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A Survey of the Processing and Chemical Composition of Gariss Produced by Nomadic Camel Women Herders in AlGaderif State, Sudan

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Abstract

Gariss is the most popular stable food for the camel herders who depend on Gariss for the sustainability of their livestock. The objective of the current study is to assess the traditional fermented camel milk (Gariss) prepared by nomadic camel woman herders in AlGadarif State in Butana. It is also meant to improve the quality of camel milk products through sharing knowledge. The samples (n= 19) were collected during rainy and dry seasons. The nomad's housekeepers were interviewed in the study area. The effect of different types of containers and the additives used during Gariss preparation and the compositional quality were all estimated. The survey reported the different types of spoilage and the variations in the shelf life of Gariss. When compared with the mean values of the Gariss samples collected during dry season, the result indicated that the values of the total solids and the pH of the samples collected during the rainy season were significantly higher ($p<0.05$), whereas the values of the fat, protein and ash were significantly lower ($p<0.05$). The container types had a significant ($p<0.05$) effect on the total solids, fat and ash content only. The Gariss prepared in Bukhsa showed the highest total solids content (13.15±0.54%) and that prepared in stainless steel showed the highest fat (4.65± 0.34%) content. However, when Gariss was prepared in plastic containers it showed the lowest pH value (3.59±0.16%), whereas samples from ''Siin'' (goat leather) was significantly lower ($p<0.05$) in the ash content (0.35± 0.09%). The present study concludes that the chemical composition of Gariss from the nomadic camel women herders is affected by seasons, types of additives and containers used. Hence more studies are needed to be done on the effect of the additive and containers on Gariss quality.

Keywords: Fermented Camel Milk, Gariss, Processing, Additives, Containers, Seasonal Movement, Nomadic Women, Sudan.

1. Introduction

Various fermented milk products, that are made of camel milk, include Gariss (Abdelgadir *et al.*, 1998; Hassan *et al.*, 2007 and Hassan *et al.*, 2008), yoghurt (Elayan *et al.*, 2008; Hashim *et al.*, 2008; El Zubeir *et al.*, 2012), fermented milk (Ashmaig *et al.*, 2009; El Zubeir and Ibrahium, 2009; Ahmed *et al.*, 2010) and cheese (El Zubeir and Jabreel, 2008). The fermented camel milk in Sudan (Gariss) is a semi-continuous fermentation process without the addition of any types of starter cultures; it is carried out in or outside the field prepared by shepherds when driving the camel for pastures in faraway places (Shori, 2012). Those herders depend on Gariss for several months as the sole source of various nutrients (Abdelgadir *et al.*, 1998).

Traditionally, fermented camel milk is allowed to ferment naturally without prior heat treatment and without addition of starter cultures (Abdelgadir *et al.*, 1998; Hassan *et al.*, 2008; Shori, 2012). Its final products have various names in different parts of the world. For example, in Sudan and Somalia, it is known as 'Gariss' (sour); however, in Sudan, it is also known as *hameedh* or *humadah*, which also means sour. It has substantial amounts of ethanol because of the acid alcoholic that is produced during milk fermentation (Dirar, 1993).

The method of Gariss preparation was described by various researchers (Dirar, 1993; Abdelgadir *et al.*, 1998; Elayan *et al.*, 2008; Hassan *et al.*, 2008; Ashmaig *et al.*, 2009; Ahmed *et al.*, 2010; El Zubeir and Ibrahium, 2009). Gariss is fermented in a large skin bag (locally named "Siin" which contains a large quantity of previously sour product, while in the absence of starter from previous lot, fermentation is initiated by adding, to the container, a few seeds of black cumin (*Nigellica sativa*) and one onion bulb (Dirar, 1993; Hassan *et al.*, 2008; and Ahmed *et al.*, 2010). Fermentation of Gariss takes place while the camels are on move and due to the inherent jerk in the camel's walk; the milk in the bags is gently shaken during fermentation (Mirghani, 1994).

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The chemical composition of Gariss was found to range of 2.8–5% fat and 10–11% total solids (Hassan *et al*., 2008; El Zubeir and Ibrahium, 2009), which were within the range of fresh camel milk: 1.8–5% of fat and 7.8–12% of total solids as stated by Shuiep *et al.* (2008). The range of pH for Gariss was 3.6–5.9 (Abdelgadir *et al.*, 2008; Hassan *et al.*, 2008; Ahmed *et al*., 2010) and the acidity as lactic acid ranged from 2.2–2.3% (Hassan *et al*., 2008).

The practice of camel herding is very well documented in Sudan, since some of the tribes of Sudan rely completely on herding and the pastoral is their life style (El Zubeir and Nour, 2006). Camels in Sudan are concentrated in two main regions; the Eastern (the Butana plains and the Red Sea hills) and the Western regions (Darfour and Kordofan). This study is conducted in order to get information about the processing techniques of Sudanese fermented camel milk prepared by nomadic women camel herders in Butana area. It was also aimed to improve the quality of camel milk products through sharing knowledge with nomadic women on the process of traditional fermentations process and how it can be controlled. Thus the present study was designed to evaluate the processing conditions of Gariss and to assess the effect on its compositional content.

2. Material and Methods

2.1. Area of Study and Target Groups

AlGedarif State, which is located in the eastern part of Sudan, is the area selected to perform this study. The camel herders chosen for this study belong to Elhlaween tribes who stay (settlement) in Butana plains during the rainy season (May to October), into the northern part of AlGedarif State and towards the southern part of the state from November to April to take the maximum advantage of the natural grazing and water resources (movement during the dry season). Nomadic livestock owners who used to find ample dry season resources (water and grazing) in the Atbra valley now traverse the area and take their animals across the border with Ethiopia, and, in most cases in the dry season, they buy the crop residues remaining from the irrigated schemes after the harvest.

2.2. Collection of Data

The nomad's housekeepers (n= 19) from the selected camel herding society were interviewed using the structural prepared questionnaire in order to assess the manufacture of local fermented camel milk (Gariss). The main parts of the questionnaire include camel milk products, traditional preserving methods, the containers used for processing, the methods of processing whether it is continuous or fed batch, the additives used and the methods of addition. Moreover, some questions about the shelf life and the defects and spoilage faced by the women herders were also included.

2.3. Collection of Samples

About 19 samples of Gariss (approximately 100 ml) were collected into a 250 ml sterile screw-capped bottle. The samples were collected during 24-36 hours every visits (n=3) and kept at 4° C until being brought to Khartoum in an ice bag. The pH of each sample was measured at the field and the chemical analysis was performed at the laboratory.

2.4. Chemical Analysis of the Samples

The pH was determined using pH meter (pH HANNA Instruments pH 211 Microprocessor pH Meter) according to Bradley *et al.* (1992). Titratable acidity was determined according to AOAC (1990a). The total solids content of the samples was determined according to the modified method of AOAC (1990b) and the ash content was determined according to AOAC (1990c). In addition, the fat content was determined by Gerber method as described by Bradley *et al.* (1992). Finally, the protein content was determined by Kjeldahl method according to AOAC (1990d).

2.5. Statistical Analysis

The data were analyzed using a completely randomized design. The significant differences between means were determined using Least Significant Different using statistix 8. The figures were plotted using Microsoft excel program.

3. Results

3.1. Gariss Processing Methods and Properties, Spoilage Occurrences and Shelf Life

This result indicated that 10.5% of the nomadic camel herders used Bukhsa (wooden Gourd) for preparing Gariss, 42.1% used plastic containers, and 42.1% used Siin and only 5.3% of the nomadic camel herders used stainless steel containers. On the other hand, the results of the survey clearly demonstrated that the nomadic camel herders preferred using plastic containers and Siin to prepare Gariss during the rainy season more than stainless steel. However, during the dry season they preferred using Bukhsa for preparing the Gariss (Figure 1). Figure 2 demonstrates that there were wide varieties of additives used for preparing Gariss; about 31.58% of households prepared Gariss without additives (plain), 21.05% of them used black cumin seeds (*Nigella sativa*) and onion (*Allium cepa*), 10.53% used ginger (*Zingiber officinale*) and black cumin seeds. The onion and fenugreek (*Trigonella foenum-graecum*) used by 15.78% of them, while 10.53% used onion, ginger, as well as fenugreek and grangal (*Alpinia galangal*). Moreover, the methods of adding these spices are varied. Some of them used the additives as powder in a piece of tied cloth and others add them directly without grinding.

The results of the survey indicate that different types of spoilage occurred (Figure 3); 26.3% of the household keepers observed a deterioration in Gariss as it became sour, and about 31.6% observed a formation of flakes/curd particles. Most of the nomadic households interviewed in the study area stated that camel milk is consumed either fresh or fermented, but some of them preferred it fresh (40%).

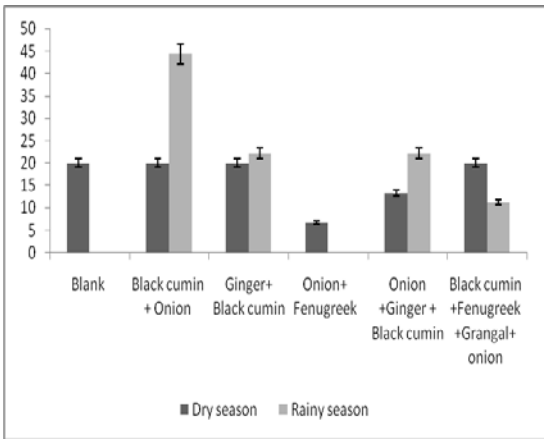

Figure 1. Percentage of different containers used in Gariss processing by nomadic camel women herders, AlGadarif State

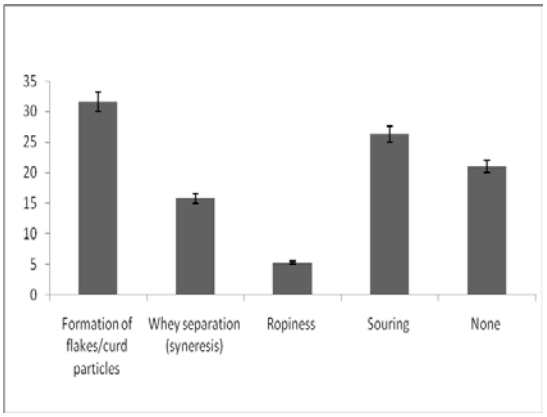

Figure 2. Percentage of different additives use in Gariss processing during the two seasons by nomadic camel women herders, AlGadarif State

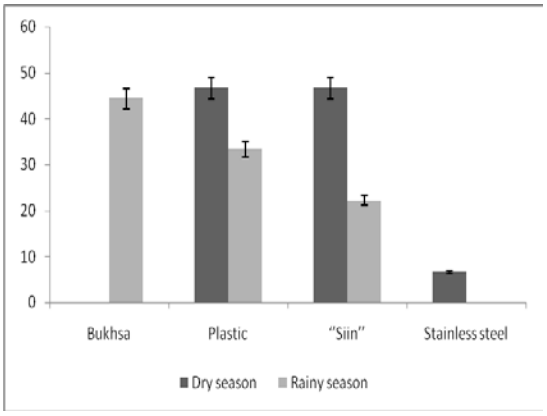

Figure 3. Percentage of different types of spoilage of Gariss faced by nomadic camel women herders, AlGadarif State

The ropiness defects represented about 5.3%, and 15.8% observed whey separation (syneresis), whereas, about 21% reported that no spoilage occurred. However the data in Figure 4 showed that 31.6% of the interviewed household keepers mentioned that the shelf life for the Gariss might extend up to 7 days, while 26.3% of them stated that it may extend up to 4 days. The shelf life proportions could be 5.3%, 21 %, and 15.8% for 24 hours, 48 hours and 3 days, respectively.

The most preferred camel milk is sour or fermented; this is suitable in the desert because of the high ambient temperature prevailing in the area which is coupled with the lack of cooling facilities that reduce the shelf life of milk.

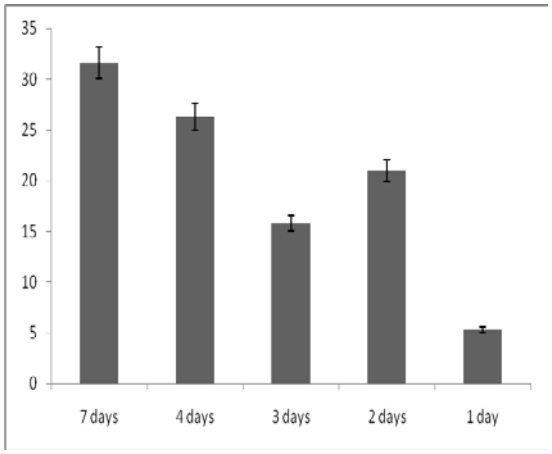

Figure 4. Percentage of different shelf lives of Gariss prepared by nomadic camel women herders, AlGadarif State

3.2. Chemical Composition of Gariss Samples Collected During Dry and Rainy Seasons of Nomadic Camel Herders, AlGadarif State

Table 1 shows that there are significant (p<0.05) differences of Gariss samples collected during dry compared to the rainy seasons concerning total solids (11.37%± 0.16 vs. 13.22%± 0.32), fat (3.73%± 0.11 vs. 3.06%± 0.22,), protein (4.88%± 0.14 vs. 3.97%± 0.27), ash (0.93%± 0.05 vs. 0.28%± 0.10), and pH (3.64± 0.1 vs. 4.52± 0.20). The highest total solids content (13.15± 0.54%) was found in Gariss prepared in Bukhsa compared to that prepared in plastic containers 11.88± 0.27%) followed by Gariss prepared in stainless steel containers (11.85± 0.76%) and ‘‘Siin’’ (11.28± 0.27%). The fat content of Gariss prepared using stainless steel container (4.65± 0.34%) was significantly higher (p<0.05) when compared to that prepared using ‘‘Siin’’ (3.71±0.12%), plastic containers (3.65± 0.12%) and Bukhsa (2.35± 0.24%) as shown in Table 2. The ash content of Gariss prepared in ‘‘Siin’’ (0.35± 0.09%) was significantly low (p<0.05) compared to that prepared using stainless steel (1.18±0.25%), plastic containers (0.76±0.09%) and Bukhsa (0.89±0.18%). However, the type of containers had an insignificant effect (p>0.05) on the acidity or the protein content of the Gariss. In regards to the type of containers, the lowest pH value (3.59± 0.16) was observed in Gariss prepared in plastic containers.

Table 3 shows that the additives types had a significant effect on the total solid contents. The total solids of Gariss prepared using mixtures of onion, black cumin, fenugreek and grangal (14.4%± 0.58) and Gariss with mixtures of onion, ginger and black cumin (13.15± 0.41%) were significantly higher (p<0.05) than the total solids of Gariss using other mixtures (10.85± 0.41% and 11.05 ±0.41%) or using no additives (11.39±0.23%). The lowest total solids content (10.85± 0.14%) was observed in Gariss prepared using additive mixture of ginger and black cumin. The fat content of Gariss prepared using an additive mixture of onion, black cumin, fenugreek and grangal (4.50± 0.34) was

significantly higher (p<0.05) compared to that prepared using additive mixtures of onion, ginger and black cumin (2.35± 0.24%), ginger and black cumin (3.25± 0.24) and onion and fenugreek (3.60± 0.15%). This might be attributed to the high oil content of these spices.

It was clear that the acidity of Gariss prepared using black cumin+ onion (2.80± 0.62%) was significantly higher (p<0.05) compared to Gariss prepared using other additives mixtures of onion+ black cumin+ fenugreek+ (0.45±0.37%),onion+ ginger+ black cumin (1.75± 0.26%); onion+ fenugreek (1.45± 0.17%) and ginger+ black cumin (1.85±0.26%) or the Gariss prepared using no additives (1.59 ±0.15%). The interviewed women herders stated that the addition of these spices improved the rate of fermentation. Furthermore, the results revealed that the types of additives had no significant effect (p<0.05) on the ash content. On the other hand, the pH value of Gariss prepared using additive mixture of onion+ ginger+ black cumin (4.55± .033%) was significantly higher (p<0.001) than that of Gariss prepared using additive mixtures of ginger+ black cumin (3.52±0.33%) and onion+ fenugreek (3.59 ±0.21%).

Table 1. Chemical composition of Gariss collected from nomadic women camel herders during dry and rainy seasons, AlGadarif State

Measurements	Dry season				Rainy season			
	Means	Min	Max	SE	Means	Min	Max	SE
Total solids (%)	11.37^{b}	13.50	10.30	0.16	13.22^{a}	12.10	14.50	0.32
Fat (%)	3.73^{a}	4.70	2.70	0.11	3.06^{b}	2.00	4.50	0.22
Protein (%)	4.88^{a}	6.38	3.70	0.14	3.97^{b}	2.30	5.10	0.27
Ash (%)	0.93^{a}	1.70	0.30	0.05	0.28^{b}	0.20	0.44	0.10
Acidity (%)	1.79^{a}	2.9	0.80	0.12	1.35^{b}	0.40	2.00	0.25
pH	3.64^{b}	5.00	2.90	0.1	4.52^{a}	3.90	5.20	0 .20

In this and the following tables:

Mean values within the same row with different superscripts letters are significantly different at p<0.05.

SE**:** Standard error

Table 2. Variation of chemical composition of Gariss prepared in different containers by nomadic camel women herders, AlGadarif State

Containers	Total solids (%) Means± SE	Fat (%) Means± SE	Acidity (%) Means± SE	Ash (%) Means± SE	pH Means± SE	Protein (%) Means± SE
Bukhsa	13.15^{a}±0.54	2.35^{c}±0.24	1.75^{a} ±0.35	0.89^{a}±0.18	4.55^{a}±0.31	4.74^{a}±0.42
Plastic	11.88^{b}± 0.27	3.65^{b}±0.12	1.47^{a} ±0.17	0.76^{a} ±0.09	3.59^{b}±0.16	4.49^{a}±0.21
Siin	11.28^{c}± 0.27	3.71^{b} ±0.12	1.867^{a} ±0.17	$0.35^{b\pm}$0.09	3.87^{ab}±0.16	4.79^{a}±0.21
Stainless steel	11.85^{bc}± 0.76	4.65^{a}±0.34	2.00^{a}±0.49	1.18^{a} ±0.25	3.95^{ab}±0.45	5.40^{a}±0.59

Table 3. Chemical composition of Gariss prepared using various additives by nomadic camel women herders, AlGadarif State

Types of containers	Total solids (%) Means± SE	Fat (%) Means± SE	Acidity (%) Means± SE	Ash (%) Means± SE	pH Means± SE	Protein (%) Means± SE
Blank	11.39^{bc} ±0.23	3.87^{ab} ±0.14	1.59^{b}±0.15	0.10^{a}±0.57	3.77^{ab} ±0.19	4.94^{a}±0.19
Black cumin+ onion	11.05^{bc} ±0.41	3.75^{abc}±0.24	2.80^{a}±0.26	0.99^{a} ±0.99	4.05^{ab} ± 0.33	4.77^{a}±0.33
Ginger+ black cumin	10.85^{c}± 0.41	3.25^{c} ± 0.24	1.85^{b}±0.26	0.60^{b}±1.40	3.52^{b}±0.33	4.47^{a} ±0.33
Onion+ fenugreek	11.93^{b}±0.26	3.60^{bc}± 0.15	1.45^{b}±0.17	0.70^{b}±0.62	3.59^{b} ±0.21	4.70^{a}±0.21
Onion+ finger+ black cumin	13.15^{a} ±0.41	2.35^{d} ±0.24	1.75^{b}±0.26	0.35^{c}±0.99	4.55^{a}±0.33	4.74^{a} ±0.33
Onion+ blak cumin+ fenugreek+ grangal	14.4^{a} ±0.58	4.5^{a}±0.34	0.45^{c}±0.37	0.20^{c}±1.40	4.05^{ab} ±0.47	2.35^{a} ±0.47

4. Discussion

Various containers are used to suit the local conditions, including seasonal movement. The seasonal systemic movement of camel herders is due to the climate conditions coupled with the lack of water (El Zubeir and Nour, 2006). The wide varieties of additives used for preparing Gariss indicating the different taste and experiences of women herders as some of the used spices were approved as having antimicrobial properties. El Zubeir *et al*. (2005) reported that black cumin, fenugreek and garlic have a significant effect on the quality of fermented milk. Moreover, the different processing methods practiced were found to influence the shelf life as presented in Figure 4. This finding supported El Zubeir and Ibrahium (2009) who concluded that pasteurization and refrigeration of camel fermented products will improve the keeping quality of the products and extending the shelf life. The variations might be due to the differences in the methods of preparation of camel's milk (Dirar, 1993; Abdelgadir *et al*., 1998; El Zubeir and Ibrahium, 2009; Ahmed *et al.*, 2010) and the storage conditions (Hassan *et al*., 2006; Hassan *et al*., 2007). Moreover, the agitation conditions under which the nomadic herders produce Gariss play a major role in the fermentation process of the product, by increasing the fermentability (Dirar, 1993; Mirghani, 1994). Finally, the temperature is found to influence the fermentative microorganisms in camel milk (Hassan *et al*., 2006).

The result for the chemical composition of Gariss agrees with that of Hassan *et al.* (2008) and Ahmed *et al.* (2010). The differences observed were attributed to the women herders' practices when separating a part of fat in order to make ghee by churning process using *Bukhsa* which reduce the fat content of the product. This was previously reported by Dirar (1993).

The Acidity of Gariss samples revealed insignificant differences among the samples collected during the two seasons, which could be due to the continuous addition of milk after the withdrawal of some Gariss, which keeps the balance of the acidity. El Zubeir and Ibrahium (2009) reported variations in developed acidity and the pH for Garris made with pasteurized and non pasteurized milk. Moreover, the variation in the chemical composition of camel milk could be due to other reasons such as the management, locations and environment (Zeleke, 2007; Bakheit *et al.*, 2008; Shuiep *et al.*, 2008; Dowelmadina *et al.*, 2014; Babiker and El Zubeir, 2014.) and processing conditions (Hassan *et al.*, 2007 and El Zubeir and Ibrahium, 2009).

The data for the pH in Gariss were similar to that of Abdelgadir *et al*. (2008); Hassan *et al*. (2008); Ahmed *et al.* (2010). This result also agrees with those reported by Dirar (1993) for Gariss samples collected from Butana area and Northern Kordofan. This might be due to the retrieving of fermented Gariss and addition of equal quantities of fresh milk, which kept the pH of the system constant (Mirghani, 1994). The data also indicated significant differences in the pH values for Gariss samples collected in different seasons, which could be explained by the storage period and quantity of previous Gariss that was used as a starter. Moreover, the acidity value also is supported by Hassan *et al*. (2008). The low pH values could be due to the type of camel milk; it might also be due to the season Shuiep *et al.*, 2008), which showed low pH during the dry season, as the camels are moved away and the frequency of adding fresh milk is prolonged. In addition, the used containers were found to affect the pH values as shown in Table 2. The low pH values of Gariss indicate major contributions of lactic acid bacteria and yeast in the fermentation. Moreover, lactic acid bacteria and yeast were reported previously as major contributing factors in the fermentation of Gariss (Dirar, 1993).

Due to the permanent movements, the nomadic camel herders need to preserve their milk for long time. Similarly Abdelgadir *et al.* (1998) reported that the pastoralists live for months depending on Gariss as their sole source of nourishment. Most of the households reported that fresh camel milk can be kept unspoiled for about 7 days. This is much longer than the shelf life of raw cows' milk; 24-48 hours; (El Zubeir, 2012). Fermented camel products generally have a longer shelf life than milk (Hassan *et al*., 2006; Hassan *et al.*, 2007; El Zubeir and Ibrahium, 2009) and are of great significance for their nutritional and social values and as a mean of generating income (Musa *et al*., 2006). Moreover, the result–showed that sometimes the camel milk may be mixed with milk from other species (mainly sheep or goat) and this is used to make porridge, and other types of cooked meal; however most of them used it alone (70%). This result supports Yagil (1982), who reported that camel milk is often mixed with fresh or churned goat milk to make milk products. A similar study in Ethiopia by Eyassu *et al*. (2007) reported that camel milk is mixed with milk of cows, goats and sheep particularly when intended to make products such as butter and cheese. El Zubeir *et al.* (2012) concluded that adding high total solids content milk of sheep to the high water content milk of camel revealed accepted yoghurt with firm texture.

5. Conclusion

The present study concluded that camel milk is consumed mainly in a fermented form (Gariss) by the nomadic camel herders. The fermentation is spontaneous using undefined bacteria at the ambient temperature. The fermentation process is uncontrollable and can result in undesirable products that shortened the product shelf life. Also the chemical constituents of Gariss were affected by the seasons (rainy and dry), types of additives and containers used in the processing. Therefore, it is recommended that training and extension should be adopted to raise awareness among producers on clean milking, handling practices for proper product quality and safety. Additional work is needed on the consistency of fermented product, effect of the additive and containers on Gariss quality.

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