Turkish Journal of Agriculture - Food Science and Technology, 4(12): 1112-1117, 2016

Turkish Journal of Agriculture - Food Science and Technology

www.agrifoodscience.com,
Turkish Science and Technology

Role of Production Area, Seasonality and Age of Fermented Camel (*Camelus Dromedarius*) Milk *Gariss* on Mineral Contents

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A R T I C L E I N F O

Article history:
Received 12 June 2016
Accepted 22 August 2016
Available online, ISSN: 2148-127X

Keywords:

Mineral content
Production site
Age of *gariss*
Seasonality
Management system

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A B S T R A C T

The objective of this work was to study the differences between some minerals content of *gariss* samples collected from two different production areas in two different production systems (i.e. traditional system Kordofan area and semi-intensive system- which, the camels are kept in an open barn and graze around the farm. The lactating female camels are supplemented with concentrates in addition to good quality ration containing groundnut cake and *Sorghum biocolor* and water supply upon required in Kordofan and Khartoum provinces in Sudan at the different seasons (summer, autumn and winter) and their *gariss* samples were collected. Sodium, potassium, calcium, magnesium and phosphorus of *gariss* samples collected in autumn season (Kordofan area), summer season (Khartoum area), and winter season (Khartoum and Kordofan areas) were determined, after that the age of *gariss* was noted from farmers directly when the samples were collected. Four different ages of *gariss* which registered were (5-8 hrs, 12 hrs, 48 hrs and more than 48 hrs). Each fermentation time (age of *gariss*) was used for analyzing mineral contents. The results showed that *gariss* prepared from different production locations and in different seasons in Kordofan and Khartoum production areas were statistically different in most of the mineral contents determined. To conclude, different feeding sources or different physiological status may affect camels' milk and consequently their *gariss* product, also different age of *gariss* had affects the mineral content of milk.

Introduction

The literature citations available on chemical composition of fermented camel milk in Sudan and other places in the world, only the effect of fermentation on the ash content were available, the data concerning the effect of fermentation on the mineral concentration of camel milk were rare. According to that reason the mineral content of *gariss* (camel milk fermented in a large skin bags, or *siin* (thin) contains a large quantity of previously soured milk product called starter. In case of the absence of a starter from a previous lot, particularly when using a new *siin*, fermentation can be initiated by adding to the container a few black cumin seeds and one onion bulb. When the first batch of the *gariss* has been successfully obtained, following the addition of fresh camel milk to the bag, Gariss can be continuously produced for many months. Fresh camel milk can be added to the *siin* whenever part of the fermented product has been withdrawn, so this process let the volume of the fermenting milk product is more or less kept constant (Dirar, 1993 and Ahmed et al., 2010). In Kazakhstan, which have high polluting conditions in some parts of the environment, the camel milk and *shubat* - which are a special fermented product, prepared from unheated camel milk through indigenous fermentation process? Although it is more or less similar to yoghurt in appearance, there are important differences between the two products which *shubat* is liquid rather than creamy, sparkling due to its CO_2 production and has a high degree of sourness (pH 3.8, Meldebekova et al., 2008) could contain pollutants as pesticides, heavy metals, and radionuclides (Konuspayeva et al., 2011a, b). The minerals composition of milks varies in different countries and is affected mainly by some factors such as the feed growing conditions such as soil, type of fertilizer and irrigation water in addition to the type of processing used which affects the pH and use of metal containers (Muller, 1996).

Minerals salts in milk were mainly sodium, calcium and magnesium chloride, phosphates and their citrates. The camel milk minerals content expressed in ash percentage, which ranges from 0.6% to 0.8%, they influence its rates of coagulation and other functional properties, the available data in literature indicated that camel milk is rich in chloride and phosphorus, and low in calcium content (Farah and Fischer, 2004). So, the present work aimed to highlight the differences between minerals in *gariss* samples collected from two different production areas in two different management systems (i.e. traditional system Kordofan area and semi-intensive system Khartoum area, a semi intensive system in which all animals were herded during night in closed pen and set free during the midday gazing in natural pasture and allowing supplementation consist of concentrates and roughages feeds, *adlibtium* access to water, health care and parasites control were practiced, but in the traditional system the animal were gazing in natural pasture without allowing supplementation, access to water, the health care and the parasites control were weakly practices (Bakheit et al., 2016). The effect of the season in which *gariss* samples collected, was also investigated in addition to the *gariss* age.

Material and Methods

Gariss samples from the two production areas under two different management systems i.e. traditional system (Kordofan area) and semi-intensive system (Khartoum area) were procured in three different seasons i.e. summer, autumn and winter. *Gariss* minerals content means which collected in summer, autumn and winter seasons were determined, after that the *gariss* age (i.e. the camel milk fermentation period) was documented directly when the samples collected. Four different *gariss* ages were registered (5-8 h, 12 h, 24 h and more than 48 h) and their influence on the minerals content of *gariss* was found.

The potassium and sodium of each extracted sample were determined according to AOAC (1984) methods using flame photometer apparatus (PFP7 Jenway).

Calcium, magnesium and phosphorus were determined by titration methods of Champman and Pratt (1961).

In order to compare the minerals patterns between season, production areas and *gariss* age, SPSS 16.00 (Statistical Packages for Social Sciences) was used to analyze minerals data using ANOVA test and Duncan Multiple Range test (DMRT) for mean separation. In order to assess the interactions between all the parameters in present investigation, multivariate analyses were applied (Principal Components Analysis-PCA). Each variation factor (season, location, age of *gariss*) was projected on the main factorial plan as supplementary variables in the space of active variables (values of the different minerals). The software XLstat (Addinsoft) was used.

Results and Discussion

Effect of Seasonality on Minerals Profile of Gariss

The factorial plan (1,2) issued from PCA by using the season as supplementary variables (Figure 1) showed that there was opposition between winter/summer (rich in Mg, poor in other minerals) and Autumn (right side) rich in P, K, Ca and Na. The values of each parameter are described below:

The total mean of sodium was found to be 400.53mg/l. Samples collected in autumn season statistically ($P \leq 0.05$) has the highest level (522 mg/l)compared to samples collected in summer season (306.1mg/l) or in winter season (233.99 mg/l)(Table 1).

The total mean of potassium was found to be 1152.5 mg/l. Samples collected in autumn season significantly ($P \leq 0.05$) has the highest level (2054.8 mg/l), while the samples investigated in summer season (192.5 mg/l) and in winter season (346.32 mg/l) were quite lower.

Mean total of calcium was found to be 677.30 mg/l. G*ariss* studied in autumn season significantly ($P \leq 0.05$) has the highest level (1244.7 mg/l), while that studied in summer season (81), and that studied in winter season (158.11 mg/l) were statistically lower. These findings were not in agreement with the statement of FAO (2008) for which the proportion of soluble calcium increased up to 61% when milk was investigated in the hot season from animals managed along traditional extensive systems.

The total mean of magnesium was found to be 203.27 mg/l. Reverse to the former minerals, samples collected in winter were statistically ($P \leq 0.05$) the highest level (386.79 mg/l). *Gariss* samples investigated in the autumn season was the lowest magnesium concentration (95.75 mg/l). With a value of, the summer season *gariss* samples had value of 265.2 mg/l, which also statistically lower than that of winter season *gariss.*

All the minerals investigated in present work are positively correlated between them except negative correlations between magnesium and other minerals Na, K, Ca and P (Figure 2).

The total mean of phosphorus observed was 563.02 mg/l. The highest values ($P \leq 0.05$) were observed in autumn samples (802.19 mg/l), while *gariss* collected in summer presented the lowest content (238.79 mg/l) compared to autumn *gariss* (802.19 mg/l) or that (465.61 mg/l) of winter *gariss*. The proportion of soluble phosphorus increased up 75 percent when milk was collected in the hot season from animals managed along traditional extensive lines (FAO, 2008).

Effect of gariss location on mineral profile

By considering the entire data and the location as supplementary variables, a clear opposition appeared on the first factor between Kordofan, projected on factorial plan right side (1,2) and Khartoum projected at the left side (Figure 2)

Samples collected in Kordofan production site had statistically ($P \leq 0.05$) higher sodium content (389.12 mg/l) compared with that of samples prepared in Khartoum production site (213.74mg/l)(Table2).

Samples collected in Kordofan production site had statistically ($P \leq 0.05$) higher potassium content (1204.37 mg/l) compared with that of samples prepared in Khartoum production site (265.6mg/l).

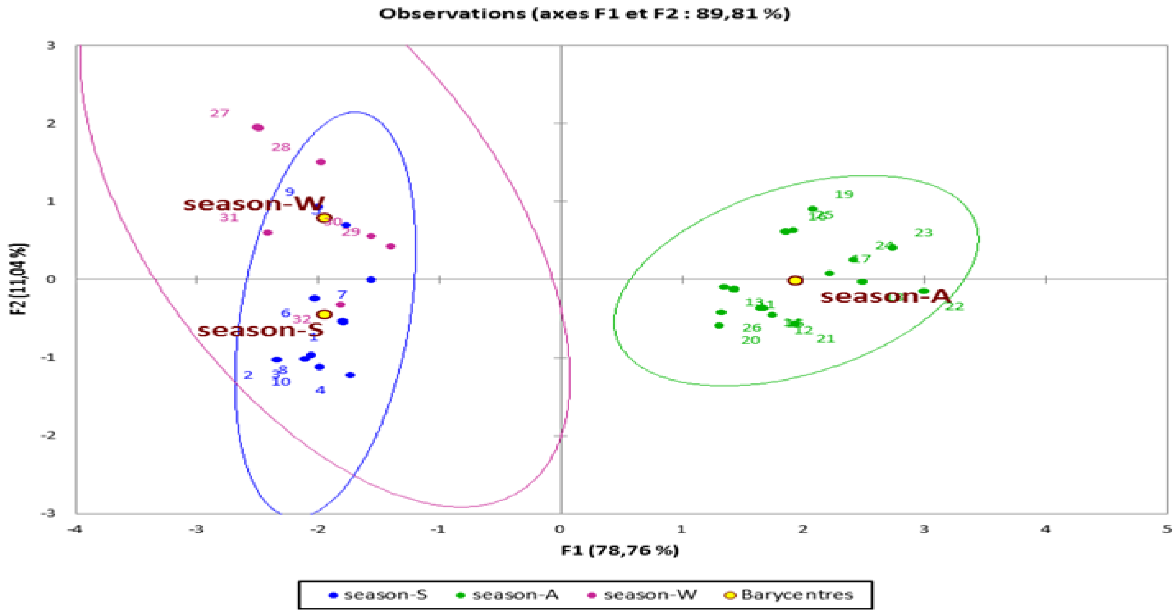

Figure 1 Projection of the seasons (S: summer; W: winter; A: Autumn) on the main factorial plan (1,2) of the PCA structured by the space of minerals concentrations in gariss

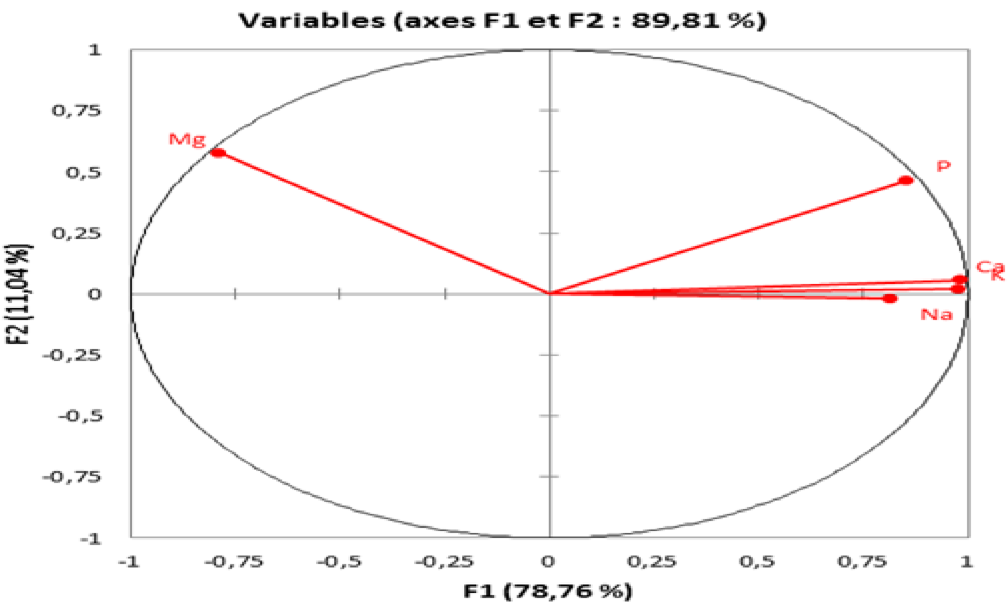

Figure 2 Correlation circle on the two first factors of the PCA.

Table 1 Effect of seasonality on mineral profile (mg/l) of *gariss* (mean±sd)

Season	Na	K	Ca	Mg	P
Autumn	522.0^{a}±114.83	2054.8^{a}±377.06	1244.7^{a}±143.85	95.75^{c}±20.05	802.19^{a}± 153.30
Summer	306.1^{b}±116.90	192.5^{c}±183.68	81.00^{c}±31.44	265.2^{b}±97.32	238.79^{c}±96.78
Winter	233.99^{c} ±153.05	346.32^{b}±116.55	158.11^{b}±36.44	386.79±91.83	465.61^{b}±84.01
Mean	400.53±172.34	1152.5±961.74	677.30±586.32	203.27±135.96	563.02±286.56

The means not sharing a common superscript letter in a column are significantly different at (P≤ 0.05) which assessed by Duncan's Multiple-Range Test.

Table 2 Effect of the location on *gariss* mineral content (mg/l)

Location	Na	K	Ca	Mg	P
Kordofan	389.12^{a}±148.00	1204.37^{a} ±214.74	682.9^{a} ±85.37	269.54^{b} ±57.89	676.13^{a} ±141.66
Khartoum	213.74^{b} ±121.92	265.6^{b} ±182.19	137.99^{b} ±38.73	297.73^{a} ±92.64	309.97^{b} ±67.17
Mean	400.53±172.34	1152.5±961.74	677.30±586.32	203.27±135.96	563.02±286.56

The means not sharing a common superscript letter in a column are significantly different at (P≤ 0.05) which assessed by Duncan's Multiple-Range Test.

Table 3 Effect of gariss age on mineral content of fermented milk

Age of gariss	Na mg /l	K mg/l	Ca mg/l	Mg mg/l	P mg/l
5-8 hours	518.125^{a}±1.25	2081.88^{a}±250.327	1257.1^{a}±154.2	1257.18^{a}±423	5816.88^{a}±81.02
12 hrs	202.99^{b}±59.18	153.29^{c}±289.05	113.62^{c}±38.17	113.625^{c}±43.5	318.584^{b}±132.3
48 hrs	423.81^{ab}±83.69	1209.2^{b}±408.78	696.02^{b}±602.08	696.022^{b}±98.6	577.131^{ab}±59.17
≥48hrs	285.66^{b}±.37.43	269.42^{c}±182.81	139.15^{c}±72.66	137.493^{c}±58.8	310.958^{b}±93.55

The means not sharing a common superscript letter in a column are significantly different at (P≤ 0.05) which assessed by Duncan's Multiple-Range Test.

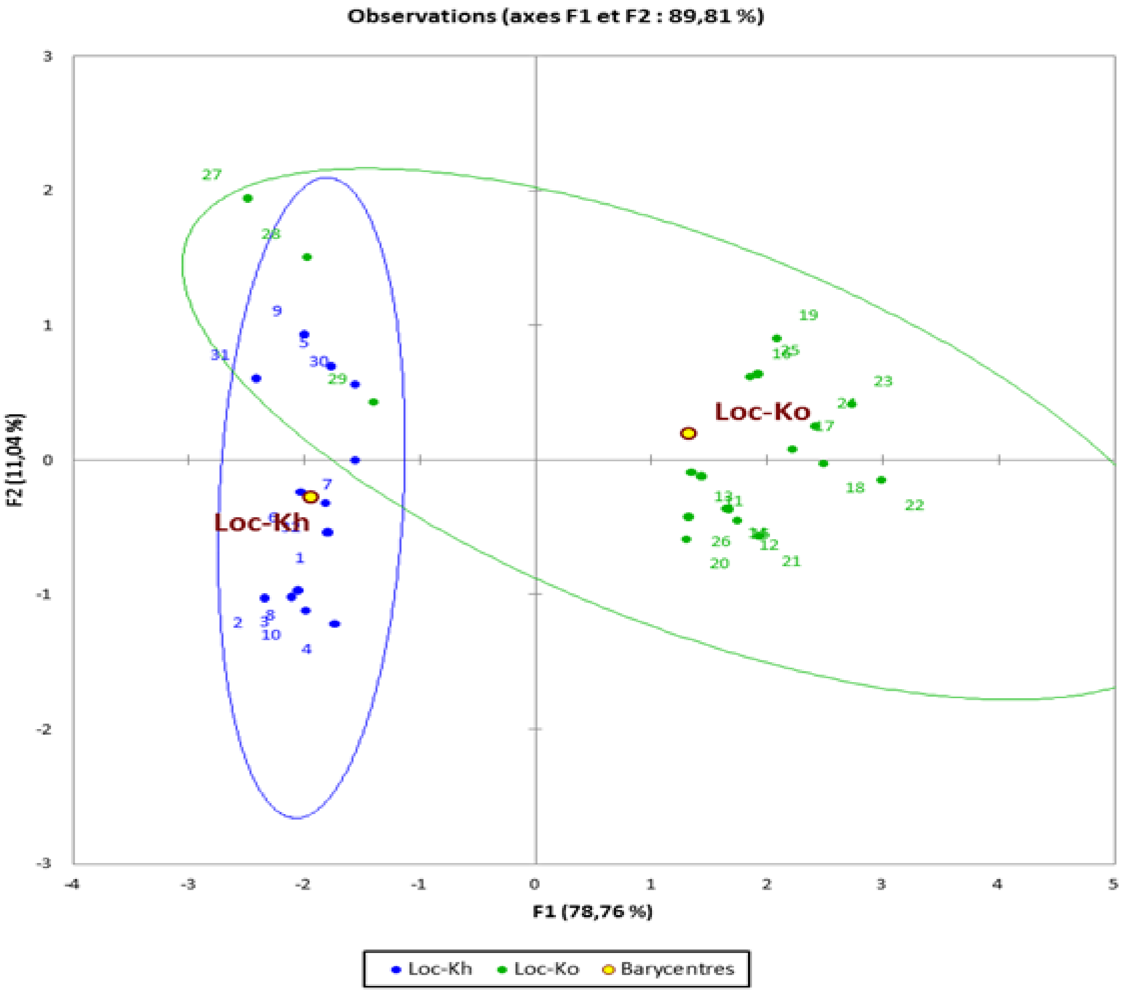

Figure 3 Projection of the locations (Ko: Kordofan; W; Kh: Khartoum) on the main factorial plan (1,2) of the PCA structured by the space of minerals concentrations in gariss.

Samples collected in Kordofan production site had statistically (P≤0.05) higher calcium content (682.9mg/l) compared with that of samples prepared in Khartoum production site (137.99mg/l).

Samples collected in Kordofan production site had statistically (P≤0.05) lower magnesium content (269.54 mg/l) compared with that of samples prepared in Khartoum production site (297.73mg/l).

Samples collected in Kordofan production site had statistically (P≤0.05) higher phosphorus content (676.13 mg/l) compared with that of samples prepared in Khartoum production site (309.97mg/l). In the study to know the effect of season and management system on the composition of raw camel milk in Khartoum state, Sudan. Shueip et al. (2008) showed that the high water content in summer season *gariss* samples negatively affected camel milk composition when compared to winter season *gariss* samples. The season effect was higher than that reported for management system on camel milk components.

Effect of Age Of Gariss on Mineral Profile

The age of *gariss* was documented as shown in Table 3. Mineral profile for all samples shared in one age of *gariss* was calculated (Table 3). By considering the projection of the fourth age classes of *gariss* in the space of quantitative values of minerals, a clear opposition appeared between old and very young *gariss* in one hand and very old and young in another hand (Figure 4).

Camel milk samples fermented for 5-8 hours had the highest sodium content (518.125 mg/l) among other period of fermentation; while 12 hrs period of fermentation had the lowest (202.99 mg/l). The sodium contents were not influenced if the camel milk was fermented for one night or more than two days (i.e. 202.99 or 285.66 mg/l). The sodium value of camel milk fermented for two days was statistically (P≤0.05) the same as those of with 5-8 hours, one night or more than two days. Bahobail et al. (2014) reported that fermentation process slightly changed sodium content of camel milk from 69 to 68.3 mg/100gm.

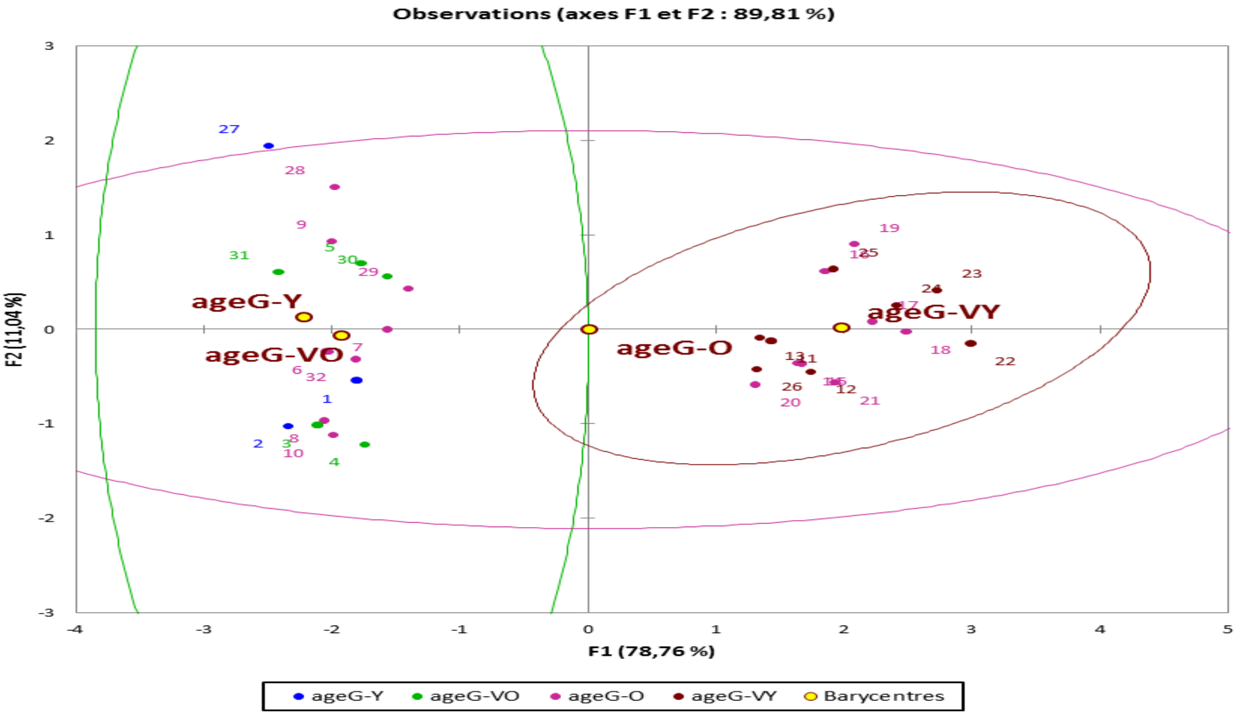

Figure 4 Projection of the age classes (VY: very young, <8h; Y: young, 8-12h; O: old, 12-24h; VO: very old, >24h) on the main factorial plan (1,2) of the PCA structured by the space of minerals concentrations in *gariss*.

The potassium content of camel milk samples fermented for 5-8 hours had the highest potassium content (2081.88 mg/l), while fermented for one night had the lowest (153.29 mg/l). The potassium contents were not affected if the camel milk was fermented for one night or more than two days (i.e. 153.29 or 269.42 mg/l). The potassium composition in camel milk changed from 164 in fresh milk to 167 mg/100gm as influenced by fermentation process (Bahobail et al., 2014).

Camel milk samples fermented for 5-8 hours had the highest calcium content (1257.1 mg/l), while 12 hrs *gariss* has the lowest one (113.62 mg/l). The calcium contents were statistically (P≤0.05) not affected if the camel milk was fermented for 12 hrs or more than two days (i.e. 113.62 or 139.15 mg/l). Bahobail et al. (2014) reported that calcium contents in the fresh milk ranged between 106-109 mg/100g, and calcium increase to 130 mg/100 g as affected by fermentation operation. Calcium composition in camel and cow milk was lower in concentration if compared with that of goat or sheep, while its sodium and potassium were higher (Alwabel, 2008; Anonymous, 1996).

Camel milk samples fermented for 5-8 hours had the highest magnesium content (2257.18 mg/l) among all other periods of fermentation. One night *gariss* had the lowest magnesium content (113.63 mg/l). The magnesium contents were not different if the camel milk was fermented for one night or more than two days (i.e. 113.63 or 137.49 mg/l). Bahobail et al (2014) found that the magnesium content was increased from 9.7 mg/100 g to 11 mg/100 g in fresh and fermented milk, respectively.

Camel milk samples fermented for 5-8 hours had the highest phosphorus content (816.88mg/l) among all other periods of fermentation, while that fermented for more than two days had the lowest (310.96 mg/l). The sodium contents were not influenced if the camel milk was fermented for one night or more than two days (i.e. 318.58 or 310.96 mg/l).

The variations in mineral content in camel milk might be due to some factors i.e. breed of camel, feeding sources, analytical procedures or water availability (Mehaia et al., 1995; Haddadin et al., 2008). It is obviously can be declared that the fermentation process of camel milk quietly increasing of most elements investigated in present work. These findings might be due to the microbial action on the milk components and milk coagulation that might results in greatest variations in concentration due to an equal distribution of the minerals between the milk curd and whey produced, that which depending on the different binding forms present of those components in milk (Bahobail et al., 2014), also these variations attributed to the facts that the chemical compositions and microbial contents were affected by management system and preparation conditions which stated by Hassan et al.(2008).

Conclusion

The minerals of *gariss* samples procured from different sources in Kordofan and Khartoum production areas were not the same, the difference may attributed to different feed sources in the two different management systems (traditional and semi intensive system) and *gariss* preparation practices or the physiological status of camels as well as breeds or other factors such as milking frequency, lactation stage and parity numbers that which affect camel milk composition and consequently the *gariss* produced from that milk. The shorter the period of fermentation was linked to the higher the mineral composition, which refers to traditional preparation of fermented camel milk that was practiced in Kordofan production area.

Acknowledgment

The authors duly acknowledge the financial support received from French Embassy in Khartoum, the helps given by the Staff and colleagues from Faculty of Natural Resource and Environmental Studies were also appreciated.

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