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Comparison of Microbiological Quality of Processed and Non Processed Sudanese White Cheese

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Abstract: The processed cheese used during the present study was made from white Sudanese cheese with different ripening time (15 and 30 days) from milk with different fat present (2.2 and 4.4%). At time of processing the processed cheese was packed into two types of packaging (glass and plastic) and stored at 4°C for 3 months. The different fat level of milk showed significant differences ($p<0.05$) on total bacterial counts and coliform count. However the psychrophilic counts and yeast and molds counts showed non significant differences ($p>0.05$) with the different fat percent of the milk from which the processed cheese was made. The psychrophilic counts, total bacterial counts, coliform counts and yeast and molds counts showed significant differences ($p<0.05$) with different ripening time (15 and 30 days). Also the storage periods showed significant differences ($p<0.05$) with psychrophilic counts, total bacterial counts, coliform counts and yeast and molds counts. Similarly the different types of packaging (plastic and glass) showed significant differences ($p<0.05$) with psychrophilic counts, coliform counts and yeast and molds counts. However total bacterial counts showed non significant differences ($p<0.05$) with the different types of packaging of the processed cheese. Hence, the present study concluded that if the Sudanese white cheese could be further reprocessed the hygienic quality and the shelf life would improve.

Key words: Sudanese white cheese, processed cheese, ripening, packaging, fat level, storage, microbial quality

Introduction

Cheese is the generic name for a group of fermented milk based food products, produced in a great range of flavours and forms throughout the world (Fox, 1993). Processed cheese may normally consider as being a stable products with a reasonable shelf life (Kristensen and Skibsted, 1999; Schar and Bosset, 2002). The cooking process helps to destroy spoilage microorganisms and improve the shelf life of the processed cheese (Siew *et al*., 2004). In cooked hard cheese *Staphylococcus aureus* is usually inactivated during the first day of manufacture due to the high cooking temperature (Zangerl and Ginzinger, 2001). Yeast and molds counts (88.9%) and the coliform counts (96.6%) were found in the 90 samples studied, moreover 4 lots (22.2%) were rejected according to International Commission on Microbiological Specifications for Food (Mercado and Rivas, 1986).

Caric and Kalab (1993) reported that processed cheese spreads are made by selecting suitable cheese according to age, flavour, body and texture. They also added that proper selection of natural cheese is the most importance for the successful production of processed cheese. Moreover it was

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concluded that locally produced soft cheese in Iraq could be used instead of imported semi-hard cheese to make processed cheese of acceptable quality (Hanna and Nader, 1996).

Packing protects food during storage, transportation and distribution against deterioration which may be physical or biological (Anadaswamy *et al.*, 1980). Processed cheese is usually packed and wrapped in lacquered foil, tubes cups, cans cardboard or plastic, cartons and occasionally in glass jars (Stanelyscharow *et al.*, 1970). Pre-sterilized cans were used to pack processed cheese spread made from cheddar cheese prepared from buffalo milk (Tewari *et al.*, 1996). Metwally *et al.* (1996) studied the effect of packaging materials on the keeping quality of processed cheese by using glass jars, locally made polymeric laminated materials and imported poly amide sheets. They recommended the use of glass for packaging processed cheese due to it inertness and its availability in Egypt. They also reported that storage temperature had a greater effect on quality compared to packaging materials.

This study was a trial to produce processed cheese from traditional Sudanese white cheese with different fat levels at different ripening periods and to estimate the hygienic quality of the resulted cheeses. Also the shelf life and package materials for the processed cheese were evaluated.

Materials and Methods

Sources of Milk Rennet and Salts

The present study was done at the Department of Dairy Production, Faculty of Animal Production, University of Khartoum during the period of November 2002 to February 2003. Fresh cow's milk was brought from Khartoum University farm, Rennet tablets were obtained from Chr-Hansen's Lab (Denmark), the salt was purchased from the local market and di-sodium phosphate was a product of Sigma Chemical Company.

Manufacture of Sudanese White Cheese

The Sudanese white cheese was made after adjustment of the milk into two different fat levels (4.4 and 2.2%) using the cream separator. The technology of Sudanese white cheese manufacturing was done as described previously by Osman (1987). Then both cheeses that made from low and high fat content of milk were stored at room temperature for ripening to both 15 and 30 days.

Manufacture of The Processed Cheese

The cheese was cut into small pieces by using stainless steel. Then 3% of di-sodium phosphate and 50% of distilled water were added. It was then mixed using a mixture at water bath steam (80°C for 5 min). Processed cheese were packed into two types of packaging (plastic pack and glass pack) and stored at 4°C.

Microbiological Examination

The samples were examined for total bacteria count, coliform count, yeast and molds count and psychrophilic counts. All media were obtained in dehydrated forms and they were prepared according to the manufactures' instruction. Plate count agar was used for the total bacteria count and psychrophilic count. MacConkey agar is a selective differential media used for coliform counts and Malt extract agar was used for enumeration of yeast and molds. Sterilization, preparation of the samples, serial dilution, incubation and counting were done according to Harrigan and MacCance (1976).

Statistical Analysis

The data of the present study were analyzed using the complete randomized design. ANOVA test and Duncan Multiple Range test were used to determine the differences between means using SAS (1989) programs.

Results

Psychrophilic Counts

Sudanese white cheese and the processed cheese showed mean counts for psychrophilic of 4.9×10^{7} and 2.1×10^{3} cfu g^{-1}, respectively (Table 1 and 2). The different fat level revealed high significant differences ($p<0.001$) for psychrophilic count for the Sudanese white cheese (4.5×10^{7} and 5.2×10^{7} cfu g^{-1} for 2.2 and 4.4% fat, respectively). However non significant differences ($p>0.05$) were obtained for the processed cheese (2.1×10^{3} and 2.1×10^{3} cfu g^{-1} for 2.2 and 4.4% fat, respectively). Significant increases ($p<0.05$) in psychrophilic counts were also found during the storage of the processed cheeses and due to variation of packaging materials as shown in Table 3. The ripening time and its interaction with the different fat % of milk, from which the Sudanese white cheese was made, showed high significant differences ($p<0.001$) for psychrophilic counts in both cheeses (Table 4). Moreover the different storage periods, the types of packaging materials and their interactions showed highly significant differences ($p<0.001$) with psychrophilic count for processed cheeses as shown in Table 4.

Table 1: Effect of different fat level of milk and ripening time on hygienic quality of Sudanese white cheese

	Fat level (%)				Ripening time (days)			
Items	2.2	4.4	Mean	SL	0	15	30	SL
Psychrophilic count (cfu g^{-1})	4.5×10^{7b}	5.2×10^{7a}	4.9×10^{7}	0.001***	7.1×10^{3c}	2.4×10^{8a}	2.2×10^{5b}	0.001***
Total bacterial count(cfu g^{-1})	3.0×10^{8a}	2.9×10^{8a}	2.9×10^{8}	NS	1.3×10^{8b}	1.6×10^{6}	$^{c}6\times10^{8a}$	0.001***
Yeast and mould count (cfu g^{-1})	4.1×10^{5a}	3.8×10^{5a}	3.1×10^{6}	NS	6.5×10^{4c}	1.8×10^{5b}	8.4×10^{5a}	0.001***
Coliform count (cfu g^{-1})	2.6×10^{6a}	3.6×10^{6a}	4×10^{5}	NS	2.3×10^{5b}	8.7×10^{4c}	6.0×10^{6a}	0.001***

In this and the following tables: SL = significant level, NS = non significant ($p>0.05$) * = ($p<0.05$), ** = ($p<0.01$), *** = ($p<0.001$), The same superscript letter in rows indicated significant differences ($p<0.05$)

Table 2: Effect of different fat level and ripening time on hygienic quality of the processed cheese

	Fat level (%)				Ripening time		
Item	2.2	4.4	Mean	SL	15	30	SL
Psychrophilic count (cfu g^{-1})	2.1×10^{3a}	2.1×10^{3a}	2.1×10^{3}	NS	2.9×10^{3a}	1×10^{3b}	NS
Total bacterial count (cfu g^{-1})	4.2×10^{7a}	1.5×10^{7b}	2.9×10^{7}	0.001***	1.7×10^{7b}	4.4×10^{7a}	0.001***
Coliform count(cfu g^{-1})	1×10^{7a}	2.1×10^{5b}	5.4×10^{6}	0.001***	1.8×10^{5b}	1.2×10^{7a}	0.001***
Yeast and mould count (cfu g^{-1})	2.4×10^{5a}	2.4×10^{5a}	2.4×10^{5}	NS	2.2×10^{5b}	2.7×10^{5a}	0.001***

The same superscript letter in columns indicated significant differences ($p<0.05$)

Table 3: Effect of storage periods and packaging material on hygienic quality of processed cheese

Item	Psychrophilic count (cfu g^{-1})	Total bacterial count (cfu g^{-1})	Coliform count (cfu g^{-1})	Yeast and mould count (cfu g^{-1})
Storage periods				
0 day	$4.6\times10^{2\,d}$	$6\times10^{6\,d}$	$1.4\times10^{4\,d}$	$3.6\times10^{4\,d}$
30 days	$7.9\times10^{2\,c}$	$2.2\times10^{7\,c}$	$1.9\times10^{6\,b}$	$5.7\times10^{4\,c}$
60 days	$1.6\times10^{3\,b}$	$4.0\times10^{7\,b}$	$1.6\times10^{7\,a}$	$3.8\times10^{5\,b}$
90 days	$9.1\times10^{3\,a}$	$6.5\times10^{7\,a}$	$6.5\times105^{\,c}$	$6.5\times10^{5\,a}$
Packaging				
Glass	$2.2\times10^{3\,a}$	$3\times10^{7\,a}$	$1.6\times10^{6\,b}$	$2.5\times10^{5\,a}$
Plastic	$2\times10^{3\,b}$	$2.8\times10^{7\,a}$	$9.2\times10^{6\,a}$	$2.3\times10^{5\,b}$

The same superscript letter in columns indicated significant differences ($p<0.05$)

Total Bacterial Counts

The total bacterial count of Sudanese white cheese and processed cheese showed mean counts of 2.9×10^{8} and 2.9×10^{7} cfu g^{-1}, respectively (Table 1 and 2). The total bacterial count of Sudanese white revealed 3.0×10^{8} and 2.9×10^{8} cfu g^{-1} for 2.2 and 4.4% fat, respectively, which were not significantly different ($p>0.05$) as shown in Table 1. However highly significant increase ($p<0.001$) was obtained when comparing means for the different ripening time (Table 2). Similarly the total bacterial count of the processed cheese showed highly significant differences ($p<0.001$) with different fat % of milk (4.2×10^{7} and 1.5×10^{7} cfu g^{-1} for 2.2 and 4.4% fat, respectively). Moreover the interaction of the ripening time and the storage periods revealed highly significant differences (Table 3 and 4). However the total bacterial counts of the processed cheese revealed non significant differences ($p>0.05$) when kept at different types of packaging (Table 3).

Coliform Counts

The mean coliform count of Sudanese white cheese and the processed cheese showed mean coliform counts of 3.1×10^{6} and 6.5×10^{6} cfu g^{-1}, respectively (Table 1 and 2.) Comparison of the different ripening time of Sudanese white cheese showed highly significance differences ($p<0.001$) as shown in Table 1. Coliform counts of the processed cheese revealed 2.6×10^{6} and 3.6×10^{6} cfu g^{-1} for 2.2 and 4.4% fat, respectively. Different fat% of the milk, ripening time of white cheese from which processed cheese was made, the different storage periods, the types of packaging and their interactions showed highly significant differences ($p<0.001$) for coliform counts (Table 2-4).

Yeast and Molds Counts

The mean counts o f yeast and molds of the Sudanese white cheese showed 4×10^{5} cfu g^{-1}, while the mean value for yeast and molds counts of the processed cheese was 2.4×10^{5} cfu g^{-1} (Table 1 and 2). The different ripening time of Sudanese white cheese showed highly significant increase ($p<0.001$) with yeast and molds counts (Table 3 and 4). Yeast and molds counts of the processed cheese were found to be 4.1×10^{5} and 3.8×10^{5} cfu g^{-1} for 2.2 and 4.4% fat, respectively. Different ripening time of the Sudanese white cheese from which processed cheese was made, the different storage periods and the types of packaging of the processed cheese showed highly significant differences ($p<0.001$) for yeast and molds counts (Table 2- 4). Similarly the interaction of the different combinations of fat % of the milk, ripening time of Sudanese white cheese from which the processed cheese was made, the storage periods and types of packaging of the processed cheese showed highly significant differences ($p<0.001$) with yeast and molds counts as shown in Table 4.

Table 4: Effect of some factors on the compositional and hygienic quality of Sudanese white cheese (variation of mean squares)

	Psychrophilic count (cfu g^{-1})	Total bacterial count (cfu g^{-1})	Coliform count (cfu g^{-1})	Yeast and mould count (cfu g^{-1})
Measurements	SL	SL	SL	SL
Fat level	0.3882^{NS}	0.001^{***}	0.001^{***}	0449^{NS}
Storage period	0.001^{***}	0.001^{***}	0.001^{***}	0.001^{***}
Packaging	0.001^{***}	0.001^{***}	0.001^{***}	0.001^{***}
Ripening time	0.2795^{NS}	0.001^{***}	0.001^{***}	0.001^{***}
Fat+ Storage period	0.9916^{NS}	0.001^{***}	0.001^{***}	0.3778^{NS}
Packaging + Ripening time	0.9546^{NS}	0.001^{***}	0.001^{***}	0.05^{*}
Fat+ Packaging	0.2022^{NS}	0.001^{***}	0.001^{***}	0.001^{***}
Storage period + Ripening time	0.2687^{NS}	0.001^{***}	0.001^{***}	0.001^{***}
Fat+ Ripening time	0.3846^{NS}	0.001^{***}	0.001^{***}	0.471^{NS}
Storage period + Packaging	0.001^{***}	0.001^{***}	0.001^{***}	0.001^{***}
Fat+ Storage period + Packaging	0.8019^{NS}	0.001^{***}	0.001^{***}	0.001^{***}
Fat+ Storage period + Ripening time	0.9510^{NS}	0.001^{***}	0.001^{***}	0.74^{NS}
Storage period + Packaging + Ripening time	0.2317^{NS}	0.001^{***}	0.001^{***}	0.001^{***}
Fat+ Storage period + Packaging + Ripening time	0.4062^{NS}	0.001^{***}	0.001^{***}	0.001^{***}

Discussion

Sudanese white cheese falls into the family of soft and semi-soft pickled cheese of east European countries, the East Mediterranean region and North Africa (Abdalla, 1992). The microbiological examination of the Sudanese white cheese and the processed cheese made out of it, revealed improvement in the hygienic quality for the processed cheese as shown by the decrease bacterial counts (Table 1 and 4). This supported Schar and Bosset (2002) who reported that the processed cheese is often expected to be a stable product with a very long shelf-life. This might be due to the heating of the processed cheese (80°C for 5 min) at time of processing. This finding supported the objectives of pasteurization that stated by IDF (1994). Moreover Viljoen (2001) added that only part of the primary microflora survives under the selective pressures exerted by the intrinsic and extrinsic biotic factors present, processing procedures and preservatives.

The counts of yeast and molds of the processed cheese showed lower values compared to those from the Sudanese white cheese which indicated the improvement in the quality (Table 1 and 2). This supported Viljoen (2001) as he reported that the general environment from which raw dairy products originate and the microbiological quality of the products in its processed state inevitably admit yeast growth and spoilage. Also the psychrophilic count of the processed cheese revealed the same improvement (Table 1 and 4). Moreover, the storage periods were also improved after processing the Sudanese white cheese (Table 3) and that gives chances of the possibility of using processed cheese in Sudan as one of food industries in the future, particularly where pasteurization of milk for the Sudanese white cheese making is not practiced. Moreover superior quality processed cheese can be produced if the milk is pasteurized before cheese processing to eliminate the original microfolora of milk. This study supported Schar and Bosset (2002) who reported that the changes with age of processed cheese are influenced by four main factors: product composition, processing, packaging and storage conditions (time and temperature).

The total bacterial counts, coliform counts and yeast and molds counts of the processed cheese were increased during the storage periods (Table 3). After 3 months the processed cheeses show spoilage, which might be due to the high initial total and coliform bacteria. However Schar and Bosset (2002) reported that even products without any bacteriological contamination retain their high quality only for a few months at room temperature. The processed cheese made from Sudanese white cheese after 30 days ripening showed higher bacterial growth compared to that made after 15 days ripening. This might be due to the effect of ripening time and the pasteurization (IDF, 1994). The present result also agreed with Aly *et al.* (1995) who reported that the increase in the level of ripening tended to increase the numbers of total bacteria. However, the psychrophilic count showed slight increase in the studied processed cheeses during storage periods (Table 3). This might be due to the refrigeration storage of the processed cheeses.

The present study recommended that hygienic handling during milking, processing of cheese, storage (packaging and preservation) and marketing should be improved and controlled. Further work is needed and recommended on different conditions to produce the processed cheese from Sudanese white cheese and to understand the microbiological characteristic of both chesses in more details.

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