Annals. Food Science and Technology
2011

COMPOSITION AND HYGIENIC QUALITY OF SUDANESE WHITE CHEESE PRODUCED BY SMALL SCALE IN RURAL AREA OF EASTERN SUDAN

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Abstract
This study was carried out to compare the chemical composition and microbiological quality of Sudanese white cheese produced by small-scale production units in rural areas of eastern Sudan (New Halfa). The study was based on collection of sixty fresh cheese samples from 10 producers (6 samples from each) during the period of February to July in 2008. The means of protein, fat, ash, total solids and titratable acidity for cheese samples were 20.20± 3.68%, 23.38± 4.80%, 5.13± 2.07%, 50.88± 5.57% and 0.71± 0 .44%, respectively. The results indicated significant (P<0.05) variations among different producers for fat, total solids and ash content and non significant (P>0.05) differences in protein content for cheese samples. High bacterial load was found in cheese samples collected from different producers. The means of total bacterial count (TBC), coliform count, yeast count and moulds count were found as log 5.83± 1.01, log 4.68± 1.52, log 5.23± 1.05 and log 4.40± 1.05 cfu/gm, respectively. These results revealed non significant differences (P>0.05) between the cheese samples for moulds count. The findings of this study suggest that intervention and training of cheese producers will be needed to improve the quality of Sudanese white cheese in rural areas of Eastern Sudan for proper utilization of the surplus milk.

Keywords: traditional white cheese processing, microbiological loads, compositional content, rural areas, eastern Sudan.

Submitted: 04.10.2011 Reviewed: 07.11.2011 Accepted: 07.12.2011

1. INTRODUCTION

Cheese is highly nutritious food with many diverse flavor and texture and it can be used as a snack or as a part of dish or prepackaged conveniences food (Guinee, 2004). In Sudan, white cheese locally known as *Gibna bayda* is the most popular type of cheese (El Owni and Hamid, 2008). They added that Sudanese white cheese is a unique among pickled cheese with high concentrations of sodium chloride, which is added to the milk before renneting. Nour Eldiam and El Zubeir, 2007 found that the yield of Sudanese white cheese made from 30 liters milk with 4.4 fat percentages was 1.750 Kg after 15 days ripening time and was 1.5 Kg after 30 days ripening time. Warsama *et al.*, 2006 studied the chemical composition of 36 samples of Sudanese white cheese in Khartoum North market and found that the total solids, ash, fat, protein and acidity for the samples were 47.8%, 6.2%, 14.0%, 15.9% and 0.04%, respectively. Hamid and El Owni, 2008 reported that the average chemical composition of Sudanese white cheese produced by small scale units in South and West Darfur State (Sudan) were 52.84% total solids, 23.79% fat, 20.41% protein and 5.34% ash, and the titratable acidity was 1.03% titratable acidity, respectively.

Ceylan *et al.*, 2003 studied the microbiological quality of sikma cheese (white pickled Turkish cheese). They reported a high average of coliform count (5.99 log cfu/g), which was attributed to the post-contamination that could

coliform counts are affected by storage (Hamid and El Owni, 2008). They also added that longer storage time was found to increase yeast and moulds count, which was significantly higher in cheese with 4% salt than that in 6%. The effect of milk pre-treatment on the keeping quality of Domiati cheese in Egypt was studied by Aly and Galal (Aly and Galal, 2002) who reported total moulds and yeast count of 6.2×10^6 and 1.9×10^6 for fresh and four months stored cheese, respectively.

In spite of the popularity of Sudanese white cheese, few studies were done on chemical composition and microbial quality of this cheese in eastern Sudan (Kassala State). Hence, this study was designed to evaluate the quality of the white fresh cheese produced by small scale producers in rural area of New Halfa, Kassala StateIn spite of the popularity of Sudanese white cheese, few studies were done on chemical composition and microbial quality of this cheese in eastern Sudan (Kassala State). Hence, this study was designed to evaluate the quality of the white fresh cheese produced by small scale producers in rural area of New Halfa, Kassala State.

2. MATERIALS AND METHODS

Source of samples

Six batches of cheese samples (60 samples) from traditional small-producers (10) in New Halfa area (Eastern Sudan) were collected during the period from February to July, 2008. Samples were collected either from cheese containers with whey or wooden mould. Cheese samples were examined for chemical and microbiological properties at Department of Dairy Production, Faculty of Animal Production, University of Khartoum.

Analysis of cheese samples

Cheese samples (200 grams) were packed into sterile plastic containers, tightly closed and sealed with cellophane tapes. Then containers were kept in a refrigerator till transferred to laboratory for chemical and microbiological examination.

Chemical analysis

Using the procedures described by AOAC (1990), protein content (Kjeldahl's method), fat content (Gerber's method), total solids, ash content and titratable acidity of the cheese samples were determined.

Microbiological examinations

All media used in this study were obtained in dehydrated form and prepared according to the manufactures instruction. Glassware such as Petri dishes, test tubes, pipettes and flasks were sterilized in hot oven (1 hr, 170 $^{\circ}$C for two hours), whereas, media and distilled water were sterilized by autoclaving (15 min, 121 $^{\circ}$C) according to the procedure described by Marshall (Marshall, 1992).

Five grams of the cheese samples were added to warm (45 $^{\circ}$C) 15 ml of 2% sodium citrate and blinded for 2 minutes. Then one ml from the mixture was transferred to 9 ml sterile normal saline in a screw capped bottle and thoroughly mixed. Then 1 ml of the prepared dilution was transferred into a second dilution bottle. This process was used to prepare ten-fold dilution from 10^{-1} to 10^{-7} as described by Richardson (Richardson, 1985) . Then one ml from each selected dilution was cultured on plates containing the selected media in duplicate and then incubated. The plates containing 25– 250 CFU were enumerated for total bacterial count, whereas the plates containing 15-150 CFU were enumerated for coliform and yeast and mould count (Christen *et al.*, 1992).

The total bacterial count was done according to Houghtby (Houghtby *et al.* 1992) using standard plate count agar. The plates were incubated at 32 $^{\circ}$C for 48 hours. MacConkey was used to determine the coliform count according to Christen (Christen *et al.*, 1992). The plates were incubated at 37 $^{\circ}$C for 18- 24 hours. The total count of yeast and mould were determined according to Frank (Frank *et al.*, 1992) using sabouraud dextrose agar. The plates were incubated at 25 $^{\circ}$C for five days. Typical colonies were counted.

Statistical analysis

All statistical calculations were performed using SAS program, General linear models

was used to estimate the effect of chemical composition and microbiological characteristics of white cheese. Duncan's multiple ranges test were carried out for mean separation between treatments (SAS, 1997).

3. RESULT AND DISCUSSION

Table 1 showed that the protein content was found in range from 14.3 to 32.8%. This finding is agreed with Warsama (Warsama *et al.* 2006) who reported 15.9% protein content for Sudanese white cheese. Similarly El Owni and Hamid (El Owni and Hamid, 2007) reported protein content ranging between 19.70 and 29.73%. Wide range of variations in protein content in cheese samples collected from different production units in New Halfa area could be due to different manufacturing procedures used by the producers. The variation of milk constituent was reported to affect manufacturing and various characteristics of cheese (Aly and Galal, 2002). Also variation can be expected due to differences in cultures, rate of acid production, moisture, salt concentration and prior treatment of milk and curd, and storage temperature (Kosikowiski, 1982).

Table 1: Comparison between chemical compositions of Sudanese white cheese produced in New Halfa

Producer	Protein (%)			Fat (%)			Total solids (%)		
	Mean± Sd.	Min	Max	Mean± Sd.	Min	Max	Mean± Sd.	Min	Max
1	18.08± 1.87	15.70	20.70	20.5^{b}± 4.80	12.00	25.00	47.45^{ab}± 4.43	41.30	54.70
2	18.25 ± 2.94	14.30	20.90	21.75^{ab}± 2.64	17.50	25.00	46.78^{b}± 3.96	41.70	51.50
3	20.11 ± 5.53	14.90	29.80	22.66^{ab}± 2.16	20.00	26.00	51.23^{ab}± 4.38	44.20	54.80
4	22.16 ± 5.89	15.90	32.80	21.00^{b}± 2.44	18.00	25.00	49.65^{ab}± 5.78	42.40	59.10
5	20.37 ± 0.92	19.30	21.90	21.67^{ab}± 1.97	18.00	23.00	50.33^{ab}± 3.83	43.30	54.80
6	19.02 ± 3.25	15.50	23.80	24.67^{ab}± 6.62	12.00	30.00	52.33^{ab}± 5.13	43.30	57.50
7	22.62 ± 3.02	19.50	27.80	26.50^{a}± 3.08	21.00	30.00	54.45^{a}± 4.84	47.30	60.90
8	20.93 ± 2.75	18.40	24.90	23.17^{ab}± 4.07	19.00	29.00	51.60^{ab}± 3.84	45.60	56.80
9	20.55 ± 3.96	16.70	28.10	25.50^{ab}± 3.02	20.00	29.00	54.35^{a}± 4.68	49.90	60.70
10	19.98 ± 3.70	14.80	23.80	26.33^{a}± 4.37	20.00	33.00	50.57^{ab}± 10.4	37.80	68.70
Average	20.20± 3.68	14.30	32.80	23.38± 4.80	12.00	33.00	50.88± 5.57	37.80	68.70
Sig	NS			*			*		

In this and the following tables: Mean within the same column bearing the same superscripts are not significant different *significant level (P<0.05) **significant level (P<0.01)
NS No significant differences

Table 2: Comparison between chemical compositions of Sudanese white cheese produced in New Halfa

Producers	Ash (%)			Acidity (%)		
	Mean± sd	Min	Max	Mean± sd	Min	Max
1	6.28^{ab}± 2.06	2.60	7.80	0.37^{cd} ± 0.19	0. 20	0.60
2	5.76^{abc}± 1.44	4.00	7.80	0.80^{abc} ± 0.48	0.17	1.24
3	6.45^{ab}± 3.03	3.50	11.20	0.66^{bcd} ±0.26	0.40	1.12
4	5.83^{abc}± 1.82	3.90	8.40	0.31^{d} ± 0.14	0.12	0.50
5	7.37^{a}± 2.27	5.40	11.40	0.46^{cd} ± 0.17	0.24	0.70
6	4.27^{bcd}± 0.86	3.00	5.20	1.03^{ab} ± 0.45	0.44	1.60
7	3.65^{bcd}± 0.57	3.00	4.70	1.24^{a} ± 0.15	1.08	1.52
8	4.57^{bcd}± 0.87	3.60	5.70	0.52^{bcd} ±0.31	0.24	1.10
9	3.82^{bcd}± 0.79	3.00	4.60	0.69^{bcd} ±0.20	0.32	0.88
10	3.25^{d}± 1.78	1.10	5.40	1.03^{ab} ± 0.72	0.52	2.40
Average	5.13± 2. 07	1.10	11.40	0.71 ± 0.44	0.12	2.40
Sig.	**			**		

Significant (P<0.05) variations were obtained for fat content, which was found in range from 12.00 to 33.00%, between different production units as shown in Table 1. These results were in accordance with those reported by Warsama (Warsama *et al.*, 2006) and Hamid and El Owni (Hamid and El Owni, 2008) who reported average fat content for Sudanese white cheese in range between 14.0 and 26.33%. The high average fat content in this study (23.38± 4.80%) might be due to high fat content of raw milk. Similar finding was reported by Nelson and Barbano (Nelson and Barbano, 2004).

Lower fat content was found to be associated with some producers (Table 1).

This result is probably due to the reason that some producers separate milk fat in order to produce ghee as additional dairy product beside production of white cheese.

The total solids content varied between 37.80 and 68.70% with significant (P<0.05) differences between the values obtained from different producers (Table 1). The estimated mean (50.88± 5.57%) was similar to the finding reported by Hamid and El Owni (Hamid and El Owni, 2008) who reported mean total solids of 52.8%. The variations in total solids content of the cheese samples between different producers could be due to the lack of standard procedure. It might also be because some producers heated the milk before processing, which results in increase of total solids of the cheese (Patel *et al.*, 1986) .

The ash content ranged between 1.10 and 11.40, moreover the results showed that there were highly significant differences (P<0.01) between the ash content of the cheese samples produced by different producers (Table 2). These results were within the range obtained by Hamid and El Owni (Hamid and El Owni, 2008) . Moreover Warsama (Warsama *et al.*, 2006) reported that the average ash content of Sudanese white cheese was 6.2%. The variations in ash content between different producers probably arise from different salt level used by producers. The result was in line with that reported by Abdalla and Ahmed (2010) [1] who stated that ash content increase with an increase in salt content in the cheese.

Table 3: Microbiological quality of the Sudanese cheese samples from New Halfa

Producers	Total bacterial count (log cfu/gm)			Coliform count (log cfu/gm)			Yeast count (log cfu/gm)			Mould count (log cfu/gm)		
	Mean ± sd	Min.	Max.	Mean± sd	Min	Max	Mean± sd	Min.	Max.	Mean ± sd	Min.	Max.
1	5.66^{ab} ±0.87	4.72	6.81	3.39^{b}±0.60	2.30	3.95	4.63^{b}± 0.94	3.40	5.76	4.13^{a} ±0.94	2.40	6.08
2	5.52^{ab} ±1.65	4.30	7.99	5.23^{b}±1.89	3.30	5.26	5.00^{b}± 0.93	3.70	6.49	4.39^{a} ±0.93	3.40	4.88
3	5.06^{b} ±0.72	4.43	6.40	4.57^{b}±1.15	3.30	5.78	5.11^{b}± 1.00	3.70	6.76	4.57^{a} ±1.00	3.40	6.76
4	6.01^{ab} ±0.92	4.79	7.41	4.93^{b}±1.56	3.30	6.34	5.60^{b}± 0.72	4.48	6.6	4.55^{a} ±0.72	3.40	6.60
5	5.57^{ab} ±0.59	4.91	6.34	4.87^{b}±1.53	3.30	5.78	4.95^{b}± 1.07	3.70	6.61	4.90^{a} ±1.07	3.70	6.60
6	5.72^{ab} ±0.97	4.23	6.59	4.71^{b}±1.59	3.30	5.70	5.42^{b}± 1.02	3.72	6.76	4.49^{a} ±1.02	3.40	5.76
7	5.43^{b} ±0.74	4.48	6.26	4.01^{b}±0.74	3.30	5.26	5.19^{b}± 1.16	3.72	6.88	4.25^{a} ±1.16	3.40	5.36
8	6.48^{ab} ±0.60	5.71	7.08	4.56^{b}±1.65	3.30	6.76	4.76^{b}± 1.19	3.70	6.76	4.25^{a} ±1.19	3.70	4.78
9	6.02^{ab} ±0.87	5.18	7.20	5.05^{b}±1.45	3.30	6.48	5.81^{a}± 1.18	4.34	7.18	4.25^{a} ±1.18	3.40	5.74
10	6.80^{a}± 1.20	4.93	7.41	5.47^{a}±2.35	3.30	6.43	5.86^{ab}± 1.19	3.70	6.85	4.27^{a} ±1.19	3.70	5.36
Average	5.83± 1.01^{**}	4.23	7.99	4.68±1.52^{**}	2.30	6.43	5.23±1 $.05^{**}$	3.40	7.18	4.40^{a} ±1.05 **	2.40	6.76
Sig.	**			**			**			NS		

Significant (P<0.05) variations were observed in titratable acidity of the collected cheese samples from the small production units (Table 2). The range was found to be 0.12 to 2.40% which was higher than that reported by Warsama *et al.* 2006 and El Owni and Hamid 2007. The high acidity of the cheese samples could be due to high bacterial count in raw milk as shown in Table 3. Abdalla and Ahmed, 2010 reported that the high acidity of raw milk cheese could be due to the fact that storage temperature activated the natural microflora of raw milk and resulted in the development of acidity as the result of lactose fermentation.

The total bacterial count in this study ranged between log 4.23 and 7.99 cfu/gm (Table 3). These results were in the range obtained by Hamid *et al.*, 2008 who reported that total bacterial count increased from day zero to day 60 then gradually decreased onwards to day 240. These results of the microorganisms in cheese samples were in line with those of Aly and Galal, 2002. The highly significance (P<0.01) differences in total bacterial count of Sudanese white cheese might be due to the use

of raw milk for the manufacture in rural areas which supported Hamid and El Owni, 2007. Nour El Diam and El Zubeir, 2006 reported that superior quality processed cheese can be produced if the milk is pasteurized before cheese processing to eliminate the original microfolora of milk.

The high total bacterial count possibly attributed to rapid growth of microorganisms during early stages of ripening. Differences between cheese samples from different producers (Table 3) might be explained by the microbial count of raw milk Ceylan *et al.*, 2003.

The coliform bacterial count determined in Sudanese white cheese produced in production units in New Halfa area ranged between log 2.30 to log 6.43 cfu/gm (Table 3). These results showed significant ($P<0.01$) variations between producers. Moreover it was similar to those reported by Warsam *et al.*, 2006 who reported that the log count of coliform bacteria were 6.56± 0.53, 6.54± 0.25 and 6.49± 0.23 for cheese samples collected from restaurant, supermarkets and groceries, respectively. This result also agreed with Coveney *et al.*, 1994. High coliform count in processed cheese might be due to poor processing conditions or post processing contamination (Nour El Diam and El Zubeir, 2006). El Zubeir *et al.*, 2006 found that the total bacterial counts were found to be higher in samples with higher count of Enterobacteriaceae and this was mainly noticed in restaurants at Khartoum, which revealed $5.6\times10^{8}\pm3.7\times10^{8}$.

The yeast and moulds count varied between log 3.4 and 7.18 cfu/gm ($P<0.01$) and log 2.40 and 6.76 cfu/gm ($P>0.05$), respectively (Table 3). These results supported Rosstita and Fleet 1998 who reported that yeast population greater than 6 log cfu/gm, which were found in 54% out 85 samples examined. Also these results were in the range obtained by Hamid and El Owni, 2007. They found yeast and moulds counts were between zero to 6.53 cfu/gm in 8 production units in Zalengi area (Western Sudan) with average count of log 4.46 cfu/gm. Similarly Nour El Diam and El Zubeir, 2007 found that different ripening periods of the Sudanese white cheese showed highly significant ($P<0.001$) differences for yeast and mould counts.

4. CONCLUSIONS

The present study concluded that variations in the chemical composition might be due to the different manufacturing methods and milk composition that affects the chemical composition of the produced cheese which supported Tarakci and Kucukoner, 2006 and Turkoglu *et al.*, 2003. High bacterial load found in cheese samples collected from different producers suggested that the level of hygiene, production methods, source of raw milk and its handling could be the main factors attributed to this high loads which might affect the quality of cheese. Hence it is recommended that traditional cheese methods need to be encouraged and improved by hygienic handling and appropriate methods of processing in order to utilize the surplus milk in rural areas.

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