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Evaluation of Chemical Composition and Yield of Mozzarella Cheese Using Two Different Methods of Processing

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Abstract: Two Mozzarella cheese making methods, Kosikowski (1982) and the modified method practiced by Khartoum Dairy Products Company (KDPC) were evaluated for their efficiencies in term of chemical composition and yield. In a comparison study; using fresh whole cow's milk; two experiments were conducted. In experiment one the cheese was manufactured according to the method described by Kosikowski (1982). While in experiment two the modified method practiced in Khartoum Dairy Product Company (KDPC) Ltd. was used. In Kosikowski (1982) method, pasteurized milk was used. Starter culture (0.5%) was added and renneting at 32.2°C, cooling and whey drainage overnight; were practiced in this method. In the modified method, raw milk was used. Starter culture (1%) and rennet were added at 38.5°C. The results showed that, fresh Mozzarella cheese; using Kosikowski (1982) method had the following means composition, fat 27.25%±0.82; protein 20.06%±0.65; total solids 51.42% ±1.32; moisture 48.59% ± 1.32; titratable acidity 066% ± 0.02; ash 2.25±0.07%; lactose 1.59±1.35% and yield 13.2%. However, the mean compositions in modified method were: fat 25.71%±2.30; protein 23.33%2.1; total solids 54.52%±2.84; moisture 45.48%±2.85; titratable acidity 0.58%0.09; ash 2.38%±0.41; lactose 2.64% ±0.73 and yield 11.65%. Cheese batches in experiment two showed a decrease in fat, protein and ash content after storage for seven days at -18°C and 4°C.

Key words: Mozzarella cheese, chemical composition, yield

INTRODUCTION

The major cheese type that produced traditionally in the Sudan is White cheese (*Gibna Bayda*) (Osman, 1987a). Some cheese types, varying in taste, flvour, texture due to production methods, ripening period and ripening conditions are locally produced. Among which are Madaffara (braided) cheese (Abdel-Razig, 2000). Mish cheese (Osman, 1987b), which are known and manufactured in limited quantities.

Cheese in Sudan is concentrated mainly in white cheese processing employing traditional technology. Other cheese varieties were also produced but in a limited scale, these include Mudaffara cheese and Mozzarella cheese.

Mozzarella cheese originated in the Battipaglia region of Italy from buffalos milk, (Citro, 1981). Mozzarella cheese was originally manufactured from high fat buffalo milk in Battipaglia region of Italy. However, it is made all over Italy, in other European countries and USA also from cow milk with certain modifications (Ghosh *et al*., 1990). It belongs to the cheese classified as "Pasta filata" which involves the principle of skillfully stretching the curd in hot water to get smooth texture in cheese. The cheese is soft, white, unripened, that may be consumed shortly after manufacture. It's melting and stretching characteristics is highly appreciated in the manufacture of Pizza as it's a key ingredient.

Mozzarella cheese belongs to the pasta filata group and is made in many countries from cow milk, buffalo milk and even milk powder. It exists in a large number of forms and sizes from 50 g-50 kg weight (Scott, 1986).

Mozzarella cheese production in Sudan is an small business. It has been manufactured and introduced to the market due to the recent popularity of Italian dishes, which was first practiced in Khartoum Dairy Product Company (KDPC). in 1992 and then practiced by other few individuals (small processing units). There is a high demand by large hotels and pizza centers. However, there is no standard procedure adopted by the different producers for its production. Moreover, there is no research on this type of cheese in Sudan. The present work was initiated to study the chemical composition and yield of Mozzarella cheese using two different methods of manufacture, the method described by Kosikowski (1982) and the other method that is practiced in KDPC.

MATERIALS AND METHODS

Cheese manufacture: Two experiments were carried out for the manufacture of Mozzarella cheese using two methods. Cow's milk supplied by KDPC and the Mozzarella cheese made in the KDPC dairy plant, the rennet and Starter culture was obtained from (Chris Hansen's) Denmark.

Experiment one: Mozzarella cheeses were made according to the method described by Kosikowski (1982), using whole cow's milk. Average fat 5.1, protein 3.58, total solids 13.50, ash 0.77 and lactose contents 4.1%. The steps of cheese making showed in Fig. 1.

Experiment two: Mozzarella cheese was made according to a method practiced in KDPC which is modified from the method described by Kosikowski (1982). In this method whole cow's milk with average 12.9 total solids, 4.22 fat, 4.13 protein, 0.75 ash and 4.31% lactose content. Fig. 2 showed the steps of the cheese making by this method.
The manufactured cheese was analyzed at zero day, and after seven days of storage at -18°C and 4°C.

Chemical analysis: Titratable acidity of milk was determined by AOAC (1990) and its total solids were determined by drying 8-11 g of milk at 100°C for 5 h (Madadlou *et al*., 2006). Cheese was analyzed for moisture content by AOAC (1990) and ash content by dry ash method (AOAC, 1990). The fat content of milk and cheese samples was determined by the Gerber method and their total protein contents were determined by measuring total nitrogen using the Kjeldahl method (AOAC, 1990) and converting it to protein content by multiplying by 6.38. All chemical measurements were done in triplicate. Cheese samples were chemically analyzed at zero day and seven days of storage at -18°C and 4°C. Apparent yield was calculated as the weight of cheese in kg cheese/100 kg milk.

RESULTS AND DISCUSSION

The results in Table 1, showed that the titratable acidity of cheese was 0.66±0.02 and 0.59±0.09 for cheese made by Kosikowski (1982) and KDPC method respectively. This was lower than the value of Shegdoni et al. (1979) and El-Koussy *et al.* (1995).
The fat content of the cheese made by Kosikowski (1982) method was higher than the cheese made by KDPC method (Table 1), with significant difference ($p<0.05$).
The average values obtained in this study were higher than that obtained by El-Koussy *et al.* (1995) and Shegdoni, *et al.* (1979). The higher values might be due to the high fat content of milk.
The average protein content of Kosikowski (1982) method was 20.06±0.82 is lower when compared to that obtained from KDPC method (23.33±2.12). However, this result is lower compared to those of Kosikowski, (1977) who reported that protein content of 22.1, 21.2 and 25.7% in fresh Mozzarella cheese, made from various milk of varying fat contents. Similar results were reported by Gilles and Lawrence (1981). This finding was disagreed with Patel *et al.* (1986), but its

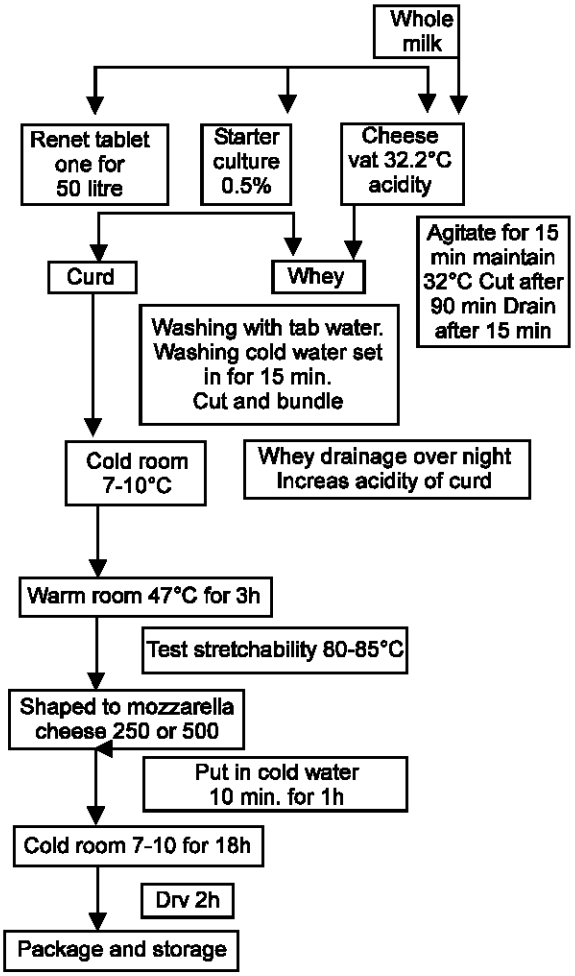

Fig. 1: Flow sheet diagram for the manufacture of Mozzarella cheese according to Kosikowski (1982)

agreed with the findings of Lou and Kwai-Hang (1992), who reported that, higher protein levels in milk were associated with higher protein in cheese. They also stated that, the regression analysis for every percentage increase in milk protein, the cheese protein increased by 0.14%.
The total solids percent of the cheese in Kosikowski (1982) method was lower (51.42± 1.32%) than that of KDPC method (54.52± 2.84%) with no significant difference. The results were similar to the values found by Shegdoni *et al.* (1979), but it is higher than that obtained by Coppola *et al.* (1995); El Koussy *et al.* (1995) and Fernandez and Kosikowski (1986) who reported 46%, 47.82% and 49.5 respectively. Such differences may be attributed to the observed high fat content in the two cheese batches made by Kosikowski (1982) and KDPC methods.
The average values for ash (2.25±0.07) were significantly ($p<0.05$) lower than that found by KDPC

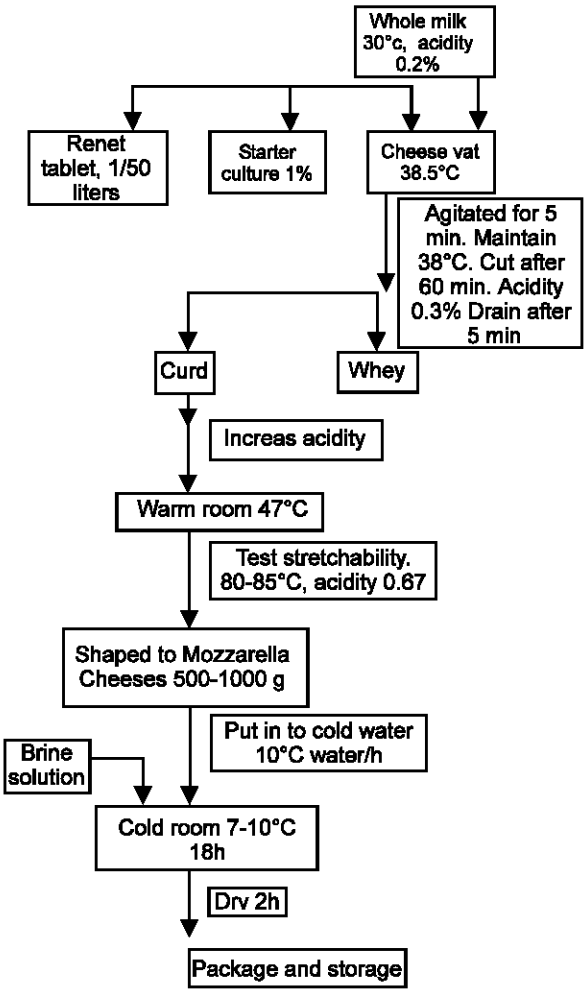

Fig.2: Flow sheet diagram for the manufacture of Mozzarella cheese according to modified method used in KDPC. Ltd

method (2.38±0.41). The ash values are lower than the value reported by Shegdoni *et al.* (1979), while, they were higher, compared to that found by Sundar and Upadhyay (1990) who found 2.03, 1.75 and 1.85% for maximum, minimum and average total ash, respectively. The cheese yield was calculated as kg cheese per 100 kg milk O´Connor (1994). So the results obtained during Kosikowski (1982) method (Table 1), showed that Mozzarella cheese prepared from heated milk, showed higher average yield (13.2) than the one prepared from raw milk in KDPC method with average of 11.65. This is in accordance with Kosikowski (1977) who reported that the yield of Mozzarella cheese usually is 11.5 pounds cheese, of 52% moisture, per 100 pounds of 3% fat milk. The denaturizing and precipitation of whey protein and higher retention of water in soft curd formed could explain the obtained increases in yield.

These findings were consistent with that of Patel *et al.* (1986), reported that, heat treatment of milk resulted in

Table 1: Chemical composition (average per cent) and the yield of Mozzarella cheese at zero time

Item	A	B	LS
Fat content %	27.25±0.82	25.71±2.3	*
Protein content %	20.06±0.82	23.33±2.12	*
Total solids content %	51.42±1.32	54.52±2.84	Ns
Moisture content %	48.59±1.32	45.48±2.85	Ns
Titratable acidity▼	0.66± 0.02	0.59±0.09	Ns
Ash content %	2.25±0.07	2.38±0.41	*
Lactose content %	1.59±1.33	2.64±0.73	*
Yield (kg/100 kg milk)	13.2	11.65	Ns

A = Cheese made according to Kosikowski (1982) method, B = Cheese made according to KDPC method, ▼ Titratable acidity was as percent lactic acid, Ns = Not significant, LS = level of significant ($p<0.05$)

better retention of protein and mineral salts in cheese curd. Consequently, this gave higher total solids content and increased the cheese yield. In addition, agitation during processing of Mozzarella cheese (Kosikowski, 1982 method), was found to improve whey drainage and reduced the loss of small cheese particles in whey.

Mozzarella cheese stored at 7-10°C and 25°C for seven days. Bacteria and mold growth spoiled all the cheese and lead to the deterioration of stored cheese because the cheese is of low salt concentration and acidity and the high temperature which is not suitable for storage the cheese. Scott (1986) reported that both Mozzarella and pizza cheese needs protective packaging, i.e. Saran or multi layer films, and have to be stored at low temp., 4°C, until used. This is similar to that suggested by Kosikowski (1977) who reported 4.4°C for Mozzarella cheese storage.

Ghosh and Kulkarni (1996) in their study of standardized process for the manufacture of low-cholesterol mozzarella cheese, reported that unsalted cheese packaged in polyethylene pouch kept well for 8-10 days at 8-10°C and for about 3 months at 10-15°C. The stretching characteristic deteriorated, while melting quality improved with increase in storage time at both temperatures.

Cheese storage: The results from Table 2, indicated that the fat, protein, total solids, ash and lactose content of the cheese storage in -18°C were lower when compared to that stored in 4°C with non significant differences except for ash content ($p<0.05$).

Table 3 shows the weight losses of mozzarella cheese were increased from 0.82%±1.02 to 3.2%±1.4. This explained by Abdel- Razig (2000); El-sheikh (1997) and Ghosh and Singh (1992), who reported that, cheese weight loss during storage was due to the loss of its moisture content as a result of curd contraction and water expulsion. Similarly, O'Connor (1994) added that cheese looses its moisture during storage if it is not properly wrapped and thus reducing its yield.

Table 2: Effect of storage temperature for seven day on chemical composition of Mozzarella cheese

Item	-18°C	4°C	LS
Fat content%	0.66±0.0.03	0.65±0.04	Ns
Protein content%	27.51±.06	27.88±1.59	Ns
Total solids content%	21.17±2.12	27.28±21.68	Ns
Moisture content%	51.87±1.32	53.48±0.65	Ns
Titratable acidity	48.14±1.32	46.52±0.65	Ns
Ash content%	2.34±0.05	2.99±0.01	*

Table 3: Effect of seven days storage (-18ºC and 4ºC) on weight loss of Mozzarella cheese

Item	-18°C	4°C
Cheese yield	13.2±0.42	13.2±0.42
Initial weight (gm)	97.67	81.60
Final weight(gm)	96.9	79.09
Weight loss(gm)	0.77±0.92	2.51±0.43
Weight loss%	0.82±1.02	3.1±1.4

Conclusion: Mozzarella cheese made by the KDPC method has a better protein and total solids content, which are important in stretch ability and reduce manufacture cost.

The low fat content may be considered a benefit for those who prefer low fat diets.

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