https://www.jresearchvalley.com/

Journal of Dietetics and Food Technology

Research Valley

Research Article

Open Access

Assessment of Physiochemical Properties of Camel Milk Samples from Farms and Sale Points in Khartoum State, Sudan

LM Warsma and I E M El Zubeir*

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

Abstract

Background: Camel milk and its products have always playing an important role in the diet of the population in the rural areas of Africa, Asia and the Middle East.

Methods: This study was conducted on fifty raw camel milk samples collected randomly from farms and sale points in Khartoum State. Twenty-five milk samples were collected during each summer and winter from the same sources. The physiochemical properties of the milk samples were examined for fat, SNF, density, protein, lactose and acidity.

Results: The average of fat content of raw camel milk was higher (3.7%±0.16%) during winter season, whereas SNF, lactose and density were high during summer season (8.5%±0.15%, 4.5%±0.0±8% and 1.030 g/cm^3, respectively). Protein and acidity revealed similar values during different seasons. The average of fat content of camel milk samples collected from dairy farms was higher (3.1% ± 0.1%) than that collected from the sale points. The SNF, density, protein and lactose of camel milk samples collected from different sources revealed similar values (8.3% ± 0.15%, 1.02g/cm^3±0.0g/cm^3, 3.2% ± 0.0%, and 4.4% ± 0.08%, respectively. The acidity of camel milk samples was 0.14% ± 0.0% and 0.15% ± 0.0% during winter season and it was 0.15% ± 0.0% and 0.14% ± 0.0% for samples collected from sale points and farms, respectively.

Conclusion: The study concluded that variations in the compositional content of camel milk might be due seasons rather than the sources from which the milk was collected.

Keywords: Camel Milk; Composition; Season; Farms; Sale Points; Sudan

Introduction

Camel milk is considered a useful component of the human as it has positive effect in the diet for individuals with allergic reactions to the protein fraction, as camel milk does not contain lactoglobulin and the content of alpha-casein is much lower than in other milk (FAO) [1]. According to *Agrawal et al.* [2], camel milk has reducing effect on blood sugar level and increases quality of life of people affected by type I diabetes mallets allowing the reduction of insulin dose of camel milk consumed every day.

The wide range of variations of camel composition was attributed to locations and feeding conditions [3-4]. The period of the year had a significant effect (P<0.05) on fat, proteins and lactose of camel milk contents as camel milk samples collected during summer revealed lower total solids content in *Ismaili et al.* [5]. On the other hand, stage and number of lactations were also reported to influence the composition of camel milk [6-8]. The superiority of camel milk compared to other milk could be linked to a confirmation on the health benefits was sowed regarding the fat content of camel milk fat [9-10]. Fat content of camel revealed wide range of variations in the levels of omega-3 fatty acids [9]. Camel's milk seems to be very different from other mammalian milk consumed by humans in the types of fatty acids composition as it is lower in the long chain fatty acids content [10]. Moreover *Konuspayeva et al.* [11] found positive correlation between fat and protein content.

Milk samples collected from the semi intensive system revealed significantly (P<0.05) higher solids not fat, protein and lactose contents, while fat was significantly (P<0.05) higher in milk samples collected from traditional nomadic system [12]. The SNF was 7.45% and 7.12% in dromedary milk produced in Tsabong, south-western Botswana [13]. Also, *Khaskheli et al.* [3] reported that the SNF was 7.12% ± 0.35% for camel milk produced in Pakistan. Protein content was also reported to vary according to season for the same breed it is lowest (2.48%) in August and highest (2.90%) in December and January [14]. However, *Shuiep et al.* [4] reported that the camel milk protein was 2.88% and 3.27% during winter and summer, respectively. The density for the camel milk in Khartoum State revealed 1.030g/cm^3 ± 0.017g/cm^3 [6]. Density of camel milk was 1.0274 g/cm^3 ± 0.002 g/cm^3 in Algeria [15] and 1.015g/cm^3 ± 0.001g/cm^3 in Pakistan [3]. Camel milk sometimes describes as sweet, salty and sometimes as bitter and lactose is the only component that almost remains unchanged over a season [14]. Lactose content of camel milk reported by *Babiker and El Zubier* was 4.59% ± 0.45% [6]. Values of lactose of camel milk samples were 4.74% ± 17% and 4.45% ± 0.17% in semi intensive and nomadic production systems, respectively [12].

Because of the increasing demands for camel milk among the urban settlers, which are mainly due to the increase awareness on its medicinal values [16]. This study was conducted with the objectives of evaluating random camel milk samples that offered for sale in farms and sale points in Khartoum State.

***Correspondence to:** I E M El Zubeir, Department of Dairy Production, Faculty of Animal Production, University of Khartoum, P. O. Box 321, Khartoum North, Sudan. E-mail: Ibtisamelzubeir17@gtmail.com, Ibtisam.elzubeir@uofk.edu

Received: March 03, 2020**; Accepted:** April 29, 2020**; Published:** May 05, 2020

Copyright: ©2020 Warsama LM, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Materials and Methods

Sources and Collection of Camel Milk Samples

This study was carried out in Khartoum State, Sudan. Twenty-five samples of raw camel milk were collected from the sale points and 25 raw camel milk samples from the collection points. The samples were collected during summer and winter seasons in order to study the chemical composition of camel milk samples.

The samples were collected into clean sterile bottles and transported into an ice-box (4-5 °C) to the laboratory of the Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Sudan.

Chemical Analysis of Camel Milk Samples

The chemical analysis of milk samples was determined by using Lactoscan milk analyzer according to the manufacture instructions (Milkotronic LTD, Europe) to determine fat, protein, lactose, SNF and density of the milk samples. The acidity was determined by using the titration methods of AOAC [17].

Statistical Analysis

The obtained data were analyzed by factorial design using SPSS (version 11.5, 1998) computer program (Statistical Packages for Social Sciences).

Results

Fat Content of Camel Milk

The average fat content of raw camel milk was 3.7% ± 0.16%, the minimum was 3.3% and the maximum was 4.0% during winter season. However, the fat content of raw camel milk was 2.4% ± 0.16%, 2.1% and 2.7% for mean, minimum and maximum values respectively; during summer season (Table 1). Fat content of camel milk samples collected from the sale points was 3.02% ± 0.1%, the minimum was 2.6% and the maximum was 3.3%. The camel milk fat from the farms revealed 3.1% ± 0.1%, the minimum was 2.7% and the maximum was 3.4%.

(Table 2) Fat content of milk samples collected from different sources showed non-significant (P≥0.05) differences, while during different seasons it revealed significant (P≤0.001) differences (Table 3).

Solids Not Fat (SNF) Content of Camel Milk

The average of SNF content of raw camel milk was 8.2% ± 0.15%, the minimum was 7.9% and the maximum was 8.5% during winter season. The average of SNF content of raw camel milk was 8.5% ± 0.15%, the minimum was 8.1% and the maximum was 8.8% during summer season (Table 1). The SNF content of camel milk samples collected from both sale points and farms was 8.3% ± 0.15%, the minimum was 8.0% and the maximum was 8.6% (Table 2). The data revealed non-significant (P≥0.05) differences (Table 3).

Protein Content of Camel Milk

The average of protein content of camel milk was 3.2% ± 0.05%, the minimum was 3.0% and the maximum was 3.3% during winter season. Similarly, the average was 3.2% ± 0.05%, the minimum was 3.1% and the maximum was 3.4% during summer season (Table 1). The average protein content of camel milk samples collected from the sale points and the farms was 3.2% ± 0.05%, the minimum was 3.1% and maximum was 3.3% (Table 2). The data revealed non-significant (P≥0.05), variation between the samples from both sources and during different seasons (Table 3).

Lactose Content of Camel Milk

The average of lactose content of raw camel milk was 4.3% ± 0.08%, the minimum was 4.2% and the maximum was 4.5% during winter season. Similarly, the average was 4.5% ± 0.08%, the minimum was 4.3% and the maximum was 4.6% during summer season (Table 1). The lactose content of camel milk samples from the sale points was 4.4 ± 0.08%, the minimum was 4.2% and the maximum was 4.6%. The mean for those collected from the farms revealed 4.4% ± 0.08%, the minimum was 4.3% and the maximum was 4.3% (Table 2). The lactose of camel milk samples collected from both sources and during seasons showed non-significant (P≥0.05) differences (Table 3).

Item	Measurements	Winter	Summer	Total	Significant level
Fat (%)	Means +SE	3.70±0.16	2.40±0.16	3.05±0.80	0.001***
	Minimum	3.30	2.10	2.10	
	Maximum	4.00	2.70	4.00	
Solid not fat (%)	Means +SE	8.20±0.15	8.50±0.15	8.35±0.70	0.22 NS
	Minimum	7.90	8.10	7.90	
	Maximum	8.50	8.80	8.80	
Density g/cm^3	Means +SE	1.030±0.00	1.028±0.00	1.032±0.00	0.12 NS
	Minimum	1.028	1.026	1.026	
	Maximum	1.032	1.031	1.032	
Protein (%)	Means +SE	3.20±0.05	3.20±0.05	3.20±0.05	0.31 NS
	Minimum	3.00	3.10	3.00	
	Maximum	3.30	3.40	3.40	
Lactose (%)	Means +SE	4.30±0.08	4.50±0.08	4.40±0.04	0.31 NS
	Minimum	4.20	4.30	4.20	
	Maximum	4.50	4.60	4.60	
Acidity (%)	Means +SE	0.14±0.00	0.15±0.00	0.15±0.00	0.46 NS
	Minimum	0.13	0.13	0.13	
	Maximum	0.15	0.15	0.15	

Table 1. Chemical composition of raw camel milk samples collected during winter and summer seasons in Khartoum State. (NS = non-significant atP ≥ 0.05; *** = highly significant at P≤0.001).

All articles published by Research Valley Publishers are Open Access under the Creative Commons Attribution License CC BY-NC.

Item	Measurements	Winter	Summer	Total	Significant level
Fat (%)	Means +SD	3.10±0.10	3.02±0.10	3.05±0.10	0.67***
	Minimum	2.70	2.60	2.60	
	Maximum	3.40	3.30	3.40	
Solid not fat (%)	Means +SD	8.30±0.15	8.30±0.15	8.30±0.16	0.99 ^{NS}
	Minimum	8.00	8.00	8.00	
	Maximum	8.60	8.60	8.60	
Density g/cm^3	Means +SD	1.02±0.00	1.029±0.00	1.02±0.00	0.36 ^{NS}
	Minimum	1.028	1.027	1.027	
	Maximum	1.031	1.031	1.031	
Protein (%)	Means +SD	3.20±0.05	3.20±0.05	3.20±0.05	0.74 ^{NS}
	Minimum	3.10	3.10	3.10	
	Maximum	3.30	3.30	3.30	
Lactose (%)	Means +SD	4.40±0.08	4.40±0.08	4.40±0.08	0.83 ^{NS}
	Minimum	4.30	4.20	4.20	
	Maximum	4.30	4.60	4.60	
Acidity (%)	Means +SD	0.14±00	0.15±00	0.15±00	0.76 ^{NS}
	Minimum	0.13	0.15	0.15	
	Maximum	0.14	0.16	0.16	

Table 2. Comparison of chemical composition of camel milk samples collected from milk supply chain in Khartoum State(NS = non-significant at P ≥ 0.05; *** = highly significant at P≤0.001).

Measurement	Sources		Seasons		Sources × Seasons	
	Mean Square	Significant Level	Mean square	Significant level	Mean square	Significant level
Fat (%)	0.119	0.67^{NS}	19.91	0.001***	0.00	0.98^{NS}
Solid not fat (%)	4.62×10^{-5}	0.99^{NS}	0.92	0.22^{NS}	0.45	0.39^{NS}
Density (%)	1.93×10^{-5}	0.36^{NS}	5.66×10^{-5}	0.12^{NS}	9.91×10^{-6}	0.51^{NS}
Protein (%)	0.009	0.74^{NS}	0.09	0.31^{NS}	0.03	0.5^{NS}
Lactose (%)	0.007	0.83^{NS}	0.174	0.31^{NS}	0.01	0.73^{NS}
Acidity (%)	0.00	0.76^{NS}	0.001	0.46^{NS}	0.002	0.188^{NS}

Table 3. Comparison of chemical composition of camel milk samples collected during winter and summer season from Khartoum State (NS = non-significant at P ≥ 0.05; *** = highly significant at P≤0.001).

Density of Camel Milk

The average of camel milk density was 1.030 ± 0.0g/cm^3, the minimum was 1.028g/cm^3 and the maximum was 1.032g/cm^3 during winter season, while it was 1.028g/cm^3 ± 0.0g/cm^3, with minimum of 1.026g/cm^3 and maximum of 1.031g/cm^3 during summer season (Table 1). The average of camel milk density from the farms was 1.028g/cm^3 ± 0.0g/cm^3, the minimum was 1.026g/cm^3 and the maximum was 1.030g/cm^3 (Table 2). The average of camel milk density from the sale point was 1.029g/cm^3 ± 0.0g/cm^3 the minimum was 1.027g/cm^3 and the maximum was 1.031g/cm^3. Density of milk samples collected from both sources and during different seasons showed non-significant (P≥0.05) differences (Table 3).

Acidity Content of Camel Milk

The average of acidity of camel milk samples was 0.14% ± 0.0%, the minimum was 0.13% and the maximum was 0.15% during winter season. Similarly, it was 0.15% ± 0.0%, the minimum was 0.13% and the maximum was 0.15% during summer season (Table 1). The acidity of camel milk samples collected from the sale points was 0.15% ± 0.0%, the minimum was 0.15% and the maximum was 0.16%. The farms samples revealed 0.14% ± 0.0% for the average, the minimum was 0.13% and maximum was 0.14% (Table 2). The acidity of camel milk samples collected from both sources and during different seasons revealed non-significant (P≥0.05) differences (Table 3).

Discussion

The average fat content of raw camel milk (3.7% ± 0.16%) during winter season was high than that during summer season (2.4% ± 0.16%). The high value of fat during winter might be because camel secretes highly diluted milk with low fat during hot summer and the water content of fodder would also affect water content of milk [3]. The availability of green fodders and concentrate feed are behind the variation obtained in the fat content of camel milk [4,6-7].

The fat content of camel milk samples collected from dairy farms was higher than that collected from the sale points (Table 2). There were also significant differences in camel fat milk from three different dairy camel farming systems as reported previously by *Babiker and El Zubier* [6]. This might be because camels produce more fat in milk compared to those received concentrates [4,12]. *Dowelmadina et al.* [9] demonstrated that camel milk fat has a wide range of variation in the levels of omega-3 fatty acids, which could have a role in lowering human serum lipids and decreasing the incidence of lipid-related cardiovascular diseases.

The solids not fat of camel milk samples showed non-significant variations between sources and during different seasons (Table 1, 2 and 3). Moreover, the results were near to those reported previously (8.49% ± 0.86%) camel milk [6]. The average solids not fat content supported *Shuiep et al.* [12] who reported highly significant variations between camel milk samples obtained from nomadic herders (8.25% ± 0.24%) compared to those from the semi intensive production system (8.84% ±

0.27%). However, *Khaskheli et al.* [3] reported that the average of SNF was 7.12% ± 0.35%.

The non significant (P≥0.05) variations obtained in protein content (Table 3) between the samples from both sources and during different seasons could be due to the availability of high feed quality [18]. Moreover, camel milk protein represents the single source of protein indicated that camel milk protein is of high biological value and could provide sufficient amount of amino acids [12]. Moreover *El-Agamy et al.* [19] suggested camel milk as a new protein source for nutrition for children allergic to cow's milk because β-casein present in cow milk also causes hypersensitivity into humans. Thus besides, camel milk contains β- casein, but its structure is very different from the cow milk protein. Also, *Shabo et al.* [20] concluded that camel milk is a good substitute for human milk as it does not contain β-lactoglobulin and that the functional components of camel milk include immunoglobulin similar to those in human milk, which are known to reduce children's allergic reactions and strengthen their future response to foods.

The lactose content of camel milk samples in this study revealed non significant variations in samples obtained from both sources and seasons (Table 1, 2 and 3). The present results supported the pervious studies indicating that the lactose content was 4.91% ± 0.70% [21]. Lactose content of camel milk is the only component that almost remains unchanged over a season [15]. Camel milk contained low lactose of small molecules and easily digested and metabolized by the human body [22]. However, the period of the year had a significant effect (P<0.05) on fat, proteins and lactose contents of milk; summer camel milk presented the lowest total solids contents of raw camel milk produced in Morocco [21].

The density of camel milk samples revealed non-significant variation in both sources and during the different seasons (Table 3). The density of the camel milk was 1.030g/cm^3 ± 0.017g/cm^3 in Khartoum State [6]. Density of camel milk was found as 1.027g/cm^3 ± 0.006g/cm^3 by *Mahboub et al.* [23] and 1.015g/cm^3 ± 0.001g/cm^3 by *Khaskheli et al.* [3]. This variation could be due to the water content in milk because the density is influenced directly by humidity of camel milk [24].

The values obtained for the acidity of camel milk samples was similar to those reported in Pakistan by *Khaskheli et al.* [3] and Sudan [25-27]. Similarly, *Rahman et al.* [28] reported that the acidity of raw camel milk was 0.17% ± 0.01% and they concluded that the variation of the season could be behind the variations. *Babiker and El Zubeir* [6] found slightly higher values for camel milk in the intensive, semi-intensive and grazing+ supplement farming systems (0.19 ± 0.02%, 0.19% ± 0.03% and 0.18% ± 0.03%, respectively) and concluded that availability of cooling facilities was behind the low acidity. Also, higher acidity (0.213% ± 0.0144%) was reported by *Mahboub et al.* [23].

The higher variations in the chemical composition was found in the present study and the overall milk composition can be influenced by several factors including physiological stage, feeding strategy, feed and water quality and quantity, seasonal variations, genetic and breed variation [29]. The variations might also be due to the supplementary feeding management [6].

Camel milk samples obtained from different sources showed non-significant differences, as the SNF, protein, lactose and density of camel milk samples collected from different sources revealed the same values (Table 2). However, during the different seasons, the values revealed significant differences (Table 1 and 3). Variations could be attributed to several factors observed in camel milk composition such as feeding conditions [3], production systems [4], breeds and stage of lactation [6-8].

Conclusion

Physicochemical qualities of camel milk such as fat, solids not fat, lactose, protein content, titratable acidity and density showed that the milk samples were of good quality. Camel milk could soon become the new super food due to its high nutritional value, easy digestibility (suitable for people with lactose intolerance) and low share of fat. Due to the less daily milk production than in cows, price of milk is higher, what is the only obstacle to the introduction of this food in everyday eating habits. To extend the limited storage life of camel milk, it should be processed into certain products as functional food or the better energy, nutrition and health.

Acknowledgement

This study was supported partially from fund received from The Arab Science and Technology Foundation (ASTF) and ALJ Grant for Funding Scientific Research and Innovation in Technology.

Reference

1. FAO (2003). Livestock Sector, Brief. Livestock Information. Sector Analysis and Policy Branch, Rome, Italy.
2. Agrawal RP, Beniwal R, Sharma S, Kochar DK, Tuteja FC, Ghorui SK, et al. Effect of raw camel milk in type 1 diabetic patients: 1 year randomised study. Journal of Camel Practice and Research. 2005 Jun 1;12(1):27.
3. Khaskheli M, Arain MA, Chaudhry S, Soomro AH, Qureshi TA. Physico-chemical quality of camel milk. Journal of Agriculture and Social Sciences. 2005 Jan 1;2:164-6.
4. Shuiep ES, El Zubeir IE, El Owni OA, Musa HH. Influence of season and management on composition of raw camel (Camelus dromedarius) milk in Khartoum state, Sudan. Tropical and subtropical Agroecosystems. 2008;8(1):101-6.
5. Ismaili MA, Saidi B, Zahar M, Hamama A, Ezzaier R. Composition and microbial quality of raw camel milk produced in Morocco. Journal of the Saudi Society of Agricultural Sciences. 2019 Jan 1;18(1):17-2
6. Babiker WI, El-Zubeir IE. Impact of husbandry, stages of lactation and parity number on milk yield and chemical composition of dromedary camel milk. Emirates Journal of Food and Agriculture. 2014 Jan 14:333-41.
7. Dowelmadina IM, El-Zubeir IE, Salim AD, Arabi OH. Influence of some factors on composition of dromedary camel milk in Sudan. Global Journal of Animal Scientific Research. 2014;2(2):120-6.
8. Elhassan SM, Dowelmadina IM, El Zubeir IE. Effect of management system, parity orders and stages of lactation on chemical composition of camel milk. Journal of Veterinary Medicine and Animal Production. 2015 Dec 4;6(2).
9. Dowelmadina IMM,ZubeirIEM, Arabi OHM, Abakar A D (2019) Omega-3 Fatty Acids in Milk Fat of Some Sudanese Camels. HSOA Journal of Dairy Research & Technology, 2: 009.
10. Dowelmadina IMM, El Zubeir IEM, Arabi OHMH, Abaker AD (2018). Qualitative and quantitative analysis of fatty acids milk from different Sudanese Arabi camels. Annals of Food Science and Technology 19 (4): 786-796.
11. Konuspayeva G, Lemarie É, Faye B, Loiseau G, Montet D. Fatty acid and cholesterol composition of camel's (Camelus bactrianus, Camelus dromedarius and hybrids) milk in Kazakhstan. Dairy Science & Technology. 2008 May 1;88(3):327-40.
12. Shuiep ET, El Zubeir EM, Yousif IA. Compositional quality of camel milk and some husbandry practices associated with camel milk production in two production systems in Sudan.
13. Makgoeng T, Seifu E, Sekwati-Monang B, Sonno K. Composition and microbial quality of camel milk produced in Tsabong, south-western Botswana.
14. Haddadin MS, Gammoh SI, Robinson RK. Seasonal variations in the chemical composition of camel milk in Jordan. Journal of Dairy Research. 2008 Feb;75(1):8-12.
15. Benyagoub EL, Ayat M, Dahan T, Smahi K. Level of control of the hygienic quality of camel milk (Camelus dromedarius) in south west Algeria and its impact on security. Peak J Food Sci Tech. 2013;1(4):53-60.

16. El Zubeir IE. Fluid milk processing and marketing for sustainable development of the camels' herders communities. SUST Journal of Agricultural and Veterinary Sciences. 2015 Jun;16(1):1-3.

17. AOAC (1990) Chlorides in milk. In: Official Methods of Analysis, No.935.43. Association of Official Analytical Chemists Inc: Virginia, USA.

18. Parraguez VH, Latorre MT, Ferrando G, Raggi LA. Milk composition in alpaca (Lama pacos): comparative study in two regions of Chile. Archivos de Zootecnia. 2003;52(200):431-9.

19. El-Agamy EI, Nawar M, Shamsia SM, Awad S, Haenlein GF. Are camel milk proteins convenient to the nutrition of cow milk allergic children? Small Ruminant Research. 2009 Mar 1;82(1):1-6.

20. Shabo Y, Barzel R, Margoulis M, Yagil R. Camel milk for food allergies in children. IMAJ-RAMAT GAN-. 2005 Dec 1;7(12):796.

21. Ehlayel MS, Hazeima KA, Al-Mesaifri F, Bener A. Camel milk: an alternative for cow's milk allergy in children. InAllergy and asthma proceedings 2011 May 1 (Vol. 32, No. 3, p. 255). OceanSide Publications.

22. Meiloud GM, Bouraya IO, Samb A, Houmeida A. Composition of mauritanian camel milk: results of first study. International Journal of Agriculture and Biology. 2011 Feb 1;13(1).

23. Mahboub N, Slimani N, Siboukeur O, Mati A. Effect of storage on the enzymatic activity of coagulation extracted from curd older camel prepared without lining. Rev. Biores. 2012;2(1):8-20.

24. Hadef L, Aggad H, Hamad B, Saied M. Study of yield and composition of camel milk in Algeria. Scientific Study & Research. Chemistry & Chemical Engineering, Biotechnology, Food Industry. 2018;19(1):1-1.

25. Shuiep ES, El Zubeir IE, El Owni OA, Mussa HH. Assessment of hygienic quality of camel (Camelus dromedarius) milk in Khartoum State, Sudan. Bulletin of Animal Health and Production in Africa. 2007;55(2):112-7.

26. Ibtisam EM, Marowa II. Effect of pasteurization of milk on the keeping quality of fermented camel milk (Gariss) in Sudan. Livestock Research for Rural Development. 2009;21(2).

27. Mohamed I, El Zubeir IE. Effect of heat treatment on keeping quality of camel milk. Ann. Food Sci. Technol. 2014;15:239-45.

28. Rahman IA, Dirar HA, Osman MA. Microbiological and biochemical changes and sensory evaluation of camel milk fermented by selected bacterial starter cultures. Afr. J. Food Sci. 2009 Dec;3(12):398-405.

29. Elhosseny M, Gwida M, Elsherbini M, Samra RA, Ashmawy AM. Evaluation of physicochemical properties and microbiological quality of camel milk from Egypt. J Dairy Vet Anim Res. 2018;7(3):92-7.