



International Journal of **Dairy Science**

ISSN 1811-9743



Academic
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Composition and Hygienic Quality of Sudanese White Soft Cheese in Khartoum North Markets (Sudan)

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Abstract: The study was based on surveying thirty six samples of Sudanese white cheese from restaurants, supermarkets and groceries (Khartoum North). The comparison of the chemical composition (total solids, total protein, fat, ash and acidity) and some of the microbial hazards (*E. coli*, *Salmonella* spp. and *Staphylococcus aureus*) associated with cheese were estimated. The means of total solids, ash, fat, protein and acidity for the samples were 47.8, 6.2, 14.0, 15.9 and 0.04%, respectively. The result indicated that there was non significant differences between total solids, ash, fat, acidity and protein in all batches in different sources. Positive isolates for *E. coli* (4), *Salmonella typhi* (4), *Salmonella paratyphi* (4) and *S. aureus* (8), were found in restaurants. Similarly 4, 4, 0 and 4 and 2, 2, 0 and 2 isolates of *Salmonella typhi*, *Salmonella paratyphi*, *S. aureus* and *E. coli* were found, respectively in supermarkets and groceries. The log counts of coliforms bacteria was 6.56006 ± 0.52936 , 6.5423 ± 0.24873 and 6.4856 ± 0.23278 and the log counts of total bacteria (SPC) was 9.46956 ± 0.58882 , 9.02652 ± 0.01826 and 8.9713 ± 0.44743 for cheese samples collected, respectively from restaurants, supermarkets and groceries. Similarly, the log of *Salmonella* spp. counts was found to be 4.0612 ± 0.0629 , 2.0037 ± 2.8337 and 4.97803 ± 1.1807 ; the log count of *Staphylococcus aureus* was 3.40887 ± 4.82087 , 4.90646 ± 6.93878 and 0 and the log of *E. coli* counts was 5.23337 ± 0.53085 , 0 and 5.33815 ± 0.771346 , respectively from restaurants, supermarkets and groceries.

Key words: Sudanese white cheese, composition, hygienic quality, SPC, coliforms counts, *Salmonella* spp., *S. aureus*, *E. coli*

Introduction

Cheese was originally developed as a mean of preserving raw milk in time of excess production and cheese is generally considered to be relatively safe food. It contains high quality proteins, vital minerals and vitamins (Ibrahim, 1971). However, the spread of some diseases by cheese have been demonstrated and as a result, most cheese is now produced from milk that has been pasteurized (Anonymous, 1998). It is indisputable that some outbreaks of food borne illness have been clearly linked with the consumption of cheese, the majority of those reported being associated with cheese made from unpasteurized milk. Whilst pathogens can gain access to cheese after curd formation, it is clear that many food borne pathogens are faecal in origin (Rampling, 1996).

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One of the most frequent food borne microbial disease is staphylococcal food poisoning, which is caused by *S. aureus* metabolites (Holeckova *et al.*, 2002). Similarly it was reported that several pathogenic bacteria (*Salmonella* spp., *Brucella* spp., *Compylobacter* spp. and *Listeria* spp.) can survive in cheese made from raw milk and may not be destroyed by some heat process (Ibrahim *et al.*, 1981). It was also investigated that the presence of some pathogenic bacteria in soft cheese were found to be *Staphylococcus aureus* and it was found in about 20% of the samples and *Escherichia coli* that was isolated from 21.1% of the samples (Araujo *et al.*, 2002). *Salmonella* spp. was responsible for 29 outbreaks, *Listeria monocytogenes* for 10 outbreaks, *E. coli* for 11 outbreaks and *Staphylococcus aureus* for 10 outbreaks in France (De Buyser *et al.*, 2001). Moreover 600 cases of salmonella outbreaks in south West Germany were reported to be due to contaminated cheese (Geiss *et al.*, 1993). However the incidences of coliforms, B-glucuronidase positive *E. coli* and *S. aureus* were higher in soft than in blue veined, semi hard, hard and fresh cheeses (De Reu *et al.*, 2002). Moreover it has been shown that curd at 8°C, for 5 min resulted in the loss of culture ability of *E. coli* O157: H7 during the production of mozzarella cheese (Spano *et al.*, 2003).

Hence, the present study was undertaken to estimate the chemical composition and the hygienic quality and to determine some food borne diseases associate with Sudanese white cheese from some markets in Khartoum North.

Materials and Methods

Source of Cheese Sample:

Thirty six samples of Sudanese white cheese were collected from Khartoum North. The survey involved restaurants, groceries and supermarkets. The collection of the samples was done in duplicate.

Analysis of Cheese Samples

The samples were collected in a clean sterile bottles and transported at 4°C to the laboratory of the Department of Dairy Production, Faculty of Animal Production, University of Khartoum, for chemical and microbiological examination.

Chemical Analysis

The protein content was determined by Kjeldahl methods, the fat content was determined by Gerber's method and total solids was determined according to the modified method (Anonymous, 1990). Similar ash content and the titratable acidity were also determined according to the method of AOAC (1990).

Microbiological Examination

The samples were enumerated for counting total bacteria (standard plate count) and some potential pathogenic bacteria (*E. coli*, *Staphylococcus aureus*, coliform and *Salmonella* spp.). Plate count agar, salmonella and shigella agar, mannitol salt agar, metachromgelb agar were the selected media for enumeration. All media were obtain in dehydrated forms and prepared according to the manufacture's instructions. Sterilization, (Barrow and Felthman, 1993) dilution of the samples (Richardson, 1985) and purification and identification of the isolates (Barrow and Felthman, 1993) were done.

Statistical Analysis

The data of the present study were analyzed statistically using Complete Randomized Design. ANOVA test and the least significant difference were used to determine the difference between means. The analysis was carried out using SAS (1989).

Results and Discussion

Chemical Composition

The fat content revealed values of $19.9167 \pm 3.9802\%$, 17.7917 ± 1.9001 and $19.6667 \pm 2.8402\%$ for cheese samples collected from restaurants, supermarkets and groceries, respectively. However values of 16.0 and 27%, 15.5 and 20% and 15 and 22.2% were reported for minimum and maximum values, respectively (Table 1). There was no significant differences between these values.

The low values of fat might be due to storage as it was indicated that fat content was high in the beginning of storage period, then gradually decreased towards the end of storage period of cheese (Nuser, 2001). Moreover, some fat must have leaked from curd into the brine solution, which partially might explain the decrease in fat content in curd during the storage period (Abdalla, 1992).

The average protein content recorded values of 13.6751 ± 2.2600 , 15.4083 ± 3.62787 and $13.3917 \pm 2.03087\%$ for cheese samples collected from restaurants, supermarkets and groceries, respectively. However, values of 11.5 and 17.5, 12.35 and 22.3, 11.7 and 16.3% were found for minimum and maximum, respectively (Table 1). All these values of protein, showed non significant differences between them.

Protein content in restaurants and groceries (Table 1) showed low values. This result agreed with the findings, which reported that protein decreased considerably due to degeneration of protein and loss in whey (Khalid, 1991; Abdel Razig, 1996).

The average acidity revealed values of $1.61 \pm 0.7731\%$, 1.5667 ± 0.5930 and $1.52561 \pm 0.5672\%$ for cheese samples collected from restaurants, supermarkets and groceries, respectively. Values of 1.05 and 3.15%, 1.0 and 2.7% and 1.15 and 2.65% were found for minimum and maximum values, respectively (Table 1). There was non significant differences between all values of the acidity. This was explained as that, the high acidity of raw milk cheese could be due to the fact that the storage temperature activated the natural microflora of raw milk to develop acidity as the result of lactose fermentation since the cheese was stored at room temperature (Hamed, 1998). Moreover it was reported that whether at room temperature or in the refrigerator about 45-80% of increase in the acidity was mainly due to lactic acid formed by the usually predominating lactic acid bacteria (Nofal *et al.*, 1981).

The average ash content values were 8.0833 ± 6.3306 , 6.95 ± 3.7303 and $8.2667 \pm 5.4458\%$ for cheese samples collected from restaurants, supermarkets and groceries, respectively. Values of 4.2 and 20.45%, 4.05 and 14.15% and 5.25 and 19.3% were reported for minimum and maximum values, respectively (Table 1). There were non significant differences between values of ash content. The increase in ash content during picking might be due to decrease in moisture content or absorption of salt by curd (Abdel Razig, 1996).

The average total solids content revealed values of 44.0792 ± 11.4859 , 43.975 ± 5.7403 and $47.4833 \pm 7.9743\%$ for cheese samples collected from restaurants, supermarkets and groceries, respectively. However values of 22.425 and 56.15%, 39.15 and 54.85% and 41.6 and 53.6% were reported for minimum and maximum values, respectively (Table 1). This values agreed with previous reports by Nuser (2001) and Hamed (1998).

Table 1: Comparison of the hygienic and compositional quality of Sudanese white soft cheese in Khartoum North

	Resturant			Supermarkets		
Items	Mean±SD	Min.	Max.	Mean±SD	Min.	Max.
<i>E. coli</i> (cfu mL)	5.23337±0.53085	4.85800	5.60874	0.00000	0.00000	0.000000
<i>S. aureus</i> (cfu mL)	3.40887±4.82087	0.00000	6.81774	4.90646±6.93878	0.00000	9.812900
<i>Salmonella</i> spp. (cfu mL)	4.06120±0.06290	4.01670	4.10560	2.00370±2.83370	0.00000	4.007500
Coliforms (cfu mL)	6.56006±0.52936	6.18574	6.93438	6.54230±0.24873	6.36642	6.718182
Total bacteria (cfu mL)	9.46956±0.58882	9.05321	9.88590	9.02652±0.01826	9.01361	9.039430
Fat (%)	19.91670±3.98020	16.00000	27.00000	17.79170±1.90010	15.50000	20.000000
Protein (%)	13.67510±2.26000	11.50000	17.00000	15.40830±3.62787	12.35000	22.300000
Lactic acid (%)	1.61000±0.77310	1.05000	3.15000	1.56670±0.59300	1.00000	2.700000
Ash (%)	8.08330±6.33060	4.20000	20.45000	6.95000±3.73030	4.05000	14.150000
Total solids (%)	44.07920±11.4859	22.42500	56.15000	43.97500±5.74030	39.15000	54.850000
Groceries						
	Mean±SD		Min.			Max.
<i>E. coli</i> (cfu mL)	5.33815±0.77130		4.79273			5.88358
<i>S. aureus</i> (cfu mL)	0.00000		0.00000			0.00000
<i>Salmonella</i> spp. (cfu mL)	4.97803±1.18070		4.14310			5.81290
Coliforms (cfu mL)	6.48560±0.23278		6.32096			6.65016
Total bacteria (cfu mL)	8.97130±0.44743		8.65492			9.28768
Fat (%)	19.66670±2.84020		15.00000			22.20000
Protein (%)	13.39170±2.03087		11.70000			16.30000
Lactic acid (%)	1.52561±0.56720		1.15000			2.65000
Ash (%)	8.26670±5.44580		5.25000			19.30000
Total solids (%)	47.48330±7.97430		41.60000			53.60000

Table 2: The prevalence of some pathogens in white soft cheese collected from Khartoum North

	<i>S. aureus</i>	<i>E.colisp</i>	<i>S. typhi</i>	<i>S. pratyphi</i>
Restaurants	8	4	4	4
Groceries	0	4	4	4
Supermarkets	2	0	2	2
Total	10	8	10	10

Bacteriology of Isolated Pathogens from Sudanese White Cheese

Incidence of Food Borne Pathogens Isolated from Sudanese White Cheese

In the present survey three different types of the potentially food borne diseases (*E. coli*, *Salmonella* spp. and *S. aureus*) were found in Sudanese white cheese (Table 2).

A total of 38 food borne pathogens were found in the samples of Sudanese white cheese. Of these 10 (26.32%) isolates were identified for each of *S. aureus*, *Salmonella typhi* and *Salmonella paratyphi* and 8 (21.05%) isolates of *E. coli* (Table 2). In restaurants and groceries 8, 4, 4 and 4 and 0, 4, 4 and 4 isolates of each of *S. aureus*, *E. coli*, *Salmonella typhi* and *Salmonella paratyphi* were identified, respectively. However the supermarkets samples revealed 2, 0, 2 and 4 isolates of those organisms, respectively (Table 2).

The Counts of Food Borne Pathogens Isolated from Sudanese White Cheese

Salmonella spp.

The log of *Salmonella* spp. counts was found to be 4.0612±0.0629, 4.0167 and 4.1056, for cheese samples collected from restaurants; for mean + standard deviation, minimum and maximum level, respectively (Table 1). However *Salmonella* spp. in cheese samples collected from supermarkets showed the log counts of 2.0037±2.8337, 0 and 4.0075, respectively (Table 1). The log of salmonella counts was found to be 4.97803±1.1807, 4.1431 and 5.8129 for cheese samples collected from groceries, respectively (Table 1).

Positive isolation of *Salmonella* spp. specially in the restaurants suggested that large numbers of people were at high risk for subjecting to those food borne disease. This might be due to mishandling or improper hygiene as raw milk contamination usually takes place by salmonella from external sources (feaces, the farmer, water pollution and dust) (Asperger, 1994). Similarly it was reported that *Salmonella* food poisoning can occur when some one drinks unpasteurized milk or eat any food contaminated during preparations, poor hygiene can also allow such carrier to spread the infection to others (Carson and Dewitt, 2002). However the present result disagreed with the findings that *Salmonella* spp. was absent in the Sudanese white soft cheese (Ahmed, 1997). Hence the present study supported the study which reported that salmonellae continue to be a major concern for the dairy industry (El-Gazzar and Marth, 1992). Since these bacteria have caused recent outbreaks of illness and have been isolated from various dairy products in the market places (De Buyser *et al.*, 2001; Geiss *et al.*, 1993; El-Gazzar and Marth, 1992). Moreover *Salmonella* can survive a prolong time in frozen foods and that *Salmonella* are readily destroyed at milk pasteurization temperatures (Vlaemynck, 1994).

Staphylococcus aureus

The log count of *Staphylococcus aureus* was found to be 3.40887 ± 4.82087 , 0 and 6.81774 for cheese samples collected from restrant, for mean + standard deviation, minimum and maximum values, respectively (Table 1). However the cheese samples collected from supermarkets revealed log counts of 4.90646 ± 6.93878 , 0 and 9.8129, respectively (Table 1). However, the present survey revealed a negative isolation for *Staphylococcus aureus* in cheese samples collected from groceries.

This result is higher compared with the report which found that the maximum log counts of *Staphylococcus aureus* in Sudanese white soft cheese was 3.500 (Asperger, 1994; Johnson *et al.*, 1990). Moreover, *Staphylococcus aureus* have been found in various types of cheese and involved in outbreaks of food poisoning (De Buyser *et al.*, 2001; De Reu *et al.*, 2002). Similarly it was reported that of 450 volunteers, 131 (29%) were *Staphylococcus aureus* carriers, mostly at the mucosal membrane (Bischoff *et al.*, 2004).

Eschriechia coli

The log mean + standard deviation, minimum and maximum values of *Eschriechia coli* counts were found to be 5.23337 ± 0.53085 , 4.8580 and 5.60874, respectively for cheese samples collected from restaurants (Table 1). Similarly the log counts of *E. coli* were 5.33815 ± 0.77134 , 4.79273 and 5.88358, respectively for cheese samples collected from groceries (Table 1). However *E. coli* during the present survey revealed a negative value (0) for cheese samples collected from supermarkets (Table 1).

The log counts of *E. coli* in restaurants was very high and this might be due to post contamination of the product (Yang and Jones, 1969; Kosikowski, 1982). Similarly this result (Table 1) could be attributed to the traditional method used for the distribution of the product which subjecting it to contamination.

The log count of *E. coli* in groceries was high. This was in support to result, which stated that the manufacturing procedure encouraged some growth of *E. coli* O157:H7 (Maher *et al.*, 2001). Moreover it was also reported that it might be due to mishandling and poor hygiene (Maher *et al.*, 2001). *Eschriechia coli* in cheese samples from supermarkets (Table 1) were absent and had a negative result (0). This was a good result compared to those samples collected from restaurants and groceries which might be due to good quality and good hygiene. However the addition of type O lactic culture might be an additional safeguard to well established good manufacturing practices and hazard analysis

control points programs in the control of growth of *E. coli* O157: H7 in cheese (Saad *et al.*, 2001). Similarly the use of *Lactobacillus paracasei* spp. *paracasei* strains was suggested to increase the safety of cheese made from raw goats milk because these cultures strongly inhibited *E. coli* without adverse sensory changes (Caridi, 2002).

Coliforms Counts

The log counts of coliforms bacteria was found to be 6.56006 ± 0.52936 , 6.18574 and 6.93438 for mean+standard deviation, minimum and maximum values respectively (Table 1), for cheese samples collected from restaurants. Similarly the log counts of coliforms bacteria was found to be 6.4856 ± 0.23278 , 6.32096 and 6.65016, respectively, for cheese samples collected from groceries (Table 1). Also the log counts of coliforms bacteria was found to be 6.5423 ± 0.24873 , 6.36642 and 6.718182 for mean + standard deviation, minimum and maximum values, respectively (Table 1), for cheese samples collected from supermarkets.

This result agreed with the previous reports (Kosikowski, 1982; Coveney *et al.*, 1994). Moreover, it was reported that coliforms bacteria grow well in cold or warm cheese causing slit eyes and that coliforms don't survive in pasteurized cheese milk but may be present as a result of post pasteurization contamination (Kosikowski, 1982). Also the high concentration of fecal coliforms was observed in mozzarella cheese (Massa *et al.*, 1992).

Total Bacteria Counts

The log counts of total bacteria was found to be 9.46956 ± 0.58882 , 9.05321 and 9.8859 for mean + standard deviation, minimum and maximum values respectively, for cheese samples collected from restaurants (Table 1). Total bacteria counts was found to be 9.02652 ± 0.01826 , 9.01361 and 9.03943, respectively (Table 1) for cheese samples collected from supermarkets. However the log counts of total bacteria was found to be 8.9713 ± 0.44743 , 8.65492 and 9.28768, respectively (Table 1) for cheese samples collected from groceries.

The results indicated the presences of pathogenic bacteria (*Salmonella* and coliforms) as shown in Table 2 during the present survey. It is disagreed with the result, which demonstrated the absence of coliform and salmonella in Sudanese white soft cheese (Carson and Dewitt, 2002). Moreover, the high counts of pathogens in cheese samples in the present survey (*Salmonella*, *E. coli*, *Staphylococcus* and coliforms) influence the counts of total bacteria (Table 1).

The present study concluded that there is non significant variation in the chemical content of the Sudanese white cheese marketed in Khartoum North. However, high bacterial load are found to be associated with cheese samples collected from different sources. Moreover, the study was able to identify some potentially foodborne pathogens; such as *Staphylococcus aureus*, *E. coli*, *Salmonella typhi* and *Salmonella paratyphi*. This might indicate that the level of hygiene and storage of the product and its handling which played a major role in the contamination of the cheese.

Hence it was recommended that processing of high quality milk, which produced from healthy animals and should be handled and processed, stored and marketed in a hygienic manner using hygienic utensils. Periodic check out for all food distributing centers by the official authorities should be employed. Further study are needed to demonstrate the vehicles and sources of contaminations with food borne diseases and poisonings. Similarly molecular characterizations of those pathogens and their toxin is needed to determine the level of the health hazards that might arise.

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