EFFECT OF COAGULATING AGENTS FOR PREPARATION OF SOY MILK-BASED RASOGOLLA

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ABSTRACT: *This experiment investigated how different coagulants affected soymilk-based Rasogolla's flavour, body and texture, colour, appearance, and chemical composition (moisture, dry matter, crude protein, fat, carbohydrate, nitrogen-free extract, ash, and crude fibre). Milk samples were collected from the Bangladesh Agricultural University dairy farm (BAU) to prepare soymilk-based Rasogolla, and Soymilk was prepared at the Dairy Technology Laboratory of BAU, Mymensingh. Cow milk and soymilk samples were coagulated using four different coagulants: calcium lactate, citric acid, lactic acid, and vinegar. The change obtained from fresh cow milk and Soymilk was mixed in a 1:1 ratio to prepare different types of Rasogolla: CLSMR (Calcium Lactate Coagulated Soymilk-based Rasogolla), CSMR (Citric Acid Coagulated Soymilk-based Rasogolla), LSMR (Lactic Acid Coagulated Soymilk-based Rasogolla), and VSMR (Vinegar Coagulated Soymilk-based Rasogolla). The effects of the coagulating agents on the different Rasogolla variants were assessed using both physical and chemical analyses. Physical evaluation focused on sensory attributes such as flavour, body and texture, colour, and overall appearance. Chemical tests measured various parameters, including total solids, moisture content, protein, fat, carbohydrate, ash, and acidity. The study revealed that the coagulating agents had a significant effect ($p < 0.05$) on the flavour of the Rasogolla samples (CLSMR, CSMR, LSMR, and VSMR) but did not significantly ($p > 0.05$) affect their body and texture, colour, or appearance. Additionally, the coagulating agents had a highly significant impact ($p < 0.01$) on the levels of crude protein, fat, ash, nitrogen-free extract, acidity, and crude fibre. However, no notable differences ($p > 0.05$) were observed in the moisture, dry matter, or carbohydrate content across the Rasogolla samples. Each treatment was replicated three times and collected data were analyzed using (SPSS) software (version 25).*

KEYWORDS: Cow milk, soy milk, coagulating agents, Rasogolla.

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INTRODUCTION

Cow milk plays a crucial role in human nutrition, serving as one of the primary sources of essential nutrients in diets worldwide. Its versatility is evident in the wide variety of milk-based products it can be transformed into, making it a key ingredient in many culinary traditions. One such product, Rasogolla, holds significant cultural importance in South Asia, particularly in Bangladesh, where it is cherished as a popular sweetmeat made from chhana. This delightful dish is a beloved treat and an integral part of various celebrations, including Eid, Puja, birthdays, and weddings. Rasogolla is often featured prominently in domestic and national events, symbolising joy and festivity. Its presence at such occasions has made it a culturally significant food, essential to marking the completion of major life events, such as marriages. Beyond its cultural and ceremonial significance, Rasogolla is also highly nutritious. It is rich in proteins, fats, minerals such as calcium and phosphorus, and fat-soluble vitamins, especially vitamins A and D, making it a valuable addition to the diet (Islam et al., 2003)

It is estimated that 50-55% of the milk produced is converted into traditional milk-based products, including yoghurt and rasogolla. Rasogolla, a popular sweet in South Asia, is made from chhana, a curdled precipitate formed by heating and acid-coagulating milk. This delectable treat, typically shaped into syrup-soaked cheese balls, is not only enjoyed for its sweetness but also its nutritional value. Rasogolla is rich in essential nutrients, including fat, high-quality protein, and key minerals such as phosphorus and calcium. Additionally, it provides fat-soluble vitamins, particularly vitamins A and D. A 100g serving of Rasogolla contains 186 calories, with the majority of these calories derived from carbohydrates (153 calories), followed by fat (17 calories) and protein (16 calories). This combination of nutrients makes Rasogolla both a flavourful and nourishing food item.

A study evaluated the impact of different coagulants on the yield, recovery of milk solids, and taste quality of chhana and the resulting Rasogolla. The research involved using six different coagulants, including sour whey (with 0.5% and 1.0% acidity), citric acid (at 0.5% and 1.0% acidity), and a mixture of sour milk and citric acid (0.5%, 1.0% acidity). While the use of these coagulants did not significantly affect the yield of chhana, they notably influenced the recovery of fat and total solids (TS), with recovery rates ranging from 90.5% to 93.8% for fat and 42% to 44% for TS of milk in chhana production (Begum et al., 2019). On the global scale, milk production in the fiscal year 2022-23 reached 140.68 lakh metric tons, a significant increase of 4.7 times compared to FY 2010-11, bringing per capita availability to 221.89 ml/day. However, a 17.82 lakh metric tons deficit still exists (DLS, 2023). In a different study, non-dairy Rasogolla (NDR), made from soybean milk, was produced using various coagulants such as calcium lactate, citric acid, lactic acid, and tartaric acid, with a control group consisting of dairy Rasogolla (DR) purchased from a local store. Among the NDRs, the citric acid-coagulated NDR (CNDR) had the highest fat content (4.95±0.18%; $p<0.05$). In terms of protein, the dairy Rasogolla (DR) exhibited lower values (8.24±0.05%; $p<0.01$) compared to the other NDR variants, except for the lactic acid-coagulated Rasogolla (LNDR), which had a protein content of 7.89±0.22% ($p<0.01$). The LNDR also had the highest moisture content (51.20±0.56%; $p<0.01$) and the most incredible carbohydrate level (34.37±0.49%; $p<0.01$) among the NDRs. However, its energy value (208.55±6.88; $p<0.01$) was significantly lower than that of the other NDRs (Sengupta et al., 2017). Additionally, satisfactory quality chhana was produced using a 1.0% citric acid solution (Kumar et al., 2007).

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The acute shortage of milk and other animal-based protein sources in Bangladesh has led to widespread malnutrition across various demographics. To address this issue, there is a need to develop low-cost, processed supplementary foods that can provide essential nutrients. Products such as vegetable milk, nutritionally balanced malt foods, and multipurpose foods have the potential to play a crucial role in alleviating this problem. Cow milk and soy milk, in particular, offer promising alternatives. Soy milk, derived from soybeans through soaking, grinding, boiling, and filtering, is a plant-based drink rich in protein, oil, and water and serves as an intermediate product in tofu manufacturing. A novel approach could involve making Rasogolla from soy milk powder, offering consumers an affordable and nutritious option.

While traditionally produced in cottage industries, mechanisation is seen as a means to increase production rates and improve quality control. The study explored various parameters affecting Rasogolla quality, including the type of milk, the acid used for chhana (a key ingredient), the moisture content of chhana, kneading techniques, the formation of chhana balls, and the concentration of sugar syrup during cooking. Additionally, the impact of soaking and reusing sugar syrup was examined, along with its influence on cooking time, soaking time, and the microstructure of the chhana ball. The preparation of Rasogolla is a highly specialised craft, often guarded as a closely held secret by confectioners, with variations in technique and quality across different producers. However, it is generally accepted that Rasogolla is best prepared from soft, freshly made cow milk chhana, contributing to its distinctive texture and flavour.

Most chhana varieties in the market are characterised by a soft body, light brown crust, and a creamy white to light brown interior. These products typically feature a moderate sweetness, rich caramelised sugar, smoky flavour, and spongy texture (Banker et al., 2016). In Bangladesh, some research has been conducted by the Department of Dairy Science at Bangladesh Agricultural University, Mymensingh, focusing on the quality of locally available Rasogolla. The findings suggest that the Rasogolla sold in local markets often fails to meet quality standards, particularly in terms of protein and fat content, which are lower than those found in high-quality Rasogolla. To address this, an experiment was conducted to prepare Rasogolla using a blend of cow milk chhana and soy milk chhana, incorporating various coagulants such as calcium lactate, lactic acid, citric acid, vinegar, and acetic acid. This study aims to identify the most suitable coagulant for producing soy milk-based Rasogolla, which could offer a nutritious alternative while maintaining desirable sensory qualities.

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MATERIALS AND METHODS

Period of study

An experiment was carried out at the Dairy Technology Laboratory of the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh, from January 1st to March 30th, 2022. The study involved preparing Rasogolla using cow milk chhana and soy milk chhana, with four different coagulating agents: calcium lactate, citric acid, lactic acid, and vinegar.

Collection and analysis of milk

The milk collected from the Bangladesh Agricultural University (BAU) dairy farm exhibited a mean fat content of 3.51% and an SNF content of 85g/kg (8.5%).

Preparation of soy milk

Fresh Soyabean seeds were collected from local markets. Soy milk was made from a big size, thin hull, not more than 1-year-old, straw yellow or yellowish varieties of immature soybeans free from field damage, and black soybeans. 1000gm whole immature soybean free from field damage, and the black spot was ground in a soy flour mill. By stirring, four-hundred-gram powder was dissolved with 2000 ml of water (125g/1000 ml water considered a standard). The milk was strained through a fine cloth to separate the residue. After staining and removing residue, the volume was reduced slightly, and water was added to increase the volume to 2000ml.

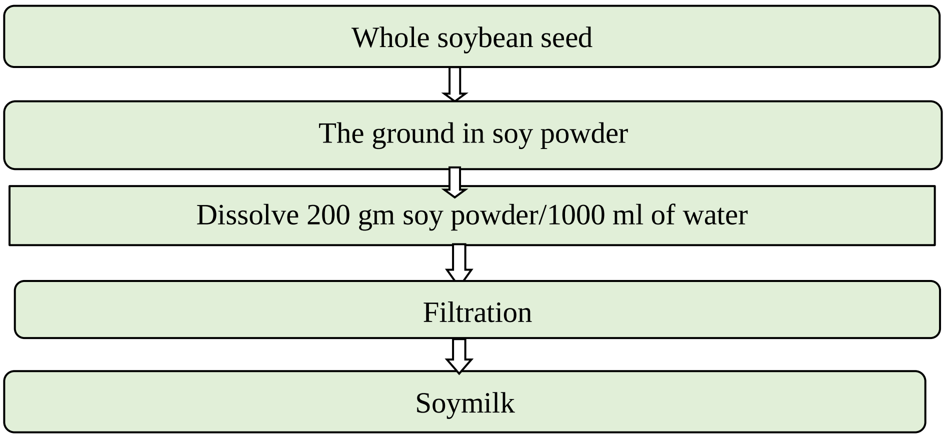

Fig. 1: Preparation of Soymilk from whole soybean seed

Table 1: Types of coagulants and amount of cow milk and soymilk used for the preparation of Rasogolla

Types of coagulant to prepare Rasogolla	Cow's milk (ml)	Soy milk (ml)
Calcium lactate (A)	500 ml (50%)	500 ml (50%)
Citric acid (B)	500 ml (50%)	500 ml (50%)
Lactic acid (C)	500 ml (50%)	500 ml (50%)
Vinegar (D)	500 ml (50%)	500 ml (50%)

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Chhana making

Cow and soy milk were used to prepare chhana separately during each trial. The milk and soy milk samples were separately boiled in iron pans for approximately 12-15 minutes, then cooled to 80°C. Coagulants A (calcium lactate: 220 ml for cow milk, 200 ml for soy milk), B (citric acid: 180 ml for cow milk, 175 ml for soy milk), C (lactic acid: 100 ml for cow milk, 120 ml for soy milk), and D (vinegar: 15 ml for cow milk, 20 ml for soy milk) were subsequently added at a temperature of 80°C. Upon the addition of coagulants to the boiling milk and soy milk, aggregates of casein, commonly referred to as chhana, were immediately produced. The content was thereafter permitted to accumulate for several minutes, resulting in a complete transformation. Approximately 5 to 10 minutes post-coagulation, the fluids were permitted to cool to ambient temperature (approximately 25°C). The coagulum was progressively strained using a muslin cloth to facilitate whey drainage. Upon completion of the whey transfer, the four corners of the cloth were secured, and the coagulum was put on hold for approximately one and a half hours to facilitate whey drainage. The quantities of chhana derived from cow milk using calcium lactate, citric acid, lactic acid, and vinegar were 189g, 120g, 125g, and 147g, respectively, while the amounts obtained from soy milk using the same coagulants were 136g, 110g, 120g, and 125g, respectively. Chhana derived from cow and soy milk was thoroughly combined in a specified ratio of 1:1.

Table 2: Ingredients used for the preparation of Rasogolla

Type A (Calcium Lactate)	**Type B (Citric Acid)**	**Type C (Lactic Acid)**	**Type D (Vinegar)**
Chhana: 200gm (100g from cow milk and 100g from Soymilk)	Chhana: 200gm (100g from cow milk and 100g from Soymilk)	Chhana: 200gm (100g from cow milk and 100g from Soymilk)	Chhana: 200gm (100g from cow milk and 100g from Soymilk)
Sugar: 1 kg	Sugar: 1 kg	Sugar: 1 kg	Sugar: 1 kg
Flour: 5%	Flour: 5%	Flour: 5%	Flour: 5%
Backing powder: 0.1%	Backing powder: 0.1%	Backing powder: 0.1%	Backing powder: 0.1%

The manufacturing method of Rasogolla:

To achieve the appropriate texture and body, the chhana was kneaded with flour. Small balls formed from the kneaded mass have perfectly smooth surfaces devoid of cracks because of the mass's consistency. Then, in a heavy-bottomed saucepan, 4 kilograms of sugar and 4 litres of water were cooked together. In order to get a clear syrup, the scum was separated off shortly after boiling. At last, the chhana balls were formed and cooked in sugar syrup. Thirty minutes was the cooking time for the chhana balls. Constantly covering the balls with foam, the heat was managed. Cold water was poured at regular intervals as it cooked to get the sugar syrup to the right consistency. Rasogolla absorbed a maximum amount of sugar syrup while cooking, which caused it to swell to almost three times its original size and slightly darken its colour. After the Rasogolla was made, it was left to cool for a while. Rasogolla was prepared and ready to be eaten after 25 to 30 minutes.

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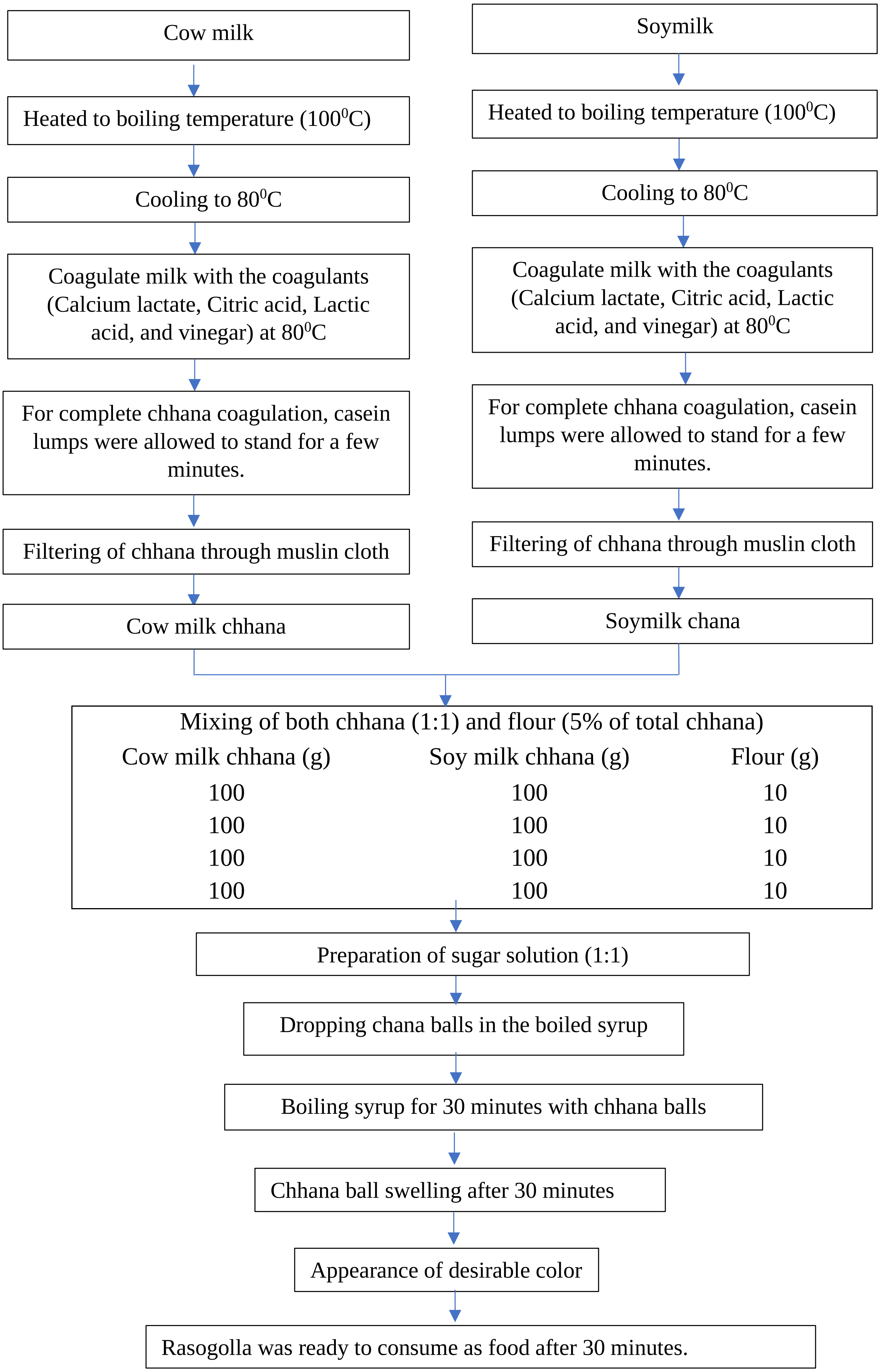

Fig. 2: Schematic diagram of Rasogolla manufacturing

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Evaluation of Rasogolla samples

Physical and chemical tests were used to assess the Rasogolla samples that had been produced. Flavour received 45 points, body and texture 30 points, colour and look 15 points, and taste 10 points on the physical rating scorecard.

Physical test (sensory and organoleptic evaluation)

Table 3 showed the results of the organoleptic, physical tests conducted with the assistance of a panel of experts from the Department of Dairy Science at BAU in Mymensingh. The judges used a 100-point scale, with 45 points for flavour, 30 for body and texture, 15 for colour and appearance, and 10 for taste of Rasogolla samples.

Table 3: Organoleptic characteristics of a fresh sample of A, B, C, and D types of Rasogolla.

Sources of Rasogolla	No. of observation	Flavor score	Body and texture	Colour and appearance	Taste score	Overall score
A	1	38.00	27.00	14.00	7.00	86.00
	2	37.00	28.00	14.00	8.00	87.00
	3	35.00	26.00	13.00	9.00	83.00
Average		36.67	27.00	13.67	8.00	85.33
B	1	40.00	24.00	10.00	6.00	80.00
	2	41.00	27.00	11.00	8.00	87.00
	3	42.00	26.00	12.00	7.00	87.00
Average		41.00	25.67	11.00	7.00	84.67
C	1	42.00	28.00	13.00	9.00	92.00
	2	43.00	27.00	11.00	7.00	88.00
	3	39.00	25.00	12.00	8.00	84.00
Average		41.33	26.67	12.00	8.00	88.00
D	1	40.00	27.00	14.00	9.00	90.00
	2	42.00	25.00	12.00	9.00	88.00
	3	39.00	28.00	11.00	8.00	86.00
Average		40.33	26.67	12.33	8.67	88.00

Chemical test

All chemical analyses were conducted at BAU, Mymensingh, in the Dairy Chemistry Laboratory of the Dairy Science Department. The gravimetric method, often used for milk (De, 1980), was used to determine the total solid and moisture content of chhana. Applying the Gerber method (IS: SP: 18, 1981), Rasogolla and cow milk fat content was ascertained. We used the method outlined by AOAC (2003**)** to find the ash and total protein content of Rasogolla.

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Statistical Analysis

Each treatment was reproduced three times. The data were analysed using SPSS software (version 25) and completely randomised block design (CRBD) was used to determine the differences among the parameters studied.

Results

In the laboratory, four distinct types of Rasogolla were crafted using two varieties of chhana fresh cow milk and soy milk, along with four different coagulants.

Effect of coagulating agents on the sensory properties of soy milk Rasogolla

The results clearly showed that soy milk-based Rasogolla prepared with four different coagulants had a significant effect ($p<0.05$) on flavour. In contrast, no significant differences ($p>0.05$) were observed in the sensory quality scores for other attributes, including body and texture, taste, colour and appearance, and overall score.

Table 4: Effect of coagulating agents on the sensory properties of different types of soy milk Rasogolla

Types of Rasogolla	Flavour	Body and texture	Colour and appearance	Taste	Overall score
	Mean±SE (3)				
CLSMR	$36.67^{b} \pm 0.88$	27.00 ± 0.58	13.67 ± 0.33	8.00± 0.58	85.33 ± 1.20
CSMR	$41.00^{a} \pm 0.58$	25.67 ± 0.88	11.00 ± 0.58	7.00± 0.58	84.67 ± 2.33
LSMR	$41.33^{a} \pm 1.20$	26.67 ± 0.88	12.00 ± 0.58	8.00± 0.58	88.00 ± 2.31
VSMR	$40.33^{a} \pm 0.88$	26.67 ± 0.88	12.33 ± 0.88	8.67± 0.33	88.00 ± 1.15
P value	0.023	0.693	0.088	0.244	0.479
Level of significance	*	NS	NS	NS	NS

* = Significant at 5% level; NS = Non- significant, SE= standard error value in the parenthesis indicates number of observations; means with different superscripts are different. CLSMR= Calcium Lactate Coagulated Soy Milk based Rasogolla; CSMR= Citric Acid Coagulated Soy Milk based Rasogolla; LSMR= Lactic Acid Coagulated Soy Milk based Rasogolla; VSMR= Vinegar Coagulated Soy Milk based Rasogolla.

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Effect of coagulating agents on the chemical properties of soy milk Rasogolla:

The effect of four coagulants on the chemical properties of soy milk-based Rasogolla was presented in Table 5.

The use of four different coagulants in the preparation of soy milk-based Rasogolla significantly ($p \leq 0.05$) influenced the levels of crude protein, fat, ash, nitrogen-free extract (NFE), acidity, and crude fibre. However, no significant ($p \geq 0.05$) effects were observed on moisture, dry matter, or carbohydrate content. A high crude protein value (7.59±0.01; was obtained by CSMR (7.59±0.01), followed by CLSMR (7.39±0.09), VSMR (7.09±0.49) and LSMR (6.06±0.01), all at a 1% significance level. The result agreed with S.S. Bankar et al. (2018), who found higher crude protein content in their Rasogolla samples using 1% citric acid as a coagulant. The fat content of CLSMR was significantly higher (4.51±0.01, $p < 0.05$) than other types of Rasogolla. The variation in the fat content may be due to using different coagulants for Rasogolla preparation. Ash content is significantly higher in CLSMR (0.82±0.01, $p < 0.05$) than in other types of Rasogolla. NFE content was significantly higher in LSMR (48.14±0.07), followed by CSMR (45.01±0.02), VSMR (45.00±1.5), and CLSMR (42.10±0.01), all at a 5% significance level. Acidity was highest in CSMR (1.50±0.15), followed by CLSMR (1.33±0.08), VSMR (1.30±0.11), and LSMR (0.67±0.08), while crude fibre content was significantly greater in CLSMR (0.77±0.01), followed by CSMR (0.72±0.05), VSMR (0.66±0.02), and LSMR (0.22±0.01), all at a 5% significance level.

Table 5: Effect of coagulating agents on the chemical properties of different types of soy milk Rasogolla

Types of Rasogolla	MC (%)	DM (%)	CP (%)	Fat (%)	CHO (%)	Ash (%)	NFE (%)	Acidity (%)	CF (%)
	Mean±SE (3)								
CLSMR	43.27 ±0.56	56.73 ±0.56	7.39^{ab} ±0.09	4.51^{a} ±0.01	33.71 ±0.97	0.82^{a} ±0.01	42.10^{c} ±0.01	1.33^{ab} ±0.08	0.77^{a} ±0.01
CSMR	42.67 ±0.33	57.33 ±0.33	7.59^{a} ±0.01	3.79^{b} ±0.02	35.41 ±0.47	0.52^{b} ±0.01	45.01^{b} ±0.02	1.50^{a} ±0.15	0.72^{a} ±0.05
LSMR	43.23 ±0.13	56.77 ±0.13	6.06^{c} ±0.01	1.53^{c} ±0.14	33.93 ±0.15	0.65^{b} ±0.01	48.14^{a} ±0.07	0.67^{c} ±0.08	0.22^{b} ±0.01
VSMR	42.11 ±0.18	57.89 ±0.18	7.09^{b}± 0.49	4.24^{a} ±0.32	34.34 ±0.58	0.68^{b}±0.07	45.00^{b} ±1.5	1.30^{b} ±0.11	0.66^{ab} ±0.02
P value	0.131	0.131	0.011	0	0.293	0.003	0.004	0.004	0
LS	NS	NS	**	**	NS	**	**	**	**

** = Significant at 1% level; NS = Non- significant; LS= Level of Significance; SE= standard error value in the parenthesis indicates number of observations; means with different superscripts are different. MC= Moisture Content; DM= Dry Matter Content; CP= Crude

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Protein Content; CHO= Carbohydrate Content; NFE= Nitrogen Free Extract Content; CF= Crude Fibre Content; CLSMR= Calcium Lactate Coagulated Soy Milk based Rasogolla; CSMR= Citric Acid Coagulated Soy Milk based Rasogolla; LSMR= Lactic Acid Coagulated Soy Milk based Rasogolla; VSMR= Vinegar Coagulated Soy Milk based Rasogolla.

DISCUSSION

Rasogolla, a widely consumed dairy product, is recognised for its high nutritional value, containing essential nutrients like protein, calcium, phosphorus, and vitamins A and D (Tarafdar et al., 2002). These nutrients contribute to its popularity, particularly for its health benefits (Chavan et al., 2011). As a result, many people consume Rasogolla for its nutritional advantages (Sahul et al., 2010). Recent studies have explored the potential health benefits of substituting dairy milk with soy milk in Rasogolla production. Dwarakanath et al. (2020) examined the effects of partial substitution; they found that Rasogolla prepared with varying levels of soy milk had moisture content ranging from 60.66% to 62.70%, fat content between 3.50% and 3.56%, protein levels from 6.01% to 6.07%, crude fibre from 0.42% to 0.63%, ash content between 0.74% and 0.80%, and carbohydrates ranging from 26.36% to 29.18% that supports the present study. In a similar study, Rupam et al. (2022) explored the impact of different soy milk and dairy milk ratios on the composition of soy Rasogolla. Their investigation indicated a rise in fat content from 3.50% (100% soy milk) to 3.56% (40% soy milk) and a slight decrease in protein content from 6.07% to 6.01% as the dairy milk proportion increased, consistent with the higher fat% of dairy milk utilized for channa preparation. Rasomalai was made with 25%, 50%, and 75% soy chhana and cow milk chhana, and its physical and chemical properties were assessed. Soy chhana decreased organoleptic scores, protein, ash, fat, and acidity ($p<0.05$). The best quality was observed in a combination of 25% soy and 75% cow milk chhana (Islam et al., 2015). These findings align with previous studies, which reported fat content in 4.2–4.6% (Bandyopadhyay et al., 2008) and (Gangopadhyay et al., 2005). Additionally, crude fibre content decreased as dairy milk levels increased, ranging from 0.63% (100% soy milk) to 0.42% (40% soy milk), while carbohydrate content increased from 26.36% to 29.18%. The total flavonoid content also showed a slight reduction, from 2.49 mg catechin equivalent per 100g to 2.13 mg catechin equivalent per 100g, because of the higher flavonoid material in soy milk in contrast to dairy milk, was reported by (Kumar et al., 2010) and (Yamabe et al., 2007). Sensory evaluation revealed that sensory scores improved as the proportion of dairy milk increased, and the product's shelf life was 60 days when stored under ambient conditions at room temperature. During this period, the pH and total sugar content decreased while the acidity and reducing sugars increased, with total soluble solids (TSS) remaining unchanged (Rupam et al., 2022). Various soy products have garnered attention worldwide for their nutritional benefits and potential health impact (Li et al., 2013).

The physicochemical study of soy Rasogolla revealed pH values between 6.45 and 6.56, acidity levels between 0.32 and 0.30, Brix range of 40°, and water activity between 0.997 and 0.995, as reported by Rupam et al. (2022). The 80% and 60% soy Rasogolla samples had lower titratable acidity levels than the 40% and 100% soy Rasogolla samples. Despite these differences, all soy Rasogolla had similar overall acceptability, with the product containing a higher percentage of dairy milk being slightly more favoured. Under high heat, Soymilk turns brown and tastes cooked (Kwok et al., 2000, cited in Egbo, 2012). According to Farinde et al. (2008) and Ikpeme et al. (2009), previous studies on soybean products have suggested future

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research to improve their colour, taste, and aroma through flavour additives or heat treatments. Rupam et al. (2022) reported that Rasogolla's flavour and smell alter with storage due to physico-chemical and microbiological changes, affecting its taste and aroma during storage. The taste and aroma scores declined over time, and the textural scores of the Rasogolla decreased as the storage period progressed. Therefore, the total acceptability score decreased with storage time, supporting (Karunanaithy et al., 2006) and (Bandyopadhyay et al., 2005, 2008).

Chhana, a heat-acid coagulated milk product similar to soft cottage cheese, is the base for traditional Indian sweets like Rasogolla and Sandesh. Mechanizing chhana production is crucial to fulfilling the increasing need for these products, focusing on automation, cost reduction, and consistent quality, with advancements targeting improvements in moisture content, texture, and hygiene at small-scale levels (Ammu et al., 2020). Using Texture Profile Analysis (TPA), Bandyopadhyay et al. (2005) assessed how the texture of chhana was affected by three different coagulants named calcium lactate, lactic acid, and citric acid. They discovered that 4-8% calcium lactate, 0.5% lactic acid, and 0.5% citric acid within acid whey produced textural qualities comparable to traditional chhana. Begum et al. (2019) found that Rasogolla made with different coagulants did not significantly affect sensory attributes, with the highest overall score observed for Rasogolla made from chhana, with 1% SW serving as the coagulant. The moisture content of chhana varied significantly between coagulants, with 0.5% SW chhana having the highest moisture and 1.0% citric acid (CA) the least. This trend was consistent with Bandyopadhyay et al. (2005), who documented a reduction in moisture content with stronger coagulants. Consistent with the results of Singh et al. (2011), who found an average protein content of 18%, the maximum protein content was observed in Chhana made with 1% SW + CA. Ash content was highest in chhana made with 1% CA and lowest with 0.5% SW, dissimilar to the 1.95% average ash concentration discovered by Singh et al. (2011). Lactose content was highest in chhana made with 1% SW + CA and lowest in 0.5% SW, with no significant difference in chhana yield across coagulants.

Additionally, Begum et al. (2019) found no statistically significant variations in the colour and appearance scores of Rasogolla samples prepared from chhana using different coagulants. Still, the Rasogolla prepared from chhana with 1% SW + CA had the highest score. Kumar et al. (2015) found no significant variations in colour and appearance scores for Rasogolla made from chhana utilizing different coagulants, such as calcium lactate, citric acid, or lactic acid. Pandey et al. (2004) prepared chhana from cow milk coagulated by lactic acid and citric acid and found that the yield of chhana was higher with lactic acid coagulant. Sahul et al. (2010) reported a moisture content of 0.583 kg per kg of milk, with a yield of 0.203 kg per kg of milk, while Bankar et al. (2014) found that as titratable acidity increased from 0.1% to 0.13%, chhana yield steadily declined. Kumar et al. (2015) observed that chhana made with calcium lactate yielded more than that made with citric acid. Fat and total solids recovery were highest when using 1% sour whey (SW), with fat loss in whey aligning with findings from Bandyopadhyay et al. (2005) and Bankar et al. (2014). Begum et al. (2019) also found that the highest moisture content for Rasogolla was recorded from chhana made with citric acid (CA) and SW combined with CA at a concentration of 0.5%. According to Reddy et al. (2016), the control Rasogolla had a moisture content of 58.09%, higher than the current study but the same as the 55% standard set by the Bangladesh Standard and Testing Institution (BSTI) in 1993. Furthermore, Begum et al. (2019) noted that the fat content of Rasogolla met the BSTI (1993) and Indian Standard (IS, 1967) requirement of at least 5%. The chhana-based Rasogolla recipe with 0.5%

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CA had the highest protein level. Thakur et al. (2015) found 1.63% ash in Rasogolla prepared with 0.5% CA, and the highest ash level was related to chhana Rasogolla prepared with 1% SW + CA. Bankar et al. (2014) discovered that chhana prepared with 1.0% citric acid and 2.0% lactic acid had identical flavour scores, and Kumar et al. (2015) discovered that Rasogolla samples from different coagulants (lactic acid and calcium lactate) did not differ significantly in sweetness. Even when chhana was coagulated with different acids (citric acid, lactic acid, and sour whey), Kumar et al. (2012) found no statistically significant variation in flavour scores for Rasogolla. Kumar et al. (2015) found that Rasogolla's body and texture scores improved significantly, with lactic acid and citric acid at 1% strength and calcium lactate at 4%. A study conducted by Bankar et al. (2014) indicated that Rasogolla produced with coagulants of 1.0% and 2.0% lactic acid, followed by 1.0% citric acid, had better body and texture scores. Begum et al. (2019) concluded that Rasogolla made from chhana using 1% SW coagulant received the highest overall sensory score. However, compared to various coagulants and their strengths, Bankar et al. (2014) found that chhana prepared with 1.0% citric acid and 2.0% lactic acid had much higher overall acceptance.

CONCLUSION

The effect of different coagulants (calcium lactate, citric acid, lactic acid, and vinegar) for manufacturing soy milk-based Rasogolla was evaluated based on sensory evaluation and the chemical composition of the four prepared Rasogolla samples. Coagulating agents had a significant effect ($p<0.05$) on the flavour of the Rasogolla samples (CLSMR, CSMR, LSMR, and VSMR) but did not significantly ($p>0.05$) affect their body and texture, colour, or appearance. Furthermore, the coagulating agents showed a highly significant effect ($p<0.01$) on the crude protein (%), fat (%), ash (%), nitrogen-free extract (%), acidity (%), and crude fibre (%) contents. However, no significant differences ($p>0.05$) were observed in the moisture, dry matter, or carbohydrate content among the Rasogolla samples.

REFERENCES

Ammu, V. K., Minz, P. S., Singh, A. K., Vairat, A. D., Chitranayak, J. A., & Jayswal, D. K. (2020). An overview of mechanization in chhana production. *Indian Journal of Dairy Science*, *73*(1), 1-6.

AOAC (2003) Official Methods of Analysis of the Association of Official's Analytical Chemists. 17th Edition, Association of Official Analytical Chemists (AOAC), Arlington, Virginia.

Bandyopadhyay, M., Chakraborty, R., & Raychaudhuri, U. (2005). The effect of coagulants on the texture of chhana (an acid and heat-coagulated product made from milk). *International journal of food science & technology*, *40*(8), 799-810.

Bandyopadhyay, M., Chakraborty, R., & Raychaudhuri, U. (2008). Effect of carrot on quality improvement of sweet syrupy cheese ball (Rasogolla). *International journal of dairy technology*, *61*(3), 290-299.

Bangladesh Standard and Testing Institution (BSTI) 1993: Bangladesh Standard Specification for Rasogolla. BDS 1309. p. 1-5.

Article DOI: 10.52589/AJAFS-JLV8IQ2H
DOI URL: https://doi.org/10.52589/AJAFS-JLV8IQ2H

Bankar, S. S., Raziuddin, M., & Zanjad, P. N. (2016). The influence of different coagulants on yield and sensory quality of cow milk chhana. *Indian Research Journal of Extension Education*, *14*(4), 61-64.

Bankar, S., Raziuddin, M., & Zanjad, P. (2018). Effect of Coagulants on Quality of Cow Milk Chhana and Chhana Podo Supplemented with Non-Dairy Ingredients. International Journal of Livestock Research, 8(9), 278-284. doi: 10.5455/ijlr.20170919080908

Bankar, S. S., Raziuddin, M., & Zanjad, P. N(2019). Effect of Coagulants on Quality of Cow Milk Chhana and Chhana Podo Supplemented with Non-Dairy Ingredients.

Begum, J., Islam, N., Rashid, H. U., Hassan, N., Islam, Z., & Siddiki, M. S. R. (2019). Effect of coagulants on the yield and quality of chhana and rasogolla. *Asian Journal of Dairy and Food Research*, *38*(3), 186–190.

Bhattacharya, D.C., & Raj, D. (1980). Studies on the production of Rasogolla I Traditional method. Indian J Dairy *Sci* **33(**2) 237–243.

Bhattacharya, D. C., & Raj, D. (1981). Studies on the production of rasogolla. II. Pressure cooker method. *Indian J Dairy Sci* **33**(4) 479–483.

BSTI 1993: BS Specification for rasogolla. Bangladesh Standards and Testing Institution, Dhaka P-3.

Chavan, R. S., Prajapati, P. S., & Chavan, S. R. (2011). Low-fat sweet syrup cheese ball (Rosogolla) manufacturing and effect of lowering fat on quality. *Sensing and Instrumentation for Food Quality and Safety*, *5*, 33-42.

De S. 1980. Outlines of Dairy Technology, Oxford University Press, New Delhi, pp.517.

Department of Livestock Services (DLS) 2023: Livestock Economy at a glance (2022-23), Ministry of Fisheries and Livestock, Bangladesh.

Dwarakanath, H., Gurumoorthi, P., Rao, K. J., & Pagote, C. N. (2020). Studies on Alum as Milk Coagulating Agent in the Manufacture of Paneer–An Indian Cottage Cheese. *Journal of Food Engineering and Technology*, *9*(2), 64-72.

Farinde, E. O., Obatolu, V. A., Fasoyiro, S. B., Adeniran, A. H., & Agboola, E. R. (2008). Use of alternative raw materials for yoghurt production. *African Journal of Biotechnology*, *7*(18).

Gangopadhyay, D., Dutta, S. K., Chakrabarti, S. R., & Gangopadhyay, S. K. (2005). Quality of rasogolla marketed in the states of Bihar and Jharkhand. 42(11), 522-527.

Ikpeme-Emmanuel, C. A., Okoi, J., & Osuchukwu, N. C. (2009). Functional, anti-nutritional and sensory acceptability of taro and soybean-based weaning food. *African Journal of Food Science*, *3*(11), 372-377.

Islam, M. N., Parvin, F., Hossain, M. S., Wadud, A., Siddiki, M. S. R., & Khan, M. S. (2015). Replacement of cow milk chhana with soy chhana in the preparation of rasomalai.

Islam, M. Z., Rahman, S. M. R., Alam, M. M., & Mannan, A. K. M. A. (2003). Manufacture of Rassomalai and its quality attributes: An indigenous milk sweetmeat of Bangladesh. *Pakistan Journal of Nutrition*, 2(5), 300-304.

IS: SP-18 Part XI. 1981. ISI Handbook for food analysis. Bureau of Indian Standards, Manak Bhavan, New Delhi.

Karunanithy, C., Varadharaju, N., & Thangavel, K. (2006). A comparative study on quality and textural parameters of commercial and machine-prepared rasogolla. *Journal of food science and technology-Mysore*. 3(5), 493- 495.

Kumar, S., Dwivedi, H. B., Yadav, S. P., & Yadav, R. N. (2007). Use of chemical and herbal coagulants in Chhana production from cow milk. Progressive Research , 2(1/2),150.

Kumar, J., Gupta, V. K., Kumar, B., & Kumar, S. (2012). The influence of varying degrees of coagulation temperature on sensory and texture characteristics of chhana and rasogolla

Article DOI: 10.52589/AJAFS-JLV8IQ2H
DOI URL: https://doi.org/10.52589/AJAFS-JLV8IQ2H

made using sweet cream buttermilk and buffalo milk. *Indian Journal of Dairy Science*, *65*(2), 129.

Kumar, J., Gupta, V. K., Kumar, S., & Kumar, S. (2015). Effect of coagulants on the quality of chhana and rasogolla obtained from admixture of buffalo milk and buttermilk. *Journal of Food Science and Technology*, *52*, 1736-1741.

Kumar, V., Rani, A., Dixit, A. K., Pratap, D., & Bhatnagar, D. (2010). A comparative assessment of total phenolic content, ferric reducing-anti-oxidative power, free radical-scavenging activity, vitamin C and isoflavones content in soybean with varying seed coat colour. *Food Research International*, *43*(1), 323-328.

Kwok, K. C., Basker, D., & Niranjan, K. (2000). Kinetics of sensory quality changes in soymilk during thermal processing, by parametric and non-parametric data analyses. *Journal of the Science of Food and Agriculture*, *80*(5), 595-600.

Kwok, K. C., & Niranjan, K. (1995). Effect of thermal processing on soymilk. *International journal of food science & technology*, *30*(3), 263-295.

Li, S., Zhu, D., Li, K., Yang, Y., Lei, Z., & Zhang, Z. (2013). Soybean curd residue: Composition, utilisation, and related limiting factors. *International Scholarly Research Notices*, *2013*(1), 423590.

Pandey, R. K., Singh, M., & Govindam. (2004). Effect of chemical and herbal extracts on yield and quality of chhana from cow's milk. Souvenir, XXXIII Dairy Industry conference, Sept. 26–28, New Delhi.

Reddy, G. M. M., Arora, P., Chandra, R., & Singh, S. S. (2016). Production and quality evaluation of Rasogolla prepared from milk with different levels of fat. *International Journal of Scientific and Engineering Research*, *7*(8), 2084-2086.

Rupam, C., Singh, A., & Chauhan, O.P. Development and evaluation of soy-based Rasogolla blended with dairy milk. The Pharma Innovation Journal. 2022; SP-11(4): 1643-1653.

Sahul, J. K., & Das, H. (2010). A continuous heat-acid coagulation unit for continuous production of chhana. *Assam University Journal of Science and Technology*, *4*(2), 40-45.

Sengupta, S., Samanta, A., & Bhowal, J. (2017). Effect of different types of coagulating agent on physico-chemical and organoleptic properties of non-dairy Rasogolla (cheese ball). The Journal of Microbiology, Biotechnology and Food Sciences, 6(4), 1107.

Singh, P. K., Singh, O. P., Kumar, R., Singh, A. K., & Singh, N. K. (2011). Quality of chhana prepared from cow milk by chemical and herbal coagulants. *Journal of Dairying Foods & Home Sciences*, *30*(3), 155-159.

Tarafdar, S. U., Pramanik, M. A. H., Basak, B., Rahman, M. S., & Biswas, S. K. (2002). A comparative study on the quality of Rasogolla made in the laboratory and collected from local markets of Mymensingh, Bangladesh. *Pakistan Journal of Nutrition*, *1*(3), 156-160.

Thakur, S. N., Kant, R., & Chandra, R. (2015). Studies on the preparation of Rosogolla from a blend of Cow Milk and Soya Milk. *The Allahabad Farmer Journal*, *70*(2), 6-9

Yamabe, S., Kobayashi-Hattori, K., Kaneko, K., Endo, H., & Takita, T. (2007). Effect of soybean varieties on the content and composition of isoflavone in rice-koji miso. *Food Chemistry*, *100*(1), 369-374.

Article DOI: 10.52589/AJAFS-JLV8IQ2H
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