

Studies on Development and Evaluation of Vegan Rasmalai from Soy Milk in Comparison with Cow and Buffalo Milk Rasmalai

Dr. A. Ravinder¹, A. Pravalika Reddy², N. Sandeep³, Samson Arul⁴,
Ch. Anil⁵

^{1,2}Assistant Professor, Department of Food Technology & Management, Loyola Academy Degree & P.G. College, Alwal, Secunderabad, Telangana, India

^{3,4,5}Department of Food Technology & Management (PG), Loyola Academy Degree & P.G. College, Alwal, Secunderabad, Telangana, India

Abstract

Rasmalai, a popular Chenna-based traditional Indian dairy dessert, was developed in a vegan form using soy milk and evaluated in comparison with conventional cow milk and buffalo milk Rasmalai. The study aimed to assess the nutritional composition, physicochemical characteristics, and sensory acceptability of the developed product. Vegan Rasmalai was prepared using soy milk obtained from soaked and dehulled soybeans, curdled with citric acid to form soy Chenna, which was kneaded, shaped into discs, cooked in sugar syrup, and soaked in flavoured sweetened soy milk enriched with cardamom and saffron.

Comparative nutritional analysis revealed that buffalo milk Rasmalai possessed the highest energy (228.33 ± 16.49 kcal/100 g), fat (11.00 ± 0.81 g), protein (7.5 ± 0.40 g), calcium (201.66 ± 16.49 mg), phosphorus (140.33 ± 8.17 mg), and vitamins A and B-complex due to its higher total solids. Cow milk Rasmalai showed moderate nutritional values, while soy milk Rasmalai contained lower energy (62.40 ± 0.56 kcal/100 g) and fat (4.63 ± 0.40 g), higher protein (6.5 ± 0.40 g), higher iron content (1.23 ± 0.20 mg), negligible cholesterol, absence of lactose, and no vitamin B12 unless fortified, making it suitable for lactose-intolerant, vegan, and health-conscious consumers. Physicochemical evaluation indicated that soy Chenna exhibited a comparatively crumbly and fragile texture when compared to the soft and firm texture of cow and buffalo milk Chenna.

Sensory evaluation using a nine-point hedonic scale showed that buffalo milk Rasmalai scored highest for texture, flavour, and overall acceptability, followed by cow milk Rasmalai. Soy milk Rasmalai, although scoring slightly lower, was found to be acceptable in terms of taste, texture, flavour, and appearance. The study concludes that soy milk can be successfully utilized to produce an acceptable vegan Rasmalai, offering a nutritious, low-fat, and cholesterol-free alternative to traditional dairy-based Rasmalai.

Keywords: Rasmalai, soy milk, vegan dessert, cow milk, buffalo milk, nutritional composition, sensory evaluation

1. INTRODUCTION

Soybean (*Glycine max*) originated in East Asia and subsequently spread to neighbouring countries such

as Japan and Korea, and later to other parts of the world. Although soybean originated in Asia, Brazil has emerged as the world’s leading producer. Soybean is nutritionally rich, containing high-quality plant protein, dietary fibre, essential minerals, and bioactive compounds, making it a valuable raw material for the development of plant-based foods.

Rasmalai is a popular Chenna-based traditional Indian dairy dessert prepared by cooking Chenna discs in sugar syrup and soaking them in sweetened, flavoured milk. Conventionally, cow milk or buffalo milk is used for Rasmalai preparation. In recent years, increasing prevalence of lactose intolerance, hypercholesterolemia, and adoption of vegan diets has led to growing interest in replacing or blending dairy milk with soy milk to develop lactose-free and plant-based alternatives.

From a nutritional perspective, cow milk Rasmalai is characterized by higher levels of saturated fat and naturally occurring calcium, whereas soy milk Rasmalai provides higher plant-based protein, is cholesterol-free, and contains appreciable amounts of iron and dietary fibre. However, several studies have reported that soy-based products may require micronutrient fortification, particularly with calcium and vitamin B12, to achieve nutritional equivalence with dairy-based products.

Processing and technological challenges arise due to differences in coagulation behaviour between dairy casein proteins and soy proteins, which significantly influence the texture and structure of Chenna. Optimization of coagulant type, concentration, and processing conditions is therefore essential to obtain acceptable soy Chenna with desirable texture and reduced beany flavour. Sensory studies indicate that dairy Rasmalai generally scores higher for creaminess and flavour, while soy Rasmalai may exhibit characteristic beany notes unless appropriate pre-treatment and washing steps are employed. Blended formulations containing 25–50% soy milk have been reported to show improved sensory acceptability. Both dairy and soy-based Rasmalai products are highly susceptible to microbial spoilage due to their high moisture and sugar content. Therefore, hygienic processing practices and refrigerated storage are critical for extending shelf life and ensuring product safety. The present study was undertaken to develop a vegan Rasmalai using soy milk and to evaluate its nutritional, physicochemical, and sensory characteristics in comparison with conventional cow milk and buffalo milk Rasmalai.

Table 1: Nutritive value of Soybean

| Parameters | Values per 100gm |
|------------------------|-------------------------|
| Moisture (g) | 8.54 |
| Energy (kcal) | 446 |
| Protein(g) | 36.49 |
| Total lipids(g) | 19.94 |
| Carbohydrates(g) | 30.16 |
| Total dietary fibre(g) | 9.3 |
| Total sugars(g) | 7.33 |
| iron(mg) | 15.07 |
| potassium(mg) | 1797 |
| magnesium(mg) | 280 |
| folate(mg) | 375 |
| Vitamin B6(mg) | 0.377 |

(Source: USDA National Nutrient Database for Standard [3])

2. Review of Literature

Several studies have reported on soybean production, processing practices, and the quality characteristics of dairy and soy-based traditional milk products. Khojely et al. (2018) reported that soybean production has expanded considerably in Sub-Saharan Africa; however, yields remain low due to limited adoption of improved varieties and poor agronomic practices. Although research institutions have developed several high-yielding soybean varieties, challenges such as limited access to credit, inadequate processing equipment, and reliance on traditional processing methods continue to restrict effective utilization. The authors emphasized that improvements in processing technologies and support services are critical for enhancing soybean utilization and ensuring food and nutrition security.

Studies focusing on the shelf life and preservation of Rasmalai have highlighted the importance of processing innovations. Qureshi et al. (2024) investigated the use of potassium sorbate and calcium propionate to improve the shelf stability of Rasmalai and their effects on compositional and sensory attributes. The study revealed that both preservatives were effective in controlling microbial growth; however, the combined treatment of potassium sorbate and calcium propionate at 500 ppm each extended the shelf life of Rasmalai up to 12 days without adversely affecting taste or texture. Untreated samples exhibited the highest microbial load, while the combined treatment showed the lowest, confirming its superior preservation efficacy.

Comparative studies on Rasmalai prepared from different types of milk have demonstrated notable variations in quality attributes. Sayedatunnesha et al. (2008) compared Rasmalai prepared from cow milk and buffalo milk and reported significant differences in chemical composition and sensory quality. Buffalo milk Rasmalai exhibited higher total solids, protein, fat, and ash content, whereas carbohydrate levels did not differ significantly between the two variants. Sensory evaluation showed significant differences in flavour, texture, colour, and overall acceptability, with buffalo milk Rasmalai receiving higher scores. The study also reported slightly lower acidity and comparable microbiological quality in buffalo milk Rasmalai, with no coliforms detected in either sample. Additionally, buffalo milk Rasmalai was found to be economically more profitable.

Soybean processing practices and their implications for food and nutrition sustainability have also been documented. Suleimen et al. (2022) evaluated soybean processing methods in Nasarawa State and observed that the majority of processors relied on traditional techniques, resulting in low processing efficiency. The study highlighted the influence of socio-economic factors such as age and income on processing efficiency and recommended improved access to credit and modern processing technologies to enhance soybean utilization.

Earlier research by Mpepereki et al. (2000) emphasized the importance of promiscuous soybean varieties capable of forming effective nitrogen-fixing nodules with a wide range of indigenous rhizobia. These varieties were found to be particularly beneficial for smallholder farmers, as they do not require commercial inoculants and contribute to improved soil fertility, crop productivity, and nutritional security. Such agronomic advancements support sustainable soybean production and increased availability of soy-based food products.

3. Materials and Methodology

The raw materials used for the preparation of soymilk Rasmalai included soybean, sugar, water, citric acid, corn flour, ghee, and saffron. All ingredients were procured from the local market. The formulation adopted for the preparation of soymilk Rasmalai is presented in Table 2.

Table 2: Formulation for the Preparation of Soymilk Rasmalai

| Ingredient | Quantity |
|------------------|----------|
| Soybean (g) | 500 |
| Sugar (g) | 400 |
| Water (L) | 1 |
| Citric acid (mL) | 2 |
| Corn flour (g) | 10 |
| Ghee (mL) | 5 |
| Saffron (g) | 1 |

3.1 Processing Methodology

The formulation ratio of 1:2 (soymilk: water) was followed for the preparation of vegan Rasmalai. The preparation process involved extraction of soymilk, preparation of soy chenna, formation of chenna balls, preparation of sugar syrup, and final assembly of Rasmalai.

Soybeans were soaked overnight in potable water, after which the hulls were removed manually. The dehulled beans were ground into a smooth paste with the addition of water in a 1:2 ratio. The resulting slurry was filtered using a muslin cloth to obtain raw soymilk. The extracted soymilk was heated at 85°C for 15 minutes to inactivate trypsin inhibitors and reduce beany flavour.

Curdling of the heated soymilk was carried out by the gradual addition of citric acid solution, resulting in the separation of whey and coagulated solids. The coagulated mass was filtered through muslin cloth to obtain chenna. The chenna was washed thoroughly with potable water to remove residual acidity and then pressed gently to remove excess moisture.

The chenna was kneaded with a small quantity of corn flour to improve binding properties. A soft dough was formed and divided into equal portions. These portions were rolled into smooth balls and flattened into discs of approximately 4 cm diameter and 1 cm thickness.

Sugar syrup was prepared by dissolving 250 g of sugar in water and boiling the solution for 10 minutes to obtain a thin syrup. The prepared chenna discs were gently cooked in the sugar syrup for 15 minutes until they absorbed the syrup and increased in size. After cooking, the chenna discs were allowed to cool at room temperature while maintaining moisture.

Separately, the remaining soymilk was boiled and sweetened with 150 g of sugar. Cardamom powder was added to enhance flavour. The cooked chenna discs were then transferred into the boiling sweetened soymilk and cooked for 5 minutes. A pinch of saffron was added to improve colour and flavour.

The prepared soymilk Rasmalai was allowed to cool, garnished with chopped almonds to enhance appearance and sensory quality, and packed in plastic containers. The product was stored under refrigeration conditions until further analysis.

3.2 Preparation of Soymilk

As illustrated in Figure 1, the preparation of soymilk involved cleaning, soaking, dehulling, grinding, cooking, filtration, and cooling. Soybeans were washed thoroughly to remove dirt and impurities and soaked in potable water for 8–12 hours. The soaked beans were ground with warm water to obtain a fine slurry, which was cooked at high temperature to improve digestibility and flavour. The cooked slurry was

filtered through muslin cloth to separate soymilk from okara. The extracted milk was cooled and used for Rasmalai preparation.

Figure 1: Process Flow Chart for Preparation of Soymilk

Soybeans → Cleaning/Washing → Soaking → Dehulling → Grinding → Addition of Water → Filtration → Soymilk

3.3 Preparation of Soy Chenna

As shown in Figure 2, fresh soymilk was heated to $85^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and curdled by the gradual addition of citric acid or lemon juice. The coagulated mass was separated from whey, filtered through muslin cloth, washed to remove acidic taste, and pressed to remove excess moisture, yielding soy chenna.

Figure 2: Process Flow Chart for Preparation of Soy Chenna

Soymilk → Boiling → Addition of Coagulant → Curdling → Separation of Curd and Whey → Filtration → Washing → Draining and Pressing → Soy Chenna

3.4 Preparation of Sugar Syrup

Sugar syrup was prepared as illustrated in Figure 3. Sugar and water were mixed in a 1:4 ratio and heated with continuous stirring until complete dissolution. The solution was boiled for 5–7 minutes to obtain a thin syrup of approximately 20–30°Brix. Foam and impurities were removed by skimming.

Figure 3: Process Flow Chart for Preparation of Sugar Syrup

Sugar + Water → Mixing → Heating → Stirring → Boiling → Skimming → Thin Sugar Syrup

3.5 Preparation of Rasmalai (Flavoured Soymilk Mixture)

According to Figure 4, the soymilk was gently simmered to enhance richness, followed by the addition of flavouring agents such as cardamom powder and saffron. The cooked chenna discs were added to the flavoured soymilk and allowed to soak for uniform flavour absorption. The finished Rasmalai was cooled, garnished with chopped almonds, packed in suitable containers, and stored under refrigeration.

Figure 4: Flow Chart for Preparation of Rasmalai (Flavoured Soymilk Mixture)

Boiling of Soymilk → Addition of Cardamom and Saffron → Addition of Cooked Chenna Discs → Cooling → Garnishing → Packing and Refrigerated Storage

4. Results and Discussion

Rasmalai prepared from soy milk was evaluated in comparison with traditional cow milk and buffalo milk Rasmalai with respect to nutritional composition, physicochemical characteristics, and sensory attributes. The comparative results are presented in Tables 3 to 8.

4.1 Nutritional Composition

The nutritive values of cow milk Rasmalai are presented in Table 3. Cow milk Rasmalai exhibited moderate energy content (195 ± 10.61 kcal/100 g), with appreciable levels of protein (6.43 ± 0.41 g), fat (7.06 ± 0.69 g), and essential minerals such as calcium (164.43 ± 6.56 mg) and phosphorus (121.73 ± 4.57 mg). The presence of lactose and vitamin B₁₂ confirms its suitability for general consumers but limits its acceptability for lactose-intolerant individuals.

Buffalo milk Rasmalai (Table 4) showed significantly higher energy (228.33 ± 16.49 kcal/100 g), fat (11.0 ± 0.81 g), protein (7.5 ± 0.40 g), and mineral content, particularly calcium (201.66 ± 16.49 mg) and phosphorus (140.33 ± 8.17 mg). This higher nutritive value can be attributed to the greater total solids content of buffalo milk. Buffalo milk Rasmalai also contained higher levels of fat-soluble vitamins and B-complex vitamins, contributing to superior sensory quality.

The nutritive composition of soy milk Rasmalai is presented in Table 5. Compared to dairy Rasmalai, soy

milk Rasmalai had significantly lower energy (62.40 ± 0.56 kcal/100 g) and fat content (4.63 ± 0.40 g), making it suitable for low-calorie and health-conscious diets. Protein content (6.5 ± 0.40 g) was comparable to dairy Rasmalai, while iron content (1.23 ± 0.20 mg) was substantially higher than both cow and buffalo milk Rasmalai. Calcium and vitamin A levels were lower unless fortified soy milk was used, and vitamin B₁₂ was absent, as expected in plant-based products.

Overall, the comparative nutritional evaluation indicates that buffalo milk Rasmalai is the richest source of energy, fat, calcium, phosphorus, potassium, and vitamins A and B-complex. Cow milk Rasmalai provides moderate nutritional value, whereas soy milk Rasmalai offers specific health benefits such as zero cholesterol, higher iron content, lower sodium, and suitability for lactose-intolerant and vegan consumers.

4.2 Physicochemical Characteristics

The physicochemical differences between dairy Rasmalai and soy milk Rasmalai are summarized in Table 6. Buffalo milk Rasmalai exhibited a firm chenna texture due to higher fat and casein content, while cow milk Rasmalai showed a soft and spongy texture. In contrast, soy milk chenna was comparatively crumbly and fragile, reflecting differences in protein structure and coagulation behaviour between soy proteins and dairy casein. The flavour of dairy Rasmalai was characterized by rich milky notes, whereas soy milk Rasmalai exhibited mild beany flavour, which can be minimized through appropriate pre-treatment and washing steps.

4.3 Sensory Evaluation

Sensory evaluation was carried out using a 9-point hedonic scale, and the results are presented in Table 7. Buffalo milk Rasmalai obtained the highest scores for texture (8.5) and appearance (8.0), reflecting its rich mouthfeel and appealing structure. Cow milk Rasmalai showed good acceptability with balanced scores for taste and flavour.

Soy milk Rasmalai demonstrated acceptable sensory scores for taste (8.0), texture (8.0), flavour (8.2), and appearance (8.3). Although slightly lower in creaminess compared to dairy counterparts, the soy-based Rasmalai was well accepted by the panelists, indicating its potential as a viable vegan alternative when appropriate formulation and processing techniques are applied.

4.4 Comparative Analysis

The comparative proximate composition of Rasmalai samples (Table 8) further confirms that buffalo milk Rasmalai contains the highest fat and protein levels, followed by cow milk Rasmalai. Soy milk Rasmalai exhibited the highest protein among the three and the lowest fat content. Moisture content was comparable across samples, while ash and fibre content were relatively higher in dairy and soy Rasmalai, respectively.

Table 3: Nutritive value of soymilk Rasmalai

| S.No | Nutrients | Reported Value (%) |
|------|------------------|--------------------|
| 01 | Moisture content | 62.12 |
| 02 | Ash content | 0.306 |
| 03 | Fat content | 4.66 |
| 04 | Crude Fiber | 0.01 |
| 05 | sugars | 28.36 |

Table 3.1: Nutritive Values of cow milk Rasmalai (per 100 g)

| Nutrient | Values per 100 g |
|-----------------------------|------------------|
| Energy(kcal) | 195±10.61 |
| Carbohydrates(g) | 27.93±1.14 |
| Sugars(g) | 23.06±1.26 |
| Protein(g) | 6.43±0.41 |
| Total Fat(g) | 7.06±0.69 |
| Calcium(mg) | 164.43±6.56 |
| Phosphorus(mg) | 121.73±4.57 |
| Lactose(g) | 4.5±0.408 |
| Sodium(mg) | 60.96±6.49 |
| Potassium(mg) | 141±4.39 |
| Iron(mg) | 0.3±0.08 |
| Vitamin A(µg) | 80.1±5.59 |
| Vitamin B2 (Riboflavin)(mg) | 0.20±0.012 |
| Vitamin B12(µg) | 0.53±0.12 |

Table 4: Nutritive Values of buffalo milk Rasmalai (per 100 g)

| Nutrient | Value per 100 g |
|-----------------------------|-----------------|
| Energy(kcal) | 228.33 ±16.49 |
| Carbohydrates(g) | 27.33±2.05 |
| Sugars(g) | 22.33±2.05 |
| Protein(g) | 7.5±0.40 |
| Total Fat(g) | 11±0.81 |
| Calcium(mg) | 201.66±16.49 |
| Phosphorus(mg) | 140.33±8.17 |
| Lactose(g) | 4.5±0.40 |
| Sodium(mg) | 70.66±8.21 |
| Potassium(mg) | 165±12.24 |
| Iron(mg) | 0.4±0.08 |
| Vitamin A(µg) | 100±8.16 |
| Vitamin B2 (Riboflavin)(mg) | 0.22±0.02 |
| Vitamin B12(µg) | 0.75±0.12 |

Table 5: Nutritive Values of Soy milk Rasmalai (per 100 g)

| Nutrient | Value per 100 g |
|-----------------------------|-----------------|
| Energy(kcal) | 62.40±0.56 |
| Carbohydrates(g) | 22.33±2.05 |
| Sugars(g) | 27.63±1.74 |
| Protein(g) | 6.5±0.40 |
| Total Fat(g) | 4.63±0.40 |
| Dietary Fiber(g) | 0.03±0.02 |
| Calcium(g) | 100±16.32 |
| Phosphorus(mg) | 113.33±12.47 |
| Iron(mg) | 1.23±0.20 |
| Sodium(mg) | 30±8.16 |
| Potassium(mg) | 136.66±16.99 |
| Vitamin A(µg) | 30±8.16 |
| Vitamin B2 (Riboflavin)(mg) | 0.08±0.02 |

Table 6: Physicochemical Differences of Soy Milk Rasmalai versus Dairy Rasmalai

| Parameter | Cow Milk | Buffalo Milk | Soy Milk |
|-------------------|----------------------|--------------|--------------------------------------|
| Fat | Moderate | High | Low |
| Protein | Moderate | High | High (but different type) |
| Texture of Chenna | Soft | Firm | Crumbly/Fragile (needs modification) |
| Flavour | Characteristic dairy | Rich dairy | Beany unless treated |

Table 7: Sensory Attributes of Cow milk, Buffalo milk and Soy milk Rasmalai

| Attribute | Cow Milk Rasmalai | Buffalo Milk Rasmalai | Soy Milk Rasmalai |
|------------|-------------------|-----------------------|-------------------|
| Taste | 8.0 | 7.5 | 8.0 |
| Texture | 7.5 | 8.5 | 8.0 |
| Flavour | 8.0 | 8.0 | 8.2 |
| Appearance | 7.0 | 8.0 | 8.3 |

Table 8: Comparative parameters of Cow milk, Buffalo milk and Soy milk Rasmalai

| Nutrients | Cowmilk Rasmalai | Buffalomilk Rasmalai | Soymilk Rasmalai |
|------------------|------------------|----------------------|------------------|
| Moisture content | 69.50% | 60.13% | 62.12% |
| Ash content | 0.75% | 1.256% | 0.306% |

| Nutrients | Cowmilk Rasmalai | Buffalomilk Rasmalai | Soymilk Rasmalai |
|-------------|------------------|----------------------|------------------|
| Crude fibre | 0.08% | 0.10% | 0.03% |
| sugars | 27.85% | 28.00% | 28.36% |
| protein | 3.20% | 4.23% | 6.03% |
| Fat content | 7.10% | 11.00% | 4.66% |

5. Overall Discussion

The results clearly demonstrate that while buffalo milk Rasmalai excels in nutritional richness and sensory quality, soy milk Rasmalai provides distinct health advantages, including lower fat, absence of cholesterol, higher iron content, and suitability for lactose-intolerant and vegan consumers. With appropriate processing modifications to improve chenna texture and flavour, soy milk Rasmalai can serve as a nutritious, acceptable, and sustainable alternative to traditional dairy-based Rasmalai

6. Conclusion:

Rasmalai prepared from buffalo milk showed the highest nutritional quality, with greater fat, protein, energy, and mineral content, giving it the best sensory scores for taste, texture, and appearance. Cow milk Rasmalai provided moderate nutritive value and acceptable quality.

Soy milk Rasmalai, although lower in fat and high in protein offered health benefits such as higher iron, zero cholesterol, and dietary fibre. It is suitable for lactose-intolerant and vegan consumers. With proper processing and flavour adjustments, soy-based Rasmalai can serve as a nutritious, affordable, and acceptable alternative to traditional dairy Rasmalai.

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