinal benefits necessitate the important of understanding fully the factors that influencing the variations of its chemical composition. So this study is a contribution towards investigating the effect of management system and parity order of camel on the chemical composition of the milk.

Materials and methods

Areas of the study and camels management

This study included three areas in and around Khartoum State, which were selected according to the management system to assess the effect of different systems and parity orders on the chemical composition of camel milk. Fourteen samples were collected from each system (seven samples from she camels at the second parity and the same number of the samples from she camels at the third parity) in different stages of lactations.

Closed system

The samples collected from this system belong to a private farm in Khartoum North. The camels type in this farm are Kenani and Anafi, the herd structure at this farm composed of about 37 lactating she camels, 16 dry she camels, 6 heifers, 10 males calves, 12 females calves and only one bull. The camels in this farm depend on labors for feeding as there was no grazing; they fed on a mixture of alfalfa, *Sorghum bicolor* (Abu 70) and groundnut cake. The camels are grouped in fences according to the age and physiological status, bull is kept separately. The herd is provided with adequate water supply, hand milking is practiced three times per day at morning, in the afternoon and in the evening.. The average daily yield is 4.4 liters per she camels.

Semi-closed system

The milk samples collected from this system belonged to a farm in West Omdurman. The she camels belong to Arabi type. The herd structure was composed of about 30 lactating she camels, 2 dry she camels, 0 heifers, 12 males calves, 15 females calves and 0 bull. The camels stay about 8 months at farm fed on a mixture of alfalfa, *Sorghum bicolor* (Abu 70) and groundnut cake. The lactating she camel stays at farm during lactating period and at pasture during the dry period. The herd is provided with adequate water supply, hand milking is practiced four times per day at morning (6:00 am and 10:00 am), in the afternoon (3:00 pm) and in the evening (6:00 pm). The average daily yield is 4.4 liters from she camels per day.

Grazing range system

The milk samples collected from camel in the grazing area that located at 33 km West Omdurman. The she camels belong to Arabi type. The herd structure composed of about 22 lactating she camels, 11 dry she camels, 12 heifers, 0 calves and 2 bulls. The camels depend only on grazing and the water interval is once per week, hand milking is practiced twice a day at morning (6:00 am) and in the afternoon (1:00 pm). The average daily milk is 5 liters for the she camel.

Collection of the camel milk samples

The camel milk samples were collected early morning at 6:00 am from she camel kept in the closed farm, in the afternoon at 1:00 pm from she camels in the grazing range and in the evening (5:00) pm from she camels kept in semi closed farm. About 50 ml of camel milk samples were collected from 42 lactating she camel (21 at second parities and 21 at third parities). The samples were collected in clean bottles and kept in an ice box during transportation to the Department of Dairy Production, Faculty of Animal Production for determination of chemical composition.

Milk samples analysis

Chemical analysis of camel milk samples were determined using Lacto scan milk analyzer (Milkotronic LTD, Europe) according to the manufactures instructions to determine fat, protein, lactose, SNF and density, each sample was reading three times.

Statistical analysis

Statistical Package for Social Science (SPSS-version 18) was used for the analysis of all data using ANOVA test and Duncan multiple range test for the separation of means.

Results and Discussion

Effect of management system on the chemical composition of camel milk

Data in table 1 revealed that camel milk composition was significantly ($P<0.05$) affected by the management system. The variations found in camel milk composition could be attributed to difference in management systems [6,7,9,11,12,13] and locations and feeding conditions [7,9,12,13,16]. Also the data in table 2 revealed variations between the chemical constituents in milk samples obtained from different production systems.

Parameter System	Total solids (%)	Fat (%)	Protein (%)	Lactose (%)	Density (mg/cm^3)
Semi closed	14.47^a±1.56	5.07^a±1.42	3.67^a±0.15	5.01^a±0.20	1.033^a±0.001
Grazing range	14.89^a±0.75	5.59^a±0.37	3.65^a±0.15	4.90^a±0.23	1.032^a±0.001
Significant level	***	**	***	***	***

Table 1: Effect of management system on the chemical composition of camel milk.

a, b means with the same superscript letters are not significantly different.
**high significant ($P<0.01$)
***highly significant ($P<0.001$)

Parameter System	Total solids (%)	Fat (%)	Protein (%)	Lactose (%)	Density (mg/cm^3)
Second parity	14.44^a±1.7	5.25^a±1.32	3.60^a±0.25	4.88^a±0.33	1.032^a±0.002
Third parity	13.46^b±1.2	4.69^b±0.63	3.46^b±0.28	4.69^b±0.38	1.031^a±0.003
Significant level	**	*	*	*	*

Table 2: Comparison of compositional content of camel milk from different production systems.

The highest mean of fat, protein, total solids, lactose and density content of the camel milk were recorded for the camel milk samples collected from both semi closed (14.47±1.56% total solids,

5.07±1.42% fat, 3.67±0.15% protein, 5.01±0.20% lactose and 1.033±0.001mg/cm^3 density) and grazing system (14.89±0.75% total solids, 5.59±0.37% fat, 3.65±0.15% protein, 4.90±0.23% lactose and 1.032±0.001 mg/cm^3 density) as shown in table 1 indicated the importance of grazing for camels, camel is a selective animal for choosing the best pasture and grazing plants when available. This finding agreed with the previous conclusion that availability of quality feed coupled with continuous water supply strongly influenced chemical composition of camel milk [12]. Also the geographical origin was reported to be one of the effective factors that influenced the composition of camel milk [17]. The present result for camel milk samples collected from semi closed supported Shuiep et al. who showed significantly higher protein, solids not fat and lactose contents in milk samples obtained from semi intensive system compared to that collected from traditional nomadic system [13]. In the semi intensive system, animals fed on cut forages and concentrates such as groundnut cake with continuous supply of water. In addition animals are also allowed going out to the natural pasture regularly [6,13]. Moreover in semi intensive system, only high milk yielded she camels are selected and kept in dairy farms in the pre-urban area of big cities [13]. On the other hand, the values of milk composition of camel in grazing system are in line to Dowelmadina et al. [7]. Similarly it was concluded that the management systems are the main factor affecting the composition of camel milk and that she-camels graze in nomadic system gave rich milk with chemical composition compared to other systems [9]. Also it was mentioned that the semi nomadic system is significantly best than the settled and nomadic systems in camel milk composition in Saudi Arabia [11]. However these findings contradicted with the findings stated that the milk composition in camels was found to be independent of the grazing system [20].

The present study showed that there were highly significant differences (P<0.001) in the total solids of camel milk grazed in the different three management systems (closed, semi closed and grazing range, it revealed 12.49±0.97%, 14.47±1.56% and 14.89±0.75% respectively (Table 1). The present result was higher than that reported previously [8,10,12,14]. It was been raised that the variations in camel milk chemical composition could be due to production systems, breed, parity number and stages of lactation [7-9]. Moreover relationship was found between the total solids content in camel milk and water intake by camel [21]. The improved husbandry practices and management oriented towards milk production in the semi intensive system has been to influence positively the compositional quality of camel milk [13].

The average fat content of camel milk samples collected from closed, semi closed and grazing range were 4.24±0.64%, 5.07±1.42% and 5.59±0.37% respectively (Table 1). The result showed that there were high significant (P<0.01) differences between the three management systems. The result was higher than that found that the fat content was 3.72±1.2% for camels in intensive farm and 4.05% for camels in semi intensive farm [6]. The lower fat content was found in camel milk samples collected from intensive system (2.64±0.40%) compared to that on the traditional system [12]. The average reported of fat content of milk from camels in the closed system supported Mohamed Elhassan et al. [9] who found 4.2% for average fat content of camel milk [9]. The highest mean of fat content was 5.6±0.37% and this agreed with those found in Ethiopia [14]. Fat percentage in the current study was higher than that reported in Saudi Arabia [11]. The high value of fat content in both semi intensive and grazing system in the present study may be due to availability of the fodder that contained high fiber [16]. Supplementation of energy concentrates decreased fat content of milk [12]. Moreover camels produce more fat in milk under traditional system, compared to those supplemented with concentrates in the semi intensive system [13].

The protein content of camel milk samples collected from closed system was 3.26±0.27%, this result agreed with the result reported previously for the samples collected from the intensive system [6] and for samples obtained from the nomadic system in Sennar [9]. The result also supported the review given by Konuspayeva et al. [17]. The mean of protein content of camel milk from the semi closed system was higher than that reported previously for the same system [6]. Significantly (P<0.05) higher protein content in camel milk samples was obtained from the semi intensive system, where camels are offered adequate quantity of feed including concentrates [13], The availability of high feed quality was the reason for the variations in milk protein content between different production systems [22].

The average of protein in the samples collected from camels in the grazing range was 3.65±0.16% and this agreed with the result mentioned previously [10]. Percentages of protein content in camel milk samples in this study were higher than those reported in Saudi Arabia [11]. The obtained variations could be related to camel breed, seasons and feed [12]. The importance of milk protein for nomadic camel herders is because it represents the single source of protein and that camel milk protein is of high biological value as it provides the needed amount of amino acids [13].

Lactose content of camel milk samples collected from the three management systems show significant differences (Table 1). The highest value was reported for the milk from semi closed system (5.01±0.20%). This result was higher than that reported previously for the same production system [6-13]. The lactose content of the samples collected from the closed system was 4.45±0.39%, which agreed with the result reported for the camel kept in intensive system [6]. Also similar findings were reported earlier [9-17].

The average density of milk sample in the present study was 1.031±0.002gm/cm^3, which was agreed with the result reported earlier [6]. However lower values (1.029±0.00 g/cm^3 - 1.030±0.017 g/cm^3) were also reported [23]. The average of milk density of she camels kept in different management systems were found to range between 1.02 to 1.03 g/cm^3 [7-13]. According to Farah, the average density of camel milk was 1.029 g/cm^3 [24]. Moreover it was less viscous than bovine milk [25]. However in Algeria the density of camel milk was 1.0274 g/cm^3±0.002 g/cm3 [26], while in Pakistan the average was 1.015 g/cm^3±0.001 g/cm^3 [16].

Effect of parity orders on the chemical composition of camel milk

As shown in table 3 the parity orders exerted significant (P<0.05) differences on the camel milk composition. She camels at the second parity recorded higher means of total solids (14.44±1.69%), fat (5.25±1.32%), protein (3.60±0.25%), lactose (4.88±0.33%) and density (1.032±0.002 mg/cm^3) than the she camels at the third parity. The result agreed with the findings reported that the mean of camel milk

composition at the third parity was lower than the second parity [6]. Also the mean values of milk constituents were lower in the subsequent parities [7]. However non significant (P>0.05) differences in fat, total solids and density of camel milk due to the variation of parity orders and highly significant (P≤0.05) differences in the contents of solids not fat, protein and lactose of camel milk as affected by the parity orders were also reported [9].

The fat content of camel milk in this study was significantly affected by parities as shown in table 3 which agreed with the previous report stated that parity order revealed significant effect on fat content of camel milk [14]. However this result contradicted with the findings shown non significant differences between parities on fat content of camel milk [8-11]. Non significant differences was reported 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 parity [7].

Lactose content of camel milk was affected by parities and it was decreased from the second parity (4.88±0.33%) to the third parity (4.69±0.69%) as shown in table 3, which disagreed with El-Amin et al. [7]. Similar to the present findings, Riyadh et al. [11] reported that the highest lactose content in camel milk was recorded in the first stage of lactation. They reported that this observation probably explains the common understanding among camel milk producers that camel milk is sweeter during first lactation than other subsequent lactations [11].

The average of milk density from she camels kept in different management systems with different parity orders and stages of lactation was ranged between 1.02 to 1.03 mg/cm^3 [6,7,13]. However all parity orders were recorded fixed mean of density (1.03± 0.4 gm cm^3) for camel milk [9]. The number of lactation was also reported to influence the composition of camel milk [6,7,9]. Previously differences were also found for camel milk chemical composition as a result of variation in the calving number [6,7,8,9,11,16].

Parameter Parity order	Total solids (%)	Fat (%)	Protein (%)	Lactose (%)	Density (mg/cm^3)
Second parity	14.44^a±1.7	5.25^a±1.32	3.60^a±0.25	4.88^a±0.33	1.032^a±0.002
Third parity	13.46^b±1.2	4.69^b±0.63	3.46^b±0.28	4.69^b±0.38	1.031^a±0.003
Significant level	**	*	*	*	*

Table 3: Effect of parity order on the chemical composition of camel milk.

a, b means with the same superscript letters are not significantly different.
*significant (P<0.05)
**high significant (P<0.01)

Conclusion

The present study concluded that she camels reared on grazing natural pasture and semi-closed system recorded approximately similar and highest percentages of total solids, fat, protein, lactose and density. On the other hand, the she camels at the second parity recorded higher percentages of fat, protein, total solids, and lactose than those at the third parity. This indicated that the type of feed and parity orders have an impact on camel milk composition. Hence it was recommended to adopt semi intensive system to make use of the increasing public awareness on the nutritional and medicinal values of camel milk. This could be done by encouraging the establishment of semi-closed farms in the different part of the country to produce reasonable milk with an acceptable milk composition in order to satisfy the increasing demand.

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