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Rasogolla – an Indian Traditional Dairy Product

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Research Article

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ABSTRACT

Rasogolla is known as the king of the sweets and highly popular throughout India. Although manufacturing of rasogolla is confined to the cottage industry, its mechanized production is needed for higher production rate and better quality control on account of its increasing popularity. The present review discusses traditional method of rasogolla preparation and the effect of different parameters on quality of rasogolla. Effects of type of milk, type and amount of acid used for making chhana, initial moisture content of chhana, kneading of chhana, formation of chhana ball, concentration of sugar syrup during cooking as well as soaking and repeated use of same sugar syrup have been studied on rasogolla quality, cooking time of chhana ball, soaking time for cooked chhana ball and its microstructure. Literature available on pressure cooking method of rasogolla preparation and mechanization of rasogolla making has also been reported.

INTRODUCTION

Milk and milk based products have been a good source of nutrition to human health. Rasogolla is an Indian traditional dairy product, stored and served in sugar syrup. In size and shape it resembles a ping-pong ball. It is snow white in colour, possesses a spongy, chewy body and smooth texture. On all festive occasions it is widely accepted as most popular sweet and all ages of people like it.

Chhana is the base material from which rasogolla is prepared. Generally cow milk is preferred for preparation of rasogolla as the cow milk chhana is having soft body and smooth texture, which are suitable for rasogolla preparation [1,2]. For the preparation of chhana, milk is heated to its boiling temperature and cooled to 70°C [3-5]. Coagulating agent like citric or lactic acid solution is added to the heated milk and mixed with gentle stirring using a ladle. The mixture is kept for some time for settling and coagulating milk solids. After the coagulation, whey is drained out; the coagulum is called as chhana. Composition of cow milk chhana is given in **Table 1**.

Table 1. Composition of chhana made from cow milk.

Moisture (%)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	Authors
53.4	24.7	17.6	2.2	2.1	Shrinivasan and Anantakrishnan [6]
53.1	24.8	17.8	2.2	2.1	Kumar and Shrinivasan [7]
55.7	23.5	16.4	2.2	2.0	Sen and Rajorhia [8]

The traditional method of rasogolla preparation is shown in **Figure 1**.

The first unit operation carried out on chhana for rasogolla preparation is the kneading of chhana to a smooth mass. Generally kneading is done manually by putting the chhana on a wooden plate. Tambat [9] reported rasogollas prepared with cow milk chhana with 3.5 to 4 percent fat and 2 to 4 percent maida levels on the weight basis of chhana were having good flavor and taste. De and Tambat [10,11] reported that rasogolla prepared without refined wheat flour showed dull white color, cracks on outer surface, undesirable soft body and loose texture with sticky surface. Goel and Agrawal [12] added sodium-bi-carbonate during kneading of cow milk chhana and observed that the sugar absorption capacity was increased in the cooked chhana balls.

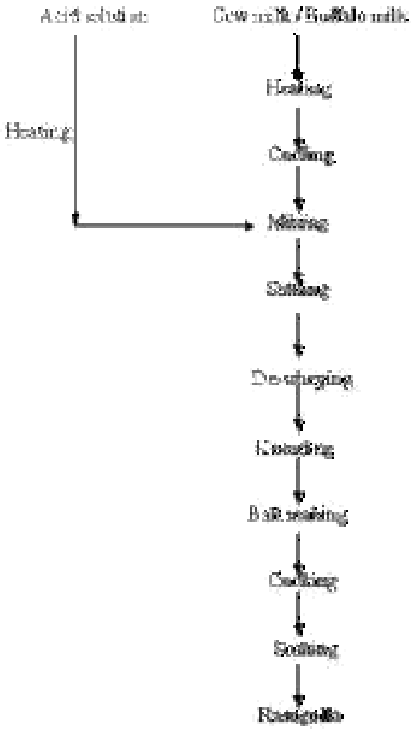

Figure 1. Process and material flow diagram for preparation of rasogolla.

About 8-10 g of kneaded chhana is taken, rolled between palms and ball is made. Care is taken not to have cracks on the surface of the ball. The balls are put in vigorously boiling sugar syrup of 50-60 percent

concentration for about 15-20 minutes [3,13,14]. During cooking a considerable amount of water evaporates and the concentration of sugar syrup increases. In order to avoid this increased concentration of sugar syrup, water is added to the boiling sugar syrup during cooking. After the cooking, balls are taken out of the boiling sugar syrup and soaked in sugar syrup having sugar concentration of about 40%, which is lower than that used for cooking [13,15]. This process stabilizes the texture of rasogolla in terms of hardness, gumminess, springiness and chewiness. During the soaking period, equilibration of sugar syrup concentration within the rasogolla takes place. Rasogolla is stored and served in this sugar syrup.

The Bureau of Indian Standards has laid down the specification for canned rasogolla as shown in **Table 2** [16].

Table 2. BIS Specification for canned rasogolla.

Characteristics	Specifications
Moisture	45-55%
Milk fat	5%
Sucrose	45%
Protein	5%
Acidity of syrup, max	6.0*
Concentration of syrup, max	55 °Brix
Bacterial count, per gram, max	500
Coliform count, per gram	nil

Kneading of Chhana

Kneading is an important step in rasogolla manufacturing. It is a mixing and folding process in which rheological and textural properties of chhana are changed **(Figures 2-4)**. Traditionally chhana is kneaded manually to a smoother mass for rasogolla preparation. Tarafdar [17] kneaded chhana by using a disc grinder, similar to the one used for reducing particle size of granular solids. It had a rotating disc, which maintained a very small gap with another stationary disc. The rotating disc was an integral part of feed auger. When the screw and the disc were rotated, chhana mass could move from a feed hopper and was forced to come out through the space between two discs. The values of flow behaviour index (n), consistency coefficient (K) modified mixing index (M) and time of compression (T_c) of the mechanically kneaded chhana nearly stabilized at 89 cm/sec disc speed.

Ten Hove and Das [3] prepared rasogolla by kneading the chhana in a disc grinder, the peripheral speed of the grinder was 0.89 m/s and balls were made from 10 g chhana lumps by rolling in between palms.

Figure 2. Chhana.

Figure 3. Kneading of chhana.

Figure 4. Kneaded chhana.

Karunanithy [4] developed a chhana kneader and ball former. The chhana kneader consisted of a kneading chamber, made up of Stainless Steel pipes and the rear end was welded with 6 mm thick Stainless Steel plate having provision to insert the rotor. The other end was closed with 6 mm thick Stainless Steel plate with bolt and nuts so as to fix the rotor with screw and spokes. Three different rotor models were fitted to kneading chamber. In model I, a screw of 25 mm pitch was fixed at both ends of the rotor shaft. Spokes were fixed in the rotor shaft in a helical pattern to facilitate simultaneous mixing and conveying. In model II, a star perforated plate was inserted after feed end screw in order to increase the shear/mixing rate. Spokes and screw were fixed on the hollow shaft and inserted inside the kneading chamber. Model III was a single spiral type flight of 225 mm length and 105 mm diameter.

Modified mixing index and uniformity of mixing index were better for model II, but model I with a peripheral speed of 93.46 cm/s was considered best based on the temperature rise, diameter expansion of chhana ball during cooking and sensory qualities of rasogolla **(Figures 5-7)**. About 2.5 g chhana lumps were put on ball former and the oscillator was turned on. On oscillation, the lumps got transformed into the shape of balls in 15 min.

Cooking of Chhana Balls at Atmospheric Pressure

Bhattacharya and Des Raj [12] reported that strength and concentration of sugar syrup primarily depend on the desired sweetness and shelf-life of rasogolla. They used 40-65% sugar solution for the purpose of cooking and 40% sugar solution for soaking. With lower concentrations (40-45%), rasogolla was less sweet and not acceptable due to its hard body and slightly decomposed texture caused by cooking for a longer period than optimum. Above 60% the quality of rasogolla was inferior on account of browning, hard body, and less spongy texture of product, because the higher concentration of sugar elevated the boiling temperature of cooking syrup. Syrup with 55% concentration was most acceptable. De [18] recommended 30 °Brix concentration of sugar syrup for cooking while no water was added to compensate for the evaporation loss. Goel [17], Kundu and De [18] and Bhattacharya and Des Raj [12] suggested that the strength of sugar syrup during cooking should be maintained between 50 and 60 ºBrix.

Figure 5. Preparing for ball making.

Figure 6. Ball formation by rolling in between palms.

Figure 7. Prepared balls.

Ten Hove and Das [3] prepared rasogolla with 45, 55, 60 and 65 ºBrix sugar solutions. The diameter of the ball was measured using a Vernier caliper at an interval of 1 min. Initial diameter of the ball was 2.7 cm, while final diameter after 10 min cooking was 3.7 cm for all the sugar solutions. So, the volume expansion was 2.6 times as compared to chhana ball after 10 min cooking time. It was found that the influence of sugar syrup concentration on the volume expansion was negligible.

Goel [17], Kundu and De [18], De [19], Bhattacharya and Des Raj [12] and Chandan [20] reported the cooking time for atmospheric cooking of rasogolla ranging from 20-30 min. Bhattacharya and Des Raj [12] found that 25 to 30 min of cooking was optimum for good quality and acceptability of rasogolla. Heating for less than 25 min gave rasogolla of white colour with minimum loss of moisture and fat from the chhana balls, but they were not acceptable due to inadequate cooking of balls, less sponginess and poor taste. Excessive cooking above 30 min resulted in rasogolla of inferior quality in all respects viz., browning, excessive loss of moisture and fat from the rasogolla, hard body, decomposed texture and poor taste. Goel and Agrawal [11] prepared rasogollas from 6 g chhana balls and reported that cooking of rasogolla at 104 to 106 ºC for 15 minute was adequate. They did not mention the cooking sugar syrup concentration but reported that the final concentration of sugar syrup was maintained at 40% by addition of water. The higher cooking temperature yielded product with hard body, with reduced springiness and darker colour of product. But in lower and shorter temperature range the product was soft and springy.

Soaking of Rasogolla in Sugar Syrup

After cooking is completed, the rasogollas are transferred to another vessel containing sugar syrup with a concentration lower than the cooking syrup. Kundu and De [18], Singh and Ray [21] kept rasogolla overnight at 40 ºBrix concentration of sugar syrup for development of texture. Karunanithy [13] prepared rasogollas from 2.5 g chhana balls and stored rasogolla at 40 °Brix for 16 h at room temperature before analysis. Tambat [9] prepared chhana balls of 1-2 cm diameter and reported that rasogolla was required to be soaked in 40-45 °Brix for 4 h for texture stabilization. Goel and Agrawal [11] prepared rasogollas from chhana balls of 6 g weight and suggested to cool down the rasogolla in 40% sugar concentration under normal room temperature for 16 h for proper development of texture **(Figures 8-11).**

Figure 8. Sugar syrup preparation for cooking rasogolla

Figure 9. Chhana balls put in sugar syrup for cooking.

Figure 10. Rasogollas kept for soaking.

Figure 11. Rasogollas kept for sale.

Cooking chhana balls under pressure

Bhattacharya and Des Raj [22] cooked chhana balls under pressure inside a pressure cooker to overcome the difficulty of maintaining proper concentration of sugar syrup during cooking of chhana balls in open pan boiling due to evaporation of water. They prepared chhana from cow milk, made balls and cooked the chhana balls under pressure. They found that a gauge pressure of 1 kg/cm², equivalent to saturation temperature of 121°C for water, required in pressure cooker was attained in about 13-15 min. This pressure was maintained for 1 to 7 min and then heating was stopped. After 10 min the pressure inside cooker was released slowly. It was found that rasogolla cooked in 50-55% sugar solution for 2-3 min under 1 kg/cm² pressure and then releasing the pressure after 10 min was more acceptable than that cooked for longer time whereas those cooked for 0 to 1 min remained uncooked.

Texture of Rasogolla

Ten Hove and Das [3] put the chhana balls in sugar syrup and a thermocouple was placed at the centre of the ball. The variation of temperature with time was read from a temperature indicator and noted at 0.5 min interval and diameter was measured using vernier caliper at 1 min interval. They found that though the centre of the rasogolla attained a maximum temperature after 6 min and the maximum volume expansion occurred after 10 min cooking time, the textural parameters of rasogolla like hardness, cohesiveness and springiness attained constant values after 20 min cooking in 55 °Brix. It was found that cohesiveness increased during cooking, probably due to settling of the casein network in rasogolla. Springiness remained nearly constant. Gumminess and chewiness increased with time. Though the maximum volume expansion took place in 10 min, but cooking was to be continued for 20 min for getting proper texture of rasogolla.

Microstructure of Rasogolla

Rasogollas were prepared with cow, buffalo and mixed milk for the study of microstructure of the rasogolla by Adhikari [14]. However, the proportion of cow and buffalo milk in the mixed milk was not mentioned by the author. For preparation of rasogolla, cow milk with 4% fat and 9.6% SNF, buffalo milk with 5% fat and 9% SNF and mixed milk with 5% fat and 9% SNF was used. The milk was boiled for 3 min and cooled at room temperature. It was then coagulated by 1% citric acid. The mixture was kept for 15 min before straining. The mixture was dipped in distilled water bath at 50 °C and was washed for 3 times. The chhana was pressed to 42-48% solid content. Wheat flour 2%, baking powder 0.05% and cardamom flavor 1% in solution form were added to chhana and kneading was done. Chhana balls of 1.5 cm diameter weighing 15-16 g were prepared and cooked for 15-16 min in 60-62% boiling sugar syrup. Then the cooked rasogollas were transferred to 40% sugar syrup and analyzed after 12 h of soaking. From the Scanning electron microscopic study, they found that cow milk rasogolla showed a loose, porous protein matrix with coalesced casein micelles forming a thread like structure. Buffalo milk rasogolla had agglomerated casein micelles which were large, compact and formed a scale or layer type structure. Mixed milk rasogolla was having combination of both type structures. Light microscopic investigation showed that cow milk rasogolla had smooth, small oval shaped pores, while buffalo milk rasogolla had rough edged irregularly shaped large pores and mixed milk rasogolla had a heterogeneous structure.

They studied the microstructure of cow, buffalo, mixed milk rasogolla and market rasogolla and found that the pore size of rasogolla prepared by cow milk varied from 0.8-1 mm, buffalo milk from 0.9-1.9 mm, mixed milk from 0.8-1.8 mm and market rasogolla from 0.7-1.25 mm **(Figures 12-14)**.

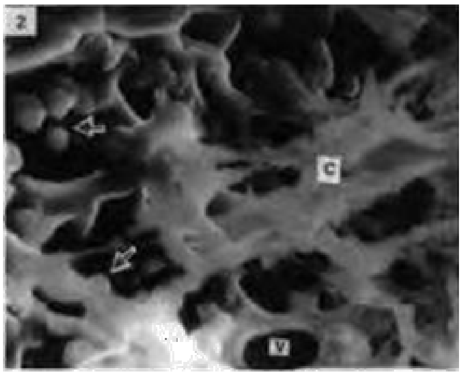

Figure 12. Scanning Electron Micrograph of cow milk rasogolla (20μm).

Variability in Rasogolla Quality

The quality of rasogolla primarily depends on the quality of chhana, initial moisture content of chhana and the chhana quality depends on many factors such as type of milk, type and amount of acid used for making chhana etc.

Types of Milk

Cow, goat and buffalo milk can be used for rasogolla making. De and Ray [1] and Joshi [23] observed that chhana produced from cow milk had a soft body, smooth texture, and light yellow color more suitable for rasogolla preparation than buffalo milk chhana, which was coarse, granular and hard. Rao [2] reported that crossbred cow's milk having 4% fat resulted in the best quality chhana for rasogolla making. Haque [24] prepared rasogolla with cow milk, buffalo milk and mixed milk (cow milk 50% and buffalo milk 50%). They reported that rasogolla prepared from the cow milk got the highest organoleptic score and the rasogolla

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prepared from the mixed milk chhana were also nearly similar to the cow milk rasogolla. Cow milk chhana was soft and buffalo milk chhana was hard in texture. Lower than 4% fat in cow milk resulted in hard body and coarse texture of chhana while higher fat level resulted in the greasy surface. Bhattacharya and Des Raj [12,22] used cow milk with 3-4% fat for preparation of rasogolla. Bhargava [25] tried rasogolla preparation with goat milk having 1, 2, 3, 4, 5, 6% fat. They reported that goat milk having 3-4% fat gave round, soft and spongy rasogolla of acceptable quality. Iyer [26] found that dilution of buffalo milk with 25% water and addition of 0.05% sodium citrate prior to boiling the milk, improved the quality of chhana for making rasogolla. It was found from the observations that cow milk with 4 percent fat was best for preparation of rasogolla as it made rasogolla soft and spongy with highest organoleptic score in comparison to those prepared from other milk.

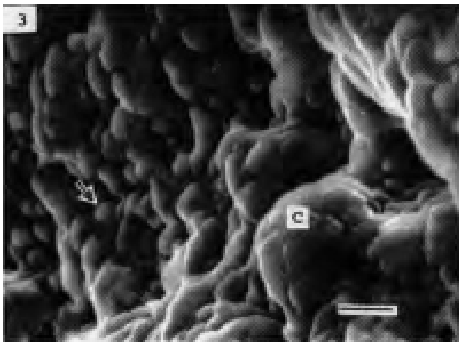

Figure 13. Scanning Electron Micrograph of buffalo milk rasogolla (20μm).

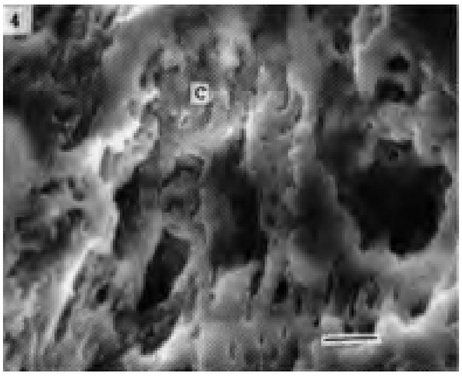

Figure 14. Scanning Electron Micrograph of Mixed milk Rasogolla (20μm).

Type and Amount of Acid Used for Making Chhana

Rao [2], Gajendran [27], Singh and Ray [22] found that good quality rasogolla could be made with chhana coagulated by citric acid. Rao [3] reported that 3.5 g citric acid per kg of cow milk was required for producing best quality chhana for rasogolla making. Soni [28] reported that 1.25 g citric acid per liter of buffalo milk was needed to produce good quality chhana for rasogolla. Bhattacharya and Des Raj [12,22] used 0.8% hot citric acid solution for coagulation of cow milk for preparation of rasogolla. Tarafdar [16] used 2% citric acid solution at the rate of 100-125 ml per lit of cow milk. Ten Hove and Das [3] used 1.5% citric acid solution at the rate of 250ml per liter of cow milk for coagulation and preparation of rasogolla. Ravichandra [29] found hardness of rasogolla was influenced maximum by fat content of the milk, followed by acidity of milk acid mixture, SNF of milk and moisture content of chhana. Rasogolla of desired hardness can be prepared with cow milk of 3.3% fat and 8% SNF, coagulated with citric acid at 0.4% lactic acid level of milk acid mixture and 58% chhana ball moisture content. Karunanithy [4] used 2% citric acid for coagulation of cow milk at the rate of 125 ml/lit of milk for preparation of rasogolla. Mahanta [30], Shrinivasan and Anantakrisnan [6], Gera [31] suggested that sour whey could be used for production of soft quality chhana suitable for rasogolla making. Citric acid is used by most of the investigators for preparation of chhana for rasogolla making.

Initial Moisture Content of Chhana

Bhattacharya and Des Raj [15] prepared rasogolla with chhana having initial moisture content of 40, 45, 50, 55, 58, 60 and 65% and reported about 55-58% moisture in chhana to be optimum for preparation of good quality rasogolla having round shape, soft body, and maximum spongy texture for atmospheric cooking. Moisture content below 50% gave rasogolla harder body, grainy and less spongy texture and at 60% and above the body of rasogolla was soft but the shape was flattened and texture was slightly decomposed.

Bhattacharya and Des Raj [22] prepared rasogolla in pressure cooker with chhana having 45, 48, 50, 55, 60, 62, 65% moisture content and found that better quality rasogollas were produced at 50-60% moisture content of chhana. Rasogollas made with chhana containing moisture below 50% were less acceptable due to hard body and grainy sensation during chewing despite having spongy texture. Chhana containing moisture above 60% yielded very soft rasogolla with broken texture and irregular sized bigger cavities.

Repeated Use of Same Syrup for Cooking of Rasogolla

Bhattacharya and Des Raj [12] used same sugar syrup for cooking four batches of rasogolla one after another. They reported that sugar syrup used up to the second time for cooking, gave rasogolla of acceptable quality. Use of sugar syrup after second time gave inferior quality rasogolla with brown color. After second time the sugar syrup intensified and led to rasogolla of inferior color and fat lost from chhana during cooking accumulated in the sugar syrup, resulting in a greasy surface in the rasogolla.

Mechanization of Rasogolla Making

Rasogolla production is largely confined to cottage and small-scale industry in India. Its production depends on the age-old practice, which is cumbersome, time consuming, labor intensive and makes it difficult to attain high quality standards. The products are handled manually during the course of their preparation, packaging and storage. In traditional method of preparation it is impossible to meet the large scale demand. For meeting the increased demand of rasogolla, maintenance of quality standards is necessary. It must be produced in a continuous manner using machines **(Figures 15-17).**

Figure 15. Rasogolla cooker developed at IIT Kharagpur for cooking rasogolla under atmospheric pressure.

Figure 16. Rasogolla Cooker developed at IIT developed at IIT Kharagpur.

Figure 17. Rasogolla cooker developed at IIT Kharagpur.

Production of rasogolla was reported to be increasing at the rate of about 67 percent per year [32]. The increased demand calls for greater opportunity in the organized dairy sectors of the country to modernize rasogolla production. Traditional milk products have a good market abroad. Entrepreneurs in Europe, North America, and Australia look for manufacturing them [33].

Kumar [34] developed a screw conveyor for kneading of chhana and portioning of the chhana to lumps of 10 g each. The lumps were made to fall on a spinning disc having a stationary disc above, which formed the chhana lumps to spherical shape.

Karunanithy [4] developed a chhana kneader having feed hopper, rotor, kneading chamber, outlet, reduction gear box and motor. Three different rotor models were fitted to kneading chamber. In model I, a screw of 25 mm pitch was fixed at both ends of the rotor shaft. Spokes were fixed in the rotor shaft in a helical pattern to facilitate simultaneous mixing and conveying. In model II a star perforated plate was inserted after feed end screw in order to increase the shear/mixing rate. Spokes and screw were fixed on the hollow shaft and inserted inside the kneading chamber. Model III was a single spiral type flight of 225 mm length and 105 mm diameter. It was found that the rotor model I fitted to the kneader having a screw of 25 mm pitch fixed at both ends of the rotor shaft with speed of 93.46 cm/s was considered as the best based on the temperature rise, diameter expansion of chhana balls during cooking and sensory qualities of rasogolla.

Karunanithy [5] developed ball former by using an oscillating tray. The kneaded chhana was manually portioned to lumps of 2.5 g. About 150 lumps were transferred to ball former for making spherical balls. After placing these lumps, the oscillator was turned on. On oscillation, the lumps got transformed into shape of balls and time required for formation was 15 min. The ball former was operated at 200 and 250 strokes/min (n), stroke length (L) of 5 and 10 cm with 0 and 5% slope (S) of ball forming surface having SS plain, SS perforated (1 mm dia and 1.5 mm pitch) and acrylic sheet. It was found that based on the sphericity of chhana balls and its retention in rasogolla, chhana ball can be successfully made from the chhana at 200 strokes/min and 5 cm stroke length and with 0% slope in SS plain surface.

Karunanithy [13] used chhana kneader and ball former as described above for preparation of rasogolla. The chhana balls were cooked in sugar syrup of 50 °Brix for 15 min and the temperature of boiling sugar syrup ranged between 105 to 110°C. The product was kept in 40 °Brix sugar syrup for 16 h. From the quality parameters study, they found that percentage of absorbed sugar syrup, porosity, expressible juice, volume expansion and overall acceptability was better for the chhana kneaded at 93.46 cm/s speed and balls formed at 200 stokes/min and 5 cm stroke length for SS plain surface with 0% slope. Porosity of rasogolla decreased with increase of stroke length and slope of ball forming unit.

Karunanithy [35] compared the quality parameters of rasogolla prepared from mechanically kneaded chhana with market samples and control. The control samples were prepared by manual kneading and forming balls by rolling in between the palms. The market rasogollas were collected from sweet shop in Coimbatore and Bangalore. They examined parameters such as porosity, expressible juice, colour, sensory scores and chemical composition of the samples. The percentage of absorbed sugar syrup, porosity, expressible juice and volume expansion were higher for the chhana kneaded in machine with balls formed at 200 strokes/min., and 5 cm stroke length for SS plain surface with 0% slope and comparable with control. Porosity and expressible juice was within the range of market samples. The hardness, colour, and overall acceptability were better for rasogollas prepared with machine kneaded chhana and machine formed balls and comparable with market samples and control samples i.e. chhana balls prepared by manual kneading and rolling.

CONCLUSION

Rasogolla is an Indian dairy product having good popularity abroad too. In recent years the marketing of rasogolla in cans has become a profitable business. Different brands of canned rasogolla are available in market. Mechanized production of rasogolla is very much needed as the demand is increasing. Only continuous chhana kneading and ball forming unit is developed but no work is done on continuous cooking machine. Development of a continuous cooking machine can facilitate continuous production of rasogolla. As pressure cooking has the potential to curtail the cooking time substantially, further work needs to be undertaken for facilitating its utilization with improved efficiency.

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Prof H. Das has been actively associated with the preparation of this paper till its finalization. Unfortunately he passed away on 22nd May, 2011 and is no more with us. His contribution is gratefully acknowledged.

REFERENCES

1. De S and Ray SC. Studies on indigenous method of chhana making, Indian J of Dairy Sci 1954; 7: 113-116.
2. Rao BVR. Effect of different concentrations of citric acid coagulant and fat levels of milk from crossbred cows on yield of chhana, fat losses in whey, moisture retained in chhana and quality chhana, M.Sc. Thesis, Allahabad University, Allahabad 1971.
3. Ten Hove K and Das H. Evaluation of yield, texture and cooking time of rasogolla, J Food Sci and Technol 1995; 32:109-114.
4. Karunanithy C, et al. Studies on development of kneader and ball former for chhana in rasogolla production Part I: Performance evaluation of chhana kneader. J Food Eng 2007a; 81: 298-305.
5. Karunanithy C, et al. Studies on development of kneader and ball former for chhana in rasogolla production. Part II: Development of chhana ball former and its evaluation. J Food Eng 2007b; 80: 961-965.
6. Shrinivasan MR and Anantakrisnan CP. Milk products of India. ICAR, New Delhi 1964; 9.

7. Kumar G and Shrinivasan M R. A comparative study on the chemical quality of three types of chhana samples. Indian J of Animal Sci, 1982; 52: 741.
8. Sen DC and Rajorhia GS. Potential application of calcium lactate as chhana coagulant. Indian Dairyman 1986; 38: 475.
9. Tambat RV, et al. Effect of fat and maida levels on rasogolla preparation. Indian Dairyman 1992; 44: 203-205.
10. De S. Chhana and chhana based sweets. Indian Dairyman 1976; 28:30-36.
11. Goel BK and Agrawal AK. Optimization of processing parameters for continuous rasogolla manufacturing. Indian Dairyman 1994; 46: 697-699.
12. Bhattacharya DC and Des Raj. Studies on production of rasogolla. Part - I. Traditional method, Indian J of Dairy Sci, 1980a; 33: 237-243.
13. Karunanithy C, et al. Studies on development of kneader and ball former for chhana in rasogolla production Part III: Quality parameters of rasogolla. J Food Eng, 2007c; 80: 966-971.
14. Adhikari AK, et al. Micro- and macro- structure of cow, buffalo and mixed milk rasogolla: a comparative scanning electron and light microscope study. Lait 1992; 72: 475-489.
15. IS: 4079-1967. Specification for canned rasogolla. Indian Standards Institution, New Delhi.
16. Tarafdar HN, et al. Mechanical kneading of chhana and quality of rasogolla, J Food Sci and Technol 1988; 25:223-227.
17. Goel VK. Studies on the manufacture and packaging of rasogolla. M.Sc. Thesis, Punjab Agricultural University, Ludhiana 1970.
18. Kundu SS and De S. Chhana production from buffalo milk. Indian J of Dairy Sci 1972; 25: 159-163.
19. De S. Outlines of Dairy Technology. Oxford University press, Delhi 1980.
20. Chandan RC. Cheese made by direct acidification, Indian Dairyman 1992; 44:133-141.
21. Singh GP and Ray TK. Effect of milk coagulants on quality of chhana and chhana whey, J Food Sci and Technol 1977; 14: 205.
22. Bhattacharya DC and Des Raj. Studies on production of rasogolla. Part - II. Pressure cooker method, Indian J of Dairy Sci 1980; 33: 479-483.
23. Joshi SV, et al. Effect of different coagulants on yield and sensory quality of chhana prepared from milk of cow, buffalo and goat, Indian J. Dairy Sci 1991; 44: 380-383.
24. Haque A, et al. Comparison of rasogolla made from Fresh Cow Milk, Fresh Buffalo Milk and Mixture of Cow and Buffalo Milk, Pakistan J of Nutrition 2003; 2: 296-299.
25. Bhargava VN, et al. Influence of fat level on production of chhana and rasogolla from goat milk. Small Ruminant Research 1992; 8: 55-65.
26. Iyer M. Physico chemical studies on chhana from cow's and buffalo's milk. M.Sc. Dissertation, Kurukshetra University, Kurukshetra 1978.
27. Gajendran KL. Effect of different concentrations of citric acid coagulant on yield and quality of chhana from homogenized buffalo milk. M.Sc. Thesis, Allahabad University, Allahabad 1976.
28. Soni K, et al. Manufacture of rasogolla from buffalo milk, Indian J of Dairy Sci 1980; 33: 357 -365.
29. Ravichandra MN, et al. Optimization of process parameters for the production of rasogolla from cow milk, J Food Sci Technol 1997; 34: 46-49.
30. Mahanta KC. Handbook of Dairy Science. Kitabstan, Allahabad 1964; 386.
31. Gera VK. Rheology of chhana from cow's and buffalo's milk. M.Sc. Dissertation, Kurukshetra University, Kurukshetra 1978.
32. Anon. Processed foods market records 16 pc growth, Indian Food Packer 1994; 48: 66-67.
33. Patil GR. Innovative processes for indigenous dairy products, Indian Dairyman 2005; 57: 82-87.
34. Kumar RR, et al. Processing identification for continuous production of sandesh and rasogolla. Seminar on packaging and preservation of indigenous dairy products. IDA East Zone, West Bengal University of Animal and fishery sciences, Mohanpur campus, Nadia 1997.
35. Karunanithy C, et al. A comparative study on quality and textural parameters of commercial and machine prepared rasogolla, J Food Sci Technol 2006; 43: 493-495.

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