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Effect of Pasteurization of Raw Camel Milk and Storage Temperature on the Chemical Composition of Fermented Camel Milk

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Abstract: The present study was carried out to investigate the effect of pasteurization and storage conditions on the chemical composition of fermented camel milk (Gariss). The Gariss which was used as a starter culture consisted of 2.65% fat, 3.13% protein, 0.51% ash, 7.37% total solids and 2.49% acidity. It had pH value of 3.8. The non pasteurized Gariss samples were found to attain high level of total solids, fat, protein and ash than the pasteurized fermented milk at the beginning of the storage period. Moreover, fat and protein, acidity and pH of the processed Gariss were found to show significant differences ($p<0.05$) in pasteurized samples that stored at 25°C. Also the mean levels of ash revealed significant differences ($p<0.05$) due to the pasteurization. Pasteurized and not pasteurized fermented camel samples both were found to withstand the storage conditions up to 243 h. The present study indicated that the chemical composition was affected by pasteurization and storage conditions (temperatures and storage periods).

Key words: Composition, fermented camel's milk, Gariss, shelf life, Sudan

INTRODUCTION

Research indicated that camel's milk has many properties that make it very useful to consumers as camel's milk is used in some parts of the world to cure certain diseases (Knoess, 1982; Yagil, 1982; Wernery, 2003). Wernery *et al.* (2003) reported that whey proteins in camel's milk are more heat resistant than those of cow's milk; as the degree of denaturation varied in camel's milk from 32 to 35% at 80°C for 5 min and pasteurization at 72°C for 5 min revealed no losses in camel's milk composition.

The milk composition of dromedary is excellent from a nutritional viewpoint, although it is often described as not easily fermented (Attia *et al.*, 2001; Hassan *et al.*, 2006). Under warm conditions, fermentation appears to be a mean to preserve the milk for only a limited period of time (Yagil, 1982). Fermented camel's milk has various names in various parts of the world. In Sudan, Gariss is a special kind of fermented milk, prepared solely from camel's milk under more or less continuous shaking (Dirar, 1993).

The present study is trial for processing camel milk in the laboratory into Gariss after laboratory pasteurization using a ready Gariss as starter. The chemical composition and shelf life of the processed Gariss were determined.

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MATERIALS AND METHODS

Source of Camel Milk and Gariss Preparation

Fresh camel milk was obtained from Elhag Yousif area (Eastern Nile, Khartoum North) and was divided into two quantities of 1250 mL each. One quantity of the milk was laboratory pasteurized at 63°C for 30 min accroding to Attia *et al*. (2001). Ready Gariss, which is intended for use as inoculums, was also obtained from the same area. Souring of the raw and pasteurized milk was carried out by the addition of 50 mL of ready Gariss (inoculum to each sample). After inoculation, each sample (pasteurized and non pasteurized) was subdivided into two equal potions, filled into plastic cups and incubated at room temperature (about 25°C) and the other was incubated at 37°C in an incubator. The incubation period was 234 h.

Analysis of Samples

The chemical analysis was done at 18 and 42 h after preparation of the samples Then the analysis was carried periodically every 48 h up to 234 h from inoculation.

Chemical Analysis

Fat (%) was determined by Gerber method and the protein (%) by Kjeldahl method, total solids (%), ash (%), acidity (%) and pH were done according to Bradley *et al*. (1993).

Data Analysis

The analysis of variance was conducted according to completely randomize design. The significant differences between means were determined using Duncan Multiple Range test by SPSS version 10.

RESULTS

Chemical Composition of Garris Culture and Fresh Camel Milk

The Gariss that was used as a starter culture consisted of 2.65% fat, 3.13% protein, 0.51% ash and 7.37% total solids. Its acidity and pH were 2.49 and 3.8%, respectively. The fresh camel milk contained 4.3% fat, 2.25% protein, 0.97% ash and 9.64% total solids. The acidity and pH of the fresh camel milk were 0.12 and 6.4%, respectively.

Chemical Compositions of Processed Gariss

Total Solids Content

Data in Table 1 shows mean total solids content of processed fermented camel milk incubated at 25 and 37°C. The means of total solids after 18 h incubation were 8.63±0.035, 8.32±0.026, 8.7±0.113 and 8.63±0.223% for pasteurized Gariss at 25°C, pasteurized Gariss at 37°C unpasteurized Gariss at 25°C and unpasteurized Gariss at 37°C, respectively. The mean total solids at the end of the storage period (234 h) were 7.61±0.019, 7.46±0.039, 8.31±0.071 and 7.87±0.37%, respectively.

The incubation temperature (Table 1) revealed significant decrease ($p<0.05$) for Gariss samples made after pasteurization of camel milk and non significant differences between Gariss samples made from non pasteurized milk.

Fat Content

The results indicated that a gradual reduction of the mean fat content was observed till it reached a minimum level after 234 h storage (Table 2). Fat % revealed 2.55±0.071, 2.55±0.071, 3.85±0.071 and 3.75±0.071%, respectively at 18 h. At 234 h they were 1.65±0.071, 1.35±0.071, 2.9±0.071 and 2.7%, respectively. Pasteurization and storage temperature differences revealed significant differences ($p<0.05$) between the processed samples.

Table 1: Total solids content of fermented camel milk (Gariss) stored at different conditions

Storage periods (h)	Storage temperature: Past. 25°C	Past. 37°C	Non past. 25°C	Non past. 37°C	Means
18	8.63±0.035	8.32±0.026	8.7±0.113	8.63±0.223	8.63[e]
42	8.42±0.071	8.11±0.013	8.695±0.05	8.46±0.246	8.46[d]
90	8.22±0.023	7.93±0.046	8.66±0.045	8.38±0.343	8.38[c]
138	8.22±0.023	7.93±0.046	8.66±0.045	8.38±0.343	8.38[c]
186	7.78±0.023	7.55±0.024	8.52±0.025	8.09±0.462	8.09[b]
234	7.61±0.020	7.46±0.039	8.31±0.071	7.87±0.37	7.87[a]
SL of means	8.15[b]	7.88[a]	8.59[c]	8.59[c]	

In this and the following tables, Past. = Pasteurized milk incubated at 25 or 37°C, Non past. = Non pasteurized milk incubated at 25 or 37°C, Means followed by the same subscript letter in column or row are not significantly affected

Table 2: Fat content of fermented camel milk (Gariss) stored at different conditions

Storage periods (h)	Storage temperature: Past. 25°C	Past. 37°C	Non past. 25°C	Non past. 37°C	Means
18	2.55±0.071	255.0±0.071	3.85±0.071	3.75±0.071	3.18[f]
42	2.5±0.000	2.35±0.071	3.85±0.071	3.7±0.000	3.1[e]
90	2.25±0.071	2.05±0.071	3.7±0.000	3.5±0.000	2.88[d]
138	2.05±0.071	1.9±0.000	3.6±0.000	3.25±0.071	2.7[c]
186	1.90±0.000	1.7±0.000	3.15±7.071	2.95±0.071	2.43[b]
234	1.65±0.071	1.35±0.071	2.9±0.071	2.7±0.000	2.16[a]
SL of means	2.15[b]	1.98[a]	3.52[d]	3.31[c]	

Table 3: Protein content of fermented camel milk (Gariss) stored at different conditions

Storage periods (h)	Storage temperature: Past. 25°C	Past. 37°C	Non past. 25°C	Non past. 37°C	Means
18	3.32	2.32	2.6	2.5902	2.4607[f]
42	2.30	2.27	2.52	2.48	2.39[e]
90	2.14	2.13	2.43	2.29	2.24[d]
138	1.61	1.59	2.00	1.97	1.79[c]
186	1.48	1.43	1.71	1.63	1.79[b]
234	1.41	1.38	1.51	1.48	1.45[a]
SL of means	1.88[b]	1.85[a]	2.13[d]	2.07[c]	

Protein Content

There was a reduction in the average protein content during incubation (Table 3). The pasteurized fermented camel milk revealed means of 2.32 and 2.32% and the non pasteurized samples 2.60 and 2.59%, respectively, after 18 h of incubation. After 234 h incubation the protein levels were 1.41, 1.38, 1.51 and 1.48%, respectively. The data illustrates significant variation ($p<0.05$) between the processed samples due to the effect of pasteurization, storage periods and incubation temperatures.

Ash Content

The means of ash content were 0.83±0.007, 0.81±0.004, 0.89±0.015 and 0.86±0.014% for Gariss samples after 18 h of incubation, respectively (Table 4). The reduction was observed in the average ash level till the end of the storage period, since they reached 0.71±0.014, 0.71±0.141, 0.76±0.007 and 0.76±0.003%, respectively. Significant variations ($p<0.05$) between Gariss samples made from pasteurized milk and Gariss samples made from non pasteurized milk incubated at 37°C as shown in Table 4 were found.

Titratable Acidity

Data in Table 5 revealed variations in the rate of increase of the mean lactic acid percent in the processed Gariss samples. The lactic acid percent after one hour of incubation revealed means of 0.14±0.000, 0.15±0.000, 0.175±0.007 and 0.2±0.000%, respectively. They were found to be

Table 4: Ash content of fermented camel milk (Gariss) stored at different conditions

Storage periods (h)	Storage temperature				
	Past. 25°C	Past. 37°C	Non past. 25°C	Non past. 37°C	Means
18	0.83±0.007	0.81±0.004	0.89±0.015	0.86±0.014	0.85^{e}
42	0.82±0.007	0.81±0.004	0.79±0.007	0.79±0.006	0.80^{d}
90	0.8±0.01	0.78±0.001	0.79±0.006	0.79±0.001	0.79^{d}
138	0.76±0.007	0.73±0.035	0.79±0.004	0.78±0.015	0.76^{c}
186	0.74±0.007	0.72±0.021	0.78±0.004	0.77±0.004	0.75^{b}
234	0.71±0.014	0.71±0.141	0.76±0.007	0.76±0.003	0.74^{a}
SL of means	0.77^{b}	0.76^{a}	0.8^{c}	0.79^{c}	

Table 5: Lactic acid Percent of fermented camel milk (Gariss) stored at different conditions

Storage periods (h)	Storage temperature				
	Past. 25°C	Past. 37°C	Non past. 25°C	Non past. 37°C	Means
1	0.14±0.000	0.15±0.000	0.175±0.0071	0.2±0.000	0.17^{a}
3	0.14±0.000	0.17±0.000	0.19±0.000	0.21±0.000	0.18^{a}
5	0.17±0.000	0.19±0.000	0.23±0.000	0.32±0.000	0.28^{b}
18	0.22±0.000	0.31±0.000	0.5±0.000	0.55±0.000	0.4^{c}
42	0.39±0.014	0.56±0.014	0.72±0.000	0.815±0.021	0.62^{d}
90	0.5±0.000	1.4±0.000	0.97±0.000	1.75±0.000	1.16^{g}
138	0.65±0.014	1.67±0.014	1.4±0.141	1.885±0.00707	1.40^{h}
186	0.59±0.014	1.235±0.07	0.59±0.000	1.515±0.0071	0.98^{e}
234	0.54±0.014	1.2±0.000	0.52±0.000	1.131±0.014	0.89^{e}
SL of means	0.37^{a}	0.77^{c}	0.59^{b}	0.95^{d}	

Table 6: The pH values of fermented camel milk (Gariss) stored at different conditions

Storage periods (h)	Storage temperature				
	Past. 25°C	Past. 37°C	Non past. 25°C	Non past. 37°C	Means
1	6.2	6	6.05±0.071	5.9	6.04^{h}
3	6	5.9	5.9	5.7	5.88^{g}
5	5.8	5.7	5.6	5.4	5.63^{f}
18	5.7±0.071	5.2±0.000	4.9±0.000	4.6±0.000	5.1^{e}
42	5.05±0.071	4.6±0.000	4.4±0.000	4.05±0.071	4.53^{d}
90	4.6±0.000	3.9±0.000	4±0.000	3.6±0.000	4.06^{c}
138	4.2±0.000	3.45±0.071	3.7±0.000	3.15±0.071	3.623^{a}
186	4.3±0.000	3.6±0.000	4.5±0.000	3.5±0.000	3.98^{b}
234	4.45±0.071	3.8±0.000	4.5±0.000	3.5±0.000	4.06^{c}
SL of means	4.84^{c}	4.68^{b}	5.14^{d}	4.38^{a}	

0.17, 0.19, 0.23 and 0.32%, respectively, after 5 h incubation. However the decrease reported for the mean lactic acid was recorded up to 234 h storage. After 234 h of storage, Gariss samples revealed mean values of 0.54±0.014, 1.2±0.000, 0.52±0.000 and 1.13±0.014%, respectively. Moreover, it was noticed that generally Gariss samples processed from pasteurized and non pasteurized camel milk incubated at 37°C had higher mean lactic acid levels than those incubated at 25°C.

Table 5 also showed significant variations ($p<0.05$) in the mean total acidity between Gariss processed samples, which resulted from the variations in the pasteurization of the milk and storage temperatures.

pH Values

The mean pH recorded after one hour of incubation was 6.2, 6, 6.05±0.071 and 5.9% for Gariss samples, respectively (Table 6). Gradual reduction continued till 18 h incubation. After 90 h incubation, Gariss samples revealed means of 4.6, 3.9, 4 and 3.6%, respectively. However, increase in the means was found to occur at 186 and 234 h. After 234 h storage the samples revealed mean of 4.45±0.071, 3.8, 4.5 and 3.5% for Gariss, respectively. Moreover, the lowest pH values were recorded for Gariss samples made from non pasteurized milk incubated at 37°C. The highest values were

recorded for Gariss samples made from pasteurized milk incubated at 25°C. Table 6 also shows significant variations ($p<0.05$) between the samples due to the effect of the pasteurization and the storage temperature.

DISCUSSION

The results indicated significant differences in the chemical compositions of the fermented camel milk (Gariss) due to the differences in temperature and storage periods. This is because pasteurization is known to affect quality of the dairy products (Harding, 1999). Moreover, the storage temperature is the single most important parameter that affects the spoilage of highly perishable foods (Jay, 1986). The Gariss samples made from pasteurized camel milk revealed low values for total solids, fat, protein and ash at the beginning of the storage than those of Gariss samples made from unpasteurized camel milk. These variations might occur due to the pasteurization process, which was used before the inoculation by the Gariss culture. These results disagree with Farah (1996), who indicated that the pasteurization of camel milk at 63°C for 30 min did not affect the chemical composition of the camel milk. Moreover, significant variations due to the pasteurization process were observed on the chemical composition of Gariss processed samples. Generally the reduction of the total solids content during the storage period might occur due to the effect of the fermentative organisms (Harding, 1999). Also fermentation causes significant increase in the free amino acids content and liberation of significant amounts of peptides (Mirgahni, 1994).

The increase in the lactic acid level started gradually at the beginning of the storage period (Table 5). This increase was accompanied by a decrease in pH level (Table 6). The rate of change in the acidity and pH was observed to be slow at the beginning and this might be due to the presence of the antimicrobial agents in the camel milk (Elagamy *et al*., 1992). The pasteurization and incubation temperature revealed significant effects in the titratable acidity and pH. Also the high values of the titratable acidity and lower level of pH for processed Gariss samples incubated at 37°C showed that temperature is the most important factor in controlling the growth of microorganisms in the milk and dairy products as stated by Olson (1950).

The processed Gariss samples were found to have high keeping quality, since the shelf life of the product was extended up to 234 h at both 25 and 37°C. When comparing the shelf life of the processed Gariss samples with other products from different milk types, the processed Gariss samples revealed longer shelf life than yoghurt which revealed a shelf life of 10 days when kept under refrigeration (Robinson, 1981). The variations in the shelf life between camel fermented milk and other fermented dairy products might occur due to the presence of antibacterial and antimicrobial agents in the camels' milk (Elagamy *et al*., 1992). Moreover, pasteurization of the milk had an effect on the keeping quality of the product, since the heat treatment is used to kill the pathogens and to extend the storage life of the products (Harding, 1999).

The spoilage of the product was found to occur after 234 h incubation at the two storage temperatures (25 and 37°C). The spoilage of the unpasteurized fermented camel's milk might occur due to the presence of lower initial numbers of contaminated yeast, which have ability to thrive in fermented milk at low pH (Olson, 1950; Jay, 1986; Hassan *et al*., 2006).

The present study concluded that processed Gariss samples revealed a longer shelf life (9 days) in the different storage conditions. The present study suggested that due to the special properties of camel's milk it must be looked at as a promising industry of the future. Hence we recommend the coordination between the private and official bodies in order to encourage the investment in the camel milk and its products. Further research is also needed to address the fermentation process of camel milk with special references to the microbial content and its properties.

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