



Formulation and quality assessment of a sugar-free jamun ready-to-serve fortified beverage with nata de coco and vitamin b12

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Abstract

The present study is concerned with the design and quality assessment of a functional, sugar-free Ready-to-Serve (RTS) beverage of Jamun (*Syzygium cumini*) fortified with Vitamin B12 and enriched with Nata de Coco. Designed particularly for diabetic and health-oriented consumers, the product employs stevia as a zero-calorie natural sweetener. Stevia-sweetened formulation was standardized with 120 ml frozen Jamun pulp (48%), 25 g Nata de Coco (10%), water, iodized salt, lemon juice, and 1.2 mcg Vitamin B12 per serving of 250 ml. Sensory analysis carried out by 10 panelists scored parameters including taste, texture, mouthfeel, and overall acceptability. The product was also studied for chemical and microbial quality. Analysis revealed favorable sensory acceptance and microbiological safety, making the product a good, functional drink alternative with possible health effects, especially for diabetics.

Keywords: Jamun RTS beverage, sugar-free formulation, Vitamin B12 fortification, Nata de Coco, sensory evaluation

Introduction

The escalating incidence of lifestyle-related diseases, especially diabetes mellitus, has created a strong need for functional drinks that are both health-promoting and compatible with constricted diets. Here, Jamun (*Syzygium cumini*), a tropical fruit with anti-diabetic, antioxidant, and anti-inflammatory activities, shows great promise for their development as value-added health drinks. Jamun pulp contains anthocyanins, flavonoids, and polyphenols, which were found to possess hypoglycemic activity through the activation of insulin and mitigation of oxidative stress.

Ready-to-Serve (RTS) drinks are convenient, refreshing, and in greater demand across all segments of age. The incorporation of functional ingredients into RTS drinks only adds to their attractiveness, especially among consumer segments that are health-conscious. Nata de Coco, a soft, transparent, jelly-like snack made from coconut water fermentation, not only enhances mouthfeel but also provides dietary fiber content, adding to the satisfaction and health benefits of the drink.

Vitamin B12 is a vital micronutrient whose deficiency is common among vegetarian and vegan diets. It is critical to the production of red blood cells, neurological function, and synthesis of DNA. Vitamin B12 adds nutritional value to the product and addresses a broader segment of consumers, particularly those who are at risk of vitamin B12 deficiency. To preserve the product's sugar-free status, stevia (INS 960) is employed as a natural, zero-calorie sweetener. Stevia is approved by worldwide regulating agencies and is ranked safe for diabetic patients because of its negligible impact on blood glucose levels.

The aim of this research was to formulate a sugar-free, vitamin-supplemented Jamun RTS drink with Nata de Coco, evaluate its sensory properties, and analyze its chemical and microbial stability. The development aimed to form a functional product that would provide the nutritional requirement of diabetic and health-oriented people while yielding a satisfying sensory effect. This study has been

conducted in the research laboratory of Food Process and Product Technology, MIT School of Food Technology, MIT ADT University, Pune, Maharashtra, India.

Materials and Methods

1. Market Survey

A market research survey was taken through Google Forms, administered to different age groups with other flavor orientations. Through the survey, important information regarding the potential market for the Jamun RTS with Nata de Coco was gained, including consumer trends, flavor orientation, and target market. The outcome showed a positive inclination towards fruit-based, vitamin-enriched drinks, with a particular interest in international flavors and functional ingredients such as Nata de Coco.

2. Raw Material Procurement

Raw materials for Jamun RTS with Nata de Coco were obtained from known sources in order to maintain uniform quality:

Frozen Jamun Pulp was obtained from Ariba Foods Pvt. Ltd., Indore, Madhya Pradesh. Since the use of frozen fruit pulp ensured uniformity, potable water was utilized for the preparation of the drink and obtained from the water filtration system at MIT ADT University, Maharashtra, India. As already stated, was utilized for dilution as well as attaining the desired consistency. Tata Salt was purchased from Ganpati Traders, Loni Khalbor, Pune, Maharashtra and utilized for flavor enhancement of the drink. Freshly squeezed lemon juice was utilized for sour taste. Lemons were purchased from the local market of Loni Khalbor, Pune, Maharashtra. Nata de Coco was bought from Sampige via Amazon, in order to provide texture and fiber. Stevia Powder was procured from Sugar Free Green through Amazon, as an artificial sweetener. Vitamin B12 was procured from Nisarg Organic Farm through Amazon, for the purpose of fortification.

All ingredients were checked for quality and freshness prior to use during the product development process.

3. Product Development

The product development process included a number of steps in order to achieve the required flavor, texture, and consistency:

An accurate recipe was created, combining frozen Jamun pulp and water, salt, lemon juice, and Nata de Coco in the best ratio. The mix of ingredients was well combined, evenly distributing flavor and texture. Nata de Coco was added to create a distinct chewy feel. Vitamin B12 was added to strengthen the drink, making it meet the requirements for nutritional intake. The exact amount of Vitamin B12 will be clarified later. Stevia powder was incorporated as artificial sweetener. The final blend was homogenized to provide smooth texture.

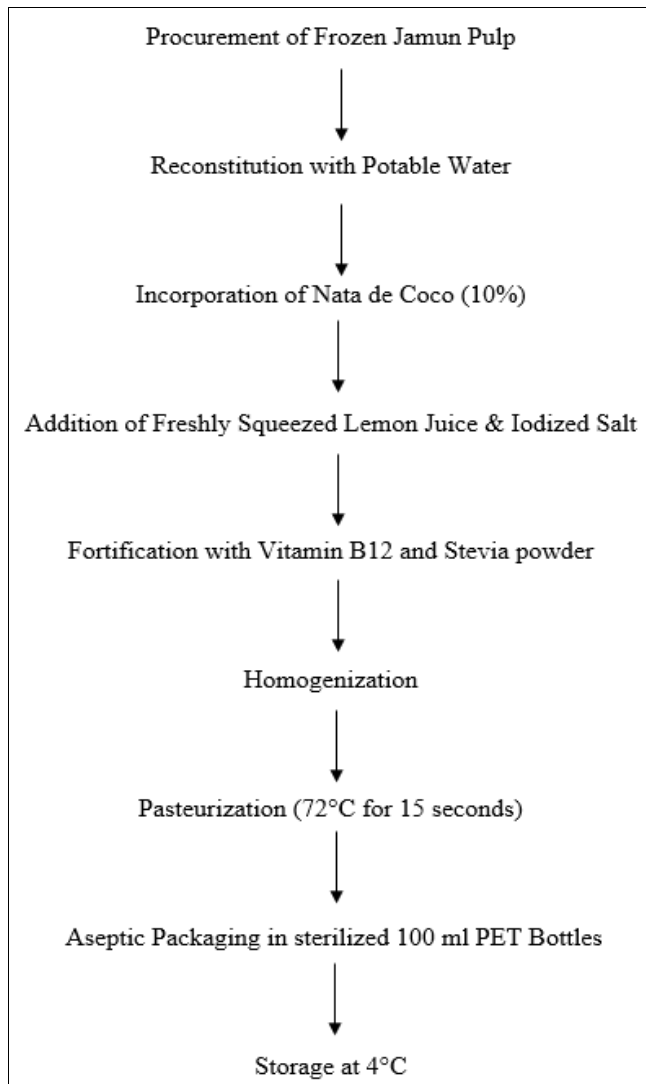


Fig. 1: Flow chart for ready-to-serve Jamun beverage production

Table 1: Formulations with varying concentrations of Nata de Coco per 100 ml.

	Control Sample	Sample A	Sample B	Sample C
Jamun Pulp	48 ml	43 ml	38 ml	33 ml
Potable Water	50 ml	50 ml	50 ml	50 ml
Nata de Coco	-	5 g	10 g	15 g
Iodized Salt	0.5 g	0.5 g	0.5 g	0.5 g
Lemon Juice	2 ml	2 ml	2 ml	2 ml
Vitamin B12	-	1.2 mcg	1.2 mcg	1.2 mcg
Stevia Powder	-	15 mg	15 mg	15 mg

4. Sensory Analysis

A sensory evaluation was conducted using a 9-point hedonic scale to assess the organoleptic properties of the Jamun RTS:

Table 2: 9-Point Hedonic Scale

9-Point Hedonic Scale	
9	Like Extremely
8	Like Very Much
7	Like Moderately
6	Like Slightly
5	Neither Like nor Dislike
4	Dislike Slightly
3	Dislike Moderately
2	Dislike Very Much
1	Dislike Extremely

The color was tested for its aesthetic appeal towards a deep purple hue characteristic of Jamun fruit. The aroma was checked for freshness and fruity smell. Panelists tested the harmony of sweetness and tartness, that the flavor is pleasing yet not too dominant. Texture and Nata de Coco contribution were tested to be pleasant and chewy. The sensory evaluation results were subsequently compared to establish the general acceptability of the product.

The overall acceptability of the product was established using the 9-point hedonic scale, which has been extensively utilized in food sensory studies for its simplicity and sensitivity to quantify consumer acceptability and liking (Stone & Sidel, 2004)^[1].

5. Chemical Analysis

5.1 Moisture

The moisture was determined using the procedure outlined by Horwitz (2005)^[2]. A clean, dry aluminium petri dish was weighed first and the weight recorded. 5 ml of the sample was weighed and placed in the aluminium petri dish. It was then placed in a hot air oven AOAC (2005)^[3] at 105°C for 3 hours. It was allowed to dry and then placed in a glass desiccator and cooled. After reaching room temperature, the aluminium petri dish with the dried sample was weighed. The percentage moisture content was calculated using the formula:

$$\text{Moisture (\%)} = \frac{(\text{Initial weight} - \text{weight of dry matter})}{\text{Initial weight}} \times 100$$

5.2 Ash

Ash content estimation was carried out by taking about 2 g of the dried sample into a silica crucible and heating it at 550°C in a muffle furnace, as per the procedure outlined in AOAC (2005)^[3]. The sample was burned to white or light grey, which shows that organic materials were fully burned. The crucible was placed in a desiccator and weighed. Ash value was determined as a percentage of the remaining mineral material to the original weight of the sample.

5.3 Protein

Protein was determined by the Kjeldahl method (AOAC, 2005)^[3]. The sample amount known was digested using concentrated sulfuric acid with a catalyst to oxidize all the nitrogen into ammonium sulfate. The resulting digested mixture was neutralized with sodium hydroxide and the released ammonia distilled over and trapped in a boric acid solution. It was then titrated against standard acid to provide an estimation of nitrogen content. Total nitrogen was

subsequently translated to the crude protein content in the sample by a factor of 6.25.

5.4 Fat

Fat content was calculated by the Soxhlet extraction technique as per AOAC (2005) [3]. Approximately 2 g of dried sample was weighed, wrapped in a filter paper thimble, and placed in a Soxhlet apparatus. Petroleum ether was used as a solvent, and it was extracted continuously for about 6 to 8 hours until the total fat was extracted. After extraction was complete, the solvent was driven away and the weight of the fat residue recorded. Percentage of fat was then calculated from the weight of fat recovered from the original sample.

5.5 Fibre

Crude fibre content was measured according to the Fiber Analyzer method of AOAC (2005) [3]. About 2 g of defatted and dried sample was taken accurately and subjected to sequential digestion with 1.25% dilute sulfuric acid and 1.25% sodium hydroxide solutions. It imitates the conditions in the human gut. The residue was filtered, washed extensively in hot water, dried in a hot air oven at 105°C, and then weighed. The sample was incinerated in a muffle furnace at 550°C until all the organic matter was eliminated and only ash was left after drying. The crude fibre content was determined by subtracting the ash weight from the dried residue weight and was stated as a percentage of the initial sample.

5.6 Carbohydrate

The total carbohydrate content was estimated by difference through the standard proximate analysis procedure (FAO, 2003) [4]. The moisture, protein, fat, ash, and fibre content was estimated first, and then total carbohydrate was estimated by subtracting the total of these fractions from 100:

$$\text{Carbohydrate (\%)} = 100 - (\text{Moisture} + \text{Protein} + \text{Fat} + \text{Ash} + \text{Fibre})$$

6. Microbial Analysis

Microbiological quality was determined to determine the safety and cleanliness of the formulated Jamun RTS drink. Three standard microbiological analyses were carried out: Total Plate Count (TPC), Yeast and Mold Count, and Coliform Detection. All analyses were carried out in aseptically under a laminar airflow cabinet.

6.1 Total Plate Count (TPC)

Viable bacterial count was approximated on Plate Count Agar (PCA) by pour plate method as outlined by El-Morshedy *et al.* (2020) [5]. Serial dilutions ranging from 10⁻¹ to 10⁻⁶ of the sample were made in sterile saline. 1 ml of the respective dilutions was placed in sterile petri plates, to which molten PCA was then added. The plates were then

incubated at 37°C for 24–48 hours after solidification. Colonies were enumerated and presented as colony-forming units per milliliter (CFU/ml).

6.2 Count of Yeast and Mold

For detection of yeast and molds, Potato Dextrose Agar (PDA) with 10% tartaric acid acidification (pH ~3.5) was employed. The process was inspired by the protocol of Kumar *et al.* (2021) [6]. 1 ml serially diluted sample was inoculated on PDA and incubated at 25°C for 3 to 5 days. Fuzzy (mold) and creamy (yeast) colonies were counted and recorded as CFU/ml.

6.3 Coliform Detection

Coliform bacteria were isolated on Eosin Methylene Blue (EMB) Agar as per the procedure of Rathi *et al.* (2019) [7]. 1 ml of sample dilution was plated on EMB agar plates using the pour plate technique and incubated at 37°C for 24 hours. Characteristic green metallic luster colonies (if found) were detected as *Escherichia coli*. Failure to detect such colonies proved that the sample was devoid of coliform contamination.

Results and Discussion

1. Results of Sensory Evaluation

Three samples (A, B, and C) were prepared by altering the level of Nata de Coco added to Jamun RTS beverage - 5%, 10%, and 15% respectively. These were evaluated for sensory acceptability using a 9-point hedonic scale by a panel of 20 trained and semi-trained evaluators. Parameters assessed were color, flavor, texture, mouthfeel, and overall acceptability.

Sample A, having 5% Nata de Coco, was enjoyed for its good balanced taste and desirable color but scored lower on texture and mouthfeel because it lacked chewiness.

Sample B, with 10% Nata de Coco content, was the top pick among panelists. The level of Nata de Coco introduced a perfect chewy and juicy texture that blended well with the smoothness of the Jamun juice. The taste was felt as refreshing, and mouthfeel was aided by the uniform distribution of Nata de Coco bits. This sample received the highest in mouthfeel (8.4), flavor (8.1), and overall acceptability (8.2).

Sample C with 15% Nata de Coco had comparatively poorer flavor and mouthfeel scores. Panelists stated that excessive Nata de Coco content overcame the flavor of Jamun, and the beverage turned too pulpy, its drinkability being compromised. Though it had better texture score, other parameters' imbalance resulted in poorer overall acceptability.

Sample B was identified as the most acceptable formulation using sensory scores and was selected for chemical and microbial evaluation.

Table 3: Sensory Evaluation of Jamun RTS Samples (Mean Scores)

Sample	Color	Flavor	Texture	Mouthfeel	Overall Acceptability
A	7.4	7.2	6.9	6.8	7.1
B	7.8	8.1	7.6	8.4	8.2
C	7.5	6.9	8.0	7.0	7.3

2. Results of Chemical analysis

The nutritional status of the developed sample was determined through the analysis of the main chemical

parameters like moisture content, ash, protein, fat, total carbohydrates, and dietary fiber. These tests yield important information on the overall quality and shelf life of the

product. Moisture content was 92.2%, determined by drying a sample at controlled temperature and determining the resulting weight loss. Protein content of 1.05 g/100 g was determined using the Kjeldahl technique, which quantifies nitrogen content and applies an assumed conversion factor. Protein analysis is crucial for determining the nutritional contribution of the product. Fat content was at 2.65 g/100 g. Fat is important to provide energy, add texture, and add to

mouthfeel. Total carbohydrate content was determined at 4.20 g/100 g, suggesting its use as a main energy source. Ash content, or the overall mineral content, was determined at 1.025% by burning the sample in a muffle furnace. This parameter plays an important role in the assessment of the micronutrient content. Finally, the dietary fiber was found to be 1.083 g/100 g, which demonstrates its role in enhancing digestive function and ensuring gut function.

Table 4: Chemical Analysis Results

Parameters	Final Product
Moisture Content (%)	92.2
Fat (g/100g)	2.65
Protein (g/100g)	1.05
Ash %	1.025
Carbohydrate (g/100g)	4.20
Fiber (g/100g)	1.083

3. Results of Microbial Analysis

Microbial testing was done to analyze the hygienic quality and safety of the formulated Jamun RTS drink. The sample was analyzed on Day 1 post-preparation for Total Plate Count (TPC), Yeast and Mold Count, and Coliform Test. The findings were within FSSAI established permissible limits for non-thermally processed fruit drinks.

Table 5: Micobial Analysis Results

Test	Result	FSSAI Permissible Limit	Inference
Total Plate Count (TPC)	2.4×10^3 CFU/ml	$\leq 1 \times 10^4$ CFU/ml	Within safe limits
Yeast and Mold Count	1.1×10^2 CFU/ml	$\leq 1 \times 10^3$ CFU/ml	Within safe limits
Coliforms (per 1 ml)	Not Detected	Absent	Satisfactory, no contamination

Findings are as follows:

All the microbial counts were less than the FSSAI acceptable limits for a drink (TPC $\leq 10^4$ CFU/ml; Yeast and Molds $\leq 10^2$ – 10^3 CFU/ml; Coliforms: Absent in 1 ml), thus ensuring the product was microbiologically safe during testing.

Low microbial load indicates that efficient hygienic procedures were adopted at raw material handling, processing, and bottling stages. The coliforms negativity also assures the sanitary status of the drink and efficiency of the packaging system.

Although these preliminary results assure the product's microbial safety in the fresh condition, additional testing for longer storage periods is advised to determine shelf-life stability under ambient and refrigeration conditions.

Conclusion

The current research was able to formulate and assess a functional, sugar-free Jamun Ready-to-Serve (RTS) drink with Nata de Coco and Vitamin B12 fortification. Formulation was designed to address diabetic and health-conscious consumers through the use of stevia as a natural sweetener, dietary fiber from Nata de Coco, and necessary micronutrient enrichment through Vitamin B12.

Of the three samples tried, Sample B with 10% Nata de Coco was the most acceptable based on sensory properties like flavor, mouthfeel, and general acceptability. Chemical analysis validated the nutritional quality of the product with significant contents of moisture, protein, fat, carbohydrates, and dietary fiber to make it nutritionally beneficial. Microbial analysis results indicated that the drink was

microbiologically safe when tested, as per FSSAI specifications for Total Plate Count, Yeast and Mold Count, and Coliform detection.

In toto, the Jamun RTS drink formulated in the current work has tremendous potential to act as a low-calorie, nutrient-fortified functional beverage, particularly apt for those handling blood sugar conditions or looking for vitamin-fortified beverages. Future research can emphasize shelf-life evaluation, large-scale consumer studies, and possible commercial viability of the formulation to determine its applicability in actual market conditions.

Disclaimer (Artificial Intelligence)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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