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Quality Evaluation of Imported and Locally Produced Processed Cheese in Sudan

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Abstract

This study used sixty samples of locally and imported processed cheeses from the market in Khartoum North and Omdurman, Sudan. The chemical composition (protein content, fat content and ash content), titratable acidity and microbiological quality (total bacterial count, coliform count and yeast and mold count) of the processed cheese were estimated. The result indicated that there was a significant difference (p<0.01) in protein content, while there were non significant differences in fat content, titratable acidity and ash content between types of cheeses. Higher values were obtained for the protein (14.60%**)** and the fat content (32.41%**)** of the processed cheese samples collected during the year 2007 compared to those collected during 2008. Moreover, significant differences (p<0.05 and p<0.001) were obtained for protein and the ash contents of processed cheese samples respectively, which were collected during 2008. The titratable acidity revealed lower values for cheese samples collected during 2007 compared to those collected during 2008. Non significant differences in total bacterial, coliform and yeast and mold counts between types of cheese were obtained. The highest total bacterial and yeast and moulds counts were found in the processed cheese samples collected during 2008, whereas the high coliform count was reported for the cheese samples collected during 2007 and the lower count was estimated in the samples collected during 2008. Moreover, significant (p<0.001) variations were found in total bacterial count and yeast and mold counts of the cheese samples collected between and within the two years. The present study concluded that the processed cheese produced in Sudan is more or less similar to that imported from Egypt in chemical composition and microbiological quality. Hence this study encourages manufacturing processed cheese in Sudan in order to utilize huge amount of raw milk produced in the rural areas and also to minimize the cost of importation.

Keywords: Processed cheese, imported, locally produced, chemical composition, microbiological quality.

1. Introduction [*]

Research on technological processes on food is focused on two main goals: improving safety and quality of final products, and changing the characteristics of raw materials to obtain value-added products (Zamora *et al*., 2007). Processed cheese is obtained by mixing natural cheese and other ingredients, along with emulsifying salts, and using heat and agitation to produce a homogeneous product that is used in a variety of forms such as slices, blocks, shreds, and sauces (Kapoor *et al*., 2007). Process-induced modifications can have both beneficial and detrimental effects on technological aspects. In dairy processes, thermal treatment of milk aims at increasing shelf life and improving food safety of the final product (Zamora *et al*., 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 microflora of milk. The selection of base cheese is also critical in the manufacture of process cheese, as the base cheese serves to provide body and texture as well as flavor (Acharya and Mistry, 2005). Cheese pH influences almost all facets of cheese quality including flavor, texture, and appearance (Upreti and Metzger, 2007). Garimella *et al.* (2006) reported that the functional properties of process cheese are determined by the ingredients used in the formulation (i.e., type of natural cheese, age of natural cheese, amount of natural cheese, type and amount of emulsifying salt) as well as processing conditions (i.e., cooking temperature, cooking time and mixing speed during manufacture).

The presence of coliforms or yeasts is indicative of low processing temperature, especially at filling or negligent sanitation. The major microbiological problem with these products is growth of yeasts and molds, especially if free moisture is available at the surface (Marth and Steele, 2001). Moreover they added that some cheese defects may be caused by poor milk quality (late lactation milk, milk from mastitic animals, high in enzymes of animal origin, i.e. lipase and protease), inappropriate rate of acid development by the starter, or poor manufacturing and storage regimens.

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This study is intended to evaluate the chemical composition of imported (Egyptian) and locally processed cheese (Sudan). It is also aimed to compare their microbiological quality.

2. Material and Methods

2.1. Collection of cheese samples

Sixty samples of two types of processed cheese (Cheeke cheese made in Sudan and La vashe qui rit made in Egypt) were collected from the market in Khartoum State. The samples were collected during the period of March 2007 to June 2008.

2.2. Cheese samples analysis

The samples were analyzed for chemical composition (protein content, fat content and ash content, titratable acidity) and microbiological quality (total bacterial count, coliform count and yeast and mold count).

2.3. Chemical composition

The protein content was determined by Kjeldahal method and the fat content was determined by Gerber method, the ash content and titratable acidity were determined according to AOAC (2000).

2.4. Microbiological examination

Sterilization, examination of culture and preparation of the serial dilution from the samples and culturing methods were done according to Houghtby *et al*. (1992). Total bacterial count was determined using plate count agar (Biomark, B 298 – Biomark Laboratories,India) according to Houghtby *et al*. (1992). The plates were incubated at 32°C for 48 hours. Coliform count was determined according to Christen *et al*. (1992) using MacConkey agar (Central Drug House, New Delhi, 110002). The plates were incubated at 37°C for 24 hours. The count of yeast and mold were determined according to Frank *et al*. (1992) using potato dextrose agar ((M 096- Kalindi Industrial Corporation, Mumbai, 400056, India)). The plates were incubated at 25°C for 5 days. The growth was examined visually with naked eyes for colonies appearance and changes in media and then the colonies were counted using manual colony counter.

2.5. Statistical analysis

Statistical analysis was performed using the SAS (1997). Duncan multiple range test was used to determine the difference between means.

3. Results

Table 1 presents means, standard deviation, minimum and maximum values of chemical composition and microbiological quality of processed cheese.

Protein content showed significant differences ($P<0.01$) between types of cheese and it was high in locally produced cheese (14.02%) compared to the values recorded in imported cheese (13.28%). Data revealed non significance differences ($P>0.05$) between the types of cheese in fat content, titratable acidity and ash content (Table 2). However, fat content, titratable acidity and ash content were high for locally produced cheese (31.26%, 1.13% and 2.08%) compared to the values recorded for imported cheese (30.20%, 1.01% and 2.04%) as shown in Table 2.

The total bacterial count and coliform count were high in locally produced cheese (log 3.79 and log 3.34) compared to the imported one (log 3.67 and log 3.09), respectively (Table 2). However, the yeast and mold counts were found to be higher in imported (log 1.09) compared to the locally produced (log 0.94) cheeses. Moreover, non significant differences ($P>0.05$) were found between the sources in total bacterial count, coliform count and yeast and mold counts (Table 2).

Higher values were obtained for the protein (14.60%) and the fat content (32.41%) of the processed cheese samples collected during the year 2007 compared to those collected during 2008 (12.35% and 28.41, respectively). Moreover significant differences ($P<0.05$) were obtained for protein content of processed cheese samples collected during 2008 (Table 3). However the ash content (3.19%) was significantly ($P<0.001$) higher for cheese samples collected during 2008. The titratable acidity revealed lower values for cheese samples collected during 2007 compared to those collected during 2008 (Table 3).

The highest total bacterial and yeast and mold counts were found in the processed cheese samples collected during 2008 (log 3.61 and log 1.22, respectively) as shown in Table 3. The lowest values were estimated for the cheese samples obtained during 2008 and 2007 (log 3.19 and log 0.67, respectively), whereas the high coliform count (log 3.25) was reported for the cheese samples collected during 2007 and the lower count (log 2.51) was estimated in the samples collected during 2008 (Table 3). Moreover significant ($P<0.001$) variations were found in total bacterial count and yeast and mold count of the cheese samples collected between and within the two years (Table 3).

4. Discussion

It is clear from Table 2 that the processed cheese produced in Sudan is better in the compositional content compared to the imported Egyptian cheese. Appropriate selection of natural cheese is important to achieve a process cheese with the desired chemical and functional characteristics (Zehren and Nusbaum, 2000). They also added that research have highlighted some of the important physicochemical characteristics of a natural cheese that influence the functional properties of process cheese. It is important for process cheese manufacturers to be able to select a base cheese with the desired degree of proteolysis and according to commercial manufacturers (Acharya and Mistry, 2005). They added that natural cheese made from concentrated milk has also been found to influence the chemical as well as functional properties of process cheese.

There was a significant difference ($p<0.01$) in protein content between the examined types of cheeses; a significant ($p<0.05$) variation was also found between the years during which the cheeses were collected in protein content. This might be due to the variation of the storage time of the collected batches of the samples.

Table 1. Chemical content and microbiological quality of processed cheese in the markets of Khartoum State

Measurements	Mean ± SD	Minimum	Maximum
Protein (%)	13.65±1.51	8.90	15.90
Fat (%)	30.73±3.10	22.00	38.00
Acidity (%)	1.07±0.38	0.50	2.00
Ash (%)	2.06±0.70	0.32	3.90
Log total bacterial count (cfu\gm)	3.73± 3.88	2.21	4.68
Log coliform count (cfu\gm)	3.23± 3.36	1.85	4.12
Log yeast and mold (cfu\gm)	1.02± 0.97	0	1.6

Table 2. Difference between processed cheese types in chemical composition and microbiological quality.

Types of cheese	Protein (%)	Fat (%)	Acidity (%)	Ash (%)	Total bacterial count (log cfu)	Coliform count (log cfu)	Yeast and mold count (log cfu)
Imported	13.28[a]	30.20[a]	1.01[a]	2.04[a]	3.67[a]	3.09[a]	1.09[a]
Locally produced	14.02[b]	31.26[a]	1.13[a]	2.08[a]	3.79[a]	3.34[a]	0.94[a]

In this and the following Table: Means in the same column with a similar letter (s) are not significantly different at p= 0.05, according to Duncan Multiple range test

Table 3. Difference between years in the chemical composition and microbiological quality.

Years	Protein (%)	Fat (%)	Acidity (%)	Ash (%)	Total bacterial count (log/ cfu)	Coliform count (log/ cfu)	Yeast and mold count (log/ cfu)
2007	13.65[a,b]	31.75[a]	0.96[a]	1.44[c]	3.4[a]	2.82[a,b]	1.10[a]
	14.16[b]	30.58[a,b]	1.10[a]	2.00[b]	3.60[b]	3.25[a]	0.80[b]
	14.60[a]	32.41[a]	0.95[a]	1.80[b]	3.30[a]	2.9[a, b]	0.67[b]
2008	12.35[c]	28.41[b]	1.15[a]	3.19[a]	3.61[a]	2.95[a b]	0.83[b]
	13.48[a,b]	30.50[a,b]	1.19[a]	1.8[b]	3.19[a]	2.51[b]	1.22[a]

Hamed *et al*. (1997) and Nour El Diam and El Zubeir (2010) found that the protein content of processed cheese decreases by storage time, a result that might by due to limited degradation or assimilation of protein in cheese (Hamed *et al*., 1997). Kim *et al*. (1992) mentioned that the protein of cheddar cheese showed a tendency to increase during storage due to the rapid decrease in the moisture content. There were non significant differences between examined types of cheese in fat content, ash content and acidity in this study (Table 2 and Table 3). Similar findings were reported by Suleiman *et al.* (2011) who found that fat, protein, ash, and titratable acidity of cheese were not significantly affected by the time of sample collection. This indicated that the processed cheese is a stable product with a reasonable shelf life (Hanna and Nader, 1996). Schar and Bosset (2002) reported that processed cheese is often expected to be a stable product with a very long shelf life. Similarly Nour El Diam and El Zubeir (2007) reported that storage period was also improved after processing the Sudanese white cheese and gives chances of possibility of using processed cheese in Sudan. This might be because cooking process helps to destroy spoilage microorganisms and improve the shelf life of the process cheese (Siew *et al.*, 2004).

The microbiological picture as shown in Table 2 revealed that the locally produced cheese is more or less similar in the properties to the imported one. This suggested that it is reasonable to produce the processed cheese with an acceptable quality in Sudan, supporting the previous study that used Sudanese white cheese for production of the processed cheese (Nour El Diam and El Zubeir, 2007). They also reported that the huge quantities

of milk produced in the rural areas can be utilized by reprocessing cheese in towns to reasonable longer shelf life cheese (processed) from the Sudanese white cheese. Similarly, Hanna and Nader (1996) concluded that locally produced soft cheese in Iraq could be used instead of imported semi-hard cheese to make processed cheese of acceptable quality.

The high number of total bacterial count reported in the present study could be due to the high coliform count as shown in Tables 1, 2, and 3. The significant difference between coliform counts was in support to the findings of Suleiman *et al.* (2011). Massa *et al*. (1992) reported that high concentration of feacal coliforms was observed in 41 samples of Mozzarella cheese. Similarly Coveney *et al*. (1994) found that the incidence of coliforms were higher in soft, semi-soft and semi-hard cheese than in hard types. High coliform count in processed cheese might be due to poor processing conditions or post processing contamination (Nour El Diam and El Zubeir, 2006). Also the presence of coliforms or yeasts is indicative of low processing temperature, especially at filling or negligent sanitation. In addition to composition, pH and water activity, the presence of melting salts may be inhibitory to the growth of clostridia (Marth and Steele, 2001).

When comparing yeast and mold count of the processed cheese, it was found that there was non significant difference and this result is in agreement with the findings of Nour El Diam and El Zubeir (2006). This might be due to heat treatment that the processed cheese was subjected to during processing (Siew *et al.*, 2004). The count of yeast and molds of the processed cheese showed lower values compared to those from the Sudanese white cheese which indicated the improvement of the quality, which might be due to heat treatment (Nour El Diam and El Zubeir, 2006). Moreover molds are not supposed to grow on cheeses that are vacuum packaged, but they sometimes do as they tend to grow on cheese where pockets of air exist between the packaging material and cheese surface (Marth and Steele, 2001).

The results recorded on this study indicate that the locally processed cheese is better than the imported one concerning the compositional content, while the imported cheese revealed slightly better microbiological quality. Hence, it is recommended that the hygienic handling especially during processing, packaging and storage should be improved and controlled. In addition, official authorities should encourage the manufacture of processed cheese in Sudan in order to minimize the high cost of importation.

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