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REGULAR ARTICLE

Impact of husbandry, stages of lactation and parity number on milk yield and chemical composition of dromedary camel milk

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Abstract

The present study was designed to assess the impact of husbandry, stage of lactation and parity number on milk yield and chemical composition of camel milk within three different camel farms at Khartoum State, Sudan. Camel milk samples (n=220) were collected from 43 healthy she-camels at different lactation stages (early, mid, late and latest stages of lactation) and parity number (1-7 parities). The overall means of daily milk yield and composition of fat, protein, lactose, solids not fat (SNF), acidity and density were 2.73±1.16 L/day, 3.69±1.31%, 3.32±0.33%, 4.59±0.45, 8.49±0.86%, 0.19±0.03% and 1.030±0.017g/cm3, respectively. Camel milk yield and composition were significantly (P<0.05) affected by husbandry, stage of lactation and parity number. The highest milk yield (3.49±0.89 L/day) was recorded for she-camels kept in the intensive farming system during early stage of lactation (2.96±1.28 L/day). The result showed that the she-camels in the second parity gave the highest milk yield (4.06±1.85 L/day), while the lower milk yield was found at the subsequent parities. 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 milk of she camels in the semi-intensive farming. The highest means of fat, protein, lactose and SNF (4.46±1.62%, 3.5±0.27%, 4.75±0.42% and 8.88±0.89%, respectively) were found in camel milk during the early stage of lactation. Moreover the highest means of protein, lactose and SNF (3.42±0.33%, 4.71±0.52% and 8.83±0.86%, respectively) were recorded in milk for the she camels at parity number five. This study concluded that husbandry systems, stage of lactation and parity number have impact on milk yield and chemical composition of camel milk. Therefore, factors that cause variations in milk yield and composition should be considered for the nutritional and technological uses of camel milk.

Key words: Camel farming systems, Milk yield, Chemical composition, Husbandry, Stage of lactation, Parity number, Sudan

Introduction

Sudan is rated as the second highest world size of camel population in the world. According to recent estimation of camels in Sudan there are about 4.623 million heads (Ministry of Animal Resources and Fisheries, 2011). In Sudan, four camel management systems were identified. These systems are: Traditional nomadic system (Shuiep et al., 2008; Ishag and Ahmed, 2011); Transhumance or semi-nomadic system (Musa et al., 2006a; Eisa and Mustafa, 2011); Sedentary or semi-sedentary system (Ishag and Ahmed, 2011; Shuiep and El Zubeir, 2012) and the Intensive system (El Zubier and Nour, 2006; Eisa and Mustafa, 2011). El Zubier and Nour (2006) described camel husbandry and practices in the periurban area of Khartoum State.

Kamoun and Jemmali (2012) reported that the milk yield of camel varies greatly depending on the region. These variation in milk yield due to breed or types (Wernery et al., 2004), stage of lactation (Musa et al., 2006b; Raziq et al., 2008; Al-Saiady et al., 2012); parity numbers (Al-Saiady et al., 2012) and the production systems (Musa et al., 2006b; Bakheit et al., 2008).

Musaad et al. (2013) concluded that camel milk composition showed a wide variability in its constituents depending on the physiological, genetic and environmental factors. Variations observed in camel milk composition could be attributed to several factors such as feeding conditions (Khaskheli et al., 2005) and production systems (Nabag et al., 2006; Sheep et al., 2008;

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Bakheit et al., 2008), seasons (Sheep et al., 2008; Haddadin et al., 2008; Konuspayeva et al., 2008), breeds and stage of lactation (EI-Amin et al., 2006; Konuspayeva et al., 2010) and calving number (EI-Amin et al., 2006; Zeleke, 2007; Konuspayeva et al., 2010). In Sudan, selling of milk is neither practiced nor accepted by camel herders in the traditional systems (Musa et al., 2006a; Shuiep and El Zubeir, 2012) and there are no well-established camel dairy farms (Shuiep and El Zubeir, 2008). However, currently a new trend towards commercialization of camel milk associated with the new semi intensive camel system has starting in Khartoum State as well as other big towns (Shuiep and El Zubeir, 2012). The objective of this study is to assess the impact of management system, stage of lactation and parity numbers on milk yield and chemical composition of camel milk.

Materials and Methods

Collection of data

This study was carried out during the period from March 2012 to May 2012. A questionnaire was prepared for data collection. The questionnaire included questions regarding general information about the farmers and farms (camel types, herd size and structure), building and design, farm management (record keeping, culling practices and general hygiene), system of feeding, health care, calf rearing and milk production and reproduction.

Husbandry practices and rearing of the selected camels

The camel husbandry practices of she camel selected for this study include intensive, semi-intensive and grazing + supplement farming systems (Table 1). In intensive farming systems, camels are kept in barns all times. The farm contains also separate fences for cows, goats and chickens. The daily ration consists of a mixture of Alfalfa, *Sorghum biocolor* (Abu70) and groundnut cake. Water supply was taken from the wells. In the semi-intensive farming system, the camels are kept in an open barn and graze around the farm. The lactating female camels are supplemented with concentrates beside good quality ration containing groundnut cake, *Sorghum biocolor*) in addition to continuous water supply. In grazing +supplement farming system, the animals graze at open areas surrounding the farm at the morning times until mid-day then they were kept inside the farm for milking and supplement feeding (Table 1).

Table 1. General information of camel Husbandry practices in the selected farms at Khartoum State.

Measurements	Farm 1	Farm 2	Farm 3
Farming systems	Intensive system	Semi-intensive system	Grazing + supplement system
Purpose of production	Commercial	Commercial and genetic improvement	Commercial and research objective
Camel breed	Kenani, Anafi	Kenani, Anafi, Bishari	Arabi
Herd size	71	146	74
Number of females	25	62	20
Number of lactating females	14	17	14
Number of calves	20	18	33
Number of mature males	1	4	1
No. of dry she camel	6	20	3
No. of pregnant she camel	5	25	3
Rearing other animals	Cows, goats, chickens	Cows, goats, sheep, chickens and horses	Non
Buildings and design of the farm			
Barn area/m^2	360 m^2	2160 m^2	150 m^2
Type of fence	Steel angles	Steel angles	Steel angles
Type of roof	Zinc	No roof	Traditional
The area covered by shadow	96 m^2	Non	24 m^2
System of feeding			
System of feeding	at farm	at farm	grazing and at farm
Type of feeds	groundnut cake, Alfalfa, *Sorghum biocolor* (Abu70)	groundnut cake, *Sorghum biocolor* (Feterita), *Sorghum biocolor* (Abu70)	grazing plants , *Sorghum biocolor* (Abu 70)
Water supply	3 wells	6 wells	Domestic Supply

Collection of milk samples

A total of 220 camel milk samples from 43 healthy she-camels (with different lactation stages and parity numbers) from the three selected camel farms were collected. One sample of 50 ml from each she-camel was taken every 15 days for 3 months. The raw camel milk samples were collected in the early morning and immediately labeled, stored in an ice box and transferred within 2-3 hours to the laboratory of the Department of Dairy Production, Faculty of Animal Production, University of Khartoum for the chemical analysis.

Chemical analysis of milk

Chemical analysis of camel milk samples were determined by using LactoScan Milk Analyzer (Milkotronic LTD, Europe) according to the manufacturer's instructions. The instatement was first calibrated as illustrated in the accompanied technical manual for the measurement of camel milk constituents. The content of fat, protein, lactose and SNF and the density were obtained as follow: Twenty five ml of the samples were taken in the sample holder after mixed gently 4- 5 times. The sample holder was put in the analyzer in the recess position and the analyzer sucks the milk and makes the measurement. When the measurement is finished, the sample returns in the sample-holder and the digital indicator shows the specified result.

Statistical analysis

Data were analyzed using SPSS software (Statistical Package for Social Sciences, V.13). Differences between means were separated by LSD.

Results and Discussion

Reproduction, milk production and health management practiced in camel farms from Khartoum State

According to the questionnaire, the gestation period was 12 months in each of the three farming systems. The calving intervals were about 25 months for semi-intensive system and 24 months for both farms that adopted intensive and grazing +supplement farming system (Table 2). The length of the dry period was estimated as 2-3 months, 3-4 months and 4 months for intensive farming system, semi-intensive system and for grazing +supplement farming system, respectively This result agreed with Musa et al. (2006b) who mentioned that gestation length was 370.28±19.06 days. Similarly Musaad et al. (2013a) found that the overall mean for the lactation length for she camels kept in the intensive system was 12.5 months and the values differed according to season of calving. On the other hand, diseases, age and production problems were the main reasons for culling at the three farms. Calves were reared in small groups and fed by the same types of food as their parents (Table 2).

Table 2. Reproduction management in camels farms at Khartoum State.

Farm management	Intensive system	Semi-intensive system	Grazing + supplement
Gestation length	12months	12 months	12 months
Length of the dry period	2-3 months	3-4 months	4 months
Period of colostrums	7 days	7 days	7 days
Culling practices	disease, age	disease, age	production problems, age
Calf rearing			
Calf rearing	at small groups	at small groups	at small groups
Age of weaning	12 months	1 month	4 months
Using milk replacer	No	No	No
Milking procedure	in the presence of calf	in the presence of calf	in the presence of calf
Types of nutrition	groundnut cake, Alfafa, *Sorghum biocolor* (Abu70)	groundnut cake, *Sorghum biocolor*(Feterita), *Sorghum biocolor* (Abu70)	*Sorghum biocolor* (Abu 70)
She camel			
Breed of milk production	Anafi	Kenani	Arabi
Source / origin	East of Sudan - Al Gadarif	East of Sudan and Kordufan	East and West of Sudan
Concentrates supplementation:	Yes	Yes	No
Mating system	Natural system	Natural system	Natural system
Calving interval /month	24 months	25 months	25 months

The daily milk yield of she camels were 40-60, 40-80 and 50 litters / day in the intensive system, semi-intensive system and grazing +supplement system, respectively (Table 3). The lactation length for camel included in this study was 9-10 months, 8-9 months and 8 months in intensive system, semi-intensive system and grazing +supplement system, respectively However Musaad et al. (2013b) reported an average total milk production of 1207 L for 11 months range between 875 and 1616 L in Saudi Arabia. Milking in all farms was practiced in the presence of the calves. Al-Haj and Al-Kanhal (2010) mentioned that the factors affecting milk yields are those, which are common to all dairy animals such as nutrient supply, health status, genetic potential for milk production, number of previous lactations or age of the animal and adequate water supply. Camel herders in the selected farm are using hired labor for milking, which was done three times per day at intensive system and twice per day for semi-intensive system and grazing +supplement. Cooling facilities were available at the three systems, which disagreed with Shuiep et al. (2007) as they viewed no cooling was applied for camel milk. All these newly introduced practiced indicated transitional stage towards modern dairy camel farming at the commercial basis. The type of milk containers were plastic in the intensive system and aluminum containers in the semi-intensive and grazing +supplement system. The milk is sold fresh at the farms except for the semi-intensive system which is sold at the market.

The effect of husbandry practices on milk yield

The mean daily milk yield of the she camels kept in the intensive, semi intensive and grazing+ supplement farming systems were 3.49± 0.89, 2.76± 1.24 and 2.08± 0.87 L, respectively (Table 4). Milk yield was significantly ($P \leq 0.05$) affected by husbandry practices, however the milk yield from individual animal over a period of 3 months revealed non-significant variations. The mean daily milk yield of the camels reared under semi intensive farming system was higher than that reared under grazing+ supplement farming system (Table 4). Similarly Bakheit et al. (2008) found that camels raised under semi-intensive management were able to produce significantly more milk than the other reared under traditional system. This could be attributed to the forage availability and the supplementary diets, water availability and health care that oriented to the camels in the semi intensive system (Table 2 and 3). This mainly might be because of the current trend towards commercialization of camel milk in the adopted new semi intensive camel system that has been established in Khartoum (Shuiep and El Zubeir, 2012).

Table 3. Milk production, general hygiene and health care practiced at the selected camels farms in Khartoum State.

Milk production	Intensive system	Semi-intensive system	Grazing + supplement
Average production of milk/day/farm (L)	40 - 60	40 – 80	50
No. of milking	three times / day	twice times / day	twice times / day
Length of lactation	9-10 months	8-9 months	8 months
Selling milk	in the farm	in the market	in the farm
Price of camel milk per liter	7 SDG	8 SDG	6 SDG
Milk processing	No	No	No
Type of milk containers	Plastic	Aluminum	Aluminum
Cooling facilities	Yes	Yes	Yes
Cleaning the udder before milking	no	Yes	No
Hygiene of milkers	Yes	Yes	Yes
Dung removal	every 2 week	Weekly	more than 2 weeks
Using disinfectants	Yes	Yes	Yes
Vaccination program	No	No	Yes
Veterinary visits	on call	on call	Daily

Table 4. Effect of husbandry practices on milk yield and chemical composition of camel milk.

Production system	Intensive system		Semi-intensive system		Grazing+ Supplement	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Milk yield L/day	1.77	5.33	0.44	6.22	0.88	4.44
Fat (%)	1.39	6.55	1.81	6.34	1.05	5.52
Protein (%)	2.54	4.58	2.28	4.08	2.64	4.00
Lactose (%)	3.18	6.02	3.71	5.67	3.71	5.71
SNF (%)	6.15	11.36	7.02	10.56	6.83	10.23
Acidity (%)	0.12	0 .25	0.13	0.25	0.1	0.26
Density (%)	1.023	1.038	1.023	1.037	1.023	1.036

The effect of husbandry practices on milk composition

The milk composition from she camels managed in the different farming systems revealed non-significant variations over a period of 3 months. Camel milk composition was significantly ($P<0.05$) affected by the husbandry practices (Table 5). 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 farming systems. This might suggested the importance of grazing in rearing the camel. Variations observed in camel milk composition could be attributed to several factors including management systems (Bakheit et al., 2008; Shuiepet al., 2008; Riyadh et al., 2012), geographical locations, feeding conditions (Khaskheli et al., 2005; Bakheit et al., 2008), seasons (Shuiep et al., 2008; Riyadh et al., 2012), stage of lactation and calving number (El-Amin et al., 2006; Zeleke, 2007; Riyadh et al., 2012). Moreover Musaad et al. (2013b) reported significantly negative correlation between milk production and percentage of the different milk components due to dilution effect. The lower mean of fat content was found for the camel milk samples collected from the grazing+ supplement farming system (3.29±1.06%). This result was higher than result reported by Shuiep et al. (2008) in Sudan and Riyadh et al. (2012) in Saudi Arabia. However the maximum fat content of camel milk (6.55%) was found in the samples collected from the intensive farming system (Table 4). This result agreed with Riyadh et al. (2012) who reported that the fat content of camel milk was higher in the settled system (intensive) than nomadic and semi nomadic production system. This might be due to the feeding of concentrate. Similarly Shuiep et al. (2008) attributed the variations of fat content to season which is affected by the availability of the grasses.

The average total protein content of camel milk samples collected from intensive, semi-intensive and grazing+ supplement farming systems were 3.28±0.38%, 3.41±0.3% and 3.26±0.31%, respectively (Table 5). There were significant ($P<0.05$) differences between the semi intensive system and both intensive and grazing +supplement systems (Table 5). The result was higher than that reported by Haddadin et al. (2008) and Konuspayeva et al. (2009). However Shuiep et al. (2008) reported non-significant differences in protein content for camel milk samples collected from semi-intensive and traditional systems.

Lactose content of camel milk were 4.43±0.48%, 4.05±1.5% and 4.47±0.43% in the intensive, semi-intensive and grazing+ supplement systems, respectively (Table 5). This result was higher than the result reported by Shuiep et al. (2008), they reported that the lactose content of camel milk samples collected from traditional system and semi-intensive system were 2.90% and 3.12%.

The average titratable acidity of camel milk (Table 5) were 0.19±0.02%, 0.19±0.03% and 0.18±0.03% in the intensive, semi-intensive and grazing + supplement farming systems, respectively. The result disagreed with result reported by Shuiep et al. (2008) who reported highly significant differences ($P\leq0.01$) in the titratable acidity between camel milk samples from semi-intensive system (0.15±0.02%) and traditional system (0.14±0.02%). Lower acidity of milk was reported for the grazing camel which supported Mohamed and El Zubeir (2012).

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Table 5: Variations of milk yield and chemical composition of the she-camels kept at different husbandry systems

Production system	Milk yield L/day	Fat (%)	Protein (%)	Lactose (%)	SNF (%)	Acidity (%)	Density (gm cm^3)
Intensive system	3.49^{b}±0.89	3.72^{a}±1.2	3.28^{b}±0.38	4.43^{b}±0.48	8.26^{b}±0.97	0.19^{a}±0.02	1.028^{a}±0.0030
Semi-intensive system	2.76^{a}±1.24	4.05^{a}±1.5	3.41^{a}±0.3	4.67^{a}±0.42	8.78^{a}±0.74	0.19^{a}±0.03	1.03^{a}±0.0031
Grazing+ Supplement	2.08^{c}±0.87	3.29^{b}±1.06	3.26^{b}±0.31	4.47^{b}±0.43	8.39^{b}±0.8	0.18^{a}±0.03	1.032^{a}±0.0029
Average	2.73±1.16	3.69±1.31	3.32±0.33	4.59±0.45	8.49±0.86	0.19±0.03	1.030±0.017

Different letters in same column indicates significant difference (P≤ 0.05)

Table 6: Effect of stage of lactation on yield and chemical composition of camel milk

Stage of lactation	Milk yield	Fat (%)	Protein (%)	Lactose (%)	SNF (%)	Acidity (%)	Density (%)
1 - 3 months	2.96^{a} ±1.28	4.46^{a}±1.62	3.5^{a}±0.27	4.75^{a}±0.42	8.88^{a}±0.89	0.2^{a}±0.02	1.030±.0035
4 - 6 months	2.47^{a}±1.28	3.86^{b}±1.01	3.39^{ab}±0.4	4.61^{ab}±0.48	8.64^{ab}±0.92	0.19^{a}±0.02	1.029±0.0032
7 - 9 months	2.68^{a}±1.08	3.43^{b}±1.15	3.3^{bc}±0.31	4.53^{bc}±0.46	8.49^{bc}±0.79	0.19^{a}±0.02	1.029±.0028
≥ 9 months	2.11^{b}±0.99	3.49^{b}±1.37	3.22^{c}±0.29	4.4^{c}±0.4	8.25^{c}±0.81	0.19^{a}±0.04	1.031±.029
Average	2.56±1.16	3.69±1.31	3.32±0.33	4.59±0.45	8.49±0.86	0.19±0.03	1.032±.017

Different letters in same column indicates significant difference (P≤ 0.05).

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Effect of stages of lactation on milk yield and milk composition of camel

The highest milk yield in the present study was obtained for camels at first three months of lactation (2.96±1.28 L) and the lower milk yield was found for camels at late lactation (2.11±0.99 L) as shown in Table 6. Although the she camels were from different production systems are grouped together to calculate the average lactations the result agreed with Al-Saiady et al. (2012). The seasons, stage of lactation and calving number (El-Amin et al., 2006; Zeleke, 2007; Riyadh et al., 2012) and the management conditions (Musa et al., 2006b; Bakheit et al., 2008; Riyadh et al., 2012) were found to affect camel milk yield.

Significant ($P \leq 0.05$) differences for stages of lactation on SNF, protein and lactose content of camel milk were observed (Table 6). The higher fat content of milk was observed (Table 6) for camels in the first three months of lactation compared to those in latter stages of lactation (4.46% and 3.49% respectively). The variations of this result from those obtained by El-Amin et al. (2006), Zeleke (2007) and Haddadin et al. (2008) could be because they follow the same animals, while this study examined the milk from different animals. Moreover Konuspayeva et al. (2010) reported that the fat content decreased all along the lactation period and the fat content varied from 4.34% to 7.81%.

Higher protein content in milk (Table 6) was found for camels at the first lactation period (3.5%) and the lower protein content was reported for camels at the end of lactation (3.22%). This result agreed with El-Amin et al. (2006), Zeleke, (2007) and Riyadh et al. (2012) who mentioned that the highest percentage of protein of camel milk were at the first lactation and then decreased along the lactation period. Significantly higher content of lactose in milk was found for camels at the first three months of lactation (4.75±0.42%) compared to those at later stages of lactation. This result agreed with Zeleke (2007) and Riyadh et al. (2012) who found that the higher lactose content was at first months of lactation and then decreased significantly at the end of lactation period. However the result disagreed with El-Amin et al. (2006) who found non-significant differences in lactose content between stages of lactation. The variations of chemical composition of camel milk at the end of lactation period might be due to the increase in the milk water content during the last stage of lactation (Riyadh et al., 2012).

Effect of parity number on milk yield and milk composition of camel

Slight differences for parities number on camel milk yield, SNF, protein and lactose was observed (Table 7). The highest milk yield was estimated for the camels in the second parity and the lowest milk yield was reported for camel at the last three parities (Table 7). This result disagreed with Al-Saiadyet al. (2012) who reported that the lowest milk yield was at the 1st, 2nd, and 4th parity. The Higher milk productivity was at the 3rd and 6th season of lactation (Table 7), which agreed with Raziq et al. (2008) who reported that she-camel has higher milk production at the 3rd season and longer and Musaad et al. (2013a) who reported that the highest average yield recorded was for camels at sixth parity. These could be due to the increased in growth and number of secretary cells in the udder or increased secretary activity of the mammary tissue or both (Herndez et al., 2008). The result showed non-significant differences between the she camels in the different parities for fat content of milk. The percentages of fat content vary between 3.5 and 3.95% (Table 7). This result agreed with El-Amin et al. (2006) and higher than that reported by Riyadh et al. (2012). Lactose content of camel milk varies between 4.71% and 4.32% (Table 7), which were lower than the result reported by Riyadh et al. (2012). The highest level of lactose content of milk in the present study (4.71%) was reported for camels in the 5th parity, which disagreed with Zeleke (2007) who reported that the highest lactose content of camel milk was recorded in the first lactation. Lactose level was viewed to be high for camels in the 2nd, 4th and 5th parities and higher than those at the 6th and 7th parities. This result disagreed with El-Amin et al. (2006) who mentioned that the lactose content was decreased from the first parity (3.75%) to the second parity (3.48%) then increase significantly ($P<0.05\%$) in the third parity (4.24%). The differences could be due to the variations in lactose content obtained by different camels and the type of plants eaten by the camel (Khaskheli et al., 2005).

The statistical model did not take in account the co-variance due to the farming system and some results regarding the effect of parity and physiological stage could be influenced by the methodology used. It was the main limit of the present study.

Table 7. Effect of parity number on milk yield and chemical composition of camel milk.

Parity No	Milk yield Lb/day	FAT (%)	Protein (%)	Lactose (%)	SNF (%)	Acidity (%)	Density (%)
1	2.60^{b}±0.99	3.81^{a}±1.56	3.28^{a}±0.38	4.48^{a}±0.52	8.35^{a}±1.04	0.2^{a}±0.03	1.035^{a}±.041
2	4.06^{a}±1.85	3.79^{a}±1.42	3.31^{a}±0.39	4.56^{ab}±0.52	8.5^{ab}±1.01	0.19^{a}±0.02	1.09^{a} ±0.003
3	2.75^{b}±1.04	3.61^{a}±1.31	3.27^{ab}±0.3	4.48^{a}±0.43	8.33^{ac}±0.78	0.19^{a}±0.03	1.029^{a}±0.0026
4	2.59^{b}±1.04	3.75^{a}±1.21	3.36^{a}±0.35	4.54^{ab}±0.41	8.62^{ab}±0.82	0.19^{a}±0.03	1.029^{a}±0.003
5	1.95^{c}±0.90	3.5^{a}±1.32	3.42^{ac}±0.33	4.71^{b}±0.52	8.83^{b}±0.86	0.19^{a}±0.03	1.03^{a}±0.0033
6	1.82^{c}±0.89	3.95^{a}±0.76	3.3^{a}±0.25	4.53^{ab}±0.33	8.48^{ab}±0.62	0.19^{a}±0.03	1.029^{a}±0.0020
7	1.78^{c}±0.00	3.25^{a}±1.22	3.17^{a}±0.18	4.32^{a}±0.27	8.11^{a}±0.44	0.19^{a}±0.04	1.028^{a}±0.0022
Average	2.52±1.11	3.69±1.31	3.32±0.33	4.59±0.45	8.49±0.86	0.19±0.03	1.030±0.017

Different letters in same column indicate significant difference ($P \leq 0.05$).

Conclusion

The present study confirmed that the husbandry practice, production system and the physiological status of camels have impact on milk yield and milk gross composition. The performance of she camels at semi-intensive system was better in comparison to the other management systems; therefore initiations of the semi-intensive system should be encouraged at the different states of Sudan. For future prospects, more research should be conducted to delineate management and nutrition requirements for the camel to improve the milk yield and composition in order to make camel rearing an economical proposition.

References

Al Haj, O. A. and H. A. Al Kanhal. 2010. Compositional, technological and nutritional aspects of dromedary camel milk. Internat. Dairy J. 20:3-7.

Al-Saiady, M. Y., H. H. Mogawer, B. Faye, Al-Mutairi, S. E. Bengoumi, M. Musaad and A. Gar-Elnaby. 2012. Some factors affecting dairy she-camel performance. Emir. J. Food Agric. 24(1):85-91.

Bakheit, S. A., A. M. Majid and A. M. Abu-Nikhila. 2008. Camels (*Camelus dromedarius*) under pastoral systems in North Kordofan, Sudan: Seasonal and parity effects on milk composition. J. Camelid Sci. 1:32-36.

Eisa, M. O. and A. B. Mustafa. 2011. Production systems and dairy production of Sudan camel (*Camelus dromedarius*): A review. Middle-East J. Sci. Res. 7(2):132-135.

El Zubeir, I. E. M. and E. M. Nour. 2006. Studies on some camel management practices in pre-urban areas of Khartoum State, Sudan. I. J. Dairy Sci. 1:104-112.

El-Amin, E. B., O. A. O. El Owni and I. E. M. El Zubier. 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, pp. 9-11.

Haddadin, M. S. Y., S. I. Gammoh and R. K. Robinson. 2008. Seasonal variations in the chemical composition of camel milk in Jordan. J. Dairy Res. 75:8-12.

Herndez, L. L., C. M. Stiening, J. B. Wheelock, L. H. Baumgard, A. M. Parkhurst and R. J. Collier. 2008. Evaluation of serotonin as a feedback inhibitor of lactation in the bovine. J. Dairy Sci. 91:1834–1844.

Ishag, I. A. and M. K. A. Ahmed. 2011. Characterization of production system of Sudanese camel breeds. Livestock Research for Rural Development 23:3. Available at www.irrd.org/irrd23/3/ishag23056.htm

Ishag, I. A., M. O. Eisa and M. K. Ahmed. 2011. Phenotypic characteristics of Sudanese camels (*Camelus dromedarius*). Livestock Research for Rural Development 23: 4. Available at www.irrd.org/irrd23/4/ishag23099.htm

Kamoun, M. and B. Jemmali. 2012. Milk yield and characteristics of Tunisian camel. J. Anim. Sci. 1:12-13.

Khaskheli, M., M. A. Arain, S. Chaudhry, A. H. Soomro and T. A. Qureshi. 2005. Physico-chemical quality of camel milk. J. Agric. Soc. Sci. 2:164-166.

Konuspayeva, G., B. Faye and G. Loiseau. 2009. The composition of camel milk: A meta-analysis of the literature data. J. Food Comp. Anal. 22:95-101.

Konuspayeva, G., B. Faye and G. Loiseau. 2010. Physiological change in camel milk composition (*Camelus dromedarius*): 1.Effect of lactation stage. Trop. Anim. Health Prod. 42:495–499.

Konuspayeva, G., E. Lemarie, B. Faye, G. Loiseau and D. Montet. 2008. Fatty acid and cholesterol composition of camel's *(Camelus bactrianus, Camelus dromedaries and hybrids)* milk in Kazakhstan. Dairy Sci. Tech. 88:327-340.

Ministry of Animal Resource and Fishers. 2011. Department of Statistic Information, Khartoum-Sudan. Statistical Bulletin for Animal Resources- Issue no 20:3-4.

Mohamed, I. M. A. and E. M. I. El Zubeir. 2012. Effect of pasteurization on the keeping quality of camel milk. ISOCARD International Conference Sultanate of Oman 29th January–1th February 2012, 3:232-233.

Musaad, A., B. Faye and A. Abu Nikhela. 2013a. Lactation curves of dairy camels in an intensive system. Trop. Anim. Health Prod. 45(4):1039–1046.

Musaad, A. M., B. Faye and S. EAl-Mutairi. 2013b. Seasonal and physiological variation of gross composition of camel milk in Saudi Arabia. Emir. J. Food Agric. 25(8):618-624.

Musa, H. H., E. S. Shuiep and I. E. M. El Zubier. 2006a. Camel husbandry among pastoralists in Darfur, western Sudan. Nomadic Peoples 10:101-104.

Musa, H. H., E. S. Shuiep and I. E. M. El Zubier. 2006b. Some reproductive and productive traits of camel (*Camelus dromedaries*) in western Sudan. J. Anim. Vet. Adv. 5(7):590-592.

Nabag, M. G., K. A. Alatti and I. E. M. El Zubier. 2006. Milk composition of camels and goats grazing in the extensive pasture of Butana area in Sudan. Proceedings of the International Scientific Conference on Camel. Part IV: 2173- 2183. Qassim University, Saudi Arabia, 9-11 May 2006.

Raziq, A., M. Younas and M. A. Kakar. 2008. Camel a potential dairy animal in difficult environments. Pak. J. Agri. Sci 45(2):263-267.

Riyadh, S. A., F.A. Faris, I. Elsyed, A. A.Mohammed, S. Ahmad and A. Moez. 2012. Effects of production system, breed, parity, and stage of lactation on milk composition of dromedary camels of Saudi Arabia. J. Anim. Vet. Adv. 11:141-147.

Sheiup, E. S. and I. E. M. El Zubeir. 2008. Current practices and future prospective in pre-urban camel farming in Khartoum State, Sudan. Competition for Resources in a Changing World: New Drive for Rural Development. Tropentag, 7-9 October 2008, Hohenheim, Germany.

Shuiep, E. S. and I. E. M. El Zubeir. 2012. The semi intensive camel farming a newly adopted system in Sudan. ISOCARD International Conference. Sultanate of Oman, 29th January–1th February 2012, 3:167-169.

Shuiep, E. S., I. E. M. El Zubeir, O. A. O. El Owni and H. H. Musa. 2007. Assessment of hygienic quality of camel (*Camelus dromedarius*) milk in Khartoum State, Sudan. Bull. Anim. Health Prod. Afr. 55:112-117.

Shuiep, E. S., I. E. M. El Zubeir, O. A. O. El Owni and H. H. Musa. 2008. Influence of season and management on composition of raw camel (*Camelus dromedarius*) milk in Khartoum State, Sudan. Trop. Subtrop. Agroecosys. 8:101-106.

Wernery, U., J. Juhasz and P. Nagy. 2004. Milk yield performance of dromedaries with an automatic bucket milking machine. J. Camel Pract. Res 11:51–57.

Zeleke, Z. M. 2007. Non-genetic factors affecting milk yield and milk composition of traditionally managed camels (*Camelus dromedarius*) in Eastern Ethiopia. Livestock Research for Rural Development 19 (6). Available at www.irrd.org/irrd19/6/zeleke 19085.htm