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Effects of Different Concentrations of Cooking and Soaking Sugar Syrup on the Physico-chemical Quality of Rasogolla

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Abstract

This study was aimed at assessing the effect of concentration of cooking and soaking sugar syrup on the quality of Rasogolla made from cow milk standardized to 4% fat. The Chhana was prepared by adding 1% citric acid in raw milk at 80°C. The Chhana obtained was kneaded with 5% (w/w) wheat flour. Three types of Rasogolla was made by cooking and soaking in sugar syrups of 40, 50 and 60° Brix concentrations, respectively. The prepared Rasogolla were scored using a 9-point hedonic scale for the sensory attributes viz. color and appearance, aroma, taste, body and texture, and overall sensory score. The proximate composition of Rasogolla was analyzed for total solids (TS), protein, fat, carbohydrate and ash. The results revealed that the effect of sugar syrup on the sensory attributes of Rasogolla was significantly differed ($p<0.05$). It was observed that Rasogolla obtained by cooking in 60° Brix sugar syrup and subsequently soaked in 40° Brix resulted in excellent quality Rasogolla with highest off-white appearance, pleasing aroma, spongy body, fluffy texture with the uniform surface without any cracks. The chemical components in the case of cooking syrup the TS, carbohydrate, and ash content were significantly differed ($p<0.05$) but protein and fat content were found non-significant ($p>0.05$) with 6 and 5%, respectively in both sugar syrup. The highest TS (47%) was recorded for 60° Brix cooking syrup but after soaking, the TS resulted in 51%. It can be concluded that the Rasogolla made from 60° Brix cooking syrup and 40° Brix soaking syrup kept for 24 h resulted in the best quality Rasogolla.

Keywords: Cooking syrup; Soaking syrup; Rasogolla; Physico-chemical

Introduction

Rasogolla is one of the most delicious and nutritious among all sweetmeats available in Bangladesh [1]. Rasogolla is a sweet syrup cheese ball most popular in the regions of South Asia, manufactured from Chhana which is obtained by heat and acid coagulation of milk. It is nutritious due to its fairly high protein, fat, mineral especially calcium and phosphorus and also fat-soluble vitamin A and D [2]. For instance, a Rasogolla of 100g contains 186 calories along with carbohydrate, fat, and protein provides 153, 17, and 16 calories, respectively.

The first pre-requisite for producing excellent quality Rasogolla is the availability of high-quality Chhana together with the binding material, kneading, and concentrations of sugar syrup, cooking and soaking time as well. The strength and concentration of sugar syrup primarily depend on the desired sweetness and preservation of Rasogolla. Concentrations of cooking sugar syrup have an important role in deciding the body and textural properties of Rasogolla. The inappropriate concentration of cooking sugar leads to cracked, flattened or even brushed Rasogolla [3]. The cooking of Chhana balls in sugar syrup is necessary for the proper body and textural characteristics of the Rasogolla. Cooking is the process in which a soft and smooth body of Chhana balls converts to a fluffy and fibrous network that provides spongy texture typical to Rasogolla. In the preparation of Rasogolla, the strength of the cooking syrup varied widely (30-80%) from laboratory to laboratory. With lower concentrations of cooking syrup (40-45%), Rasogolla may result in less sweet and harder body and slightly decompressed texture caused by cooking for a longer period than optimum. On the contrary, the soaking process stabilizes the texture of Rasogolla in terms of hardness, gumminess springiness and chewiness. During the soaking period, the equilibration of sugar syrup concentration within the Rasogolla takes place. Rasogolla is stored and served in this sugar syrup.

More than a few scholars revealed that the strength of sugar syrup for cooking should be in the range of 50 to 55° Brix [4,5]. [6] reported the effect of cooking syrup strength on the volume expansion of Chhana balls. The optimization of the cooking syrup concentration to 40° Brix has been suggested by [7]. On the contrary, the concentration of sugar syrup during soaking and kept the balls overnight in that syrup should be 40° Brix, recommended by several researchers [5,8-10]. Furthermore, Goel and Agrawal [11] observed that a 40% sugar concentration for 16 h under room temperature gave proper texture development of Rasogolla ball. Mohanta & Shrivastava [7] optimized the concentration of soaking sugar syrup to 35° Brix and preserve in soaking syrup for 14.37 h.

Materials and Methods

Raw cow milk was collected from Bangladesh Agricultural University Dairy Farm (BAUDF), Mymensingh, Bangladesh and standardized to 4.0 % fat using skim milk separated from the same milk. Food grade citric acid (RFCL Ltd., India), soft wheat flour (ACI Pure, Dhaka-Bangladesh) & cane sugar (Fresh, Dhaka-Bangladesh) and cardamom were purchased from the local market of BAU, Mymensingh[33].

Chhana Preparation

Chhana was prepared according to the method described by De [9] with few modifications. In brief, 1 L of fresh cow milk (standardized to 4.0 % fat) was heated to 95ºC temperature and subsequently cooled to 75-80°C. Afterward, coagulants (1% citric acid) were slowly added to the milk with continuous stirring. The coagulated mass was kept undisturbed for the complete coagulation of milk and allowed to cool up to 37ºC. Chhana was then separated from whey by filtering through a muslin cloth for about 2-3 h for the visible cessation of drainage of whey.

Preparation of sugar syrup

In each case of sugar syruppreparation, different concentration of cooking and soaking syrup viz. 40, 50 and 60°Brix were prepared, respectively. All sugar syrups were clarified by adding a few mL of milk during boiling about 2-3 minutes.

Rasogolla preparation

Rasogolla was made according to the procedure of Bhattacharya and Raj [4] with little modifications. The Chhana was mixed with wheat flour (5.0 %, w/w) and kneaded properly to make uniform and smooth dough. Chhana dough was divided into small pieces of 10±2 g and rolled between the palms to obtain smooth balls, without cracks. Cooking and soaking sugar syrup of 40, 50 and 60.0 % was prepared separately by dissolving the requisite amount of sugar in potable water. In each trial, a 1.5 L sugar solution was used for cooking and 1.0 L for soaking. All sugar syrups were clarified by adding some quantity of raw milk during boiling and filtered through a muslin cloth. Previously formed Chhana balls were gently dropped into the boiling syrup contained in Karahi. After a few seconds, the foam was formed which covered the floating balls. The mild temperature was regulated as the balls were constantly covered with foam. Some quantity of water was sprinkled during the continued boiling of sugar syrup to maintain the sugar syrup concentration. Complete cooking of Chhana balls was accomplished within 20 to 30 min. The balls were swollen to about double the original size. Finally, the balls were transferred to the clarified hot sugar syrup having 40, 50 and 60% strength for soaking and 2-3 cardamom pieces were added to the sugar syrup and cooled down to room temperature or below.

Sensory evaluation of Rasogolla

The sensory scoring of the product was carried out by an expert panel of six judges from the Department of Dairy Science, BAU, Mymensingh, Bangladesh. The samples of Rasogolla were scored using a 9-point hedonic scale for sensory attributes such as color and appearance, aroma, taste, body and texture, and overall sensory score.

Chemical analysis

Moisture, fat, carbohydrate and ash content of milk, Chhana and Rasogolla were determined as per AOAC, 2003 method. The protein content of the products was determined by the Kjeldahl method and the acidity was analyzed by acid-base titration method [12].

Statistical analysis

Data collected on different parameters were subjected to statistical analysis. Analysis Variance (ANOVA) test was done to find out the statistical differences between different groups with the help of wasp2 (Web Agri Stat Package, version 2.0) computer program.

Results and Discussion

Effect of sugar syrup on the sensory characteristics of Rasogolla

The data regarding sensory attributes of Rasogolla are depicted in (Tables 1,2). Based on sensory characteristics Rasogolla with a sugar concentration of 60° Brix was found significantly highest with color and appearance, aroma, tastes and body, and texture. The reason behind this may be the strength and concentration of sugar syrup for cooking. It might be attributed to an increase in total solids, boiling point at cooking syrup also higher. The effect of cooking time is the vice-versa to the level of sugar added to the syrup. The flavor of Rasogolla was enhanced by cooking. These findings agreed with the result of Bhattacharya and Ra [4] and Acharya and Kanth [13]. It had increased foaming characteristics of the medium which could adhere to the product surface resulting in more swell of Chhana ball and facilitates quicker absorption of syrup within the porous structure. Acharya and Kanth [13] found that in un-neutralized whey medium as the sucrose level increased color and appearance score was significantly ($p<0.05$) decreased but neutralized whey medium 50% (w/w) sucrose gave higher

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color score than others. Bhattacharya and Raj [4], Kundu and De [5] suggested that the strength of sugar syrup during cooking should be maintained between 50 and 60° Brix. Shelke et al. [3] observed that the Chhana balls obtained by cooking in 50% sugar syrup resulted in good quality Rasogolla.

Table 1: Effect of different Concentrations of Cooking Sugar Syrup on the Sensory Characteristics of Rasogolla.

Parameters	Cooking Sugar Syrup			CD
	40° Brix	50° Brix	60° Brix	
Colour and appearance	11.92^{c}±0.08	12.71^{b}±0.04	13.96^{a}±0.21	0.26
Aroma	39.62^{c}±0.12	40.66^{b}±0.15	42.63^{a}±0.37	0.49
Taste	7.88^{b}±0.37	8.58^{a}±0.08	9.21^{a}±0.46	0.7
Body and texture	23.04^{b}±2.21	25.58^{ab}±0.41	28.08^{a}±0.41	2.64
Overall sensory score	82.46^{c}±2.79	87.53^{b}±0.22	93.88^{a}±0.63	3.32

Mean ± SD. Vales followed by different superscript letter in a raw are significantly different (p ≤0.05). CD = Confidence distribution.

Table 2: Effect of Different Concentrations of Cooking Sugar Syrup on the Chemical Composition of Rasogolla.

Parameters (%)	Cooking Sugar Syrup			CD
	40° Brix	50° Brix	60° Brix	
Total solids	42.70^{c}±1.85	44.50^{b}±1.50	47.30^{a}±1.75	3.4
Protein	5.77±4.56	5.56±2.91	6.16±1.85	-
Fat	5.25±7.50	5.50±5.00	5.00±5.00	-
Carbohydrate	31.00^{b}±14.56	32.60^{ab}±9.71	34.73^{a}±8.70	22.54
Ash	0.73^{c}±0.65	0.83^{b}±0.30	0.94^{a}±0.10	0.84

Mean ± SD. Vales followed by different superscript letter in a raw are significantly different (p ≤0.05). CD = Confidence distribution.

Soaking sugar syrup on the sensory characteristics of Rasogolla

In the case of soaking sugar syrup, all the sensory attributes significantly differed. The color and appearance score were recorded highest in 40° Brix sugar syrup. It might be due to the sugar consistency of the syrup. Forty percent of sugar syrup is enough to appear acceptable color but an increase in soaking sugar concentration is not responsible for appropriate white color Rahman et al. [14]. In contrast, Goyal [15] studied the different types of dipping media and revealed that there was no significant difference among all the samples in their color and appearance. However, the great aroma score was noted for the same concentration of soaking syrup. It might be due to 40° Brix Rasogolla contains appropriate sugar consistency for soaking which is necessary for proper texture stabilization and possibly the aroma of the product made. Kundu and De [5], Singh and Ray [8], Karunanithy et al. [16] and different researchers kept Rasogolla overnight at 40º oBrix concentration of sugar syrup which was lower than that used for cooking. Fifty percent sugar syrup concentration for soaking obtained the highest score, lower taste score may be attributed to the higher consistency of soaking medium. Haque et al. [17] found there was no significant difference in the taste score of different types of Rasogolla. Basak et al. [18] observed that there were significant differences ($p<0.01$) among the taste score of different types of Rasogolla. Significantly highest body and texture scores were recorded for 40° Brix Rasogolla which might be attributed to the effective absorption syrup texture improvement increased [18,19]. Finally, the overall score indicated that the 40° Brix sugar was found best based on sensory attributes.

Cooking sugar syrup on the chemical composition of Rasogolla

As far as the chemical composition of Rasogolla is concerned, the TS, carbohydrate and ash content have significantly differed among the various concentration of cooking sugar syrup. The higher TS was found for 60° Brix sugar syrup followed by 50° Brix and 40° Brix. It may be due to the cooking of Rasogolla in a higher concentration of sugar. These results are also agreed with by other scholars [3,4]. A non-significant effect of cooking syrup was recorded for the protein and fat content. Among three types of sugar concentration, 60° Brix was showed little higher protein value (6.14%) which is supported by various previous findings David [20] who found 5.92%, Thakur et al. [21] with 6.82% and Haque et al. [17] with 5.58%. Besides, Acharya and Kanth [13], they found 6.25% protein with the same sugar concentration. Bhattacharya and Raj [4] found that with the increasing sugar concentration in cooking syrup from 40 to 50% fat of Rasogolla varied slightly. Present research findings are partially supported by the above-stated evidence. In the case of fat content, Haque et al. [17] and Bandyopadhyay et al. [22] were observed Rasogolla made from 100% cow milk should be contained 4.90 and 5.44% fat, respectively with both 50 and 60% sugar concentration.

The facts agree with our results (Table 2). According to the BSTI standard [23], sucrose content of cow milk Rasogolla must be 45 (% mass, max). Sur et al. [24] cooked Rasogolla in 60% sugar syrup and found average sucrose content in cow milk Rasogolla about 32%. Besides, Puranik [25] also cooked Rasogolla in the same strength of syrup and found 38% sugar in the Rasogolla made, which is partially supported by current research findings. Desai et al. [26] reported that 35.16% of carbohydrates remain in better quality sponge Rasogolla that is similar to our findings. In addition, the highest sugar content (43%) in Rasogolla when made with blending of soya and cow milk (50:50) whereas the Rasogolla made from cow milk was 39.34% [21]. Sugar concentration 60% syrup obtained significantly higher ash content followed by 50% and 40%. It might be due to the highest number of total solids in 60% sugar Rasogolla. The current research finding is similar to

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Haque et al. [17] they found that ash in cow milk Rasogolla was 0.84%. The observation is also in agreement with the finding of Katara and Bhargava (1990) they recorded 0.88% ash from cow milk Rasogolla. In contrast, Thakur et al. [21] observed ash content of cow milk Rasogolla was 1.63% which is not matched to present research findings (Table 3,4).

Table 3: Effect of different concentrations of soaking sugar syrup on the sensory characteristics of Rasogolla.

Parameters	Soaking Sugar Syrup			CD
	40° Brix	50° Brix	60° Brix	
Colour and appearance	13.67^{a}±1.16	12.16^{b}±0.16	11.83^{b}±0.50	1.47
Aroma	42.66^{a}±0.88	41.00^{b}±0.00	40.11^{b}±1.17	1.69
Taste	9.16^{a}±0.50	8.16^{b}±0.16	7.66^{b}±0.33	0.72
Body and texture	27.83^{a}±1.17	25.33^{b}±1.00	24.50^{b}±0.16	1.79
Overall sensory score	93.32^{a}±2.65	86.65^{b}±1.00	84.10^{b}±2.16	4.11

Mean ± SD. Vales followed by different superscript letter in a raw are significantly different (p ≤0.05). CD = Confidence distribution.

Table 4: Effect of Different Concentrations of Soaking Sugar Syrup on the Chemical Composition of Rasogolla.

Parameters	Soaking Sugar Syrup			CD
	40° Brix	50° Brix	60° Brix	
Total solids	47.60^{c}±58.31	48.60^{b}±1.30	51.39^{a}±1.30	0.62
Protein	6.75±4.00	6.86±0.2.90	6.56±4.85	-
Fat	5.62±3.75	5.97±0.25	5.37±13.75	-
Carbohydrate	34.54±50.30	35.03±4.08	38.46±10.17	0.77
Ash	0.65^{c}±0.25	0.74^{b}±0.37	1.00^{a}±0.03	0.52

Mean ± SD. Vales followed by different superscript letter in a raw are significantly different (p ≤0.05). CD = Confidence distribution.

Soaking sugar syrup on the chemical composition of Rasogolla

As far as the soaking sugar syrup is concerned, the results revealed that all the chemical components except ash content were non-significantly deferred. Although the Rasogolla made from 60° Brix was found slightly higher with 52% TS. Lokhande et al. [27] recorded 58.75% TS which is more than present research along with David (2016) recorded 48.8% TS from cow milk Rasogolla by using 40 and 50% sugar syrup, respectively. In accordance, Tarafdar et al. [28] observed 47% TS from cow milk Rasogolla by soaking in 50° Brix syrup. So, the results obtained by the scientists are more or less agreed with the current research findings. Among the three samples, 50° Brix sugar concentration syrup for soaking carried the highest protein value of 6.8%. Thakur [21] observed that minimum value (5.88%) was obtained and the highest mean value for protein 6.82% of Rasogolla was obtained from the Blending of soymilk and cow milk (50:50) in different ratios. Rahman et al. [14] found laboratory made Balish Rasogolla contains 6.20% protein [29-31].

Conclusion

It can be summarized that the best quality Rasogolla, should be soft and spongy. The quality of Rasogolla largely depends on the quality of basal material Chhana and the strength and concentration of cooking and soaking sugar syrup. A wide range of chemical and physical composition was observed by many researchers due to the usage of varieties of milk and ingredients to prepare the product and optimization parameters of processing. However, based on the sensory characteristics with its suitability for Rasogolla making, cooking and soaking sugar syrup @ 60 and 40° Brix concentrations were found most suitable for Rasogolla making using admixture of 5% (w/w) wheat flour.

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