academicJournals

Vol. 8(47), pp. 5967-5977, 5 December, 2013
DOI: 10.5897/AJAR11.012
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Assessment of rural and experimental dairy products under dryland farming in Sudan

F. M. El-Hag[1]*, M. M. M. Ahamed[2], K. E. Hag Mahmoud[3], M. A. M. Khair[4], O. E. Elbushra[1] and T. K. Ahamed[5]

[1]Agricultural Research Corporation (ARC), Dryland Research Center (DLRC), Soba, Khartoum.
[2]Institute of Environmental Studies, University of Khartoum, Khartoum, Sudan.
[3]State Ministry of Agriculture, Animal Resources and Irrigation, Kordofan State, El-Obeid, Sudan.
[4]Agricultural Research Corporation (ARC), Wad Medani, Sudan.
[5]Food Research Centre, Shambat, Sudan.

Accepted 12 January, 2011

Rural dairy processing situation in western Sudan (North Kordofan) was first assessed through a structured questionnaire. Some rural dairy products were sampled and assayed for bacteriological and chemical composition. The objectives were to investigate traditional dairy products and evaluate their nutrients composition and hygienic situation. Laboratory cheese making trials were then conducted to study the effects of milk type (goat vs. cow) and cheese type (white soft vs. braided) on cheese characteristics. Descriptive statistics were used for the statistical analysis of the survey data, a randomized complete block design for the cheese samples data and a 2×2 factorial experiment in a randomized complete block design for the laboratory trials data. There were seasonal fluctuations in quantities of milk processed. Most of the producers (62.7%) used mixed cow, sheep and goat milks for cheese processing. Braided cheese had a high cost of production compared with white soft cheese. Major production constraints stated were marketing, fluctuations in milk supply and shortage of water. Milk sources reported were from nomadic and transhumant herds, and to a lesser extent from villages and only very few of the producers had their own dairy animals. Cheese samples contained variable chemical constituents (total solids, fat and protein) that varied from location to another.

Key words: Rural dairy products, cows, goats.

INTRODUCTION

Milk composition is found to be affected by production systems by mechanisms likely to be linked to the stage and length of the grazing period, and diet composition, which will influence subsequent processing, and sensory and potential nutritional qualities of the milk (Chen et al., 2004; Lock et al., 2004; Gillian et al., 2005; Dewhurst et al., 2007). Food processing is an important measure for the preservation of food constituents as sources of nutrients and cash for many people in the world. Milk as a food is an ideal medium for the growth of bacteria and if kept at above 16°C the bacteria present will multiply rapidly thereby causing deterioration in quality (O'Connor, 1993). Therefore, surplus milk needs to be processed to preserve its valuable constituents for a long time. The fatty acid (FA) and fat-soluble antioxidant composition in milk fat is known to affect processing and sensory quality

*Corresponding author. E-mail: faisalelhag@hotmail.com, Tel: +249 912959765.

of dairy products (Jones et al., 2005; Kristensen et al., 2004) and may also affect their nutritional value (Thorsdottir et al., 2004; Havemose et al., 2006). The degree of saturation in milk fat has a bearing on the hardness, texture and taste of manufactured dairy products, particularly butter and cheese (Chen et al., 2004).

In Sudan, milk is traditionally preserved into different products e.g. ghee, butter and cheese to mention but three. The traditional cheese making is concentrated in the White Nile and Kordofan States. However, in some other areas where there is surplus fresh milk, no suitable method of preservation is available (Macquat and Bujanble, 1960; Ibrahim, 1970). In these areas where refrigeration or chilling means are not available, the importance of fermentation is obvious as it is the only method of preserving most of the milk nutrients. In Kordofan region, traditional cheese making is a seasonal activity. During the rainy season when plenty of milk is available, few people are actively engaged in making cheese. This, perhaps, is the most commonly practiced method of preservation of milk in the Sudan (Ibrahim, 1970).

Rural development projects in the area have many mobile laboratories or units for cheese making, scattered along the migration routes and camping areas of transhumant tribes in North Kordofan State (Ahmed, 1985). However, no thorough investigation of traditional processing methods and quality of dairy products in the area has been undertaken. This work was carried out with an ultimate objective of assessing rural dairy products situation and quality in North Kordofan, and comparing cheeses made from goat and cow milk.

MATERIALS AND METHODS

Study area

This study was carried out in western Sudan (North-Kordofan State) under semi-arid conditions; latitude 11° 15' N, longitude 27° 32' E, altitude 560 above sea level (asl). Average temperature varied between 30 to 35°C with peaks above 40°C. Summer rainy season extends from July to October during which many animal herders are engaged in cheese making from surplus milk.

Assessment of cheese quality products of local producers

A total of 51 local dairy producers were interviewed using purposive sampling technique. The interview focused on milk type (animal source), handling, processing; marketing and production constraints. 24 samples of dairy products included 6 braided cheeses and their whey, 6 white cheeses and their whey. Samples were collected from three different geographical locations and analyzed for bacterial contamination and biochemical composition.

Trials within the station

At the research station, two types of white cheese (soft and braided) were processed from cows and goats using rennet and table salt (NaCl). The trials were replicated six times for six consecutive days. Milk from both sources were first heated to 72°C, cooled and divided into two equal portions, one possessed for braided and the other for soft white cheese.

The white cheese was made by heating the milk to 40°C table salt (8%) and rennet (one tablet/50 kg milk) added. This was stirred with milk for 5 min and left to coagulate. The curd was cut into cubes, placed in a mesh and left to drain the whey for 20 to 30 min. The whey was kept for further use, whereas the cubes were transferred into clean wooden moulds lined with cheese cloth and pressed overnight. The cubes were finally stored in plastic containers containing the previously preserved whey heated to 72°C for 1 min and cooled.

The braided cheese was prepared as the soft cheese but the cubes produced were scolded until the required acidity (0.46 to 0.60) when kneading was reached. Ripening was assessed by testing the ability of the curds to be kneaded into ropes. After draining off the whey, the ripened cubes were placed in a wooden plate and cut into slices to which *Nigella sativa* seeds were added. The slices were then hand-kneaded and pulled into braided ropes washed and stored with the whey in plastic containers.

Chemical analyses

Chemical analyses of milk, cheese and whey were carried out. Fat was determined by the Gerber method, crude protein (CP) according to Kejldahl method, total solids (TS) and water by the draft oven method (Marshall, 1993). Lactose was determined as outlined by Taylor (1970), while pH and ash were estimated according to AOAC (1990).

Bacteriological analyses

Media preparation and chemical tests for bacteria were carried out as shown by Cowan and Steel (1981). Viable bacterial counts were done according to Schalm et al. (1971).

Panel test

Ten untrained panelists were chosen to judge the quality of cheese (color, texture, flavor and taste) using hedonic scale of 1 to 4 (Watts et al., 1989).

Statistical analyses

Descriptive statistics were used for the questionnaire. For chemical composition data, random complete block design was utilized. The data of the laboratory cheese making trials and panel test used a 2 × 2 factorial randomized block design. Duncan multiple range test was used to test mean separation (Steel and Torrie, 1980).

RESULTS

Questionnaire of rural dairy products

Fifty-one rural cheese processing producers were interviewed through a structured questionnaire. The majority of the respondents (78.4%) reported that they produced cheese during rainy season, a time of high milk availability (Table 1). There was a complete consensus among the interviewed farmers that there were fluctuations

Table 1. Production season, milk supply situation and processing of rural dairy products as reported by the respondent farmers (%).

Evaluation parameters	Frequency	Percent
Production season		
One season	40	78.4
All around the season	11	21.6
Fluctuation in milk quantity		
Yes	51	100.0
No	0	00.0
Time between milk receipt and processing		
Direct manufacture	51	100.0
Storage	0	00.0
Treatment of milk before processing		
Yes	0	00.0
No	51	100.0
Type of cheese produced:		
White	13	25.5
Braided	15	29.4
White + Braided	9	17.6
White + Rome	1	2.0
Braided + Rome	2	3.9
White + Braided + Rome	11	21.6
Any other type of dairy products		
Yes	28	54.9
No	23	45.1
Type of other dairy products		
Ghee	2	7.14
Hard fermented milk (HFM)	1	3.57
Butter	1	3.57
Soft fermented milk (SFM)+ ghee	8	28.58
Ghee + HFM	9	32.14
HFM + SFM + ghee	6	21.43
HFM + SFM + ghee + butter	1	3.57

in milk quantity and handling during the period of production. Also there was no treatment made to the milk from collection to the time of processing. Braided cheese recorded the highest production rate (29.4%) followed by white cheese (25.5%), while the combined production of both shuddered cheese and white cheeses recorded the lowest percentage (2.0%). One-third of persons interviewed (32.14%) reported that they also produced ghee and fermented hard milk, 28.58% produced soft fermented milk and ghee while farmers producing soft fermented milk, ghee, hard fermented milk and butter recorded the lowest percentage (3.57%) (Table 1).

The bulk of milk for these rural dairy processing units was reported to be purchased from nomads (54.9%), and to a lesser extent from villages (19.6%). Only very few (2.0%) of the producers had their own dairy animals. The majority of the respondents (58.8%) reported that they mixed cow, sheep and goat milks for cheese processing, whereas the use of goat + cow milk recorded the lowest percentage (3.9%). Quantities of milk processed into cheese in these units ranged from 50 to 200 L/day in the majority (39.2%) of units surveyed, while 7.8% of the interviewed producers stated that they processed quantities of milk in the range of 500 to 650 L/day. Half

Table 2. Milk sources, quantities used and equipment used in Cheese processing as reported by respondent farmers (%).

Evaluation parameters	Frequency	Percent
Milk source		
Village	10	19.6
Nomads	28	54.9
Own dairy animals	1	2.0
Village + nomads	9	17.0
Village + own dairy animals	1	2.0
Nomads + own dairy animals	2	3.9
Type of milk used in processing		
Cow	19	37.3
Cow + goat	2	3.9
Cow + goat + sheep	30	58.8
A mount of milk used per day		
50 – 200 liter	20	39.2
201- 350 liter	9	17.6
351 – 500 liter	12	23.5
501 – 650 liter	4	7.8
More than 650 liter	6	11.8
Milk containers		
Plastic barrel	26	51.0
Metal barrel	15	29.4
Plastic + metal barrel	10	19.6
Type of cheese cloth used		
Cotton cloth	41	80.4
Synthetic	7	13.7
None	3	5.9
Cheese storage containers		
Plastic barrel	29	56.9
Metal barrel	17	33.3
Plastic + metal barrel	5	9.8

(51.0%) of the respondents reported that they used plastic barrels as milk containers and for cheese storage, whereas the use of both plastic and metal barrels recorded the lowest percentage (10%). The majority (80.4%) of the producers reported that they used cheese cloth to separate the whey from coagulated cheese (Table 2).

More than two-thirds (68.6%) of the interviewed producers reported that braided cheese had a higher cost of production than white cheese. Most of the respondents (60.78%) used to sell their dairy products at El-Obeid market due to availability of marketing facilities especially the purchasing power. The rest of interviewees (5.88%) who lack the means of transportation used local markets through which marketing of dairy products was done. Although poisoning of milk and milk products could easily happen due to the vulnerability to contamination by germs and bacteria, 94.1% of the interviewed producers reported that there were no poisoning cases in their local processing units. The most important problems mentioned by respondents were marketing problems, shortage of milk and shortage of water which recorded 20.00, 18.57 and 8.56% of the interviewees' answers, respectively. Other minor constraints reported were difficulty in coagulation, rise in milk prices and unavailability of transportation means to marketing centers and storage especially during the rainy season (Table 3).

Table 3. Relative production cost of different cheese types, markets and production constraints as reported by the interviewed producers (%)

Evaluation parameters	Frequency	Percent
High production cost		
White	16	31.4
Braided	35	68.6
Markets		
Local	3	5.9
El-Obeid town	31	60. 8
Out of State	4	7.8
Local + town	10	19.6
Town + out of State	3	5.9
Cheese poisoning		
Yes	3	5.9
No	48	94.1
Constraints to cheese production		
Yes	21	41.2
No	30	58.8
What are the constraints?		
Marketing	14	20.0
Shortage of milk	13	18.6
Shortage of water	6	8. 6
Coagulation difficulties	5	7.1
Prices reduction	3	4.3
Rise in milk prices	5	7.1
Failure of production	2	2.9
Lack of capital	2	2.9
shortage of canning equipment	5	7.1
Veterinary facilities and follow up not enough	1	1.4
Shortage of store in production area	1	1.4
Transportation to stores during high rainfall	5	7.1
Shortage of rennet tablet	3	4.3
Milk adulteration	3	4.3
Mobility of milk producer	2	2.9

Chemical composition and bacteriological profile of dairy products

Processing dairy units in the area of study

Samples of dairy products taken from different locations in the area of study were analyzed for their nutrient contents, chemical composition and bacterial constituents. It was observed that, cheese obtained from location 2 had the highest (P <0.05) fat content, whereas the braided cheese showed higher (P <0.05) fat and protein contents than the white cheese (Table 4). On the other hand, the whey of the braided cheese had higher (P <0.05) fat content than that of the white cheese (Table 5). There was no significant difference between both white and braided cheese in bacteriological profile (Table 6).

Station dairy products trials

Fresh milk samples from cows and goats, analyzed for their nutrient contents and chemical composition showed that, cow milk had higher (P <0.05) total solids (TS), fat and protein contents, whereas goat milk had higher (P

Table 4. Chemical composition of sampled white and braided cheese produced in the area of study.

Factor	pH	TS[1] (%)	Ash (%)	Fat (%)	Protein (%)	Lactose (%)
Location						
1	4.9	49.7	4.1	16.8	12.3	16.4
2	4.3	54.4	5.8	24.5	13.4	9.9
3	5.1	48.5	6.6	20.5	13.2	8.3
± SE	0.28^{NS}	4.3^{NS}	0.33^{NS}	0.80^{*}	0.44^{NS}	3.4^{NS}
Cheese type						
White	4.4	45.3	5.6	19.1	8.5	11. 9
Braided	5.2	56. 5	5.4	22.1	17.4	11.1
±SE	0.13^{*}	2.9^{NS}	0.77^{NS}	0.51^{*}	0.61^{*}	2.1^{NS}
Location x Cheese type						
±SE (Interaction)	0.22^{NS}	5.2^{NS}	1.3^{NS}	0.88^{NS}	1.0569^{NS}	3.7^{NS}

NS = not significant (P > 0. 05), * Significant at P < 0.05. [1] total solids.

Table 5. Chemical composition of white and braid cheese whey samples produced in the area of study.

Factor	pH	TS (%)	Ash (%)	Fat (%)	Protein (%)	Lactose (%)
Location						
1	4.9	17.9	10.6	0.33	0.58	6.5
2	5.1	16.7	8.8	0.36	0.65	6.9
3	5. 5	14.8	8.2	0.35	0.50	5.7
± SE	0.50^{NS}	1.1^{NS}	0.29^{NS}	0.30^{NS}	0.03^{NS}	0.90^{NS}
Cheese type						
White	5.8	17.1	9.3	0.62	0.52	6.8
Braided	4.6	15.8	9.1	0.08	0.63	5.9
± SE	0.35^{NS}	1.08^{NS}	0.53^{NS}	0.42^{*}	0.049^{NS}	1.5^{NS}
Location x Cheese type						
±SE Interaction	0.60^{NS}	1.8^{NS}	0.92^{NS}	0.73^{NS}	0.08^{NS}	2.55^{NS}

NS = not significant (P > 0. 05), * Significant at P < 0.05.

Table 6. Chemical composition of milk.

Constituent	Cow milk	Goat milk	SE±
pH value	6.6	6.7	0.04*
Total solids (%)	13.2	12.2	0.28*
Ash (%)	0.7	0.9	0.03*
Fat (%)	3.9	3.5	0.10*
Protein (%)	3.7	3.4	0.09*
Lactose (%)	4. 8	4.5	0.22^{NS}

NS = not significant (P > 0.05), * Significant at P < 0.05

<0.05) pH and ash values (Table 7). Effects of milk and cheese types on coagulation time and yield, showed that, goats' milk had longer (P <0.05) coagulation time but lesser yield (P <0.001) than cows' milk, whereas braided cheese was higher yield (P <0.001) than the white cheese. Interactions of type of milk X type of cheese

Table 7. Effects of milk type and cheese type on coagulation time (hr) and yield of cheese.

Factor	Coagulation Time (h)	Cheese Yield (kg/100 kg milk)
Type of milk		
Cow	6.5	13.7
Goat	10.6	11.9
± SE (Type of milk)	1.06*	0.12 ***
Type of cheese		
White	9.1	15. 9
Braided	7.9	9. 8
± SE (Type of cheese)	1.06^{NS}	0.12***
Type of milk × Type of cheese		
Cow–White (CW)	5.1^{b}	17^{a}
Goat–White (GW)	13.2^{a}	14.8^{b}
Cow–braided (CB)	7.8^{b}	10.8^{c}
Goat–braided (GB)	8.1^{b}	9.2^{d}
± SE (interaction)	1.5*	0.17*

[abcd]Values within the same column bearing different superscripts vary significantly at (P<0.05). NS = not significant (P>0.05). *Significant at P<0.05, *** highly significant at P<0.001.

Table 8. Effects of milk type and cheese type on cheese chemical composition.

Factor	pH	TS[1] (%)	Ash (%)	Fat (%)	Protein (%)	Lactose (%)
Type of milk						
Cow	5.3	58.3	7.9	24.6	20.8	4.9
Goat	5.4	55.2	9.1	21.8	19.6	4.8
±SE	0.07*	0.62*	0.17**	0.42**	0.39*	0.38^{NS}
Type of cheese						
White	5.1	54.0	8.5	23.5	16.6	5.4
Braided	5. 7	59.5	8.5	22.8	23.8	4.4
±SE	0.07***	0.62***	0.17^{NS}	0.42^{NS}	0.39***	0.38^{NS}
Type of milk × type of cheese						
Cow-white (CW)	4.9	56.3	8.37^{bc}	24.9	17.3	5.8
Goat-white (GW)	5.1	51.7	8.8^{ab}	22.2	15.9	4.9
Cow-Braided (CB)	5.7	60.3	7.64^{c}	24.2	24.3	4.0
Goat-braided (GB)	5.7	58.7	9.4^{a}	21.3	23.3	4.7
±SE	0.10^{NS}	$0. 9^{NS}$	0.25**	0.59^{NS}	0.55^{NS}	0.5^{NS}

[abc]Values within the same column bearing different superscripts vary significantly at (P<0.05). NS = not significant (P>0.05). *Significant at P<0.05, ** highly significant at P<0.001 *** very highly significant at P<0.001. [1] total solids.

showed significant (P <0.05) longer time for coagulation of white cheese from goats but at the same time higher yields for the white cheese from goat milk. The lowest yield was obtained for braided cheese of goat milk (Table 8).

Except for lactose, significant differences due to milk type could be detected. TS, and ash (P <0.01) as well as fat and protein (P <0.05) were higher in cheese produced from cow than those from goats, whereas the pH was higher (P <0.05) in cheese produced from goats. Braided cheese showed higher (P <0.001) pH, TS and protein values than white cheese. Interaction due to type of milk X type of cheese was only significant (P <0.05) for ash where braided cheese from goats was higher than that of both white and braided cheeses from cows (Table 9).

Efficiencies of milk fat and protein recovered were

Table 9. Effects of type of milk used and type of cheese produced on nutrient recovery in different cheeses.

Factor	Efficiency of fat recovery (%)	Efficiency of protein recovery (%)	Efficiency of lactose recovery (%)
Type of milk			
Cow	85.9	78.7	14.3
Goat	78.7	74.7	14.8
± SE (type of milk)	2.22*	1.75*	1.23NS
Type of cheese			
White	91.7	72.0	17.4
Braided	72.8	81.4	11.7
± SE (type of cheese)	2.22**	1.75**	1.23**
Type of milk × type of cheese			
±SE (interaction)	3.15NS	2.48NS	1.73NS

NS = not significant (P > 0.05) *Significant at P<0.05, ** highly significant at P<0.001.

Table 10. Effect of milk type and cheese type on first whey (the whey before ripening) chemical composition.

Factor	pH	TS[1]%	Ash%	Fat%	Protein%	Lactose%
Type of milk						
Cow	5.8	10.3	4.0	0.08	1.06	5.1
Goat	5.7	11.0	4.6	0.09	1.07	5.3
±SE	0.14NS	0.40NS	0.41NS	0.27NS	0.066NS	0.28NS
Type of milk cheese						
White	5.9	14.5	8.0	0.14	0.99	5.3
Braided	5.6	6.9	0.55	0.02	1.13	5.1
±SE	0.14NS	0.40***	0.41***	0.03**	0.07NS	0.28 NS
Type of milk x type of cheese						
Cow-white (CW)	6.0	14.0	7.5	0.13	1.1ab	5.3
Goat-white (GW)	5.8	14.9	8.5	0.15	0.88b	5.4
Cow-braided (CB)	5.7	6.6	0.50	0.02	1.03ab	5.1
Goat-braided (GB)	5.5	7.1	0.59	0.02	1.3a	5.2
±SE	0.19NS	0.57NS	0.58NS	0.03NS	0.09*	0.40 NS

[ab]Values within the same column bearing different superscripts vary significantly at (P<0.05). NS = not significant (P>0.05). *Significant at P<0.05, ** highly significant at P<0.001 *** very highly significant at P<0.001. [1] total solids.

higher (P <0.05) in milk from cows than those recovered from goats, whereas braided cheese showed higher (P <0.01) protein recovery but less (P <0.01) fat recovery (Table 10).

First whey characteristics were shown to be significantly affected by both cheese type and interaction of milk type X cheese type. Fat (P <0.01), TS and ash (P <0.001) were higher in braided than white cheese. Interaction was only significant (P <0.05) for the protein content where braided cheese first whey from goat milk had higher protein content than that of the white cheese (Table 11). Second whey showed higher fat and protein contents (P <0.001) as well as lactose values (P <0.05) in the white cheese whey compared to braided cheese (Table 12). The microbial profile for the dairy products' whey was not affected by either type of milk or type of cheese or their interaction (Table 13).

Organoleptic scoring of white and braided cheese

Cheese of cow milk had higher scores for taste and texture (P <0.05) as well as flavor (P <0.001) than goat milk. However, type of milk did not show significant effect

Table 11. Effect of milk type and cheese type on chemical composition of second whey (the whey after cheese ripening)

Factor	pH	TS[1]%	Ash%	Fat%	Protein%	Lactose%
Type of milk						
Cow	4.8	13.1	8.4	0.15	1.0	3.5
Goat	4.9	13. 6	9.2	0.24	1.1	3.0
±SE	0.12^{NS}	0.52^{NS}	0.44^{NS}	0.03^{NS}	0.08^{NS}	0.29^{NS}
Type of milk cheese						
White	4.4	14.1	8.1	0.37	1.04	3.9
Braided	5.3	12.6	9.4	0.03	0.45	2.7
±SE	0.12**	0.52^{NS}	0.44^{NS}	0.03***	0.08***	0.29*
Type of milk x type of cheese						
±SE	0.17^{NS}	0.74^{NS}	0.63^{NS}	0.04^{NS}	0.11^{NS}	0.42^{NS}

NS = not significant (P>0.05). *Significant at P<0.05, ** highly significant at P<0.001 *** very highly significant at P<0.001. [1] total solids.

Table 12. The microbiological profile of milk types used and cheese processed in the laboratory.

Factor	*Staphylococcus*	*Bacillus*	*Coliform*	Total Bacteria Count
Milk type				
Cow	1.2×10^4	0	0	12×10^4
Goat	2.2×10^4	1.3×10^4	0	3.5×10^4
Cheese type × Milk type				
Cow-White (CB)	0	4.9×10^2	0	4.9×10^2
Goat-White (GW)	0	6.1×10^2	0	6.1×10^2
Cow-Braided (CB)	0	3.1×10^2	0	3.1×10^2
Goat-Braided (GB)	0	3.3×10^2	0	3.3×10^2

Table 13. Organoleptic scoring of white and braided cheese made from milk of cows and goats.

Factor	Color	Texture	Flavor	Taste
Type of milk				
Cow	2.81	3.53	3.42	3.06
Goat	2.94	3.03	2.50	2.33
±SE	0.214^{NS}	0.153*	0.134***	0.192*
Type of cheese				
White	3.11	3.36	2.97	2.86
Braided	2.64	3.19	2.94	2.53
±SE	0.214^{NS}	0.153^{NS}	0.134^{NS}	0.192^{NS}
Type of milk x Type of cheese				
Cow-White (CW)	2.78	3.44	3.22^{a}	3.00
Goat-White (GW)	3.44	3.28	2.72^{ab}	2.72
Cow-Braided (CB)	2.83	3.61	3.61^{a}	3.11
Goat-Braided (GB)	2.44	2.78	2.29^{b}	1.94
±SE	0.303^{NS}	0.217^{NS}	0.189^{NS}	0.271^{NS}

[ab]Values within the same column bearing different superscripts vary significantly at (P<0.05). NS = not significant (P>0.05). *Significant at P<0.05, ** highly significant at P<0.001 *** very highly significant at P<0.001.

on organoleptic scoring. Interactions showed that white cheese of cow milk had higher (P <0.05) flavor score than goat braided cheese (Table 13).

DISCUSSION

Dairy rural products

Most of the rural dairy producers surveyed in this study agreed that there were fluctuations in milk quantities during the rainy season depending on rain amounts and availability of pasture, a situation which led to mixing of milk from different animal species (cows, goats, and sheep). The high cost of braided cheese as reported by the respondents was due to the extra cost needed for heating before milk processing. Other constraints were shortage of water and marketing.

Variations in the nutrient contents and chemical composition observed in dairy products obtained from different locations could be contributed to factors such as percentage of differences in type of milk mixed and manufacturing conditions.

Dairy products processed at station

Nutrient contents of fresh milk and milk products processed at station showed higher fat, protein and total solid (TS) for cow's milk and milk products than goats milk. This could be attributed to species differences where goats' milk is characterized by small fat globules and low protein content and hence lower TS. Similar observations were obtained in the milk composition of Nigerian cattle, sheep and goats indicating significant variations in all constituents except protein percentage. Caprine milk contained the highest percentages of fat (5.80%), total solids (15.37%) and ash (0.77%), and bovine milk contained the least percentages of fat (0.68%) and lactose (1.84%) (Aduli et al., 2002). Also, it has been pointed out that as fat content increases, moisture content decreases (El Erian, 1976). Also goat's milk showed longer time to coagulate, the poor cheese making ability with goats milk could be due to the specific properties of casein micelles such as composition, hydration and size compared to cow's milk (Abdel-Razig, 1966). The paste rennet, usually produced by shepherds themselves from the abomasum of the lambs or kids of their flock, or the vegetable rennet from the cardoon (*Cynara cardunculus*) flowers locally harvested, are technological factors that strongly influence the quality of the local dairy products (Scintu and Piredda, 2007). It has also been found that renneting time for goat milk is shorter than for cow milk, and the weak consistency of the gel is beneficial for human digestion but decreases its cheese yield (Park et al., 2007). On the other hand, the high yield of cheese from cow's milk could be attributed to the high TS content (Moneib et al., 19881; Ahmed and Khalifa, 1989).

Bacterial profile

Bacillus was found in all samples of cheese either made in laboratory or from rural processing units. This was attributed to the wide range of pH for the growth of *Bacillus*: 4.9 to 9.3 at salt content of 7.5 to 10% (Buchanon and Gibbons, 1974). Other studies on isolates of lactic acid bacteria, from local (Jordan) white cheese made from sheep raw milk indicated that the presence of heterofermentative *Lactobacillus* with variable levels of contamination and frequency (Haddadin, 2005). Also samples collected from different farms in Italy was found to affect bacterial profile of Caprine cheese, isolated species were: coliforms, lactococci, lactobacilli and halotolerant (Foschino, et al., 2002). While those obtained in traditional Egyptian soft Domiati cheese were: *Leuconostoc mesenteroides*, *Lactococcus garvieae*, *Aerococcus viridans*, *Lactobacillus versmoldensis*, *Pediococcus inopinatus*, and *Lactococcus lactis* (El-Baradei et al., 2007).

Staphylococcus aureus was found in samples of white cheese obtained from the traditional processing units but not in pasteurized milk. The major factors that contribute to the presence of *S. aureus* in cheese were the use of un-pasteurized milk with high infected starter culture (Santos and Genigeorg, 1981). Santos et al. (1980) reported that the use of raw milk for manufacture of cheese contains high count of *S. aureus.* And if the milk was collected by non-refrigerated truck and brought to the plant after 3 to 5 h, *Staphylococci* and other organisms will multiply rapidly. Lack of satisfactory sanitary practices in the dairies may contribute to heavy contamination of the milk. Preformed enter toxin can survive milk pasteurization. Therefore, pasteurization cannot be substituted for sanitary milk production. Microbes enter milk and milk products via air, handling, equipments, and high environmental temperatures (> 16°C) (O'Mahony, 1988). It was found that the source of microbial milk contamination was its handling in the time from leaving the udder (65,000 bacteria/ml) until reaching the refrigeration farm tank (in the case of machine-milking, with 362,000 bacteria/ml) or the bulk tank of the cooperative (in the case of hand-milking, with 262,000 bacteria/ml). Farms with fewer animals (<100 animals) that practiced hand-milking had a better hygiene-sanitary quality (Delgado-Pertiñez et al., 2003).

The average total bacteria count for cow and goat milk used for cheese manufacturing at the station were 1.2×10^4 and 3.5×10^2 CFU/ml. These were low counts compared with those reported by Zeng and Escobar (1996) who obtained maximum bacterial counts of 6.4×10^5 CFU/ml. Also O'Ocnnor (1993) stated that plate count of bacteria should not exceed 50000 bacteri a per

milliliter. The average of *Staphylococcus* counts found in cow and goat milk were 1.2×10^4 and 2.2×10^4 per ml, respectively. This count was in the range of the recommended number of *Staphylococcus* < 10^3 to 10^6 CFU/ml, depending on origin of milk (Zeng and Escobar, 1996). Similarly, samples cheese collected from different goat breeds showed that the counts of coliform were within the normal range, although there were significant differences between farms in different regions (Muostafa et al., 2009)

Organoleptic scores of white and braided cheese made from cow and goat milk

Cow milk cheese recorded the highest score points for texture flavor, and taste. Generally, white cheese recorded relatively the highest score points in color, texture, flavor and taste compared to braided cheese. White cheese made from cow milk had the highest scores score points in color, flavor and taste. These results were in accord with the findings of Abdalla and Abdel-Razig (1997) who reported that white cheese made from cow milk significantly scored the best texture and flavor, while the color, saltiness and sourness were not significantly affected by type of milk. It is worth noting here that the cheese obtained in this study was of high standard quality, good color, attractive and glossy with smooth but firm body and texture, with better consistency, richness, much clean and had a good flavor, and without gas holes.

REFERENCES

Abdel-Razig KA (1996). The Production of White Soft Cheese from Different Milk Sources. M.Sc. Thesis, University of Khartoum, Sudan.

Abdalla MO, Abdel-Razig K.A (1997). Effect of type of milk on the quality of white soft cheese. University of Khartoum J. Agric. Sci. 5:47.

Aduli E, Othniel M-A and Yakubu R A (2002).Comparative study of milk compositions of cattle, sheep and goats in Nigeria. Anim. Sci. J. 73:541–544.

Ahmed AM (1985). Bacteriological and Chemical Characteristics of Sudanese White Cheese Produced and Stored under Different Conditions, Ph.D. Theses. University of Khartoum, Sudan.

Ahmed TK, Khalifa NA (1989). The Manufacture of white soft cheese from recombined milk. Sudan J. Anim. Prod. 2:63-69.

AOAC (1990). Official Methods of Analysis (15th Edn.). Association of Official Analytical Chemists (AOAC). Washington, D.C., USA

Cowan ST, Steel RL (1981). Cowan and Steel's Manual for the Identification of Medical Bacteria. 2nd edition.

Chilliard Y, Rouel J, Leroux C (2006) .Goats alpha-s1 casein genotype influence its milk fatty acid composition and delta-9 desaturation ratios. Animal Feed Sci. Technol. 131:474-487.

Delgado-Pertiñez M, Alcalde MJ, Guzmán-Guerrero JL, Castel JM, Mena YF, Caravaca F (2003). Effect of hygiene-sanitary management on goat milk quality in semi-extensive systems in Spain. Small Rum. Res. 47:51–61.

Dewhurst RJ, Shingfield KJ, Lee MRF and Scollan ND (2006). Increasing the concentrations of beneficial polyunsaturated fatty acids in milk produced by dairy cows in high-forage
systems. Anim Feed Sci Technol. 131:168–206.

El-Barade G, Delacroix-Buchet A, Ogier JC (2007). Biodiversity of Bacterial Ecosystems in Traditional Egyptian Domiati Cheese. Appl Environ Microbiol. 73(4):1248–1255.

El-Erian AFM, Abdel T, GadElrab IE (1976). The Effect of Brine Salting Method on the Quality and Chemical Composition of Domiati Cheese from Unsalted Milk. Agric. Res. Rev. 54(7):173-179.

Baradei F, Soryal K, Zeng S, Van Hekken D, Bah B, Villaquiran Sanz Sampelayo MR, Chilliard , Schmidely PH, Boza J (2007). Influence of type of diet on the fat constituents of goat and sheep milk. Small Rum. Res. 68:42-63.

Foschino R , invernizzi A, barucco R and stradiotto K (2002). Microbial composition, including the incidence of pathogens, of goat milk from the Bergamo region of Italy during a lactation year. J. Dairy Res. 69:2:213-225.

Macquat G, Bujanbe SM (1960). Technology of Ewes Milk and Goat's Milk Products. Dairy Sci, Abstr. 22:1.

Moustafa EL, El-Demerdash ME, Hashem ME (2009). Survey study on goat milk from different breeds raised under Egyptian conditions. Egypt. J. Sheep. Goat Sci. 4(1):89-98.

O'Connor CB (1993). Traditional Cheese Making Manual. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia.

O'Mahony F (1988). Rural Dairy Processing: Experiences in Ethiopia. ILCA (International Livestock Centre for Africa) Manual No. 4. ILCA, Addis Ababa, Ethiopia. P. 64.

Santos EG, Genigeorgis CC (1981). Survival and Growth of *Staphylococcus aureus* in Commercially Manufactured Brazition Minas Cheese. J. Food Prod. 44,177-184.

Schalm WO, Carrol EJ, Jain NC (1971). Bovine Mastitis, a book. School of Veterinary Medicine, University of California Press, Davis, USA.

Scintu MF, Piredda G (2007). Typicity and biodiversity of goat and sheep milk products. Small Ruminant Res. 68(1):221-231.

Steel RGD, Torrie JK (1980). Principle and Procedures of Statistics A biometrical Approach (2nd Edn.). McGraw-Hill Books CO. NY. USA.

Talpur FN, Bhanger MI, Memon NN, (2009). Milk fatty acid composition of indigenous goat and ewe breeds from Sindh, Pakistan. J. Food Comp. Anal. 22:59-64.

Taylor GC (1970). A rapid enzymatic method for the determination of lactose in cheese. Austr. J. Dairy Technol. 25:7.

Thorsdottir I, Hill J, Ramel A, Short communication: seasonal variation in *cis*-9, *trans*-11 conjugated linoleic acid content in milk fat from Nordic countries. J. Dairy Sci. 87:2800-2802 (2004).

Zeng SS, Escobar EN (1996). Effect of Breed and Milking Method on Somatic Cell Count, Standard Plate Count and Composition of Goat Milk. Small Rum. Res. 19:169-175.