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Original Article

Study on Chemical Composition of Fermented Camel (*Camelus dromedarius*) Milk *Gariss*

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ABSTRACT

The objective of the present investigation was to study the chemical composition of fermented camel milk *gariss* procured from different locations of Khartoum State production sites, Sudan. *Gariss* prepared in Khartoum State collected from ten different locations (i.e. five from Khartoum, three from Khartoum North and two from Omdurman) were subjected to chemical composition (i.e. protein, fat, ash, lactose, total solids, pH and acidity). According to the statistical analysis of the present data there were significant differences in total means of protein, fat, total solids, titratable acidity in the three production sites of Khartoum State, but there were no significant differences in ash and lactose contents. The study concluded that chemical composition of *gariss* collected from different locations in Khartoum production sites has different trends associated with this factor.

Keywords: Fermented camel milk, *gariss*, Khartoum State, chemical composition and production site.

INTRODUCTION

According to the recent statistics by the Food and Agriculture Organization (FAO), the total population of camels in the world is estimated to be about 20 million, with Somalia having the largest herd worldwide, Sudan is the second larger country in camel population which of 4.4 million and that representative about 17.79% of the world camel population and 20.93% of the African camel population (Faye *et al*., 2011; FAO, 2008). Camel's population in Kordofan estimated at 1.54 million heads which is equivalent to 38% of total camel population in the country (Sukar *et al*, 2002).

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The camel (*Camelus dromedarius*) is of significant socio-economic importance in many arid and semi-arid parts of the world and its milk constitutes an important component of human diets in these regions (Farah and Fischer, 2004).

Camels' (*Camelus dromedarius*) milk is a very important nutrient resource for humans in several arid and semiarid zones of subtropical and tropical regions where it represents often the only protein source. In hostile environment, where the availability of water is scarce and ambient temperature is very high, dairy camels can provide milk almost all the year in quantities greater than other domestic animals (Farah, 1996).

In order to preserve camel milk from spoilage there are many products can be made from this milk i.e. Cheeses, butter, fermented milk (which locally known as Gariss) e.t.c. Under warm conditions raw milk does not keep for long time and actually its fermentation appears to be a means to preserve into only for a limited period of time otherwise in pastoral communities, milk is traditionally consumed mostly in the form of fermented milk (Yagil, 1982 and Farah and Fischer, 2004). Milk from the lactating camel must provide nourishment for her young calf as well as for human, not a great deal will be left for milk products. Moreover, the composition of camel milk does not allow for making some of the accepted products that are made from cow, sheep and goat milk. Nevertheless, milk products are made from camel milk, and the milk itself is used for purposes other than simply nutrition. Camel products have various names in various parts of the world (Asresie and Adugna, 2014). *Gariss* (Sudanese fermented camel milk) is special kind of fermented milk, prepared solely from camel milk under more or less shaking. The camel milk is fermented in a large skin bags, or siin (thin) which contain a large quantity of previously soured product called starter. In the absence of a starter from a previous lot, particularly when using a new siin, fermentation is initiated by adding to the container a few seeds of black cumin and one onion bulb. Once the first batch of *Gariss* has been successfully obtained, following the addition of fresh camel milk to the bag, *Gariss* can be continuously produced for months. Fresh camel milk is added to the siin whenever part of the fermented product has been consumed, so that the volume of the fermenting milk is more or less kept constant (Dirar, 1993), various dairy products were reported to be produced successfully from camel milk with some modifications to their production procedure the objective of the present investigation was to study the chemical composition of fermented camel milk *gariss* collected from different locations of Khartoum State production sites, Sudan.

MATERIALS AND METHODS

Sampling

Samples were collected from ten different locations of Khartoum State during period from June to September 2009. Three from Khartoum (E= Gandol centre Khartoum, F= Faiha tower Khartoum and G= Saeed Centre Khartoum), five from Khartoum North (C= Mauna street Dr. Galal Farm, D= Afia centre Saad Gishera, H =Camel Research Centre University of Khartoum, K= Ibrahim Talab Farm and M= Abualarabi Centre Mirghana Street) and two from Omdurman (A=Gandahar Bakheit azain farm B= Camel Market sheikh Omer Farm). These samples were collected directly from plot containers in the farms or retailers and kept with ice back transferred to the laboratory for the analysis. Protein, total solids, fat, lactose, ash, pH and titratable acidity were determined.

Chemical Analysis

Protein, ash, fat, lactose, total solids content and titratable acidity (TA) of *gariss* was determined according to AOAC (1990). The pH was determined using a glass electrode pH meter.

Statistical Analysis
Statistical Packages for Social Sciences (SPSS 16.00) was used to analyze data using ANOVA and Duncan Multiple Range Test (DMRT) for mean separation.

RESULTS AND DISCUSSION
The chemical composition of fermented camel milk *gariss* collected from different locations of three production sites in Khartoum State (i.e. Khartoum, Khartoum North and Omdurman) are shown in Tables 1 and 2.
Total mean of protein was found to be 2.96% in the three production sites of Khartoum State; the samples collected from Omdurman production site were found to have higher value of protein it's significantly different $P< 0.05$ from Khartoum and Khartoum North (i.e.3.67; 3.21 and 2.52% of Omdurman, Khartoum and Khartoum North, respectively). The differences of the protein may be according to the different food sources in these production sites (this lead to different chemical composition of fresh milk accompanied by *gariss* different composition), fermentation procedure, time of fermentation and fermentation conditions.
The protein contents of locations A, B and F are significantly highest protein content, while that of locations D and H were significantly lowest protein content amongst all locations studied. The result of the present studied revealed that protein content was higher than that2.32 and 2.58% observed by Hassan *et al* (2008) for transhumant and Nomadic *gariss*, respectively and in the range of 2.15 to 4.90% reported by Konuspayeva *et al* (2009). But lower than 3.21 - 3.49% and3.4–3.85% reported by Abdelrahman (2007) and Mirghani (1994) for *gariss* prepared by starter cultures during 6 hours period of fermentation in the laboratory conditions and *gariss* collected from Butana and the Hawawir of Northern Kordofan, Sudan, respectively.

Fat
The analysis of variance for fat contents showed that there were significant differences ($P\leq0.05$) among the investigated production sites. The fat content was found to be 2.81% table (2), samples collected from Omdurman production site showed higher content of fat i.e.3.68% significantly higher than that collected from Khartoum and Khartoum North which were 2.72 and 2.51%, respectively. There were significant differences among the samples in all locations table (2), locations B has 4.2% and D has 1.33% of fat highest and lower fat percentage amongst those locations of *gariss* studied.
The fat content was lower than 3.55- 3.65%, 4.85and 3.46%, 3.4- 3.85% and3.55- 3.65% reported that reported by Hassan *et al* (2008), Mirghani (1994) and Abdelrahman (2007). The differences may attributed to the control condition of *gariss* or due to the high fat contents of the milk which used in the production of *gariss*, which affect the end product (Dirar, 1993)

Total solids
The statistical analysis for total solids showed significant differences ($P\leq0.05$) among the production sites investigated. The mean of total solids of the present study was 9.94% Table (3), samples collected from Omdurman production site were significantly higher ($P\leq0.05$) than that collected from Khartoum and Khartoum North Table (1). Location B has the highest total solids in all locations observed Table (2), while that of location H was the lowest (7.27%) total solids.
The total solids were higher than 7.35 - 8.3% and 9.81% for *gariss* collected from Butana and the Hawawir of Northern Kordofan and Nomadic *gariss* collected from Butana Area , Sudan studied by Mirghani (1994) and Hassan *et al* (2008) respectively, while lower than 11.64- 12.78 % and 11.29% for *gariss* prepared in the laboratory conditions during 6 hours

period of fermentation using different starter cultures and *gariss* procured from transhumant camel herders East Nile province Khartoum State studied by Abdelrahman (2007) and Hassan *et al* (2008), respectively. These variations enhanced by Al haj and Al Kanhal (2010) who they concluded that variations observed in camel milk composition were attributed to several factors, such as different analytical procedures, geographical locations, seasonal variations, feeding conditions and breed of camel.

Ash

Total ash was 0.61% table (3), no significant different ($P \leq 0.05$) observed between samples collected from Omdurman, Khartoum and Khartoum North production sites, respectively. Table (2) showed that location D has higher ash content amongst all locations studied (0.84%) only this location in agreement with Mirghani (1994) and Abdelrahman (2007) whose observed that ash were 0.75- 80% and 0.82- 0.89% for *gariss* prepared in the laboratory conditions during 6 hours of fermentation using starter cultures and *gariss* collected from Butana and the Hawawir of Northern Kordofan, Sudan, respectively, while that (0.35%) of location H was the lowest ash content in all locations studied. The total ash contents were lower than (1.3 and 0.87%) obtained by Hassan *et al* (2008) for *gariss* procured from transhumant herders in Khartoum State and Butana area, respectively. Omer and Eltinay (2009) revealed that ash content of camel milk stored in room temperature during period of three days is 1.11%. Konuspayeva *et al* (2009) concluded that ash content of camel milk range from 0.6 to 0.9%. Omer and Alkanhal (2010) observed that ash percent of camel milk was 0.79%.

Titratable acidity

The total mean of titratable acidity was 0.89%, samples collected from Khartoum production site locations were significantly ($P \leq 0.05$) higher than that collected from Khartoum North and Omdurman i.e. titratable acidity of those locations were 1.21, 0.82 and 0.58%, respectively, no significant differences were observed between Khartoum North and Omdurman locations.

Locations D, F and J table (2) were significantly ($P \leq 0.05$) higher than all other locations there values were 1.91, 1.92 and 1.03% while location H has the lowest(0.14%). The acidity in line with Omer and Eltinay (2009) who they gave 0.5% and 0.64% of acidity of camel milk stored for three days at ambient temperature and 42days at refrigeration temperature, respectively, while was lower than that observed by Mirghani (1994) and Suleiman (2006).

Hassan *et al* (2008) gave higher values of titratable acidity (2.29 and 2.24%) for fermented camel milk *gariss* collected from transhumant herders in Khartoum State and Butana area, respectively.

pH

Total pH mean was 4.39% table (3), samples collected from Omdurman production site(5.83)was significantly higher($P \leq 0.05$) than that of (4.47)of Khartoum North and Khartoum(3.33), location B has significantly higher($P \leq 0.05$) pH (6.03), while location F was the lowest (3.07) table (2).

The present results were in line with 3.41 and 3.82 for *gariss* collected from transhumance and nomadic herders of Khartoum State and Butana area, respectively studied by Hassan *et al* (2008), and in agreement of 3.25–3.40 and 4.42 *gariss* pH procured by Mirghani (1994)and Suleiman (2006) from Butana and the Hawawir of Northern Kordofan, Sudan, respectively.

Table (1): Chemical Composition of fermented camel milk collected from the three locations of Khartoum State

production sites	Protein	Fat	TS	Ash	Lactose	Acidity	pH
Omdurman	(3.67)^{a}±0.05	(3.68)^{a}±0.57	(12.03)^{a}±0.77	(0.59)^{a}±0.03	(2.42)^{a}±0.15	(0.58)^{b}±0.03	(5.83)^{a}±0.23
Khartoum North	(2.52)^{c}±0.41	(2.51)^{b}±0.64	(9.25)^{b}±1.41	(0.60)^{a}±0.17	(2.03)^{a}±0.69	(0.82)^{b}±0.63	(4.47)^{b}±0.94
Khartoum	(3.21)^{b}±0.43	(2.72)^{b}±0.19	(9.69)^{b}±1.40	(0.65)^{a}±0.06	(2.500)^{a}±1.26	(1.207)^{a}±0.54	(3.33)^{c}±0.21

- Each value is an average of three experimental samples.
- Values are (means) ± standard deviation (SD).
- Means not sharing a common superscript letter in a column are significantly different at $P \leq 0.05$ as assessed by Duncan's Multiple-Range Test.

Table (2): Chemical Composition of fermented camel milk *gariss* collected different from different points in Khartoum State

Location	Protein%	Fat%	TS%	Ash%	Acidity%	PH	Lactose%
A	(3.67)^{a}± 0.058	(3.17)^{b} ±0.153	(11.33)^{b} ±0.058	(0.61)^{bc}±0.015	(0.55)^{d} ±0.006	(5.63)^{b}±0.058	(2.37)^{d}±0.208
B	(3.67)^{a} ±0.058	(4.20)^{a} ±0.000	(12.73)^{a}±0.115	(0.57)^{bc}±0.115	(0.60)^{c} ±0.006	(6.03)^{a} ±0.058	(2.47)^{cd} ±0.058
C	(2.77)^{d} ±0.058	(2.97)^{c} ±0.058	(10.97)^{c}±0.208	(0.64)^{bc}±0.085	(0.48)^{e} ±0.006	(5.30)^{c}±0.00	(2.63)^{c}±0.058
D	(2.07)^{e} ±0.058	(1.33)^{f} ±0.058	(8.13)^{f} ±0.153	(0.84)^{a} ±0.006	(1.91)^{a} ±0.010	(3.47)^{e} ±0.058	(0.87)^{f} ±0.058
E	(3.33)^{b} ±0.12	(2.53)^{e} ±0.058	(11.23)^{b}±0.058	(0.63)^{bc}±0.087	(0.75)^{b} ±0.006	(3.47)^{e} ±0.058	(3.20)^{b} ±0.10
F	(3.60)^{a} ±0.2	(2.87)^{cd} ±0.153	(8.01)^{f} ±0.017	(0.65)^{bc}±0.081	(1.92)^{a} ±0.028	(3.07)^{f} ±0.115	(0.83)^{f}± 0.058
G	(2.70)^{d} ±0.17	(2.77)^{d} ±0.153	(9.83)^{e} ±0.058	(0.66)^{b} ±0.032	(0.95)^{b} ±0.010	(3.47)^{e} ±0.058	(3.47)^{a} ±0.115
H	(2.03)^{e} ±0.058	(2.47)^{e}± 0.058	(7.27)^{g} ±0.058	(0.35)^{d} ±0.068	(0.14)^{f} ±0.006	(5.57)^{b} ±0.153	(2.57)^{cd} ±0.208
J	(2.77)^{d} ±0.058	(3.00)^{c}± 0.00	(9.67)^{e}±0.153	(0.56)^{c} ±0.006	(1.03)^{a} ±0.015	(3.37)^{e} ±0.058	(1.77)^{e} ±0.153
K	(2.97)^{c} ±0.058	(2.77)^{d} ±0.058	(10.23)^{d}±0.115	(0.58)^{bc}±0.031	(0.55)^{d} ±0.006	(4.53)^{d} ±0.058	(2.33)^{d} ±0.153

- Each value is an average of three experimental samples. - Values are (means) ± SD.
- Means not sharing a common superscript letter in a column are significantly different at $P < 0.05$ as assessed by Duncan's Multiple-Range Test.

Table (3): The chemical composition of *gariss* according to the source of collection

Samples Sources	Protein	Fat	TS	Ash	Lactose	Acidity	pH
Farms	(3.04)^{a}±0.79	(3.21)^{a}±0.72	(10.25)^{a}±2.35	(0.52)^{b}±0.12	(2.30)^{a}±0.36	(0.58)^{b}±0.36	(5.15)^{a}±1.2
Retailers	(2.91)^{a}±0.53	(2.54^{b}±0.61	(9.73)^{b}±1.38	(0.67)^{a}±0.09	(2.22)^{a}±1.14	(1.1)^{a}±0.66	(3.89)^{b}±0.85
Total	2.96±0.59	(2.81)±0.67	(9.94)±1.67	(0.61)±0.12	(2.25)±0.85	(0.89)±0.57	(4.39)±1.11

Lactose

The mean value of lactose content was 2.55% table (2), no significant different observed between Khartoum (2.5%), Khartoum North (2.03%) and Omdurman (2.42%) production sites location G has highest lactose content (3.47) and significantly ($P \leq 0.05$) higher than all other locations, while that of location D (0.87%) table (2) and location F (0.83%) were significantly ($P \leq 0.05$) lower than all other locations. The lactose was higher than that observed by Mirghani (1994), while lower than 3.69 – 4.04% reported by Abdelrahman (2007). Omer and Eltinay (2009) observed lactose contents of camel milk during storage of 3and 42 days at ambient and refrigerator temperature they found that lactose was 3.28% and 2.68%, respectively. Alhaj and Alkanhal (2010) gave higher value (4.4%) of camel milk. The fermented camel milk *Gariss* was found to have high nutritive values, which is important for the deserts people, since they depend only on it. However, the chemical composition and the microbial contents were affected by management systems and the preparation conditions (Hassan *et al*., 2008) the same trends was reported by Dowelmadina et al (2014) who revealed that variation in chemical composition of camel milk were mainly attributed to factors such as management systems, breed, parity number and stage of lactation. The study of the chemical composition of camel milk fermented under controlled conditions with different strains of lactic acids bacteria isolated from traditional *gariss* is required as recommended points of view that will be our future work.

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