



Development, Optimization and Quality Evaluation of a Ready-to-Serve Beverage Incorporating Raw Mango (*Mangifera indica*) and Cluster Fig (*Ficus racemosa*)

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Abstract— This study aimed to develop and optimize a Ready-to-Serve (RTS) beverage from raw mango (*Mangifera indica*) and cluster fig (*Ficus racemosa*) pulp using jaggery as a natural sweetener. Five formulations (T_0 – T_4) were prepared by varying the proportions of raw mango pulp, cluster fig pulp, and jaggery, with T_0 serving as the control. The formulations were evaluated using a 9-point hedonic scale to determine sensory acceptability. Among the formulations, T_3 , containing 7 gm raw mango pulp, 7 gm cluster fig pulp, and 10 gm jaggery, recorded the highest overall acceptability score (8.15) and was selected as the optimized formulation. The optimized beverage contained 3.95 mg/100 mL vitamin C, 1.06–1.36 mg/100 ml iron, and 7.15–13.15 mg/100 ml calcium. The incorporation of cluster fig enhanced the nutritional potential of the beverage, while raw mango contributed desirable acidity and characteristic fruit flavour. The optimized RTS beverage demonstrated good sensory acceptability and potential as a value-added fruit-based beverage utilizing cluster fig.

Keywords— *Ficus Racemosa*, Formulation, Jaggery, *Mangifera Indica*, Ready-to-Serve beverage.

I. INTRODUCTION

Ready-to-serve (RTS) beverages are fruit-based drinks prepared for direct consumption without dilution. They provide convenience, refreshment and an opportunity to convert seasonal fruits into value-added products. RTS beverage development generally involves the selection of suitable fruit pulp, adjustment of sweetness and acidity, blending, pasteurization and hygienic packaging. Mango-based RTS beverages have been studied widely because mango pulp provides characteristic flavour, colour and nutritional components such as carbohydrates and vitamin C. Mango pulp contains approximately 36.4 mg Vitamin C per 100 g, although its composition varies according to variety, maturity and processing conditions.

Raw mango is an important seasonal fruit in India and is commonly used in traditional beverages, pickles, chutneys and preserves. It has a naturally sour taste and

characteristic aroma, making it suitable for beverage preparation. However, its high acidity requires balancing with a suitable sweetener. The use of raw mango in an RTS beverage can help improve its utilization, reduce seasonal wastage and provide a refreshing fruit-based product.

Cluster fig, botanically known as *Ficus racemosa* L., is an underutilized fruit that grows in several parts of India. It is also known by regional names such as udumbara and gular. The fruit contains carbohydrates, fibre, minerals and bioactive components, but it is not commonly incorporated into commercial beverage products. Reports on *Ficus racemosa* fruit indicate the presence of moisture, protein, carbohydrates, fibre, ash and vitamin C, demonstrating its potential for nutritional value addition.

Blending raw mango with cluster fig may produce a beverage with improved nutritional and sensory characteristics. Raw mango can contribute sourness, aroma and vitamin C, while cluster fig may contribute dietary fibre, minerals and a distinctive fruit character. Jaggery is used in the formulation as a natural sweetening ingredient. Unlike refined sugar, jaggery retains variable amounts of minerals such as iron and calcium; however, its nutrient composition depends on the quality and processing method of the jaggery.

In the present investigation, a raw mango–cluster fig RTS beverage was developed using raw mango pulp, cluster fig pulp, jaggery and water. Five formulations were prepared by varying the quantities of raw mango pulp, cluster fig pulp and jaggery. Among the treatments, T₃, containing 7 g raw mango pulp, 7 g cluster fig pulp and 10 g jaggery, was selected as the most acceptable formulation based on sensory evaluation using a nine-point hedonic scale.

The selected T₃ formulation was considered the final market sample for nutritional evaluation. The nutritional assessment included proximate components such as moisture, ash, protein, fat, crude fibre, carbohydrate and energy. Selected micronutrients, particularly vitamin C, iron and calcium, were also considered because they are nutritionally relevant to the fruit and jaggery ingredients. The nutritional values of the final product must be confirmed through laboratory analysis because processing, heating, dilution, raw-material variety and storage may influence nutrient retention.

Therefore, the present study was undertaken to develop a raw mango-cluster fig RTS beverage and to evaluate the nutritional composition of the selected T₃ formulation as a potential value-added fruit beverage.

II. MATERIALS AND METHODS

The present study was conducted in the Department of Food Plant Operation, Food Chemistry and Nutrition, and Food Microbiology at K. K. Wagh College of Food Technology, affiliated with Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri, Maharashtra, India. The research focused on the development and optimization of a Ready-to-Serve (RTS) beverage prepared from raw mango pulp and cluster fig pulp, with jaggery used as a natural sweetening agent. Different formulations were developed by varying the proportions of raw mango pulp, cluster fig pulp, and jaggery to determine the most acceptable formulation based on subsequent sensory and physicochemical evaluation. Fresh, mature raw mangoes and cluster figs were procured from the local market in

Nashik, Maharashtra, and selected based on freshness, maturity, freedom from visible damage, and suitability for pulp preparation. Jaggery of good quality was also procured from the local market and used as the natural sweetener. All raw materials were handled under hygienic conditions and were stored appropriately until further processing.

III. PROXIMATE ANALYSIS

Different chemical properties of samples were analysed for moisture content, ash, fat, protein and total carbohydrate. All the determinations were done in triplicate and the results were expressed as the average value.

3.1 Moisture content

Moisture content was determined adopting method as following:

$$\% \text{ Moisture Content} = \frac{\text{Loss in Weight}}{\text{Weight of sample}} \times 100$$

Fat

(AOAC, 2005 Method using Soxhlet apparatus was used to determine crude fat content of the sample. The percent of crude fat was expressed as follows:

$$\% \text{ Crude Fat} = \frac{\text{Weight of Dried ether soluble material}}{\text{Weight of Sample}} \times 100$$

Protein

Protein content was determined using (AOAC, 2005 method. Percentage of nitrogen and protein calculated by the following equation:

$$T_s - T_b \times \text{Normality of acid} \times 0.014$$

$$\% \text{ Nitrogen} = \frac{T_s - T_b \times \text{Normality of acid} \times 0.014}{\text{Weight of Sample}} \times 100$$

Where, T_s = Titre volume of the sample (ml), T_b = Titre volume of Blank (ml), 0.014 = M eq. of N₂.

$$\% \text{ Protein} = \text{Nitrogen} \times 6.25$$

3.2 Total carbohydrate

Total carbohydrate content of the samples was determined as total carbohydrate by difference, that is by subtracting the measured protein, fat, ash and moisture from 100 phenol sulphuric acid method as given by (AOAC, 2005).

3.3 Ash

Drying the sample at 1000 °C and churned over an electric heater. It was then ashes in muffle furnace at 5500 °C for 5 hrs.

It was calculated using the following formula:

$$\% \text{ Ash Content} = \frac{AW}{IW} \times 100$$

Where, AW = Weight of Ash and IW= Initial weight of dry matter

IV. MICRONUTRIENT ANALYSIS

The selected micronutrients, namely vitamin C, iron, and calcium, were determined using appropriate analytical methods. The results were expressed as approximate values per 100 mL of the developed RTS beverage.

4.1 Vitamin C

Vitamin C content was determined by the 2,6-dichlorophenol indophenol (DCPIP) titration method. The vitamin C content was calculated and expressed as mg ascorbic acid per 100 mL of sample.

$$\text{Vitamin C (mg/100 mL)} = V_s T \times F \times V \times 100$$

Where

T = Titre value of DCPIP (ml)

F = Dye factor (mg ascorbic acid equivalent to 1 mL DCPIP)

V = Total volume of extract (ml)

V = Volume of extract used for titration (ml)

The Vitamin C content was found to be approximately 3.95 mg/100 ml.

4.2 Iron

Iron content was determined using an appropriate validated analytical method such as Atomic Absorption

Spectroscopy (AAS), Inductively Coupled Plasma–Optical Emission Spectrometry (ICP-OES), or a validated colorimetric method. The iron concentration was

determined against suitable iron standards and expressed as mg per 100 mL of sample.

The iron content was found to be approximately **1.06–1.36 mg/100 m**.

4.3 Calcium

Calcium content was determined using an appropriate validated analytical method such as Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma–Optical Emission Spectrometry (ICP-OES), or EDTA complexometric titration. The calcium concentration was calculated from the analytical determination and expressed as mg per 100 mL of sample.

The calcium content was found to be approximately 7.15–13.15 mg/100 ml.

V. METHODOLOGY

Five formulations of the raw mango–cluster fig Ready-to-Serve (RTS) beverage were developed for standardization, comprising a control (T_0) prepared using raw mango pulp without cluster fig pulp and four treatment formulations (T_1 – T_4) containing varying proportions of raw mango pulp, cluster fig pulp, and jaggery. The formulations were prepared using a trial-based standardization approach. The control served as the reference formulation, while the treatment formulations were developed by partially replacing raw mango pulp with cluster fig pulp and varying the level of jaggery. The developed formulations were evaluated for their colour, appearance, aroma, taste, flavour, mouthfeel, consistency, and overall sensory acceptability. Based on the sensory characteristics and overall acceptability of the developed RTS formulations, the most acceptable formulation was selected as the optimized treatment for further physicochemical, nutritional, and other quality evaluations.

Table 1: Recipe Standardization for RTS

Treatment	Colour and appearance	Aroma	Taste	Flavor	Mouthfeel	Aftertaste	Overall acceptability
T_0	6.80	6.60	6.50	6.60	6.70	6.40	6.60
T_1	7.10	7.00	7.20	7.10	6.90	6.90	7.03
T_2	7.30	7.20	7.40	7.30	7.20	7.10	7.24
T_3	8.20	8.10	8.30	8.20	8.00	8.10	8.15
T_4	7.00	6.80	6.70	6.80	6.50	6.60	6.73

Where, T_0 : Control

T_1 , T_2 , T_3 and T_4 : Trials

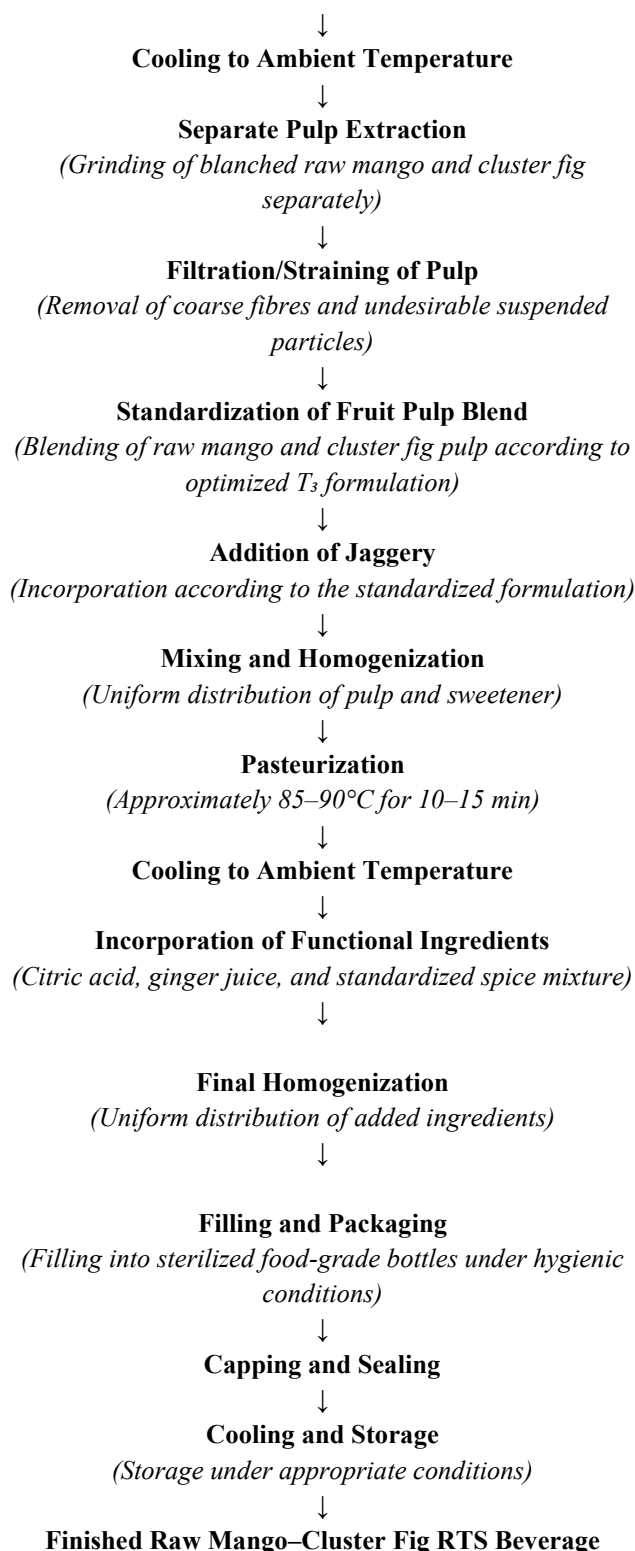
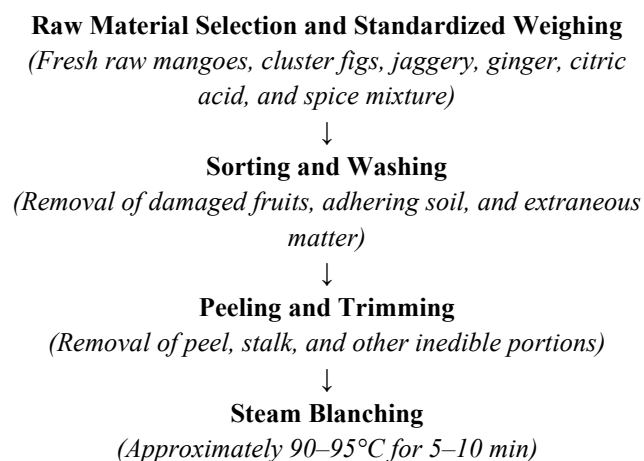
VI. PREPARATION METHOD

The raw mango–cluster fig Ready-to-Serve (RTS) beverage was prepared following a standardized fruit

beverage processing method. Fresh raw mangoes and cluster figs were selected based on their freshness, maturity, freedom from physical damage, and suitability

for pulp extraction. The selected fruits were thoroughly washed under potable running water to remove adhering dirt and extraneous matter. The fruits were then peeled and trimmed to remove the peel, stalk, and other inedible portions. The prepared raw mangoes and cluster figs were subjected separately to **steam blanching at approximately 90–95°C for 5–10 min** to soften the tissues, facilitate pulp extraction, and reduce enzymatic activity. Following blanching, the fruits were allowed to cool to ambient temperature. The blanched raw mangoes and cluster figs were then ground separately using a mixer grinder to obtain individual fruit pulps. The pulps were passed through a suitable strainer to remove coarse fibres, seeds, and other undesirable particulate matter and to obtain a smooth and uniform pulp. The filtered raw mango and cluster fig pulps were blended in the proportion corresponding to the optimized **T₃ formulation**. Jaggery was then incorporated according to the standardized formulation and thoroughly mixed to ensure uniform distribution and dissolution. The prepared beverage mixture was subjected to **thermal pasteurization at approximately 85–90°C for 10–15 min** under controlled heating conditions to improve microbiological safety and enhance product stability. After pasteurization, the beverage was allowed to cool to a suitable temperature. **Citric acid, ginger juice, and the standardized spice mixture** were subsequently incorporated and thoroughly homogenized to ensure uniform distribution of the ingredients throughout the beverage. The finalized RTS beverage was then filled into clean and sterilized **food-grade bottles**, followed by immediate capping and sealing under hygienic conditions. The packaged beverage was cooled to ambient temperature and stored under appropriate conditions for subsequent **sensory, physicochemical, proximate, micronutrient, microbiological, and shelf-life evaluation**.

VII. FLOW CHART



VIII. RESULTS AND DISCUSSION

8.1 Sensory Evaluation

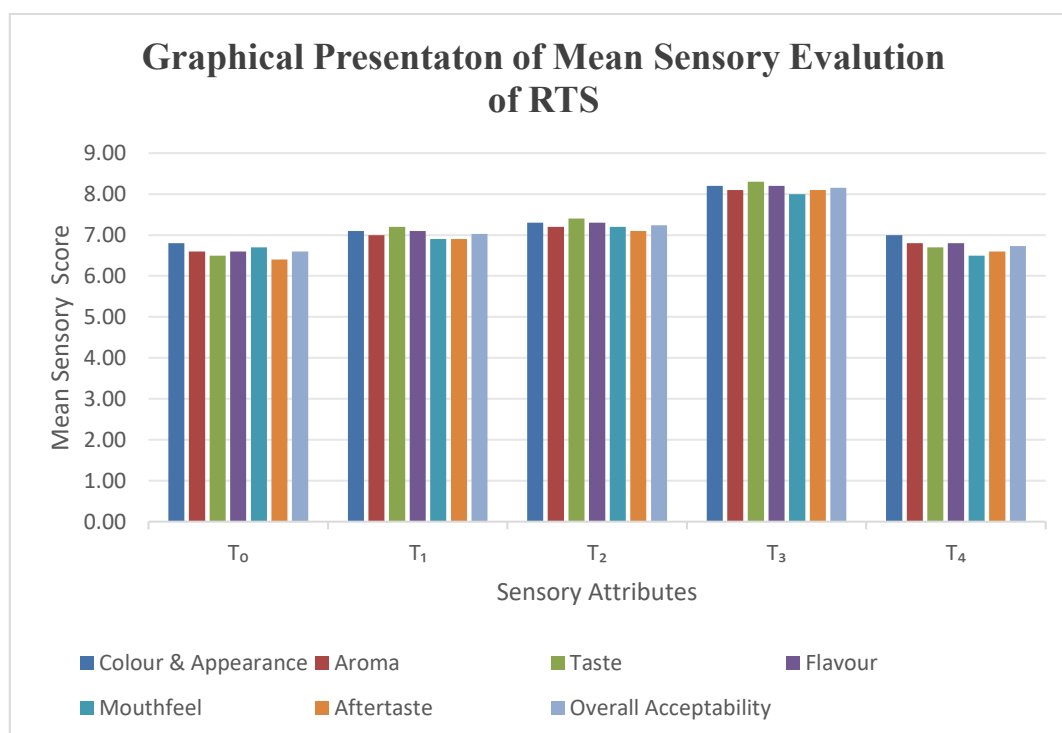
Sensory evaluation using a nine-point hedonic scale indicated that T₃ received the highest overall sensory scores among the developed formulations. The optimized formulation exhibited a desirable balance of colour,

appearance, aroma, taste, flavour, mouthfeel, consistency, and overall acceptability. The combination of raw mango and cluster fig pulp contributed to a characteristic fruity flavour and appealing colour, while jaggery provided desirable sweetness and complemented the natural acidity of raw mango. The incorporation of ginger juice, citric

acid, and the standardized spice mixture further enhanced the flavour profile and overall palatability of the RTS beverage. Based on its superior sensory characteristics and overall acceptability, T₃ was selected as the optimized formulation for further physicochemical, nutritional, microbiological, and storage evaluation.

Table 2: Mean Sensory Scores of RTS (9-Point Hedonic Scale)

Ingredients	T ₀	T ₁	T ₂	T ₃	T ₄
Raw Mango Pulp	15 gm	12 gm	10 gm	7 gm	7 gm
Cluster Fig Pulp	0 gm	5 gm	5 gm	7 gm	10 gm
Jaggery	20 gm	20 gm	15 gm	10 gm	10 gm



Graph 1: Graphical Representation of Sensory evaluation chart

8.2 Chemical and Nutritional Analysis

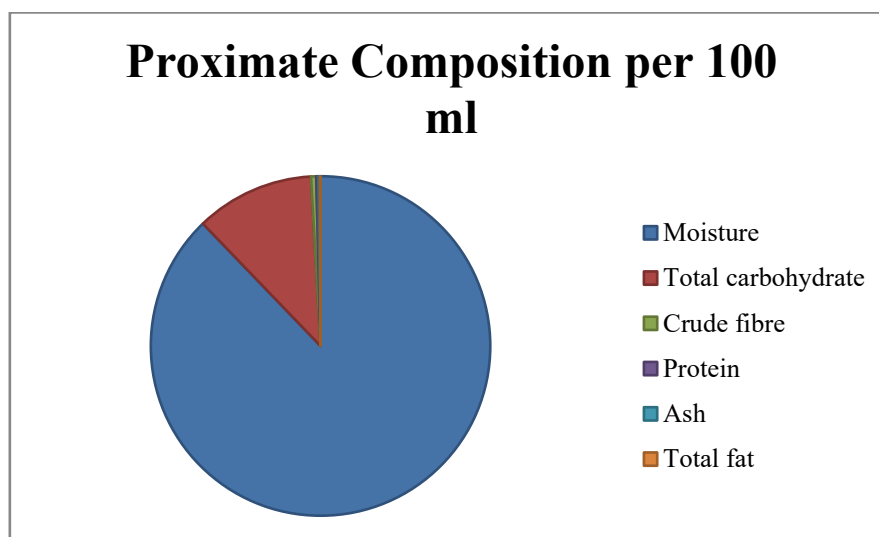
The optimized raw mango–cluster fig RTS beverage was subjected to proximate and micronutrient analysis to assess its nutritional composition. The analysis included moisture, protein, total fat, crude fibre, total carbohydrate, total sugars, ash, vitamin C, iron, and calcium. The beverage contained 46.5 kcal energy, 87.79 gm moisture, 11.29 gm carbohydrate, 10.62 gm total sugars, 0.19 gm protein, 0.06 gm fat, 0.49 gm crude fibre, and 0.16 gm ash per 100 mL. The micronutrient profile showed approximately 3.95 mg vitamin C, 1.06–1.36 mg iron, and 7.15–13.15 mg calcium per 100 ml, indicating the nutritional contribution of the developed fruit-based RTS beverage.

Table 3: Tabular Representation of Proximate Analysis

Nutrient	Approximate value per 100 ml
Energy	46.5 kcal
Moisture	87.79 g
Protein	0.19 g
Total fat	0.06 g
Crude fibre	0.49 g
Total carbohydrate	11.29 g
Total sugars	10.62 g
Ash	0.16 g

Table 4: Tabular Representation of Micronutrient Analysis

Micronutrient	Approximate value per 100 ml	Suggested method
Vitamin C	3.95 mg	DCPIP titration
Iron	1.06–1.36 mg	AAS, ICP-OES or validated colorimetric method
Calcium	7.15–13.15 mg	AAS, ICP-OES or EDTA titration



Graph 2: Graphical Representation of Chemical Analysis

8.3 Microbial Analysis

8.3.1 Total Plate Count (TPC)

The total plate count (TPC) of RTS was evaluated at regular intervals during storage to monitor the changes in microbial load. The results are presented in Table X. The initial TPC recorded on the 3rd day of storage was $5.0\text{--}7.0 \times 10^3$ CFU/g. The microbial count gradually increased with the advancement of storage period, reaching 1.5×10^4 CFU/g on the 6th day and $2.5\text{--}2.6 \times 10^4$ CFU/g on the 9th day. Further increase in TPC was observed on the 12th day ($3.4\text{--}3.5 \times 10^4$ CFU/g) and 15th day (4.5×10^4 CFU/g).

The TPC continued to increase up to the 18th day, reaching a maximum value of 6.0×10^4 CFU/g. Thereafter, a slight reduction in microbial count was observed, with values of 5.9×10^4 CFU/g and 5.8×10^4 CFU/g on the 21st and 24th days, respectively. Overall, the results showed a progressive increase in microbial load during the initial storage period, followed by a slight decline towards the end of the storage study.

Table 4: Assessment of Microbial Stability of RTS During Storage

Storage period (days)	Adjusted colony count	Dilution	Calculated TPC (CFU/g)
3	50–70	10^{-2}	$5.0\text{--}7.0 \times 10^3$
6	150	10^{-2}	1.5×10^4
9	250–260	10^{-2}	$2.5\text{--}2.6 \times 10^4$
12	340–350	10^{-2}	$3.4\text{--}3.5 \times 10^4$
15	450	10^{-2}	4.5×10^4
18	600	10^{-2}	6.0×10^4
21	590	10^{-2}	5.9×10^4
24	580	10^{-2}	5.8×10^4

IX. CONCLUSION

The present study successfully developed and optimized a Ready-to-Serve (RTS) beverage using raw mango (*Mangifera indica*) and cluster fig (*Ficus racemosa*) pulp, with jaggery as a natural sweetening agent. Among the five formulations evaluated ($T_0\text{--}T_4$), treatment T_3 (7 g raw mango pulp, 7 g cluster fig pulp, and 10 g jaggery)

recorded the highest sensory acceptability score (8.15/9) and was selected as the optimized formulation.

Proximate analysis of the optimized beverage revealed an energy value of 46.5 kcal, along with 11.29 g carbohydrate, 0.19 g protein, 0.06 g fat, 0.49 g crude fibre, and 0.16 g ash per 100 ml. The micronutrient profile indicated the presence of vitamin C (3.95 mg/100 ml), iron (1.06–1.36 mg/100 ml), and calcium (7.15–13.15 mg/100 ml), confirming that incorporation of cluster fig pulp meaningfully enhanced the nutritional density of the beverage compared to a mango-only formulation, while raw mango contributed characteristic acidity, aroma, and flavour.

Microbial analysis showed that the total plate count remained within acceptable limits during the initial storage period, with a gradual increase up to the 18th day followed by a slight decline, indicating the need for further optimization of pasteurization parameters and packaging conditions to extend shelf life.

Overall, the study demonstrates that cluster fig, an underutilized fruit, can be successfully valorised in combination with raw mango to develop a nutritionally enriched, sensorially acceptable, and cost-effective RTS beverage using jaggery as a natural sweetener. This approach supports diversification of fruit-based beverages, reduction of seasonal fruit wastage, and utilization of an underexploited indigenous fruit resource. Further studies on shelf-life extension, packaging optimization, and consumer acceptability at a larger scale are recommended before commercial-scale production.

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