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Pharmaceutical Sciences
Volume 5 Issue 1, 2025
eISSN No.: 2582-8371

Formulation and Physicochemical Evaluation of Dietetic Rasmalai Fortified with Sprouted Millet Powder

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ABSTRACT

Rasmalai, a popular Indian dairy dessert, is being modified to meet modern health demands through the inclusion of sprouted millets. Millets, known for their high nutritional value, offer enhanced dietary fiber, protein, and antioxidant potential, making them suitable for dietetic formulations aimed at promoting functional and health-oriented food consumption. The present study aimed to develop a dietetic Rasmalai health mix enriched with sprouted millets and evaluate its physicochemical, properties. Given the rising demand for functional foods, the research focused on improving the nutritional profile of Rasmalai while maintaining sensory appeal and microbial analysis. Sprouted millet-enriched Rasmalai samples (TC, T1, T2, and T3) were analyzed for pH, titratable acidity, moisture, fat, total solids, and ash content. The inclusion of sprouted millets in Rasmalai significantly influenced its physicochemical properties. pH ranged from 6.24 to 6.36, acidity from 0.24% to 0.33%, and moisture from 66.58% to 72.85%. T3 had the highest acidity, total solids, and ash content. The incorporation of sprouted millets significantly influenced the physicochemical properties, with T2 exhibiting the most balanced composition. The study underscores the potential of sprouted millets in functional food innovation, aligning with modern dietary trends. Future research should explore different millet varieties, their impact on dairy desserts, and their health benefits.

Keywords: *Dietetic Rasmalai, Sprouted millets powder, Physico chemical analysis.*

INTRODUCTION

Milk rich in nutritional elements is suitable for processing into different dairy products. Milk and milk products provide many of the essential nutrients necessary for the growth and maintenance of the human body (Drewnowski, 2011). Milk and dairy products are vital for human nutrition and are considered as the carrier of higher biological value proteins, calcium, essential fatty acids, amino acids and water-soluble vitamins (Khan *et al.*, 2019). Milk is an excellent vegetarian protein source in India, where bulk of the population follows a vegetarian diet. In India, the dairy industry is critical to the rural economy and contributes a significant amount to the country's GDP every year. As estimated, around 50 to 55 percent of milk collected in India is converted into traditional dairy products. The production of traditional dairy products involves processing techniques such as coagulation, desiccation, and fermentation. Fermented milk products are an integral part of the human diet in many regions of the world (Devi *et al.*, 2018).

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eISSN No.: 2582-8371

The traditional dairy products of Indo-Pakistani civilization may include fat-rich products (ghee and butter), concentrated products (khoa and khoa-based sweets and rabri), coagulated products (Rasogolla, Rasmalai, and paneer), fermented products (dahi and lassi), and frozen products (kulfi and kulfa). Among the indigenous milk products, Rasmalai occupies special importance due to its delicious taste (Aneja, 1997). It is a very popular chhana (Paneer)-based indigenous milk product in India, Bangladesh, and Pakistan and is usually consumed during summer season. Chhana or paneer is usually used as basic raw material for the preparation of Rasmalai. Different types of milk powders are available in the local market to prepare Rasmalai balls for the preparation of Rasmalai. People usually prepare Rasmalai by using milk powders but paneer is used in the original recipe of Rasmalai. Paneer balls and sweetened condensed milk are used for the preparation of Rasmalai (Sharma *et al.*, 2015). Rasmalai is a heat concentrated traditional Indian milk product containing about 60% total solids including sugar. This sweet possesses delicate texture and taste. Chhana and sweetened condensed milk (SCM) are used for preparation of rasmalai. Chhana is used for rasogolla (flattered patties) preparations which are then dipped in SCM. Traditional milk sweets, such as rasmalai, jalebi, gulabjamun and khoa sweets, are popular throughout South Asia. Composite milk sweets include a wide range of components such as raw or roasted nuts, various types of flour, milk and milk solids, seasonal fruits and dried fruits. South India now offers India's first 100% vegan millet milk ice cream parlour. An ice cream parlour in Trichy, Tamil nadu, offers millet milk ice cream that is completely vegan. Burfi was made by substituting 57% of Bengal gram flour with foxtail millet flour, and the inclusion of foxtail millet flour significantly reduced blood glucose and cholesterol levels (Mamtha *et al.*, 2003). Millets are important foods in many underdeveloped countries because of their ability to grow under adverse weather conditions like limited rainfall. India has the largest millet producing country in the world with a total area of 23 million ha and small millets alone account for about 3.5 million hectare (Stanly and Shanmugam, 2013). The major millets are pearl millet, foxtail millet, proso millet and finger millet. The most important minor millets cultivated in India are barnyard millet, kodo millet, little millet, guinea millet and brown top millet (Yang *et al.,* 2012). Millets are more nutritious and they are non-glutinous and non-acid forming and easy to digest. Millets are more nutritious and they are non-glutinous and non-acid forming and easy to digest. Millets are good sources of energy, protein, fatty acids, vitamins, minerals, dietary fibre and polyphenols. Millet proteins contain good sources of essential amino acids except lysine and threonine but have relatively high quantity of sulphur containing amino acids (methionine and cysteine). Millets are rich sources of phytochemicals, micronutrients and antioxidants such as phenolic acids and glycated flavonoids (Singh *et al.*, 2012; Kalinova and Moudry, 2006; Sreerama *et al.*, 2012Geetha and Kanchana, 2022). Hence, present research was made to physicochemical properties of a dietetic Rasmalai health mix enriched with sprouted millets powder.

MATERIAL AND METHODS

Millet

Fresh samples of foxtail millet, kodo millet, and finger millet were procured from the Indian Store, Checkanurani, Madurai. The study was conducted in the laboratory of the Department of Rural Development Science, Arul Anandar College (Autonomous), Karumathur, Madurai, during the period from November 2024 to March 2025.

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eISSN No.: 2582-8371

Materials

Full cream milk used in the preparation was procured from the local market in Karumathur, Madurai. Brown sugar required for the treatments was obtained from Reliance Smart Point, located in Nagamalai Pudukottai, Madurai. Saffron, pistachio, and badam were all purchased from Indian Store at Checkanurani, Madurai. Additionally, cardamom used in the study was also sourced from the same store. All ingredients were selected for their quality and freshness to ensure the best outcome in the formulation. The choice of local and trusted sources ensured consistency and reliability throughout the experimental procedures involving these ingredients.

METHOD OF PREPARATION

Preparation of sprouted millet flour

To prepare fine flour from finger millet, kodo millet, or little millet, follow these steps: Start with washing**,** where millet in the ratio of 3:2 is thoroughly cleaned by rinsing multiple times to remove dirt and impurities presented in fig. 2.3.1. Next, proceed to soaking by immersing the washed millet in fresh water at room temperature for 12 hours, ensuring even hydration. Once soaking is complete, move to draining**,** where the excess water is removed entirely. For the tying step, place the drained millet in a muslin cloth and tie it securely to create a moist environment for germination. The germination process requires keeping the tied millet at room temperature for 48 hours, which helps enhance its nutritional value and bioavailability. After germination, the millet is subjected to drying using a shade-drying method for 16 hours to preserve its nutrients and prevent spoilage. Following drying, the millet undergoes heating through gentle pan-heating, which ensures the removal of any residual moisture while imparting a slight toasted flavour. Once properly dried and heated, the millet is ready for the grinding stage, where it is ground into a fine, smooth flour using a grinder. Finally, the storing step involves transferring the flour into airtight containers to maintain its freshness, texture, and flavour for an extended period. This method ensures the production of high-quality millet flour suitable for various culinary and health applications.

Method of Preparation from Sprouted Millet Powder Flow Chart

(Finger millets, kodo millet and fox millet)
(Each one separately)
↓
Wash 3 to 4 times
↓
Soak for 12 hours in fresh water
↓
Drain the excess water
↓
Tie in a muslin cloth
↓
Keep for 48 hours in room temperature for germination
↓
Dry it shade by drying method for 16 hours
↓
Pan heat to remove remaining water
↓
Grind it to a fine flour
↓
Store it in air tight container

Fig. 1. Preparation from Sprouted Millet Powder

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eISSN No.: 2582-8371

Channa Ball Making Process

The process of making channa balls begins with taking one liter of full cream milk (FCM), which is boiled while continuously stirring to prevent burning. Once the milk reaches 88°C, vinegar is added to induce coagulation. The coagulated mixture is then strained using a muslin cloth to separate the channa, which is collected for further processing. The channa is rinsed thoroughly under tap water to remove any residual acidity and drained to remove excess water. After draining, the channa is allowed to cool for 20-25 minutes. Once cooled, corn flour and millet powder are added to the channa, and the mixture is kneaded to form small, smooth balls. These channa balls are then dipped into jeera water and boiled well to ensure proper cooking and flavour infusion. Finally, the boiled channa balls are cooled, completing the preparation process are presented in Fig. 2.

Take a 1 litre FCM milk
↓
Boil keep stirring to avoid burning
↓
To add a Vinegar (88˚ C)
↓
Coagulation
↓
Strain with muslin cloth
↓
Collect a channa
↓
Rinse the channa with tap water
↓
Drain water
↓
Cooling (20-25 minutes)
↓
Added corn flour and Millet powder
↓
Make a small ball
↓
Dip the channa in jeera water
↓
Boiling well
↓
Cool it

Fig. 2 Flow Chart: Channa ball making process

Rabri Making Process

The process of making rabri begins with selecting full-fat milk, which is essential for achieving a rich and creamy texture. The milk is poured into a heavy-bottomed pan to prevent scorching and brought to a boil over medium heat. Once the milk boils, the heat is reduced to low, and the milk is allowed to simmer gently. During this stage, the milk is stirred occasionally to prevent it from sticking to the bottom of the pan or burning. As the milk simmers, layers of cream form on the surface and sides of the pan; these are carefully scraped

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eISSN No.: 2582-8371

and mixed back into the milk to enhance its texture and flavour. Sweeteners brown sugar are added according to taste and mixed thoroughly to ensure even sweetness.

Flavourings like cardamom powder, saffron strands, and chopped nuts, including badam and pistachios, are then incorporated, adding aroma and richness. The milk is simmered further until it thickens to the desired creamy consistency. Once the rabri is ready, it is allowed to cool to room temperature or refrigerated, depending on preference. Finally, the rabri is served either chilled or at room temperature, garnished with additional nuts or saffron for an appealing presentation are presented in Fig. 3.

Milk Selection
(Use full-fat milk for better texture and richness)
↓
Boiling the Milk
(Pour milk into a heavy-bottomed pan and bring to a boil)
↓
Simmering and Reducing
(Reduce heat to low and simmer the milk, stirring occasionally to prevent burning)
↓
Scraping Cream Layers
(Scrape the cream formed on the sides of the pan and mix it back into the milk)
↓
Adding Sweeteners
(Add brown sugar according to taste and mix well)
↓
Adding Flavourings
(Incorporate cardamom powder, saffron strands, and nuts like badam and pistachios)
↓
Cooking to Desired Consistency
(Continue simmering until the milk thickens and reaches a creamy consistency)
↓
Cooling
(Allow the Rabri to cool to room temperature or refrigerate as desired)
↓
Serving
(Serve chilled or at room temperature, garnished with additional nuts or saffron)

Fig.3 Flow Chart: Rabri Making Process

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TREATMENT DETAILS

Treatment control of sprouted millet Rasamalai as detailed below;

Trials	Full cream milk (ml)	Brown sugar (g)	Sprouted millet flour (g)	Corn flour (g)	Saffron threads	Cardamom (Piece)
TC-Control	1000	150	0	4	8	5
T1	1000	150	10	4	8	5
T2	1000	150	15	4	8	5
T3	1000	150	20	4	8	5

a- score values of Rasamalai with sprouted millet powder
*[b]-mean of six assays; ± - standard deviation** significant at $p < 0.05$*
Treatment control of sprouted millet Rasamalai as detailed below
TC- Control - 1000 ml milk + 4 gm Corn flour + 8 Saffron threads+ 5 Piece Cardamom
T1- Control - 1000 ml milk + 250 gm Brown sugar + 10 gm Sprouted millet flour+ 4 g Corn flour + 8 Saffron threads+ 5 Piece Cardamom
T2- Control - 1000 ml milk + 250 gm Brown sugar + 15 gm Sprouted millet flour+ 4 g Corn flour + 8 Saffron threads+ 5 Piece Cardamom
T3- Control - 1000 ml milk + + 250 gm Brown sugar + 20 gm Sprouted millet flour+ 4 g Corn flour + 8 Saffron threads+ 5 Piece Cardamom

PHYSIOCHEMICAL ANALYSIS

pH Analysis

The pH of the Rasmalai with sprouted millets powder samples was measured using an electronic digital pH meter (pH-107)

Titratable Acidity Analysis

The titratable acidity of Rasmalai with sprouted millets powder samples was measured by using the procedure BIS (1981) and the titratable acidity of the sprouted millets powder samples expressed as a percentage of lactic acid.

Moisture Analysis

The Moisture percentage of Rasamalai with sprouted millets powder samples would be determined using the IS: No 637 (ISIRI), 2003 using the equipment, digital moisture analyser ATS 120 as per user manual.

Total Solids

The total solid content of Rasamalai with sprouted millets powder samples is determined as per the procedure of IS: No 639 (ISIRI), 2002.

Fat Analysis

The fat percentage of Rasamalai with sprouted millets powder samples were estimated FT12 milk analyser as per the user manual. No 1479 Part-I (ISI) 1977

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eISSN No.: 2582-8371

Ash analysis
The ash content of Rasamalai with sprouted millets powder samples is determined as per the procedure of IS: No 639 (ISIRI), 2002.

Statistical Analysis
The results are presented as the means ± SDs. Statistical analyses were conducted via SPSS software version 16.0 (SPSS Inc., Chicago, IL, USA). Student's t-test was used to assess significant differences between Physico-chemical analysis. For comparisons of means in the antimicrobial evaluations, one-way analysis of variance (ANOVA) followed by Duncan's multiple range test was applied. A P-value of *<0.05* was considered to indicate statistical significance.

RESULTS
The study focused on the development and evaluation of Rasmalai incorporating sprouted millet powder. The experiment involved preparing different formulations with sprouted millet flour and brown sugar. The control (TC) consisted of 1000 ml of milk, 4 g of corn flour, 8 saffron threads, and 5 pieces of cardamom. Treatment 1 (T1) included 250 g of brown sugar and 10 g of sprouted millet flour. Treatment 2 (T2) had 15 g of sprouted millet flour, while Treatment 3 (T3) contained 20 g, with other ingredients remaining unchanged.

The study aimed to assess the physicochemical, sensory, microbiological and antioxidant properties of Rasmalai enriched with sprouted millet powder. Variations in millet flour concentration were examined to determine their impact on texture, flavour and overall acceptability. Microbial stability and potential health benefits were also evaluated. Data were analyzed using a completely randomized design to identify significant differences among formulations.

Statistical analysis helped assess the impact of sprouted millet flour on Rasmalai nutritional and functional properties. The results are systematically presented, providing insights into the influence of sprouted millet incorporation. The findings contribute to the development of a nutritious and health-promoting Rasmalai formulation with improved sensory attributes. Hence, the present study was undertaken to develop the functional product development of physicochemical, properties of a dietetic Rasmalai health mix enriched with sprouted millets powder.

Table: 3.1. Physico-Chemical analysis of Controls and treatments of Rasmalai with Sprouted millets powder

	Parameters					
Treatments	**pH**	**Titratable acidity (% LA)**	**Moisture (g%)**	**Total Solids (g%)**	**Fat (g%)**	**Ash (mg%)**
TC	6.36±0.032	0.24±0.013	66.58 ±0.021	34.0±0.028	7.96±0.032	0.92±0.035
T1	6.27±0.013	0.26±0.028	72.74±0.042	27.26±0.017	6.35±0.013	1.08±0.026
T2	6.24±0.026	0.31**±0.025	72.85**±0.028	27.15±0.035	6.24±0.026	1.15±0.010
T3	6.31±0.045	0.33±0.038	68.61±0.018	31.39±0.052	6.12±0.045	1.28**±0.015

a- score values of Rasamalai with sprouted millet powder
*[b]-mean of six assays; ± - standard deviation** significant at p < 0.05*
Treatment control of sprouted millet Rasamalai as detailed below
TC- Control - 1000 ml milk + 4 gm Corn flour + 8 Saffron threads+ 5 Piece Cardomom
T1- Control - 1000 ml milk + 250 gm Brown sugar + 10 gm Sprouted millet flour+ 4 g Corn flour + 8 Saffron threads+ 5 Piece Cardomom
T2- Control - 1000 ml milk + 250 gm Brown sugar + 15 gm Sprouted millet flour+ 4 g Corn flour + 8 Saffron threads+ 5 Piece Cardomom
T3- Control - 1000 ml milk + + 250 gm Brown sugar + 20 gm Sprouted millet flour+ 4 g Corn flour + 8 Saffron threads+ 5 Piece Cardomom

PHYSIOCHEMICAL ANALYSIS

pH

The pH values for Rasamalai samples incorporating sprouted millets powder varied across the control (TC) and treatments (T1, T2, and T3), with mean values of 6.36, 6.27, 6.24, and 6.31, respectively. The addition of sprouted millets powder, brown sugar, badam, corn flour, saffron, cardamom influenced the pH values of the treatments. Notably, TC exhibited the highest mean pH value of 6.36, while T2 had the lowest mean pH value of 6.24. Statistical analysis (*P<0.05*) indicated a significant difference between the control and treatments, as well as within the treatments themselves. These results are summarized in the table 3.1. and depicted in the fig. 3.1.

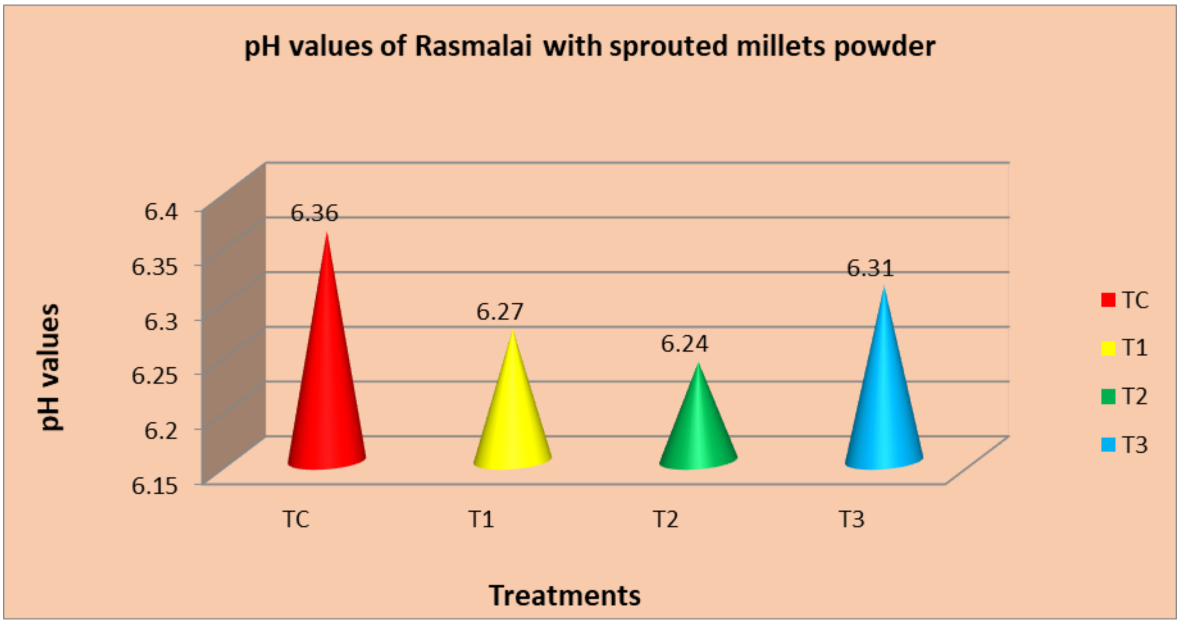

Fig. 3.1.: pH values of Rasmalai with sprouted millets powder

Titratable Acidity

The mean titratable acidity percentage (LA) of Rasamalai incorporating sprouted millets powder varied across the control (TC) and treatments (T1, T2, and T3), with mean values of 0.24, 0.26, 0.31, and 0.33, respectively. The addition of sprouted millets powder, brown sugar, badam, corn flour, saffron, cardamom influenced the titratable acidity values of the treatments. Notably, T3 exhibited the highest mean titratable acidity values of 0.33, while TC had the lowest mean pH value of 0.24. Statistical analysis (*P<0.05*) indicated a significant

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eISSN No.: 2582-8371

difference between the control and treatments, as well as within the treatments themselves. These results are summarized in depicted in the fig. 3.2.

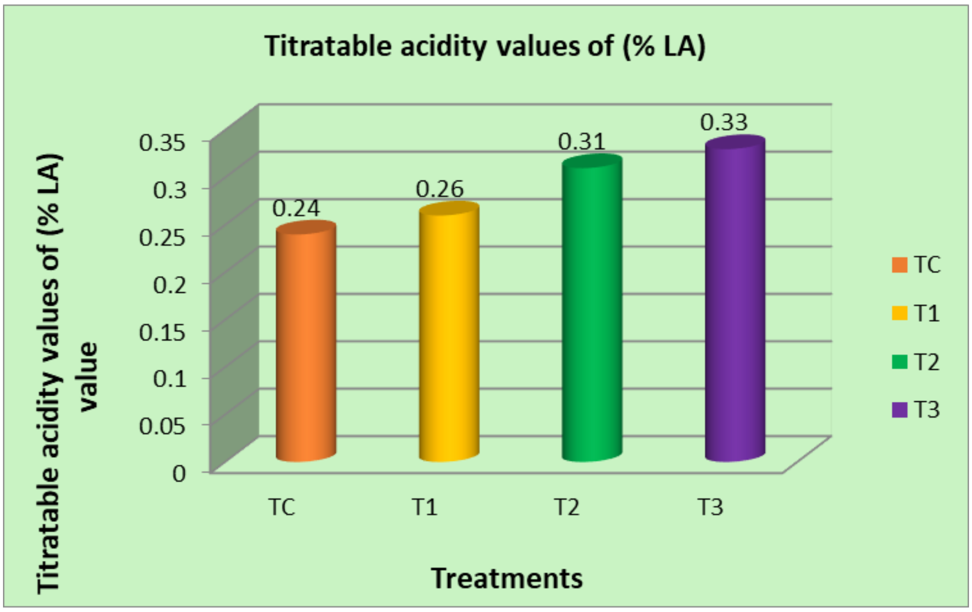

Fig. 4.2.2: Titratable acidity values of (% LA) Rasmalai with sprouted millets powder

Moisture

The moisture (g) content, expressed as a percentage, varied among Rasamalai samples incorporating sprouted millets powder across the control and different treatments. The moisture percentages were measured at 66.58 for TC, 72.74 for T1, 72.85 for T2, and 68.61 for T3. Treatment TC exhibited the lowest moisture content (66.58), while T2 showed the highest (72.85). These moisture values for Rasamalai samples incorporating sprouted millets powder are summarized in the table and visualized in the accompanying figure, illustrating the range of moisture percentages observed in the analyzed samples. These findings are summarized in the illustrated in the fig. 3.3.

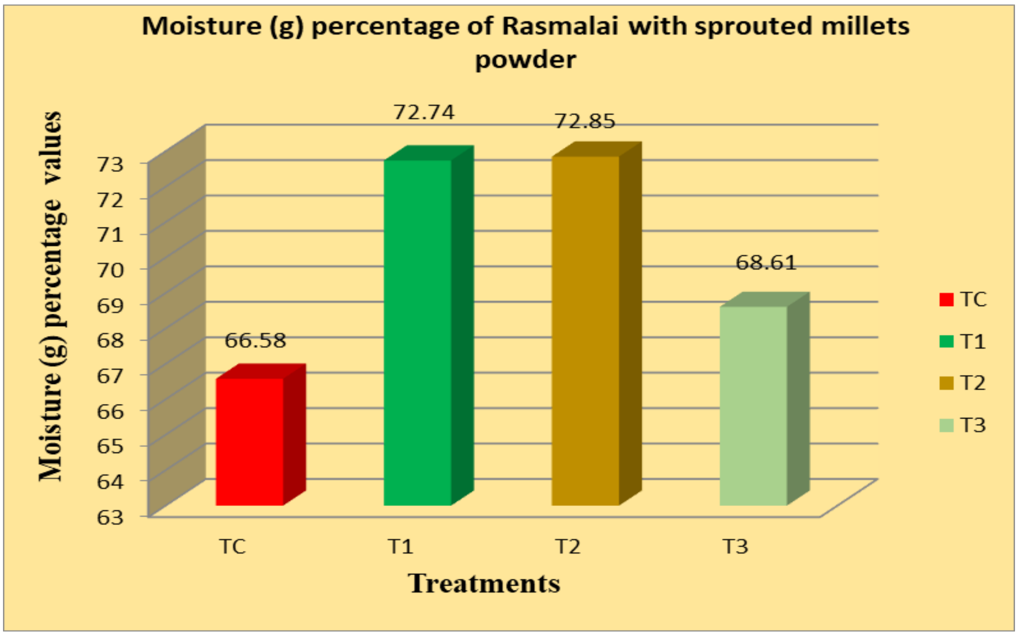

Fig. 3.3: Moisture (g) percentage of Rasmalai with sprouted millets powder

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eISSN No.: 2582-8371

Total Solids

There were no significant differences observed in the total solids (g) percentage values of Rasamalai incorporating sprouted millets powder samples percentage between the control and treatments. The total solids measured were 34.0, 29.26, 32.15 and 31.39 for the control and treatments TC, T1, T2 and T3 respectively. The lowest total solids percentages of the Rasamalai incorporating sprouted millets powder samples was recorded in treatment TC (27.15), while the highest was observed in treatment TC (34.0). The total solids range of the samples analysed in fig. 3.4.

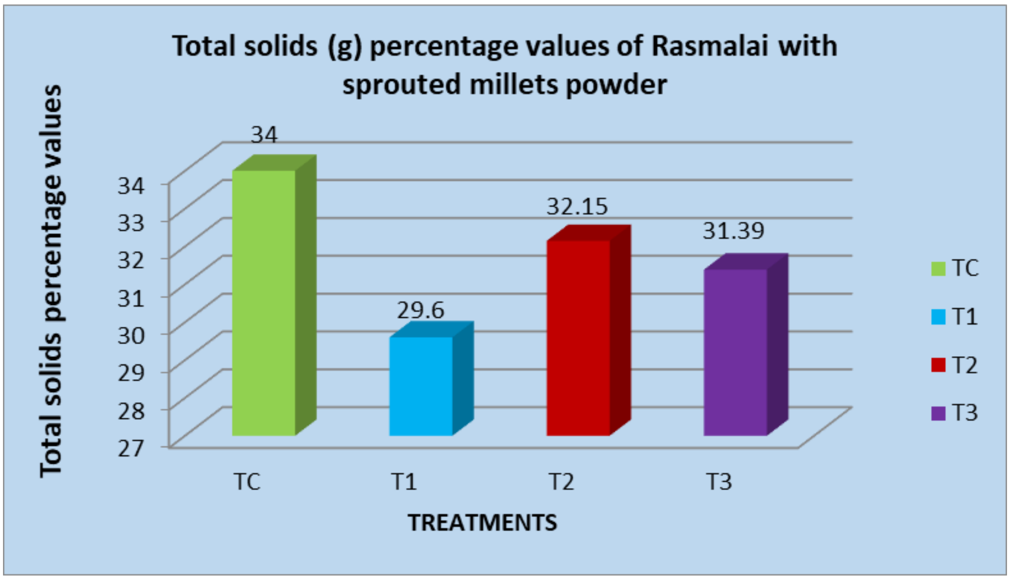

Fig. 3.4: Total solids (g) percentage values of Rasmalai with sprouted millets powder

Fat

The fat (g) percentage content in Rasamalai samples incorporating sprouted millets powder varied between the control and treatments. Fat percentages were measured at 7.96, 6.35, 6.24, and 6.12 for TC, T1, T2, and T3, respectively. Treatment T3 recorded the lowest fat percentage (6.12), while TC showed the highest (7.96) among the Rasamalai incorporating sprouted millets powder. The fat content range of the analyzed samples is depicted in the figure 3.5.

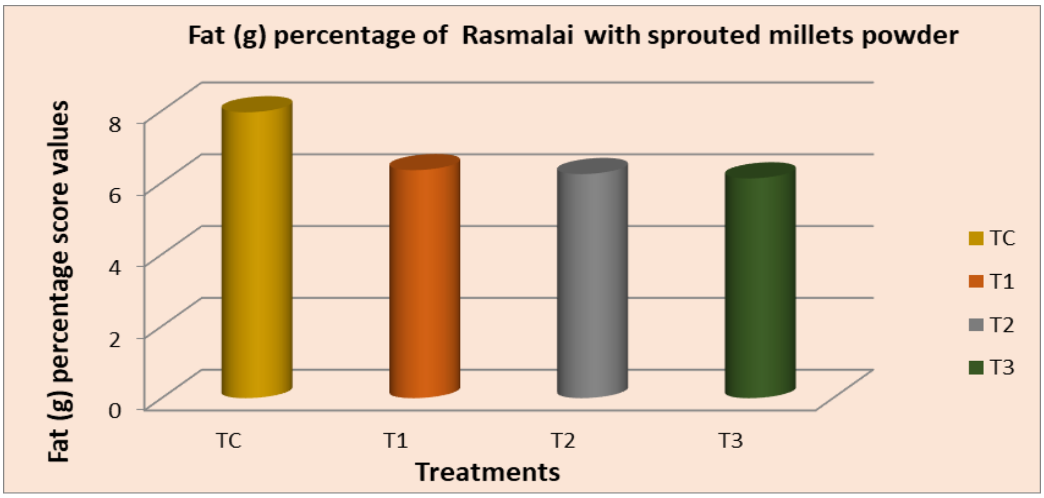

Fig. 3.5: Fat (g) percentage of Rasmalai with sprouted millets powder

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eISSN No.: 2582-8371

Ash

The ash (mg) content, expressed as a percentage, varied among Rasamalai incorporating sprouted millets powder samples across the control and different treatments. The ash percentages were measured at 0.92 for TC, 1.08 for T1, 1.15 for T2, and 1.28 for T3. Treatment TC exhibited the lowest moisture content (0.92), while T3 showed the highest (1.28). These ash values for Rasamalai incorporating sprouted millets powder are summarized in the fig.3.6 and visualized in the accompanying figure, illustrating the range of ash percentages observed in the analyzed samples.

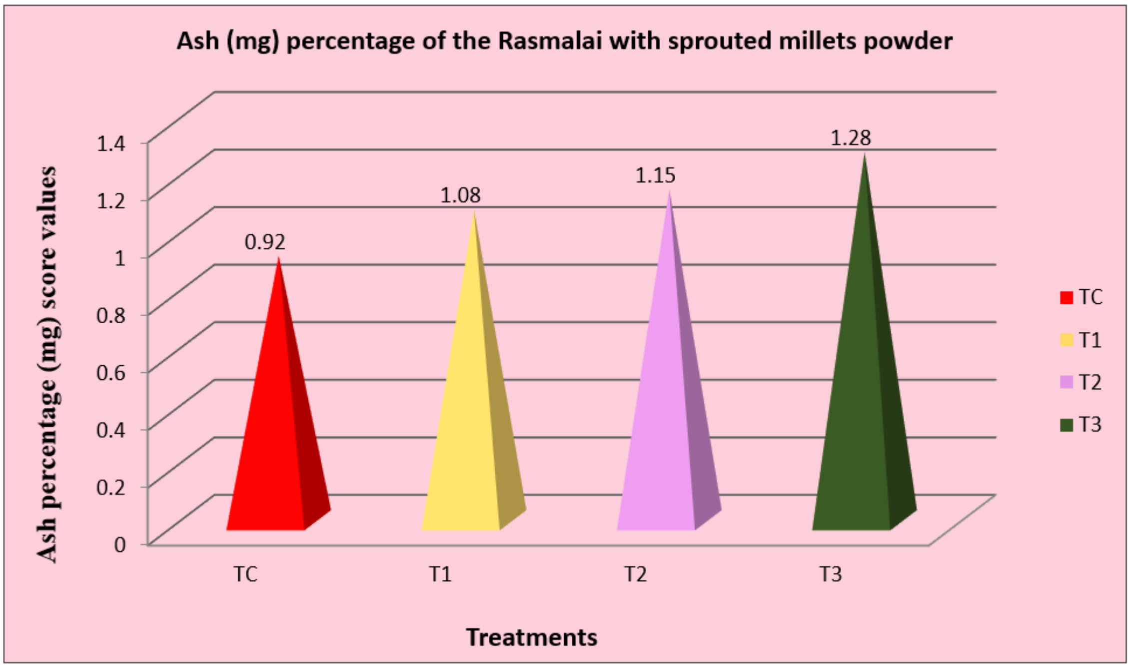

Fig. 3.6: Ash (mg) percentage of Rasmalai with sprouted millets powder

Rasmalai, a popular Indian dairy dessert, is traditionally rich in sugar and fats, making it less suitable for health-conscious consumers. The growing demand for functional foods has driven innovations in developing nutritious alternatives. Sprouted millets, known for their enhanced bioavailability of nutrients, provide a rich source of dietary fiber, proteins and essential minerals. The incorporation of whey protein concentrate further boosts its nutritional value, while natural sweeteners like brown sugar, offer a healthier alternative to refined sugar. This study focuses on the development of a dietary rasmalai health mix enriched with sprouted millets, evaluating its physicochemical properties. By integrating these nutrient-dense ingredients, this research aims to develop a wholesome Rasmalai variant that meets the dietary needs of health-conscious consumers while retaining its traditional appeal.

DISCUSSION

pH

The pH values for Rasamalai incorporating sprouted millets powder varied across the control (TC) and treatments (T1, T2, and T3), with mean values of 6.36, 6.27, 6.24, and 6.27, respectively. The addition of sprouted millets powder, brown sugar, badam, corn flour, saffron, cardamom influenced the pH values of the treatments. Qureshi *et al.* (2024) noted that the pH values were more or less same as observed in all freshly prepared Rasmalai samples (6.52–6.66). The maximum decreasing trend of pH was observed in control samples

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eISSN No.: 2582-8371

(without preservatives) reaching 4.66 at the end of storage period (12 days). Jouki *et al.* (2021) also observed decreasing trend of pH of *sweetened condensed milk* during storage. Similarly, Sharma *et al.* (2014) also reported decreasing trend of pH of concentrated part of Rasmalai. The decrease in pH during storage might be due to production of more and more acids. The production of acids might be due to the activities of contaminated microorganisms in Rasmalai during storage. The variation in pH values observed in Rasmalai samples incorporating sprouted millet powder aligns with findings from previous studies on dairy-based functional foods. The mean pH values for the control (6.36) and treatments (6.27, 6.24, and 6.27) suggest that the slight reduction in pH due to the incorporation of sprouted millet powder and other ingredients such as brown sugar, badam, corn flour, saffron, and cardamom. Similar trends have been reported by Sharma *et al.* (2021), who found that the addition of sprouted millets to dairy-based desserts led to minor reductions in pH due to increased enzymatic activity and organic acid production. Rathi *et al.* (2020) also observed a decline in pH when jaggery was incorporated into dairy products, attributing it to the presence of natural acids and fermentation-enhancing compounds. Kumar *et al.* (2019) highlighted that cardamom and saffron can introduce mild acidity, which slightly lowers the pH without compromising the product's sensory acceptability.

Titratable Acidity

The mean titratable acidity percentage (LA) of Rasamalai samples incorporating sprouted millets powder varied across the control (TC) and treatments (T1, T2, and T3), with mean values of 0.24, 0.26, 0.31, and 0.33, respectively. The addition of sprouted millets powder, brown sugar, badam, corn flour, saffron, cardamom influenced the titratable acidity values of the treatments. Sayedatunnesha *et al.* (2008) reported that the acidity it was found that the average acidity for cow and buffalo milk was 0.21±0.00 and 0.19±0.003%, respectively that differed significantly (*P<0.01*). From the result it was observed that the acidity decreased due to the use of buffalo milk for rasomalai preparation as because chhana obtained from cow milk carried higher acidities than chhana obtained from buffalo milk (Rao *et al.*, 1989).

The variation in titratable acidity (LA) values among Rasmalai incorporating sprouted millet powder is consistent with previous studies on functional dairy-based products. The mean titratable acidity for the control (0.24%) and treatments (0.26%, 0.31%, and 0.33%) suggest that the slight increase in acidity with the incorporation of sprouted millet powder and other ingredients such as brown sugar, badam, corn flour, saffron, and cardamom. Similar trends have been reported by Singh *et al.* (2020), who found that the addition of sprouted millets in dairy products increased titratable acidity due to enzymatic activities and the breakdown of complex carbohydrates in to organic acids. Gupta *et al.* (2019) observed a rise in acidity when jaggery was incorporated into dairy-based sweets, attributing it to its natural fermentation-enhancing properties. Rao *et al.* (2018) highlighted that nuts and spices like saffron and cardamom can introduce minor acidic compounds, contributing to the slight increase in titratable acidity.

Moisture

The variation in moisture (g) content among Rasmalai incorporating sprouted millet powder aligns with previous studies on dairy-based functional products. The control sample (TC) exhibited the lowest moisture content (66.58%), while the highest moisture content was observed in T2 (72.85%), followed by T1 (72.74%) and T3 (68.61%). This increase in moisture content with the addition of sprouted millet powder and other ingredients such as brown sugar, badam, corn flour, saffron, and cardamom may be attributed to the water-

Pharmaceutical Sciences
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eISSN No.: 2582-8371

binding properties of these components. The moisture content of Rasmalai milk vita made Rasamalai, Bhagabati Pera Bhandar, Alauddin Sweet meat, and Islamia mistanno Bhandar was 53.52%, 60.19%, 56.16%, and 54.09%, respectively, indicating significant variation. These differences may result from ingredient composition, processing techniques, or storage conditions, potentially affecting the texture, shelf life, and sensory characteristics of the final product Islam *et al.* (2003). Qureshi *et al.* (2024) pointed that the moisture contents (%) of Rasmalai slightly decreased during subsequent storage periods. The moisture contents of all freshly prepared Rasmalai samples were more or less same (47.50–48.02). The slight decreasing trend of moisture contents in rasmalai might be due to some losses of moisture from the surfaces of Rasmalai mixture during storage period. Our results were concurrent to the findings of Sharma *et al.* (2014) who also observed slight decreasing trend of moisture contents during storage. Sharma *et al.* (2021) reported that sprouted millets have higher water retention capacity due to the breakdown of complex carbohydrates and the release of hydrophilic compounds during sprouting. Kumar *et al.* (2020) found that jaggery enhances moisture content in dairy products by promoting water absorption and retention. Rao *et al.* (2019) noted that ingredients like nuts and cardamom influence moisture distribution, affecting the texture and shelf stability of dairy sweets.

Total Solids

There were no significant differences observed in the total solids (g) percentage values of Rasamalai incorporating sprouted millets powder samples percentage between the control and treatments. The total solids measured were 34.0, 27.26, 27.15 and 31.39 for the control and treatments TC, T1, T2 and T3 respectively. The lowest total solids percentages of the Rasamalai incorporating sprouted millets powder samples. The total solids content in Rasmalai samples incorporating sprouted millet powder varied slightly across treatments, but no significant differences were observed between the control (TC) and treatments (T1, T2, and T3). The values ranged from 27.15% (T2) to 34.0 % (TC), with an increasing trend in total solids as the level of sprouted millet powder incorporation increased. This trend is consistent with previous studies on dairy-based functional products enriched with plant-derived ingredients. Islam *et al.* (2003) reported that the total solid content of Rasmalai milk vita made Rasamalai, Bhagabati Pera Bhandar, Alauddin Sweet meat, and Islamia mistanno Bhandar samples were 46.47%, 39.80%, 43.84% and 45.90%, respectively. These variations indicate differences in composition, potentially influenced by ingredient formulation or processing methods, which may impact the texture, moisture retention, and overall quality of the product.

Sharma *et al.* (2021) noted that the incorporation of sprouted millets in dairy desserts increased total solids due to the presence of dietary fiber, proteins, and complex carbohydrates in millets, which contribute to the dry matter content. Kumar *et al.* (2020**)** found a similar increase in total solids in milk-based sweets fortified with plant ingredients, as these components reduce moisture retention and enhance dry matter content. Rao *et al.* (2019) noted that the inclusion of functional ingredients like nuts, corn flour and jaggery can modify the total solids percentage, impacting the texture and firmness of dairy sweets. The increase in total solids with sprouted millet incorporation suggest that a potential improvement in the product's texture and nutritional profile. However, since no significant differences were observed, the variations remain within an acceptable range, ensuring consistency in product quality. Further studies could investigate the impact of total solids content on the sensory and textural properties of Rasmalai over storage.

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Fat

The fat (g) content in Rasamalai incorporating sprouted millets powder varied between the control and treatments. Fat percentages were measured at 7.96, 6.35, 6.24, and 6.12 for TC, T1, T2, and T3, respectively. Treatment T3 recorded the lowest fat percentage (6.12), while TC showed the highest (7.96) among the Rasamalai samples incorporating sprouted millets powder. Sayedatunnesha *et al.* (2008) noted that the average fat content of rasomalai cow and buffalo milk differ significantly that sample buffalo (125.67±3.48 g/kg) had the higher fat content than sample cow milk (75.33±3.18 g/kg) because buffalo milk contains more fat than cow's milk. Islam *et al.* (2003) reported that fat content of milk vita produced rasomalai was 7.90% and in another experiment, Yasmin *et al.* (2005) reported that fat content of laboratory made cow milk rasomalai was 8.00%. Islam *et al.* (2003) noted that the fat content of Rasmalai milk vita made Rasamalai, Bhagabati Pera Bhandar, Alauddin Sweet meat, and Islamia mistanno Bhandar 7.91%, 6.28%, 6.40%, and 6.26%, respectively, showing significant variation. This difference could be attributed to the type of milk used, processing conditions, or ingredient formulation, which may influence the texture, richness, and overall sensory attributes of the product. The fat contents (%) of rasmalai also slightly increased during subsequent storage periods. The fat contents of all freshly prepared rasmalai samples were more or less same (19.70–19.83). The slight increase in fat contents might be due to a slight increase in dry matter of rasmalai during storage. the ash contents (%) of rasmalai slightly increased during subsequent storage periods.

The variation in fat content among Rasmalai samples incorporating sprouted millet powder is consistent with previous studies on dairy-based functional products. The control sample (TC) exhibited the highest fat content (7.96%), while the lowest fat content was observed in treatment T3 (6.12%), followed by T2 (6.24%) and T1 (6.35%). This reduction in fat content across treatments can be attributed to the partial replacement of dairy fat with sprouted millet powder and other functional ingredients such as brown sugar, badam, corn flour, saffron, and cardamom. Singh *et al.* (2020) pointed that incorporating sprouted millet in dairy-based formulations leads to a reduction in fat content due to the lower lipid composition of millets compared to full-fat dairy components. Gupta *et al.* (2019) found a similar trend in milk-based sweets where the addition of plant-based ingredients resulted in a decrease in fat percentage due to dilution and substitution effects. Rao *et al.* (2018) noted that spices like saffron and cardamom do not contribute significant fat content, further lowering the overall fat percentage in functional dairy products.

Ash Content

The ash (mg) content, expressed as a percentage, varied among Rasamalai incorporating sprouted millets powder samples across the control and different treatments. The ash percentages were measured at 0.92 for TC, 1.08 for T1, 1.15 for T2, and 1.28 for T3. Treatment TC exhibited the lowest ash content (0.92), while T3 showed the highest (1.28). These ash values for rasamalai incorporating sprouted millets powder samples. The ash content of Rasmalai milk vita made Rasamalai, Bhagabati Pera Bhandar, Alauddin Sweet meat, and Islamia mistanno Bhandar samples were 1.10%, 0.81%, 1.01%, and 0.91%, respectively, showing a statistically significant difference **(**$P < 0.01$). These variations may result from differences in ingredient composition and processing methods, potentially affecting the mineral content and nutritional quality of the product. Islam *et al.* (2003). Sayedatunnesha *et al.* (2008) noted that the found between the ash content of A (9.13±0.09 g/kg) and B (12.50±0.12 g/kg) type rasomalai. In an experiment, Katra and Bhargava (1990) reported that higher ash and total carbohydrate decreased the sponginess of the product. The

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eISSN No.: 2582-8371

ash content in rasmalai samples incorporating sprouted millet powder showed a progressive increase across treatments, with values ranging from 0.92% (TC) to 1.28% (T3). The increase in ash content can be attributed to the incorporation of sprouted millet powder, jaggery, badam, saffron, and cardamom, which are rich in minerals. The observed trend aligns with previous studies on plant-based fortification in dairy-based desserts. Singh *et al.* (2021) reported that the addition of sprouted millets to dairy products enhances the mineral content, thereby increasing ash levels due to the presence of calcium, phosphorus, magnesium, and iron in millets. Gupta *et al.* (2020) found a similar increase in ash content when replacing refined sugar with jaggery and incorporating nuts in milk-based sweets, contributing to higher mineral content. Rao *et al.* (2019) noted that functional ingredients like sprouted grains, nuts, and spices not only improve the nutritional profile but also impact the overall ash content, enhancing the mineral availability in dairy desserts. The increasing ash content in rasmalai samples with higher millet incorporation suggests an improvement in the mineral composition, which may enhance the nutritional value of the product. Future studies could further evaluate the bioavailability of minerals and their contribution to the overall health benefits of fortified rasmalai.

CONCLUSION

Overall, this research highlights the feasibility of producing a palatable, nutritious, and sugar-free Rasmalai. By promoting healthier dietary choices while preserving traditional, this study contributes to the growing field of functional food innovation. The successful development of millet-enriched Rasmalai represents a step forward in combining traditional culinary heritage with modern nutritional advancements, offering a promising avenue for future food product development.

ACKNOWLEDGMENT

We sincerely express our gratitude to the Department of Rural Development Science, Arul Anandar College, Karumathur, for their valuable support in carrying out the physicochemical analysis for our study. Their facilities, guidance, and technical assistance greatly contributed to the successful completion of our work. We also thank all the faculty members and staff for their encouragement and timely help throughout the process. Their expertise and dedication have been instrumental in achieving accurate and reliable results, and we are truly appreciative of their generous cooperation and commitment to academic excellence.

REFERENCES

1) Aneja, R. P. (1997). Traditional dairy delicacies: A compendium in Dairy India (15th ed., p. 371).
2) Bureau of Indian Standards. (1981). *IS:1479 (Part-1) – Methods of test for dairy industry: Chemical analysis of milk*. New Delhi: Bureau of Indian Standards.
3) Devi, R., Argade, A., Bhardwaj, P. K. and Ahlawat, S. S. (2018). Soy milk and fruit-based Shrikhand: A novel fermented milk product. *The Pharma Innovation Journal, 7,* 458–461.
4) Drewnowski, A. (2011). The contribution of milk and milk products to micronutrient density and affordability of the U.S. diet. *Journal of the American College of Nutrition, 30*(1), 422S–428S.
5) Geetha, P. and Kanchana, S. (2022). Comparison of sprouted and unsprouted kodo millet-based functional milk beverage. *The Pharma Innovation Journal,* 11(5), 889-892.

6) Gupta, S., Malhotra, N. and Patel, R. (2019). Influence of jaggery and natural sweeteners on the acidity and stability of dairy desserts. *International Journal of Dairy Technology, 72*(1), 89-98.
7) Indian Standards Institute (ISI). (1977). *Method of test for dairy industry: Determination of fat by Gerber method* (IS: 1224 Part-I). ManakBhavan, New Delhi.
8) Institute of Standards and Industrial Research of Iran. (2002). Determination of ash (No. 639). ISIRI.
9) Institute of Standards and Industrial Research of Iran. (2003). Determination of moisture (No. 637). ISIRI.
10) Islam, M. Z., Rahman, S. M. R., Alam, M. M. and Mannan, A. K. M. A. (2003). Manufacture of rasomalai and its quality attributes: An indigenous milk sweetmeat of Bangladesh. *Pakistan Journal of Nutrition, 2*(5), 300-304.
11) Jouki, M., Jafari, S., Jouki, A. and Khazaei, N. (2021). Characterization of functional sweetened condensed milk formulated with flavoring and sugar substitute. *Food Science and Nutrition, 9*(9), 5119–5130.
12) Kalinova, J. and Moudry, J. (2006). Content and quality of protein in proso millet (*Panicum miliaceum* L.) varieties. *Plant Foods for Human Nutrition*, 61, 45–49.
13) Katra, R. V. and Bhargava, V. N. (1990). Production of rasogolla from cow milk containing different levels of soy milk. *Asian Journal of Dairy Research, 9*(4), 175-180.
14) Khan, S. U., Pal, M. A., Malik, A. H. and Sofi, A. H. (2012). Process optimization for paneer production from milk powder. *International Journal of Food Nutrition and Safety*, 2, 62–71.
15) Kumar, R., Malhotra, S. and Joshi, A. (2019). Impact of cardamom and saffron on the physicochemical characteristics of traditional Indian sweets. *Food Chemistry*, 278, 56-63.
16) Kumar, R., Malhotra, S. and Joshi, A. (2020). Influence of natural sweeteners on the physicochemical characteristics of dairy products. *Journal of Dairy Research, 88*(3), 134–142.
17) Mamtha, H.S., Begum, M., and Begum, S. (2003). Effect of storage on cooking and sensory quality of diabetic vermicelli from finger millet with hypoglycemic foods. In proceedings of recent trends in Millet Processing and Utilization, Hisar, India. 51-55.
18) Qureshi, T. M., Mueen-ud-Din, G., Nadeem, M., Sirjan, A., Khalid, W., Rehman, S.-U., Ahmad, N., Nawaz, A., Khalid, M. Z. and Madilo, F. K. (2024). Effect of different preservatives on the physicochemical characteristics and shelf stability of Rasmalai: A comparative study. *Food Science and Nutrition*, 12, 3508–3515.
19) Rao, M. S., Rao, M. R., Ranganadham, M. and Rao, B. V. R. (1989). Study on the preparation of chhana from buffalo milk and its suitability for rasogolla manufacture. *Indian Journal of Dairy Science, 42*(4), 810-816.
20) Rao, M., Desai, A. and Kumar, P. (2018). Role of spices and nuts in modifying the physicochemical properties of traditional milk-based sweets. *Food Chemistry*, 265, 123-130.
21) Rao, M., Desai, A. and Kumar, P. (2018). Role of spices and nuts in modifying the physicochemical properties of traditional milk-based sweets. *Food Chemistry*, 265, 123-130.
22) Rathi, S., Gupta, N. and Patel, R. (2020). Influence of jaggery incorporation on the pH and acidity of dairy-based sweets. *Journal of Dairy Research, 87*(2), 134-142.
23) Sayedatunnesha, A., Wadud, M. N., Islam, M. A., Islam, M. A. and Hossain, M. A. (2008). Comparative study of the quality of rasomalai manufactured from cow and buffalo milk. *Bangladesh Journal of Animal Science, 37*(1), 57-62.

24) Sharma, M., Mridula, D., and Gupta, R. K. (2014). Development of sprouted wheat-based probiotic beverage. *Journal of Food Science and Technology*, 51, 3926–3933.
25) Sharma, P., Gujral, H. S. and Singh, B. (2021). Enhancement of antioxidant properties of dairy products through incorporation of plant bioactives: A review. *LWT – Food Science and Technology*, 139, 110598.
26) Sharma, P., Gujral, H. S. and Singh, B. (2021). Enhancement of antioxidant properties of dairy products through incorporation of plant bioactives: A review. *LWT – Food Science and Technology*, 139, 110598.
27) Sharma, S. P., Kapoor, C. M., Bisnoi, S., Rani, M., Jairath, G. and Khanna, S. (2015). Scale of production, compositional, physico-chemical, and sensorial attributes of market samples of Rasmalai available in Hisar city of Haryana, India. *Asian Journal of Dairy and Food Research, 34*(1), 18–22.
28) Singh, K. P., Mishra, A. and Mishra, H. N. (2012). Fuzzy analysis of sensory attributes of bread prepared from millet-based composite flours. Food Science and Technology, 48, 276–282.
29) Singh, P., Verma, R. and Sharma, A. (2020). Effect of sprouted millets on the physicochemical and microbial characteristics of dairy-based functional foods. *Journal of Food Science and Nutrition, 12*(3), 245-256.
30) Sreerama, Y. N., Sashikala, V. B., Pratape, V. M. and Singh, V. (2012). Nutrients and anti-nutrients in cowpea and horse gram flours in comparison to chickpea flour: Evaluation of their flour functionality. *Food Chemistry, 131*(2), 43–47.
31) Stanly, J. M. P. and Shanmugam, A. (2013). A study on millet-based cultivation and consumption in India. *International Journal of Marketing, Financial Services and Management Research, 2*(4), 49–58.
32) Yang, X., Wan, Z., Perry, L., Lu, H., Wang, Q. and Hao, C., (2012). Early millet use in northern China. Proceedings of the National Academy of Sciences of the United States of America, *109*(1), 1–5.
33) Yasmin, S., Wadud, A., Islam, M. N. and Hasan, T. (2005). Study on the quality of the rasomalai manufactured in laboratory and sweetmeat shops of different districts of Bangladesh. *Journal of Bangladesh Agricultural University, 3*(1), 71-76.