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Impact of early weaning on constituents and nutritional values of camel milk in modern system

Ayman Balla Mustafa^{1*}, Asim Faraz², Douglas Baum³, Abdalla Elgenaidi¹, Mohanad Bashari⁴,
Adukali Alkaskas¹ and Ahmed Elhag⁵

¹Therapeutic Nutrition Department, Faculty of Nursing and Health Sciences, Misurata University, Misurata, Libya

²Department of Livestock and Poultry Production, Bahauddin Zakariya University, Multan, Pakistan

³Independent Researcher, 123 CR 3360 Valley Mills, Texas 76689, USA

⁴Department of Food Science and Human Nutrition, College of Applied and Health Sciences,
A'Sharqiah University, Ibra, Sultanate of Oman

⁵Faculty of Veterinary Medicine, University of Gadarif, Gadarif, Sudan

Abstract

Background: Camel milk is very suitable for human nutritional requirements, and its composition has similarities to mother's milk. Many scientific researches focusing on the myth of nutritional and therapeutic properties of camel milk have been brought to public attention.

Aim: This study aims to clarify the impact of early weaning on constituents and nutritional values of the milk of camels reared under a modern farming system during four months postpartum.

Methods: Eight lactating camels and eight calves were selected immediately after calving and were assigned to two equal groups under a semi-intensive system in a farm. In the early weaning group (G1), all the calves were allowed to freely suckle their mother's teats from birth to 30 days postpartum. Afterward, the calves were used to stimulate milk letdown for each of the camels' teats for a few seconds before the milking procedure. While in the late weaning group (G2), the calves freely suckled their mother's teats up to 80 days postpartum. Afterward, the calves were restricted from suckling and were used mainly to stimulate milk letdown for the milking procedure. Collection of milk samples started in the 2nd week of postpartum and continued over biweekly intervals up to 16 weeks to determine major fat, protein, lactose, solid non-fat (SNF), and density percentages.

Results: The results revealed significant differences in fat, lactose, and density content between groups. We reported significant increases in the percentages of fat, lactose, protein, and SNF levels, besides fluctuations in density with the advancement of the lactation stage.

Conclusion: In the early weaning group, the dams produced milk containing high levels of fat and SNF compared to the lactating dams in the late weaning group.

Keywords: Dromedary camel, Early weaning, Milk constituents, Modern system, Nutritional value.

Introduction

Camels are important dairy animals in arid lands and their milk is an essential food for the sustenance of people. In pastoral conditions, milk can be consumed either fresh in its raw state without heat treatment or in varying degrees of sourness (Abdelrahman et al., 2011). Camel milk is a complex mixture of fat, protein, lactose, minerals, vitamins, and miscellaneous constituents dispersed in water. The wide variation in the constituents of camel milk is attributed to some factors such as parity, season, and physiological stage. The data on the physiological change of the main components of camel milk are very scarce (Konuspayeva et al., 2009b). Arab et al. (2019) carried out studies on camel rearing in the sedentary system, and found that the lactose, solid non-fat (SNF), total solids, and protein contents were higher when compared to that in the nomadic production system. The variation might be

due to the different feeding and management systems. Furthermore, in the sedentary production system, she-camels were fed a supplement of concentrate ration that altered the composition of milk. Alwan and Zwaik (2014) reported the variation in the chemical composition of camel rearing in farm conditions and desert systems, and found that the significant effects on water, lactose, ash, and total solids may be attributed to factors such as age, number of calves, management, stage of lactation, and sampling technique. Camel milk composition was found to be less stable than other species, such as bovine milk. However, variations observed in camel milk composition can be attributed to several factors, such as analytical measurement procedures, geographical locations, feeding conditions, and samples taken from different breeds, in addition to other factors, which include the stage of lactation, age, and number of calves (Khaskheli et al., 2005).

*Corresponding Author: Ayman Balla Mustafa. Therapeutic Nutrition Department, Faculty of Nursing and Health Sciences, Misurata University, Misurata, Libya. Email: aymansw@hotmail.com

Milk protein, fat, lactose, and ash content were all affected by season. Therefore, protein, fat, and ash content were higher during summer (May–July) and decreased during winter (October–January). However, lactose content showed an opposite trend, being higher during the rainy season and decreasing during the summer season in Sudan (Bakheit et al., 2008). In Saudi Arabia, Abdelgadir et al. (2013) reported no significant effect of parity, gestation length, or calf birth weight on milk constituents.

A strong positive correlation was found between fat and protein contents (Haddadin et al., 2008). The composition of camel milk varies with the quality and availability of feed, as well as differences in husbandry practices. However, interventions to improve the production practices through better hygiene and medical care of camels and their milk are needed. We hypothesize that the early weaning practice may accelerate the estrus cycle and lead to changes in milk constituents. Hence, early weaning can be an interesting way to reduce the calving interval and increase the productivity of camels. Thus, this study aims to elucidate the impact of some husbandry practices and early weaning on nutritional values and constituents of camel milk under the modern farming system.

Material and Methods

Experimental animals

Eight lactating one-humped camels, eight calves, and one mature male camel were chosen from a mixed herd of camels on the farm of the Camel Research Centre, University of Khartoum, Sudan. Camels were clinically healthy and the criteria adopted for the selection of dams were similarity in body weight, age, and order of breed. The age of the she-camels used in the experiment ranged from 6 to 17 years, wherein the average mean of dam body weight was 396.57 ± 45.86 kg. This study was carried out according to the rules governing the use of experimental animals as acceptable internationally.

All the experimental animals were herded in closed pens and set free for 5 hours during daylight (9:00 am–2:00 pm) to graze and browse outdoor, then returned to the pens each afternoon. The dams were supplemented with ration feed, which included 2 kg/head/day of concentrates in addition to roughages, such as sorghum straw, as shown in Table 6. The water source was available daily, and healthcare and parasites control were practiced as needed. In this modern system, the animals were brought for browsing on irrigated schemes on limited areas around the farm, approximately 700–1,200 km from the farm site, where they selected preferable plants, thorns, and herbs by themselves from the available range.

Experimental design

Eight lactating camels and their calves were selected and divided into two groups (G1 and G2), while the mature male camel (Al Fahal) was separated.

In group one (G1), all the calves were allowed to freely suckle from birth to 30 days postpartum. Afterward, they calves were weaned early and used to stimulate milk letdown for each of the she-camel's teats for a few seconds before the milking procedure. The remaining milk in the udder quarters was consumed by the calf immediately after hand milking. After 60 days, all the four quarters of the udder were milked completely, and the calves were used only to stimulate milk "letdown" by suckling for a few seconds, then returning to the pens near their dams that were restricted from breastfeeding. In group two (G2), the calves were allowed to freely suckle up to 75–80 days postpartum. Afterward, the calves were weaned and were used to stimulate milk letdown by sucking each of the she-camels teats for a few seconds before the milking procedure, the remaining milk in the other quarters was left to be consumed by the calf. Calves remained with their dams all day and were separated during the night hours into special pens. Restriction of suckling was applied by a traditional method called "Shemal", which is adopted by many herders in Sudan. Shemal is made from nylon or cotton material, and it is a bag used to cover the mouth of the calf to restrict it from suckling.

Milk samples collection

Milk samples were collected in sterile glass bottles (40 ml). The collection of samples was started in the 14th day postpartum and continued over biweekly intervals up to the 4th month postpartum. Hand milking was carried out twice a day, with the first milking at 8:00 am every morning and the second milking at 4:00 pm every afternoon. These samples were immediately delivered to the Dairy Lab in the Faculty of Animal Production, University of Khartoum, Sudan, for laboratory analysis. Mastitis incidence and calf mortality

During the experiment, one dam had mastitis and internal parasites, whereas one calf's sudden death was documented at 2 months of age. In such cases, the dams were discarded from the experiment.

Laboratory analysis of milk composition

The fat, protein, lactose, SNF, and density percentages were determined biweekly for 16 weeks postpartum by an automatic Lactoscan SP milk analyzer device (Lactoscan SP, Model-90, Europe).

Statistical analysis

All the data were subjected to the general linear model using statistics version 8 software program; variations of means regarding treatments and weeks were calculated. Least Significant Difference test was used to differentiate the means (Free Software Foundation, Boston, MA).

Ethical approval

The protocol for this study was approved by the Ethics Committee of Applied Sciences, which is authorized by the Faculty of Graduate Study, University of Khartoum. Thereafter, the experiment was conducted in the Camel Research Centre at the University of Khartoum.

Results

The results shown in Table 1 elucidate the fat contents of camel milk for G1 and G2 during the experimental period. The fat content reached a peak value ($7.99\% \pm 0.69\%$) within week 10 and 12 postpartum, and the results revealed that the fat content in week 10 and 12 postpartum was significantly high ($p < 0.01$) in G1 when compared to that in G2. Obviously, the fluctuation in fat contents was realized within 16 weeks in G2 group, and they ranged from $2.52\% \pm 0.60\%$ to $4.2567\% \pm 0.69\%$, while a slight increase in fat content with the advancement of lactation declined in weeks 14 and 16. The current study noted significantly ($p < 0.05$) higher fat contents in the milk of the animals in G1 ($4.95\% \pm 0.25\%$) when compared to G2 ($3.53\% \pm 0.22\%$) within 4 months postpartum. These are shown in Figures 1–3. Table 2 presents the results of the average lactose content in camel milk for 4 months postpartum in G1 and G2. There was no significant difference ($p > 0.05$) in the lactose content during the 4 months, although there was a slight increase with the advancement of the lactation stage. The results prove that a significantly ($p < 0.05$) higher value of lactose was reported in G2 (4.96

± 0.24) when compared to that in G1 ($4.88\% \pm 0.29\%$) for the entire experimental period.

The results presented in Table 3 indicate the milk protein content for both the groups at early and late weaning periods with the lack of variation ($p > 0.05$) in protein content between two groups for the entire experimental period. Clearly, the protein level was slightly increased with the advancement in the lactation period, especially in G2 when compared to that in G1.

Table 4 shows the SNF content of milk produced by G1 and G2 during the experimental period. In this study, there was no significant ($p > 0.05$) different in SNF content in G1 when compared to G2. The increase in SNF content coincided with the advancement in the lactation stage during the experimental period. Moreover, the results revealed that SNF content was realized during the first 6 weeks postpartum (8.63 ± 0.13 – 8.67), and was significantly ($p < 0.05$) lower during the weeks that followed (9.13 ± 0.15 – $9.55\% \pm 0.15\%$), as shown in Figures 2 and 3.

The results presented in Table 5 shows the density of milk in G1 and G2. The milk density was significantly

Table 1. Variations (Mean \pm SE) in fat content (%) of milk during the experimental period (2nd–16th week postpartum) under the modern system.

Treatment	2nd week	4th week	6th week	8th week	10th week	12th week	14th week	16th week	Overall
G1	1.83 \pm 0.69f	2.52 \pm 0.69ef	5.04 \pm 0.69bc	3.48 \pm 0.69cdef	7.99 \pm 0.69a	7.99 \pm 0.69a	4.59 \pm 0.69bcd	6.17 \pm 0.69ab	4.95 \pm 0.25a
G2	3.52 \pm 0.60cdef	3.05 \pm 0.60def	4.08 \pm 0.53cde	2.52 \pm 0.60ef	3.02 \pm 0.69def	3.72 \pm 0.60cde	4.07 \pm 0.60cde	4.26 \pm 0.69bcde	3.53 \pm 0.21b
Overall	2.68 \pm 0.45c	2.78 \pm 0.45c	4.56 \pm 0.4b	3.0 \pm 0.45c	5.50 \pm 0.49ab	5.86 \pm 0.45a	4.33 \pm 0.45b	5.22 \pm 0.49ab	4.24 \pm 1.85

Different letters in the same column and row indicate a significant difference ($p < 0.05$)

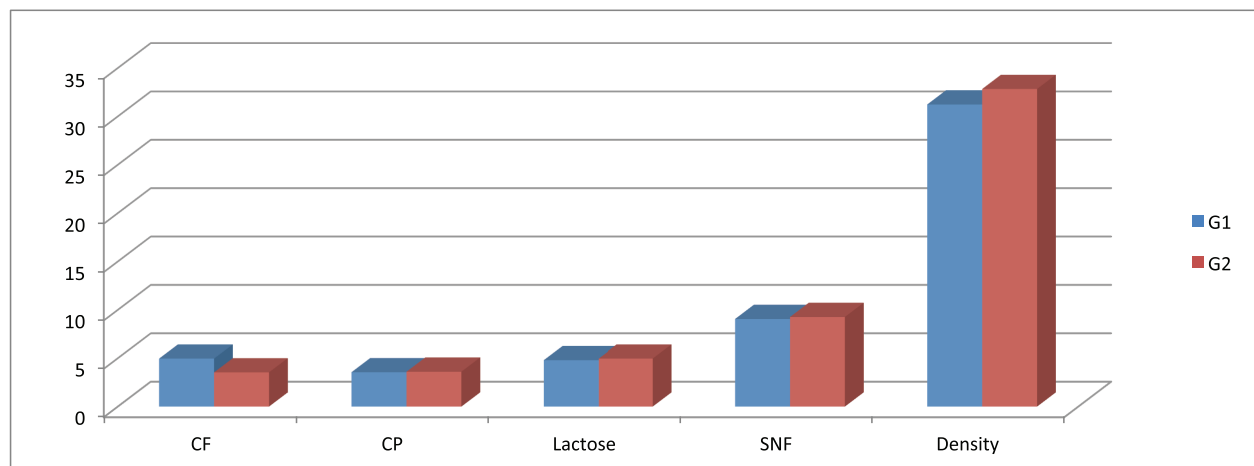


Fig. 1. Variations of average means (%) for components of camel milk under the modern system.

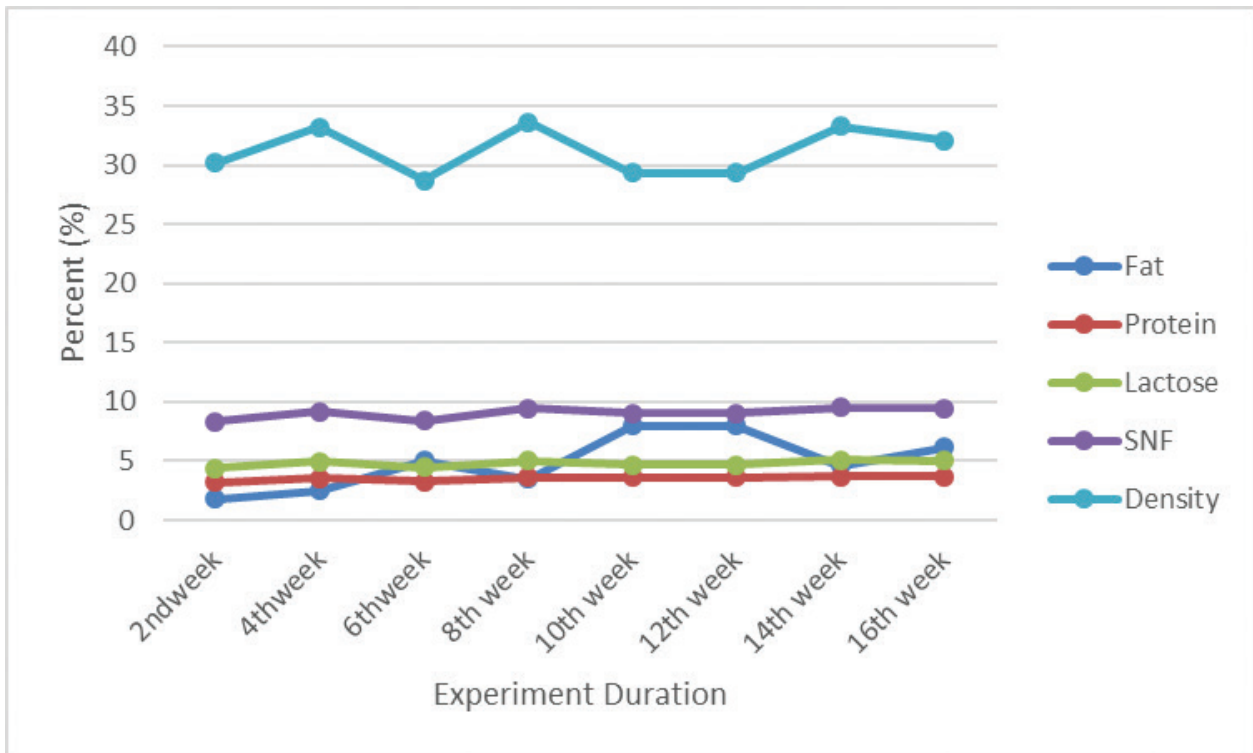


Fig. 2. Curve of the level of components of camel milk of G1 during the experimental period.

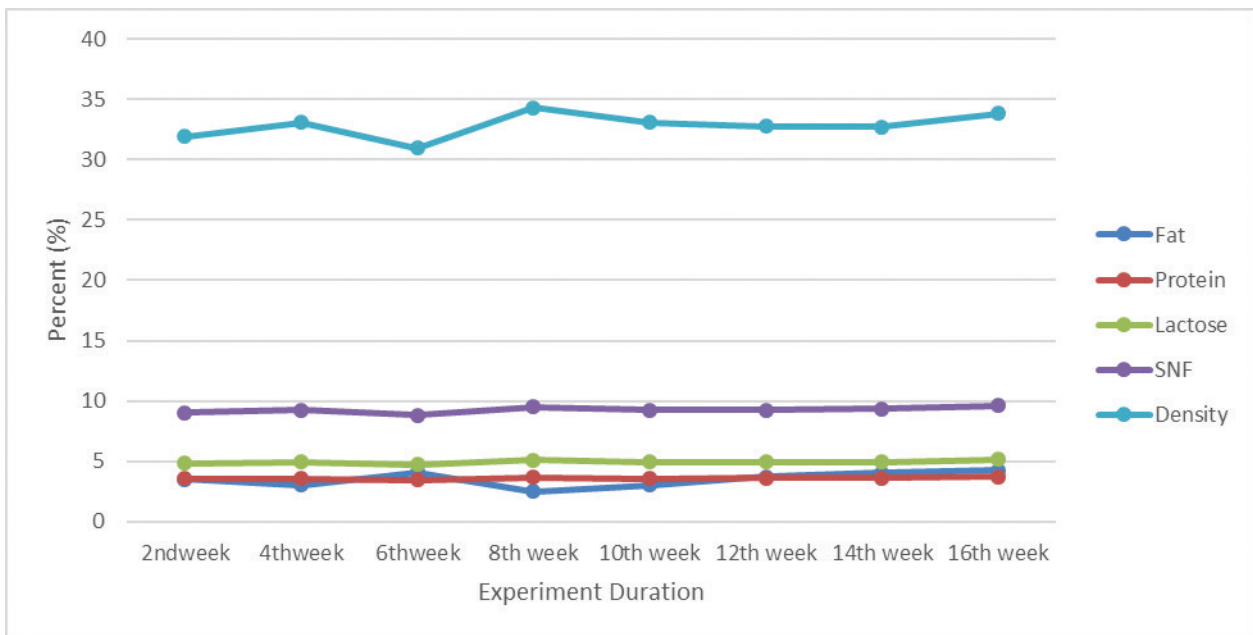


Fig. 3. Curve of the level of components of camel milk of G2 during the experimental period.

($p < 0.05$) different in the tenth and twelfth lactation weeks in both experimental groups as shown in Figures 2 and 3. This study noted a significantly

($p < 0.05$) higher average of milk density that was produced by G2 ($32.83\% \pm 0.26\%$) when compared to G1 ($31.2\% \pm 0.3\%$).

Table 2. Variations (Mean ± SE) in lactose content (%) of milk during the experimental period (2nd–16th week postpartum) under the modern system.

Treatment	2nd week	4th week	6th week	8th week	10th week	12th week	14th week	16th week	Overall
G1	4.38 ± 0.11d	4.95 ± 0.11ab	4.46 ± 0.91cd	5.06 ± 0.11a	4.71 ± 0.11bcd	4.71 ± 0.11bcd	5.07 ± 0.11a	5 ± 0.11ab	4.78 ± 0.29b
G2	4.83 ± 0.10ab	4.96 ± 0.10ab	4.72 ± 0.09bc	5.11 ± 0.10a	4.96 ± 0.11ab	4.96 ± 0.10ab	4.97 ± 0.10ab	5.14 ± 0.11a	4.96 ± 0.24a
Overall	4.61 ± 0.08	4.96 ± 0.08	4.58 ± 0.1	5.08 ± 0.08	4.84 ± 0.08	4.84 ± 0.08	5.02 ± 0.08	5.0717 ± 0.08	4.875 ± 0.2

Different letters in the same column and row indicate a significant difference ($p < 0.05$).

Table 3. Variations (Mean ± SE) in protein content (%) of camel milk during the experimental period (2nd–16th weeks postpartum) under the modern system.

Treatment	2nd week	4th week	6th week	8th week	10th week	12th week	14th week	16th week	Overall
G1	3.2 ± 0.09c	3.54 ± 0.09b	3.31 ± 0.09c	3.66 ± 0.08ab	3.6 ± 0.09ab	3.6 ± 0.08ab	3.72 ± 0.08a	3.73 ± 0.09a	3.55 ± 0.03a
G2	3.57 ± 0.08 b	3.58 ± 0.08 b	3.44 ± 0.074c	3.65 ± 0.08ab	3.57 ± 0.09b	3.6 ± 0.09ab	3.63 ± 0.08ab	3.75 ± 0.09a	3.6 ± 0.03a
Overall	3.38 ± 0.06c	3.56 ± 0.05 b	3.37 ± 0.05c	3.66 ± 0.06ab	3.58 ± 0.06ab	3.6 ± 0.06ab	3.67 ± 0.06ab	3.74 ± 0.06a	3.6 ± 0.03

Different letters in the same column and row indicate a significant difference ($p < 0.05$).

Table 4. Variations (Mean ± SE) in SNF content (%) of camel milk during the experimental period (2nd–16th weeks postpartum) under the modern system.

Treatment	2nd week	4th week	6th week	8th week	10th week	12th week	14th week	16th week	Overall
G1	8.31 ± 0.22b	9.2 ± 0.22a	8.42 ± 0.22 b	9.45 ± 0.22 a	9.02 ± 0.22a	9.02 ± 0.22a	9.52 ± 0.22a	9.46 ± 0.22a	9.05 ± 0.08a
G2	9.02 ± 0.20a	9.24 ± 0.20a	8.84 ± 0.17b	9.49 ± 0.2a	9.24 ± 0.22a	9.27 ± 0.2a	9.33 ± 0.2a	9.64 ± 0.22a	9.26 ± 0.07a
Overall	8.67 ± 0.14b	9.22 ± 0.14a	8.63 ± 0.13b	9.47 ± 0.14a	9.13 ± 0.15a	9.15 ± 0.14a	9.4 ± 0.14a	9.55 ± 0.15a	9.15 ± 0.48

Different letters in the same column and row indicate a significant difference ($p < 0.05$).

Table 5. Variations (Mean ± SE) in density (%) of camel milk during the experimental period (2nd–16th week postpartum) under the modern system.

Treatment	2nd week	4th week	6th week	8th week	10th week	12th week	14th week	16th week	Overall
G1	30.2 ± 0.8b	33.2 ± 0.8a	28.7 ± 0.8b	33.59 ± 0.8a	29.36 ± 0.83b	29.36 ± 0.83b	33.26 ± 0.3a	32.08 ± 0.83a	31.2 ± 0.3b
G2	31.94 ± 0.73b	33.06 ± 0.73a	30.95 ± 0.65b	34.29 ± 0.73a	33.06 ± 0.84a	32.78 ± 0.72a	32.7 ± 0.72a	33.84 ± 0.8a	32.83 ± 0.26a
Overall	31.09 ± 0.54b	33.13 ± 0.54a	29.83 ± 0.5b	33.94 ± 0.55a	31.21 ± 0.59b	31.07 ± 0.5b	32.97 ± 0.55a	32.96 ± 0.59a	32.03 ± 1.96

Different letters in the same column and row indicate a significant difference ($P < 0.05$)

Table 6. Average feed composition that was provided to the camels during the experimental period.

The average of feed ration (concentrate) composition							
Samples	DM	Fat	CP	CF	Ash	NFE	ME (kcal/kg)
Concentrate	94.78	2.90	21.15	10.10	5.35	60.49	1.240
Average of roughage composition							
Samples	DM	Fat	CP	CF	Ash		
Sorghum straw	94.55	1.26	1.87	59.26	4.33		

Discussion

In this study, the early weaning method eventually influenced the milk constituents and nutritional values of camels raised in the modern farming system. These findings are similar to the data reported by Wafa and El-Zubeir (2014), Riyadh et al. (2012), Hassabo (2010), Konuspayeva et al. (2009a), and Indra et al. (2003). Whereas the findings in this study are different than the findings reported by Shuiep et al. (2008), Bakheit et al., (2008), and Khaskheli et al. (2005).

In this study, we observed that the fat, lactose, and protein content had increased slightly with the advancement of the lactation stage. These findings are in agreement with the observations reported by Bakheit et al. (2008), who observed that fat, protein, and lactose increased with the advancement of first lactation. Furthermore, it is also in agreement with the studies of Sheriha (1986), Shuiep et al. (2008), and Abdelgadir et al. (2013), who stated that the milk components were elevated during the first stage of lactation, whereas high values of fat content were observed during the 4 months postpartum in this study, which is in agreement with the findings of Iqbal et al. (2001), Raghvendar et al. (2004), Riek and Gerken (2006), and Zeleke (2007). In this study, wide variations between milk constituents of camels, regarding dams that were suckled by their calves (late weaning) and the others that were restricted from being suckled (early weaning), were observed. This may be attributed to the physiological process according to Sambraus (1995), who suggested that the duration of suckling and the vigor of butting or extracting milk by the calf from the gland can influence the strength of milk ejection reflex and affect milk secretion independently of suckling frequency. The results of this study reveals that high values of fat content and low values of lactose, protein, and SNF of milk were produced by camels, whose calves were early weaned (restricted from suckling). These results are in agreement with the findings of Martinez (1989) who reported a negative correlation between fat content, on one hand, and protein and lactose contents, on the other hand. The variation in fat content of milk between the two groups is indirectly related to the milk yield as described by Khaskheli et al. (2005) and Bakheit et al. (2008), who reported that during the dry season, camels can produce a high diluted amount of milk with low fat.

Conclusion

Lactating she-camels with early weaned calves, restricted from suckling, produced milk containing high levels of fat and SNF compared to the late weaning lactating she-camels that had free suckling calves. Further research is required to investigate the effect of restrictive suckling and early weaning on the physiological changes, milk productivity, and fertility of camels.

Conflict of interest

The authors declare that there is no conflict of interest.

Authors' contribution

A.M.B. and A.F. designed the research. A.B.M. and A.E. formulated the plans and supervised the experiment. They also assisted in data collection and performed the experiments. A.R.E. and M.B. assisted with the lab work and statistical analysis. A.B.M., A.A., and D.B. wrote and reviewed the manuscript. All authors critically reviewed the data and the manuscript.

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