Standardization and Development of Probiotic Mixed Fruit Jelly Candy Incorporating Wood Apple and Pineapple with Natural Sweeteners

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ABSTRACT

The present study aimed to develop a value-added mixed fruit jelly candy by standardizing a juice combination of wood apple (*Limonia acidissima*) and pineapple (*Ananas comosus*), and incorporating natural sweeteners for enhanced nutritional benefits. Four juice combinations (Control, WAPJ-1, WAPJ-2, WAPJ-3) were prepared by varying the ratios of wood apple and pineapple pulp. Sensory evaluation indicated that WAPJ-1 (80:20) achieved the highest overall acceptability (8.60), making it the selected formulation for jelly candy preparation. Subsequently, four jelly candy formulations (Control, MFJC-1, MFJC-2, MFJC-3) were developed by varying sugar and jaggery levels. The incorporation of jaggery improved the nutritional profile by replacing refined sugar and introducing functional health properties. Among all formulations, MFJC-1 (50% sugar + 50% jaggery) recorded the highest sensory score (8.60) with superior appearance, texture, taste, and aroma. The study demonstrates that mixed fruit jelly candy prepared with optimal blending of wood apple, pineapple, and natural sweeteners can deliver both superior sensory qualities and enhanced nutritional value, offering a healthier confectionery alternative.

Keywords

Wood apple, pineapple, mixed fruit jelly candy, standardization, jaggery, sensory evaluation, natural sweeteners, product development.

INTRODUCTION

The confectionery industry has witnessed significant innovation in recent years with growing consumer demand for healthier, functional, and value-added products. Among various confectionery types, jelly candies occupy a prominent position due to their appealing texture, vibrant appearance, and ease of consumption across all age groups. Traditionally, jelly candies are formulated using gelling agents like gelatin or agar-agar, combined with sweeteners, colorants, and flavoring agents to achieve desirable sensory attributes (Pobar, 2015). However, with rising health consciousness, there is a growing emphasis on incorporating nutritionally rich and medicinally beneficial ingredients into these products.

Fruits offer a natural and functional alternative to artificial additives, providing essential nutrients, dietary fiber, phytochemicals, and bioactive compounds. In this context, wood apple (Limonia acidissima) and pineapple (Ananas comosus) emerge as promising candidates for the development of value-added jelly products. Many Indian plants with tremendous medicinal value against various human ailments are still underutilized among which wood apple is one such edible fruit plant. The leaves, bark, roots, fruits and seeds are used extensively in Ayurvedic medicine for the treatment of chronic diarrhea, dysentery and peptic ulcers, as a laxative and to treat myriad ailments. Extensive scientific studies have also validated its ethno medicinal properties and presence of a variety of bioactive compounds which possess antihyperglycemic, antidiabetic, anticancer, antimicrobial, hepatoprotective and various other such activities. This review majorly provides information about the nutritional values, phytochemistry, traditional and modern pharmacological aspects of largely underutilized and neglected wood apple (Thakur et al. 2020). On the other hand, pineapple is widely consumed globally for its refreshing flavor and its content of bromelain enzyme, vitamin C, antioxidants, and anti-inflammatory properties (Bartolomé et al., 1995; Joy, 2010).

The primary sweetening agents used in many processed sweet products are sugar and jaggery. While refined sugar remains widely used for its sweetness and preservative properties, its long-term consumption has been associated with serious health issues such as Type II diabetes, obesity, and cardiovascular diseases, leading many consumers to reduce or avoid sugar-based products (Doddanavar, 2018). In contrast, jaggery, an unrefined natural sweetener, is a more complex carbohydrate source that releases energy slowly and steadily, thus helping to maintain stable blood sugar levels (Dubey et al., 2022). Known as "medicinal sugar," jaggery not only serves as a sweetener but also offers multiple

health benefits, including improved digestion, liver detoxification, relief from constipation, enhanced energy, blood purification, anti-toxic and anti-carcinogenic properties, stress reduction, and support in managing bronchial infections and pre-menstrual syndrome.

The process of recipe standardization is critical in developing an optimized formulation that balances the nutritional, sensory, and functional properties of the final product. Standardization ensures product consistency, consumer acceptability, and commercial viability. Hence, the present study was undertaken to develop and standardize a mixed fruit jelly candy formulation by blending wood apple and pineapple pulp with varying ratios, utilizing agar-agar as a vegetarian gelling agent and jaggery as a natural sweetener. The standardized recipe aims to achieve superior sensory attributes while delivering added nutritional and functional benefits.

2. MATERIALS AND METHODS

2.1 Raw Materials

Fully ripened wood apple (*Limonia acidissima*) and pineapple (*Ananas comosus*) fruits were procured from local markets in Parbhani, Maharashtra, India. Commercial-grade sugar, jaggery, and agar-agar powder were also purchased from local suppliers. All chemicals used in the analysis were of analytical grade.

2.2 Preparation of Fruit Pulp

The wood apples were broken manually, and the pulp was separated from the seeds and shell. The pulp was passed through a stainless-steel sieve to obtain a uniform puree. Similarly, the pineapple was peeled, cored, and pulped using a mixer grinder. Both fruit pulps were stored at 4°C until further use to preserve freshness.

2.3 Standardization of Juice Combination

Four different juice combinations were prepared by blending wood apple and pineapple pulp in varying ratios while keeping the total quantity of fruit pulp constant. The formulations included Control

(100:0), WAPJ-1 (80:20), WAPJ-2 (60:40), and WAPJ-3 (40:60). These blends were then subjected to sensory evaluation in order to determine the most acceptable ratio for further jelly candy preparation.

2.4 Encapsulation of probiotic organisms

Microencapsulation of probiotic bacteria was performed by extrusion technique. The hydrocolloid coating material was prepared by using a combination of sodium alginate and guar gum at 1 and 0.8% (w/v) respectively. For probiotification of 100 ml sweet orange juice, 10 ml of inoculum (5 ml each of L. bulgaricus and L. plantarum) was mixed in 20 ml of polymer solution. Probiotic cultures and polymer solution were mixed properly and passed through a syringe in the form of droplets into 0.3M calcium chloride solution. Interaction between the two solutions led to formation of beads (2-5mm) and the resulting beads were then stored in 0.1% peptone solution at 4°C (Poshadri and Aparna, 2010).

2.5 Preparation of Probiotic Mixed Fruit Jelly Candy

Based on juice standardization results, WAPJ-1 (80:20) was selected for jelly candy development. Four formulations of jelly candy (Control, MFJC-1, MFJC-2, MFJC-3) were prepared by varying sugar and jaggery levels as shown in Table 3. For each formulation, agar-agar powder (10 g) was dissolved in 100 ml of distilled water and heated until fully dissolved. Separately, the blended fruit pulp (100 g total: 80 g wood apple + 20 g pineapple) was mixed with the required amounts of sugar and jaggery as per formulation. The agar-agar solution was gradually incorporated into the pulp mixture under continuous stirring. The entire mixture was heated to 80–85°C with constant stirring until a uniform gel-like consistency was achieved. The hot mixture was then poured into pre-sterilized silicone molds and allowed to set at room up to 45ºC and beads added then allow to set in temperature (25±2°C) for 4–6 hours. After complete setting, the jelly candies were demolded and packed in airtight polyethylene bags for further evaluation.

Table 3: Formulation of Mixed Fruit Jelly Candy

Sl. No.	Ingredient (g)	Control	MFJC-1	MFJC-2	MFJC-3

1	Wood apple	100	80	80	80
2	Pineapple	0	20	20	20
3	Sugar	100	50	25	0
4	Jaggery	0	50	75	100
5	Agar-agar	10	10	10	10
6	Probiotic beads	0	10%	10%	10%

2.6 Sensory Evaluation

Sensory evaluation of both juice combinations and jelly candies was conducted using a 9-point Hedonic scale, where 9 indicated "like extremely" and 1 indicated "dislike extremely." Six sensory attributes — appearance, texture, color, aroma, taste, and overall acceptability — were evaluated. A semi-trained panel of 10 members participated in the evaluation. The coded samples were presented in randomized order to eliminate bias. All sensory evaluations were carried out under controlled laboratory conditions. The collected data were subjected to statistical analysis using Completely Randomized Design (CRD) and analyzed for significance at $p < 0.05$ level.

3. RESULTS AND DISCUSSION

3.1 Standardization of Mixed Fruit Juice Combination

The initial phase of the study involved blending wood apple and pineapple pulp in different ratios to standardize the juice combination for jelly candy preparation. The formulations included Control (100% wood apple), WAPJ-1 (80:20), WAPJ-2 (60:40), and WAPJ-3 (40:60), as presented in Table 1.

Table 1: Formulation of Juice Combination (Wood Apple and Pineapple Pulp)

Sl. No.	Ingredient (g)	Control	WAPJ-1	WAPJ-2	WAPJ-3
1	Wood apple	100	80	60	40
2	Pineapple	0	20	40	60

As pineapple content increased, improvements in visual appeal, aroma, and color were observed due to pineapple's bright yellow hue and characteristic fruity aroma. However, higher pineapple proportions (WAPJ-2 and WAPJ-3) resulted in excessive acidity and reduction in the natural astringency and fiber mouthfeel contributed by wood apple.

The sensory evaluation results for juice combinations (Table 2) indicated that WAPJ-1 (80% wood apple: 20% pineapple) recorded the highest overall acceptability score (8.60), followed by the control (7.55), while WAPJ-3 scored the lowest (7.09). Therefore, WAPJ-1 was selected as the optimum juice combination for jelly candy preparation.

Table 2: Sensory Evaluation of Juice Combination (9-Point Hedonic Scale)

Treatment	Appearance	Texture	Colour	Aroma	Taste	Overall Acceptability
Control	8.00	7.65	7.70	7.30	7.75	7.55
WAPJ-1	8.74	8.44	8.42	8.15	8.20	8.60
WAPJ-2	7.75	7.25	7.50	7.30	7.43	7.19
WAPJ-3	7.53	7.39	7.25	7.20	7.30	7.09
WAPJ-4	8.20	7.85	8.10	7.75	7.90	8.00
SEm±	0.17	0.17	0.17	0.17	0.18	0.18
CD at 5%	0.47	0.42	0.48	0.48	0.50	0.50

3.2 Formulation and Standardization of Jelly Candy

Following juice standardization, four jelly candy formulations (Control, MFJC-1, MFJC-2, and MFJC-3) were developed using the selected juice ratio (WAPJ-1) while varying sugar and jaggery concentrations, as shown in Table 3.

In MFJC-1, sugar and jaggery were incorporated equally (50 g each), while in MFJC-2 and MFJC-3, sugar levels were gradually decreased and replaced with increasing amounts of jaggery (75 g and 100 g respectively). Agar-agar was maintained constant at 10 g across all treatments.

The rationale behind replacing sugar with jaggery was to improve nutritional value, reduce the adverse health effects of refined sugar, and utilize jaggery's functional properties like antioxidant, anti-inflammatory, hepatoprotective, and anti-carcinogenic effects (Doddanavar, 2018; Dubey et al., 2022).

3.3 Sensory Evaluation of Jelly Candy

The sensory scores for the developed jelly candy samples are presented in Table 4. MFJC-1 achieved the highest overall acceptability score (8.70), superior to the control (7.55) and significantly better than MFJC-2 (8.20) and MFJC-3 (7.85).

Table 4: Sensory Evaluation of Jelly Candy (9-Point Hedonic Scale)

Treatment	Appearance	Texture	Colour	Aroma	Taste	Overall Acceptability
Control	8.00	7.65	7.70	7.30	7.75	7.55
MFJC-1	**8.85**	**8.60**	**8.65**	**8.35**	**8.55**	**8.70**
MFJC-2	8.30	8.15	8.10	7.95	8.05	8.20
MFJC-3	7.95	7.80	7.85	7.60	7.90	7.85
SE±	0.12	0.10	0.11	0.14	0.13	0.09
CD at 5%	0.36	0.30	0.32	0.42	0.39	0.28

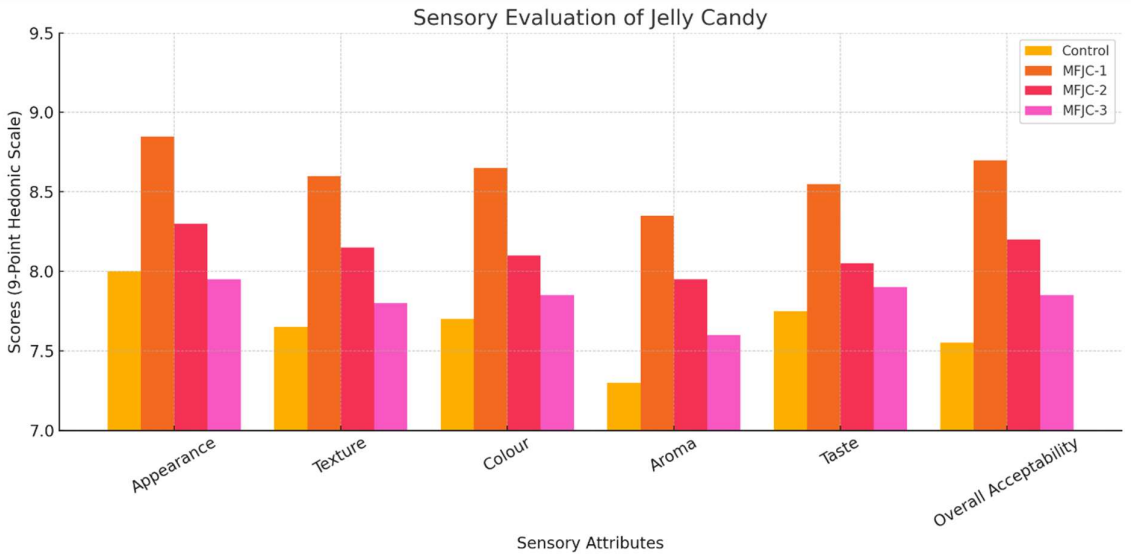

Figure 1: Sensory Evaluation of Probiotic Jelly Candy

MFJC-1 was most preferred due to its balanced sweetness, improved color, smooth texture, and pleasant aroma resulting from optimal blending of wood apple, pineapple, sugar, and jaggery. As jaggery concentration increased in MFJC-2 and MFJC-3, panelists reported slight bitterness, darker color, and changes in mouthfeel, which negatively affected overall acceptability.

The statistical analysis revealed that differences among treatments were significant at $p < 0.05$ for all sensory attributes, as indicated by the calculated critical difference (CD) values.

These findings are supported by earlier studies (Periche et al., 2016; Achumi et al., 2018) which demonstrated that controlled blending of fruit pulps and sweeteners improves both nutritional and sensory qualities in jelly products.

3.4 Overall Product Optimization

Based on comprehensive sensory evaluation and formulation balance, MFJC-1 was finalized as the optimum formulation for mixed fruit jelly candy incorporating 80% wood apple, 20% pineapple, 50 g sugar, 50 g jaggery, and 10 g agar-agar. This product successfully combined functional nutritional benefits with high consumer acceptability, offering a healthier alternative to conventional sugar-based candies.

CONCLUSION

The present investigation successfully standardized a mixed fruit jelly candy formulation incorporating wood apple and pineapple pulp with natural sweeteners. The juice combination WAJ-1 (80:20) was found to be most acceptable for jelly candy development. Replacement of refined sugar with jaggery improved both sensory and nutritional properties. The MFJC-1 formulation, containing equal proportions of sugar and jaggery, achieved the highest overall acceptability score (8.60), indicating superior consumer preference. This study demonstrates the potential of utilizing underutilized fruits like wood apple and traditional sweeteners like jaggery for developing functional confectionery products with enhanced health benefits. Such value-added products can serve as attractive, nutritious alternatives to conventional sugar-based jelly candies and hold promise for commercial scale production.

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