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Assessment of Rural Dairy Products in North Kordofan State, Sudan

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ABSTRACT

Laboratory cheese making trials were conducted in a rural area of western Sudan (North Kordofan) to study the effects of milk type (goat vs. cow) and cheese type (white soft vs. braided) on cheese characteristics. Randomized complete block design for the cheese samples data and a 2×2 factorial randomized complete block design for the laboratory trials data were used. Goat milk recorded the highest ($P < 0.05$) ash contents, whereas cow milk contained the highest total solids (TS), fat, lactose and protein. Goat milk required longer coagulation time compared with cow milk. White cheese required relatively ($P > 0.05$) more time to coagulate compared with braided cheese. White cheese made from goat milk (WG) required the longest ($P < 0.05$) coagulation time, followed by braided cheese from goat milk (BG), braided cheese from cow milk (BC) and then white cheese from cow milk (WC). Cheese yield was significantly affected by both milk and cheese types ($P < 0.01$) and their interaction ($P < 0.05$). The yield of WC was the highest, followed by WG, BC and the least was for BG. Goat cheese had the highest pH, whereas cow cheese had the highest TS, fat and protein contents. Braided cheese had the highest pH, TS, and protein contents while fat contents were highest in white soft cheese. Efficiency of protein and fat recovery were highest in cow cheese ($P < 0.05$). The highest efficiency of recovery was found in braided cheese. No staphylococcus and Coliform bacteria were detected in milk samples used in cheese making trials. BG recorded the highest scores in color ($P < 0.001$), texture ($P > 0.05$) and flavor ($P< 0.01$). However, taste score was higher ($P < 0.05$) in BC compared to the other three cheese types. Cheese produced under laboratory conditions in this study was of high quality. However, there is a high need to raise the awareness of rural dairy producers on hygiene and public health measures necessary for obtaining safe dairy products. Milk intended for dairy processing should be heated (boiling, pasteurization) in order to control bacterial growth and to ensure good quality dairy products. Moreover, there is also a high need for setting quality standards and measures for the different dairy products. Cheese making from sheep and camel milk should also be tested. Other milk coagulants (natural and/or synthetic) should also be evaluated to reduce cost.

Key words: dairy products, cow, goat

INTRODUCTION

Cheese making in Sudan is the major preservation method for surplus milk in rural area especially during rainy season when plenty of milk is available (El Owni and Hamid, 2008). White cheese is the major type of cheese in Sudan. Other cheese varieties are also produced but in limited scale, these include braided (Mudaffara) and recently Gouda and Mozzarella have been introduced (Ibrahim, 2008). White cheese is usually made from raw milk and without the use of starter culture (Abdalla *et al*., 1993). The gross composition of cheese milk, especially the concentrations of protein, casein and fat, has a major influence on several aspects of cheese manufacture, including rennet coagulability, gel strength, curd syneresis, cheese composition, yield and quality (Guinee *et al*., 2007).

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 chemical preservation of milk in 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

Area of study

This study was carried out in western Sudan (North-Kordofan state) under semi-arid conditions; latitude 11° 15’ N, longitude 27° 32’ E. Average temperature varied between 30 – 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.

Laboratory cheese products making

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 6 times for 6 consecutive days. Milk from both sources were first heated to 72°C, cooled and divided into two equal portions, one is used to make braided chesses 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) were added, stirred for 5 minutes and left to coagulate. The curd was cut into cubes, placed in a mesh and left to drain the whey for 20 – 30 minutes. 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 colded until the required acidity (0.46 –

0.60) for 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 for 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 determined according to AOAC (1990).

Bacteriological analyses

Media preparation and chemical tests of 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 X 2 factorial randomized block design. Duncan multiple range test was used to test mean separation (Steel and Torrie, 1980).

Results

Chemical Composition and Bacteriological Profile of Dairy Products

Dairy products trials

Fresh milk samples from cows and goats, analyzed for their nutrient contents and chemical composition showed that, cow milk had higher ($P < 0.05$) TS, fat and protein contents, whereas goat milk had higher ($P < 0.05$) pH and ash values (Table 1).

Table 1. 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	0.22NS

NS = not significant (P > 0.05), * Significant (P < 0.05), SE = Standard Error

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 showed higher yield (P <0.001) than the white cheese. Interactions of type of milk X type of cheese (interaction between type of milk and type of cheese) 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 2).

Table 2. Effects of milk type and cheese type on coagulation time (hr) and yield of cheese

Factor	Coagulation Time (hr)	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)	1.06NS	0.12 ***
Type of milk×Type of cheese		
Cow–White (CW)	5.1b	17a
Goat–White (GW)	13.2a	14.8b
Cow–braided (CB)	7.8b	10.8c
Goat–braided (GB)	8.1b	9.2d
± SE (interaction)	1.5*	0.17*

abcdValues 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.

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 3).

Table 3. 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*	0.38NS
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***	0.17NS	0.42NS	0.39***	0.38NS
Type of milk × type of cheese						
Cow-white (CW)	4.9	56.3	8.37bc	24.9	17.3	5.8
Goat-white (GW)	5.1	51.7	8.8ab	22.2	15.9	4.9
Cow-Braided (CB)	5.7	60.3	7.64c	24.2	24.3	4.0
Goat-braided (GB)	5.7	58.7	9.4a	21.3	23.3	4.7
±SE	0.10NS	0. 9NS	0.25**	0.59NS	0.55 NS	0.5NS

abcValues 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

Efficiencies of milk fat and protein recovered were 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 4).

Table 4. 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

A first whey characteristic was 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 5).

Table 5. 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	0.14^{NS}	0.40^{NS}	0.41^{NS}	0.27^{NS}	0.066^{NS}	0.28^{NS}
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	0.14^{NS}	0.40***	0.41***	0.03**	0.07^{NS}	0.28^{NS}
Type of milk x type of cheese						
Cow-white (CW)	6.0	14.0	7.5	0.13	1.1^{ab}	5.3
Goat-white (GW)	5.8	14.9	8.5	0.15	0.88^{b}	5.4
Cow-braided (CB)	5.7	6.6	0.50	0.02	1.03^{ab}	5.1
Goat-braided (GB)	5.5	7.1	0.59	0.02	1.3^{a}	5.2
±SE	0.19^{NS}	0.57^{NS}	0.58^{NS}	0.03^{NS}	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

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 6). The microbial profiles for the dairy products were not affected by either type of milk, type of cheese or their interaction (Table 7).

Table 6. 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 7. The microbiological profile of milk types used and cheese processed in the laboratory

	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 x 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

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 on organoleptic scoring. Interactions showed that white cheese of cow milk had higher ($P<0.05$) flavor score than goat braided cheese (Table 8).

Table 8. 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	0.214NS	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 $P<0.001$.

DISCUSSION

Dairy products assessment

Nutrient contents of fresh and processed milk products 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. Similarly, it has been pointed out that as fat content increases, moisture content decreases (El Erian *et al*., 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 cows milk (Abdel-Razig, 1966). On the other hand, the high yield of cheese from cow's milk could be attributed to the high TS content (Moneib *et al.*, 1981: Ahmed and Khalifa, 1989).

Bacterial profile

Bacillus was found in all samples of cheese, this was attributed to that the wide range of pH for the growth of *Bacillus* that is 4.9 to 9.3 and salt content of 7.5 to 10% (Buchanon and Gibbons, 1974). The average total bacteria count for cow and goat milk used for cheese manufacturing 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 a maximum bacterial count of 6.4×10^5 CFU/ml. Also O'Oconnor (1993) stated that plate count of bacteria should not exceed 50000 bacteria per milliliter. The average of *Staphylococcus* counts found in cow and goat milk were 1.2×10^4 and $2.2x10^4$ 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).

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 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.

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