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Compositional and Rheological Properties of Mozzarella Cheese Prepared from Buffalo Milk

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Abstract: Mozzarella cheese was prepared from buffalo milk using liquid rennet extracted from calf stomach at the Laboratory of Animal Products Technology, Sindh Agriculture University Tandojam. All the cheese batches were evaluated for compositional, rheological and sensory characteristics. The mean moisture content of mozzarella cheese was 55.15±0.88%, whereas, protein, non protein nitrogen and fat content was 25.28±0.45, 1.56±0.07 and 15.69±0.29%, respectively. The average ash and chloride content was observed as 3.42±0.10 and 1.60±0.02%, respectively. The meltability and strechability of mozzarella cheese was observed as 6.11±0.16 and 12.75±0.15cm, respectively. The sensory attributes showed that color/appearance of mozzarella cheese perceived 4.10±0.27 score, the score for flavor of mozzarella cheese was 27.90±0.43 and the body/texture received 23.60 ±0.52 score. It was concluded that average moisture content of mozzarella cheese revealed that the product was under high moisture category cheese, regardless the fat, meltability and strechability concludes it to be used primarily as an ingredient for pizza making.

Key words: Composition, rheology, sensory attributes, mozzarella cheese

INTRODUCTION

Mozzarella cheese is a sliceable curd cheese originated in Italy and traditionally produced from milk of water buffalo. Its flavor is very highly prized thus has become one of the most popular cheese varieties in the world. It is estimated that approximately 70% of Mozzarella cheese is used as toping on pizza. Its usage is expected to grow as global interest and increased demands of pizza. In a survey, over 50% of pizza restaurants reported occasional to frequent problems in quality of cheese of which 67% were related to melting of Mozzarella cheese (Pilcher and Kindstedt, 1990). The functional properties of Mozzarella cheese develop in two distinct but interdependent phases. The first phase occurs during manufacture, when the basic curd structure is established and the second occurs during storage, when functionality and curd structure alter. The functional properties attributed to melted Mozzarella cheese are widely varied which is largely responsible for consumer perception (Rowney *et al*., 1999). Defects associated with Mozzarella cheese include a rubbery, tough texture, lack of flavor, paleness or green tint, inability to melt and poor Stretch ability (Fife *et al*., 1996). These functional properties of Mozzarella cheese are influenced by a multitude of factors that include cheese composition, especially the moisture and fat contents, pH, coagulating enzymes, starter culture, homogenization, cooking and stretching, salt content and the changes occurring during aging and storage (Diefes *et al*., 1993). Since pizza is getting more popularity in the literate society in the big cities of Pakistan, it is of prime importance to evaluate the compositional as well as rheological properties of mozzarella cheese. However, no any reliable work has been carried out so far in any aspect of mozzarella cheese in Sindh province. Thus, present study was planned to produce and evaluate the compositional and rheological characteristics of mozzarella cheese.

MATERIALS AND METHODS

A total of 30 batches of mozzarella cheese were prepared from whole buffalo milk at the Laboratory of Animal Products Technology. Buffalo milk procured from Livestock Experiment Station, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University, Tandojam, was used during the experiment.

Preparation of starter culture: Artisan starter culture was prepared by fermenting the skimmed buffalo milk with natural yoghurt culture and purified by re-culturing it

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several times. The purified culture was maintained during the experimental period.

Preparation of brine solution: Sodium chloride (25g) was dissolved in distilled water (1000ml) and kept refrigerated (4°C) till use.

Rennet enzyme: Liquid rennet produced in the Department of Animal Products Technology, Faculty of Animal Husbandry and Veterinary Sciences, Sindh Agriculture University Tandojam was used in the mozzarella cheese making.

Preparation of Mozzarella cheese: Mozzarella cheese was prepared according to the method reported by Dave *et al.* (2003) with slight modifications. Raw buffalo milk was filtered through muslin cloth to remove any remedy present in it. Milk was pasteurized (65°C) in cheese vat for 30 min and cooled (~32±1°C) by circulating cold water. The starter culture (3%) prepared at the Laboratory was added and pre ripened for 45 min. The liquid rennet (1.64 ml/l) was mixed and ripened till pH values decreased in the range of 5.2-5.4. In this stage, the curd was cut into ½" cubes and cooked for half an hour. After that the temperature was gradually increased up to 40±1°C and cooked for 10 min. Further the whey (1/3rd) was drained off and the curd was gently stirred till pH of whey became at~5.2. At this pH value, all the whey liquid was drained off and the curd cubes were cooked (40±1°C) for 90 min. The cubes were turned ups and down and cooked (40±1°C) again for 30 min. These cubes were again cut into ½" cubes and the excess whey was drained off. Curd cubes were immersed in hot water (76±1°C) for 2 min and shaped in ball like structure using two large wooden spoons. Immediately after that the cheese was again soaked in cold (4°C) brine solution and soaked for 60 min. Finally, the cheese was packed and stored (6-8°C) till analysis.

Chemical analysis: Moisture, Total Solids, fat, protein, ash and chloride contents of Mozzarella cheese were analyzed according to the methods as described by Association of Official Analytical Chemists (AOAC, 2000). Non Protein Nitrogen (NPN) content was determined according to the method of International Dairy Federation (IDF, 1993).

Rheological analysis of Mozzarella cheese

Meltability: Meltability of mozzarella cheese was detected according to the method as reported by Muthukumarappan *et al.* (1999) with slight modification. Cheese sample was cut in to small pieces with knife and placed in the middle of the glass petri dishes and plastic plates. The initial diameter of the mozzarella cheese specimen was measured and heated (60±1°C) in microwave oven. The cheese specimen was taken out of the microwave oven and cooled to room temperature for 30 min before measuring the diameter by verneir caliper. Meltability was calculated by detecting the initial diameter of specimen cheese sample from the diameter of melted specimen of cheese.

Stretch ability: The cheese was removed from refrigerated storage (5°C) and rapidly cut into small pieces with a knife, then grated in a blender (Anex, Germany) at an ambient temperature. The size of the cheese particles was approximately 5 mm. Two-hundred grams of grated cheese was put in a large diameter glass container and heated at 60°C. The specimen cheese sample was manually stretched with fingers till cheese string was nearly to break and the length was measured using measuring scale. The result was calculated by detecting the initial length of specimen cheese from the length of final stretchable specimen cheese.

Sensorial analysis of Mozzarella cheese: Sensory attributes of Mozzarella cheese were evaluated according to method of Nelson and Trout (1981). The sensory panel comprising of six judges were selected and they were first experienced with different sensory attributes like appearance/color, flavor and body/texture. Thereafter samples of Mozzarella cheese were served to rate the score.

RESULTS AND DISCUSSION

Compositional characteristics: The results of present study presented in Table 1 showed that the moisture content of Mozzarella cheese varied from 51.68 to 60.00%. However the average values (55.15±0.88%) of moisture observed in the present study categorized the product under high moisture (> 52 to = 60%) mozzarella cheese which is assumed to have poor shredding, melting and limited shelf life (Bertola *et al.*, 1996). While most of the batches of mozzarella cheese were in line with the results reported by Muthukumarappan *et al.* (1999) and Sameen *et al.* (2008) (i.e., 52.44 and 50.49%, respectively) which could have categorized under low moisture mozzarella cheese and assumed to use primarily as an ingredient for pizza (Bertola *et al.*, 1996).

Significant concentration (25.28±0.88%) of protein content was observed in mozzarella cheese while, it

Table 1: Chemical composition of Mozzarella cheese

Components (%)	Minimum	Maximum	Mean±SE
Moisture	51.68	60.00	55.15±0.88
Protein	22.33	26.80	25.28±0.45
NPN	1.34	1.79	1.56±0.07
Fat	14.40	16.80	15.69±0.29
Ash	2.61	3.85	3.42±0.10
Chloride	1.48	1.71	1.60±0.02

remarkably varied in between 22.33 and 26.80%. The trend of variation could be attributed with milk base. Although buffalo milk is rich in protein content especially the casein (Ahmed *et al*., 2008) which might have resulted higher concentration in the mozzarella cheese. Moreover, relatively the higher concentration (32.53%) of protein was observed by Dave *et al*. (2003).

The fat content (wet basis) in mozzarella cheese varied in between 14.40 and 16.80% and averaged as 15.69±0.29%. These results were not in line with the results of different workers (Muthukumarappan *et al*., 1999). Dave *et al*. (2003), Reparet and Noel (2003), Sameen *et al*. (2008), who reported 21-25, 18.79, 20.0 and 17.13% fat in mozzarella cheese, respectively. However, the fat content was the major variable among components influencing the composition of cheese particularly in the development of the texture (Johnson, 1999). Fat content also plays a significant factor in meltability. Increased fat content prevents casein aggregation from interacting with each other thereby producing a weaker protein matrix (Johanson, 1999).

In present study a slight variation (1.34-1.79%) in NPN content of mozzarella cheese was evident. However; mean value (1.56±0.07%) was 12 folds higher than milk base. The increase in the concentration of NPN content in the product reflected the metabolites of amino acids and nucleic acid which probably arise from the activity of coagulating enzyme added during manufacturing of mozzarella cheese.

The ash content was remarkably higher (i.e., 2.61-3.85% and averaged 3.42±0.10%) in mozzarella cheese. This increase in ash content could be associated with total solids contents of mozzarella cheese which was also found in higher concentration level. However the average value (3.42±0.10%) of ash content observed in the present study were in line with the results reported by Kanwal *et al*. (2004), Sameen *et al*. (2008) and Dave *et al*. (2003) they observed ash content as 4.0-6.5, 4.11 and 3.53%, respectively.

The average concentration of chloride contents was observed as 1.60±0.02% in mozzarella cheese, however, it was varied in between 1.48-1.71%. The trend is likely related to the results (0.053-0.058%) obtained by Dubey *et al*. (1998). However, relatively low concentration of chloride was observed by Dave *et al*. (2003) and Muthukamarappan *et al*. (1999) which was i.e., 1.05 and 1.44%, respectively).

Rheological properties: In present study the meltability (Fig. 1) of mozzarella cheese varied in between 5.10-7.10 cm and averaged as 6.11±0.16 cm. Meltability has a considerable influence on cheese composition especially the moisture and fat content. These results are moderately varied to 3.4 cm observed by Bertola *et al*. (1996).

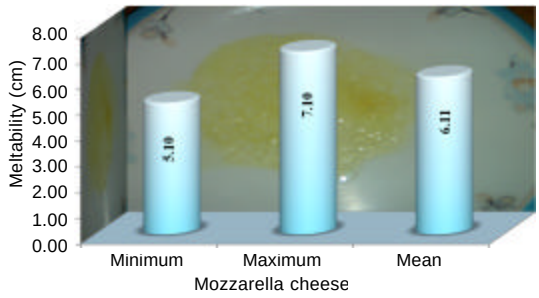

Fig. 1: Meltability (cm) of Mozzarella cheese. SE± = 0.16, CV = 8.21%

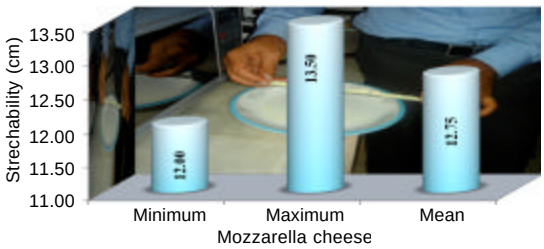

Fig. 2: Meltability (cm) of Mozzarella cheese. SE± = 0.15, CV = 3.85%

The average Stretch ability (Fig. 2) of mozzarella cheese was observed as 12.75±0.15 cm in present study with the range of 12.0-13.50 cm. These results are closely related to the results of Muthukamarppan *et al*. (1999) i.e., 12.3 cm.

Sensorial analysis: The results shown in Table 2 illustrated that the significantly higher score was awarded to the mozzarella cheese samples for over all sensory attributes (flavor, body/texture, color). In the present study, the mozzarella cheese perceived an average score of 27.90 for flavor, whilst the color received 4.10 score as an average and the overall average score rated for body texture was 23.60, among the total score 30, 5 and 25, respectively. However, in the sensory attributes the flavor is considered to be the most important factor for determining consumer's response. During ripening, the metabolic processes are responsible for the basic flavor and texture changes (Smit *et al*., 2005). The activity of microbes and residual rennet may break down the fat and protein contents. The metabolite produced may contribute to flavoring and smooth texture of mozzarella cheese (Barbano *et al*., 1994). The results of present study are in line with the results of Matzdorf *et al*. (1994) who reported the relatively similar trend in score for color (9.3), flavor (8.95) and body/texture (9.47) out of 10 in each category.

Table 2: Sensory evaluation (score) of Mozzarella cheese

Sensory attributes	Minimum	Maximum	Mean±SE
Color (5)	3.00	5.00	4.10±0.27
Flavor (30)	26.00	30.00	27.90±0.43
Body/texture (25)	20.00	25.00	23.60±0.52

Conclusion: The average concentration of moisture content was high regardless of 50% batches were under low moisture (<52%) and assumed to be used primarily as an ingredient for pizza. Concentration of fat supports the melting characteristic of mozzarella cheese. Concentration of protein and NPN contents in mozzarella cheese were found to be within reported range. Considerable meltability and strechability of mozzarella cheese were observed.

REFERENCES

Ahmed, S.I., F. Gaucher, E. Rousseau, Baucher, M. Piot, J.F. Grongnet and F. Gaucheron, 2008. Effects of acidification on physic-chemical characteristics of buffalo milk, a comparison with Cow's milk. J. Food Chem., 106: 11-17.

AOAC, 2000. Dairy products. In: Official Methods of Analysis. Association of Official Analytical Chemists Inc: Gaithersburg, USA.

Barbano, D.M., J.J., Yun and P.S. Kindstedt, 1994. Mozzarella cheese making by a stirred curd, no brine procedure. J. Dairy Sci., 77: 2687-2694.

Bertola, N.C., A.N. Califano, A.E. Bevilacqua and N.E. Zaritzky, 1996. Effect of freezing conditions on functional properties of low moisture mozzarella cheese. J. Dairy Sci., 79: 185-190.

Dave, R.I., P. Sharma and K. Muthukumarappan, 2003. Effects of starter culture and coagulating enzymes on viscoelastic behavior and melt of mozzarella cheese. J. Food Sci., 68: Nr. 4.

Diefes, H.A., S.S.H. Rizvi and J.A. Bartsch, 1993. Rheological behavior of frozen and thawed low moisture part-skim mozzarella cheese. J. Food Sci., 58: 764-769.

Dubey, P.C., C.L. Suman, M.K. Aanal, S. Rajendra, H.S. Pandy, M.M. Saxena and R.M. Sing, 1998. Some factor affecting the milk chloride, pH and acidity in buffalo milk. Ind. Vet. J., 75: 3.

Fife, R.L., D.J. McMahon and C.J. Oberg, 1996. Functionality of low fat mozzarella cheese. J. Dairy Sci., 79: 1903-1910.

IDF, 1993. Determination of the non protein nitrogen content of liquid milk and cheese. In: International Dairy Federation, Brussel (Belgium).

Johanson, 1999. Cheese chemistry. In: Fundamentals of dairy chemistry. Wong (Ed). Aspen Pubishers, Inc. Gaithersburg, Maryland, pp: 635-649.

Kanwal, R., T. Ahmed and B. Mirza, 2004. Comparative analysis of quality of milk collected from buffalo, cow, goat and sheep of Rawalpindi/Islamabad region in Pakistan. Asian. J. Plant. Sci., 3: 300-305.

Muthukumarappan, K., Y. C. Wang and S. 2Gunasekaran, 1999. Short communication: modified schreiber test for evaluation of mozzarella cheese meltability. J. Dairy Sci., 82: 1068-1071.

Matzdorf, B., S.L. Cuppett, L.J. Keeler and R.W. Hutkins, 1994. Browning of temperature of mozzarella cheese during high pizza baking. J. Dairy Sci., 77: 2850-2853.

Nelson, J.A. and G.M. Trout, 1981. Judging and grading cheese. Judging dairy products, 4th Edn., AVI Publishing company Inc. Westport, Connecticut, pp: 174-254.

Pilcher, S.W. and P.S. Kindstedt, 1990. Survey of mozzarella cheese quality at restaurant. J. Dairy Sci., 73: 1644-1647.

Rowney, M., P. Roupas, M.W. Hickey and D.W. Everett, 1999. Factors affecting the functionality of mozzarella cheese. Aust. J. Dairy Technol. 54: 94-102.

Reparet, J.M. and Y. Noel, 2003. Relation between a temperature-Sweep Dynamic Shear Test and functional properties of cheese. Lait, 83: 321-333.

Sameen, A.A., F. Muhammad, N. Huma and H. Nawaz, 2008. Quality evaluation of mozzarella cheese from different milk sources. Pak. J. Nutr., 7: 753-756.

Smit, G., B.A. Smit and J.M. Engles, 2005. Flavour formation by lactic acid bacteria and Biochemical flavor profiling of cheese products. F.E.M.S. Microbiol. Rey., 29: 591-610.