



Development of Nutrient-Fortified Melon Jelly Bites with Enhanced Hydration Properties

A Reddy Shalini*¹, Dr. A. Swaroopa Rani¹, D Jagadeesh²

¹*Student, Department of food technology, Oil Technological & pharmaceutical Research Institute, J.N.T University, Ananthapuramu-515001, Andhra Pradesh, India.

¹Professor of Food Technology Department, Oil Technological & Pharmaceutical Research Institute, J.N.T University, Ananthapuramu-515001, Andhra Pradesh, India.

²HOD (QA & QC), Mayora India Pvt Ltd, Hyderabad, Telangana-500014, India.

*Corresponding author email: shaliniluthar1106@gmail.com

Abstract:

The research project developed operational watermelon jelly through the use of ginger extract and basil seeds as its main ingredients. Watermelon serves as a refreshing base due to its high water content, while ginger provides digestive benefits and serves as an antioxidant. The product includes basil seeds to provide dietary fiber and natural cooling properties, which enable consumption during hot weather. The formulation combines attractive taste with additional health advantages. The jelly was prepared using appropriate gelling agents and optimized levels of sweeteners to achieve desirable texture and stability. The researchers controlled main parameters through pH testing and total soluble solids measurement and moisture content assessment to achieve successful gel formation. The sensory evaluation results showed high acceptability for the product's flavor and texture and visual appearance. The developed product demonstrates potential as a value-added functional jelly that meets the growing demand for innovative, health-oriented foods.

Keywords: Watermelon jelly, Functional food, Ginger extract, Basil seeds (sabja), Hydration, Dietary fiber, Gelling agents, Value-added product.

1. INTRODUCTION:

Jelly is a semi-solid food product derived by cooking and processing fruit juice along with sweeteners and gelling agents, and it is widely accepted due to its pleasant flavor and mouthfeel (Brijdukovaa et al., 2023). In recent years, functional foods have gained global demand as consumers seek benefits beyond basic nutrition (Desai & Park, 2023). Watermelon is considered a suitable raw material for jelly preparation due to its high water content, refreshing flavor, and nutritional components such as vitamins and antioxidants, particularly lycopene (Krajewska et al., 2025). Sabja seeds contribute additional dietary fiber and possess cooling properties, while ginger extract enhances digestion and acts as an anti-inflammatory agent (Verma et al., 2024). Fructooligosaccharides (FOS) serve as a prebiotic sweetener beneficial for gut health (Guo et al., 2023), and pectin is added to achieve the desired gel consistency (Farzalieva & Ökten, 2025). Potassium sorbate is used as a preservative to extend shelf life. Therefore, this study focuses on the development of watermelon jelly with enhanced nutritional value and improved sensory characteristics.

2. MATERIALS:

Fresh watermelon fruits were procured from the local market. Sabja seeds (basil seeds), food-grade pectin powder, fructooligosaccharides (FOS), sugar, ginger, citric acid, and potassium sorbate were used to prepare the jelly. All chemicals and reagents used for analysis were of analytical grade.



Water melon juice



Ginger Extract



Sugar



Soaked Basil seeds



Fig 1 – Materials

3. METHODOLOGY:

Preparation of Watermelon Juice:

Watermelon fruits were washed thoroughly, and cut into small pieces. The pulp was extracted using a blender and filtered through a muslin cloth to obtain clear juice. The extracted juice was used immediately for jelly preparation.

Preparation of jelly:

The preparation of watermelon jelly begins with the selection of fresh raw materials, followed by thorough washing and cleaning to remove impurities. The watermelon is then cut and subjected to juice extraction, after which the juice is filtered to obtain a clear liquid. Ginger extract is prepared separately, and basil seeds (sabja) are soaked until fully hydrated. All ingredients, including sugar or fructooligosaccharides (FOS), gelling agent (pectin), and acid, are accurately weighed. The filtered watermelon juice is then heated, and the gelling agent is added along with sugar. The mixture is cooked until the desired °Brix level is achieved. Once the required consistency is reached, the heating process is stopped, and citric acid is added to adjust the pH. Subsequently, ginger extract and soaked basil seeds are incorporated into the mixture and mixed thoroughly. The final product is then poured into molds and allowed to cool for proper setting. After cooling, the jelly is packaged and stored under suitable conditions. Finally, the product undergoes storage and evaluation based on physicochemical and sensory characteristics (Krajewska et al., 2025).

Fig-2 Final product- jelly



FORMULATION OF JELLY:

Ingredients(g)	Trial 1	Trial 2	Trial 3	Trail 4
Watermelon Juice	60	60	60	60
Sugar	28	10	23	20
FOS (Fructooligosaccharides)	5	20	8	10
Pectin Powder	0.6	0.8	0.7	0.9
Sabja Seeds	3	3	3	3
Ginger Extract	3	6	5	5
Citric Acid	1	1	1	1
Potassium Sorbate	0.05	0.05	0.05	0.05

Table 1**PHYSICO-CHEMICAL ANALYSIS:**

Developed jelly samples were analyzed to determine their physicochemical properties, including moisture content, ash content, pH, reducing sugars, and titratable acidity, using standard analytical methods (Israfi et al., 2025; Rao et al., 2023).

• MOISTURE CONTENT:

Moisture content of the sample was determined by the hot air oven method, which is based on the principle of weight loss upon drying. A known quantity of the sample was accurately weighed in a clean, dry, and pre-weighed moisture dish. The sample was then placed in a hot air oven maintained at $105 \pm 2^\circ\text{C}$ and dried for a specified period, usually until a constant weight was obtained. After drying, the dish was transferred to a desiccator to cool to room temperature and then reweighed. The loss in weight represented the moisture content present in the sample. The moisture percentage was calculated using the difference between the initial and final weights and expressed as grams per 100 grams of the sample. This method is widely used due to its simplicity, reliability, and suitability for determining moisture content in food products such as jelly. (Rao et al., 2023).

$$\text{Moisture (\%)} = ((W_2 - W_3) \div (W_2 - W_1)) \times 100$$

Where:

W1= Weight of empty dish

W2= Weight of dish + sample before drying

W3 = Weight of dish + sample after drying

• pH VALUE:

The pH of the sample was determined using a digital pH meter based on the principle of electrometric measurement. Initially, the pH meter was calibrated using standard buffer solutions of known pH (commonly pH 4.0, 7.0, and 9.2) to ensure accuracy. A small quantity of the sample was prepared, and if necessary, diluted with distilled water to obtain a uniform solution. The electrode of the pH meter was then immersed into the sample, ensuring proper contact without trapping air bubbles. The reading was allowed to stabilize, and the pH value was recorded directly from the display. After each measurement, the electrode was rinsed with distilled water to avoid contamination. This method provides a rapid and accurate determination of the acidity or alkalinity of the sample. (Israfi et al., 2025; Rao et al., 2023).

• REDUCING SUGARS:

The reducing sugar content of the sample was determined by the Lane and Eynon method, which is based on the reduction of Fehling's solution by reducing sugars present in the sample. In this method, a known volume of Fehling's solution (mixture of Fehling's A and Fehling's B) was taken and heated to boiling. (Israfi et al., 2025; Rao et al., 2023). The sample solution was prepared by appropriate dilution and added from a burette to the boiling Fehling's solution until the blue color of copper ions was reduced to a brick-red precipitate of cuprous oxide, indicating the endpoint. To improve accuracy, an internal indicator such as methylene blue was used, which loses its color at the endpoint. The volume of sample required for complete reduction was noted, and the reducing sugar content was calculated using standard tables or factors. This method is widely used for estimating reducing sugars in food products like jelly due to its simplicity and reliability.

$$\text{Reducing Sugar(\%)} = \text{Factor} \times \text{dilution} \times 100 \div (\text{titrate value}) \times 100$$

Where:

Factor = Amount of sugar (in grams) required to completely reduce the Fehling's solution (obtained from standardization)

Dilution = Total volume to which the sample solution is made

Titre Value = Volume of sample solution used during titration (mL)

Weight of Sample = Weight of the sample taken (g)

• ASH CONTENT:

The ash content of the sample was determined using a muffle furnace method, which is based on the principle of complete oxidation of organic matter, leaving behind inorganic mineral residues. A clean, dry, and pre-weighed crucible was taken, and a known quantity of the sample was accurately weighed into it. The sample was first charred gently over a low flame or hot plate to avoid losses due to spattering. The crucible was then placed in a muffle furnace maintained at $550 \pm 25^\circ\text{C}$ and incinerated for several hours until a light gray or white ash was obtained, indicating complete combustion of organic matter. After ashing, the crucible was carefully removed and cooled in a desiccator to room temperature, and then weighed. The difference in weight was used to calculate the total ash content, which represents the mineral content of the sample. This method is widely used for determining total ash in food products such as jelly. (Israfi et al., 2025; Zhao et al., 2024).

$$\text{Ash (\%)} = (W_2 - W_1/W) \times 100$$

Where:

W1= Weight of empty dish

W2 = Weight of crucible + ash

W= Weight of sample taken (g)

• MICROBIAL ANALYSIS:

The microbial safety of the developed jelly samples was assessed to ensure that the product remained safe and stable during storage without significant loss of quality. Microbiological analysis included the determination of Total Plate Count (TPC), coliform count, as well as yeast and mold counts using standard microbiological p(Rao et al., 2023; Feng et al., 2023). These analyses helped evaluate the hygienic quality and shelf stability of the jelly samples during storage.

Total Plate Count (TPC):

Total viable bacterial load was determined using the standard plate count method. One gram of the sample was aseptically homogenized in 9 mL of sterile diluent to obtain a 10^{-1} dilution, followed by serial dilutions

up to 10^{-5} . One milliliter of the selected dilution was poured into sterile Petri plates, and molten Plate Count Agar (PCA) was added. After solidification, plates were incubated at 37°C for 24–48 hours, and colonies were counted. Only plates containing 30–300 colonies were considered for enumeration. The TPC method is widely used for assessing microbial load in food products and provides an estimate of viable aerobic microorganisms (Ilham et al., 2025; Tamiru et al., 2024).

CFU/g = Number of Colonies × Dilution Factor ÷ Volume plated(ml)

Coliform Count:

Coliform bacteria were enumerated using Violet Red Bile Agar (VRBA) following standard pour plate techniques. Serial dilutions were prepared, and 1 mL aliquots were inoculated into sterile plates, followed by addition of molten VRBA. After incubation at 37°C for 24 hours, characteristic pink to red colonies with bile precipitation were counted as coliforms.

Coliform analysis serves as an indicator of sanitary quality and potential contamination in food systems and is widely used in food safety evaluation (Tamiru et al., 2024; Neyaz et al., 2024).

CFU/g = Number of Colonies × Dilution Factor

Yeast and Mold Count

Yeast and mold counts were determined using the spread plate method. Appropriate dilutions were prepared, and 0.1 mL aliquots were spread onto Potato Dextrose Agar (PDA) acidified to pH 3.5 to suppress bacterial growth. Plates were incubated at $25\text{--}28^{\circ}\text{C}$ for 3–5 days. Yeast colonies appeared smooth and creamy, while mold colonies were filamentous and fuzzy.

Yeast and mold enumeration is essential for evaluating spoilage and shelf-life stability of food products, particularly fruit-based products such as jelly (Ilham et al., 2025; Selvaraj et al., 2024).

CFU/g = (Number of Colonies × Dilution Factor) ÷ 0.1

• **SENSORY EVALUATION:**

Sensory evaluation of the developed jelly samples was conducted using a 9-point hedonic scale, where 1 indicated “dislike extremely” and 9 indicated “like extremely,” to assess attributes such as color, flavor, texture, taste, and overall acceptability (Israfi et al., 2025; Zhao et al., 2024).

• **SHELF-LIFE OBSERVATION:**

The developed jelly samples were subjected to accelerated storage studies using a stability chamber, where one day of storage was considered equivalent to one month of real-time storage. The samples were evaluated over a period of 3 to 4 days, representing an actual shelf life of 3 to 4 months under normal storage conditions. During the storage period, the samples were assessed for changes in visual appearance, color, texture, aroma, and overall acceptability (Israfi et al., 2025; Zhao et al., 2024). The results indicated no significant changes during the initial two days; however, slight variations in texture and aroma were observed towards the end of the study period. Despite these minor changes, all parameters remained within acceptable limits throughout the storage duration (Rao et al., 2023). The incorporation of potassium sorbate proved effective in inhibiting microbial growth and maintaining product quality (Feng et al., 2023). Among the different formulations, Trial 3 exhibited the highest stability by retaining its physicochemical and sensory attributes during the entire storage period. Overall, the accelerated storage study confirmed that the developed jelly remained stable and acceptable for a shelf life of 3 to 4 months under standard storage conditions.

4. RESULTS AND DISCUSSIONS:

The results of physicochemical and sensory evaluation indicated significant differences among the four developed jelly trials. Among them, Trial 3 exhibited the highest quality, as it maintained optimal moisture

content, appropriate pH, and a balanced composition of reducing sugars and acidity, which contributed to improved gel formation and overall product stability (Rao et al., 2023; Israfi et al., 2025). Sensory evaluation further revealed that Trial 3 achieved the highest scores across all attributes, including appearance, color, aroma, taste, texture, and overall acceptability (Zhao et al., 2024). The superior sensory characteristics, along with enhanced functional properties, established Trial 3 as the most suitable formulation for further development and potential commercial application (Feng et al., 2023).

Parameter	Trial 1	Trial 2	Trial 3	Trail 4
Moisture	28	29	35	36
Ash	0.50	0.53	0.42	06
pH	3.2	3.3	3.4	3.8
Reducing sugars	10	17	23	25
Titrateable acidity	0.75	0.81	0.60	1.2

Table 2- Physicochemical Analysis

Parameter	Trail 1 (CFU/g)	Trail 2 (CFU/g)	Trail 3 (CFU/g)	Trail 4 (CFU/g)
Total Plate Count	2.5×10^2	2.0×10^2	1.2×10^2	1.5×10^2
Coliform	Absent	Absent	Absent	Absent
Yeast and Mold	1.8×10^2	1.5×10^2	0.8×10^2	1.0×10^2

Table 3- Microbial Analysis

Attributes	Trial 1	Trial 2	Trial 3	Trail 4
Appearance	7.0	7.5	9.0	8.0
Color	7.0	7.0	9.5	8.5
Aroma	6.5	7.0	8.7	7.0
Taste	7.0	6.5	9.0	8.5
Texture	6.0	7.0	9.5	7.5
Overall Acceptability	6.5	7.0	9.5	8.0

Table 4 – Sensory Evaluation

The findings of the present study demonstrated that variations in ingredient combinations significantly influenced the physicochemical and sensory properties of the developed jelly. The proportion of sugar and fructooligosaccharides (FOS) played a crucial role in determining sweetness, texture, and overall product acceptability (Rao et al., 2023; Guo et al., 2023). Trial 1 exhibited higher sweetness due to increased sugar content; however, it resulted in a comparatively softer texture. In contrast, Trial 2 showed improved firmness due to enhanced interaction between FOS and pectin, although it imparted a stronger ginger flavor to the product (Israfi et al., 2025).

Trial 3 demonstrated an optimal balance of ingredients, achieving desirable moisture content, appropriate pH, and balanced levels of reducing sugars and titrateable acidity, which supported proper gel formation and product stability (Rao et al., 2023; Zhao et al., 2024). The formation of a stable gel network was

facilitated by the interaction of pectin with controlled acidity, while the incorporation of FOS contributed additional functional benefits due to its prebiotic properties (Guo et al., 2023).

Trial 4 resulted in the formation of a firmer gel due to higher pectin concentration; however, elevated moisture content adversely affected the structural integrity and mouthfeel of the product (Feng et al., 2023). The inclusion of sabja seeds enhanced the dietary fiber content and improved water-holding capacity, while ginger extract contributed a characteristic flavor along with potential health benefits without negatively affecting sensory attributes (Israfi et al., 2025). The use of potassium sorbate effectively inhibited microbial growth, thereby extending the shelf life of the product (Feng et al., 2023).

Sensory evaluation results were consistent with physicochemical findings, with Trial 3 receiving the highest scores for appearance, color, taste, aroma, texture, and overall acceptability (Zhao et al., 2024). Accelerated shelf-life studies indicated that the developed jelly maintained its stability and quality for up to 3–4 months under standard storage conditions (Rao et al., 2023). Overall, the study highlights that proper optimization of ingredients can lead to the development of watermelon jelly with enhanced nutritional value, desirable sensory properties, and good storage stability.

5. CONCLUSION:

The research project resulted in a successful development of watermelon jelly which contains sabja seeds and ginger extract and fructooligosaccharides (FOS). The product characteristics showed noticeable changes which occurred because of different formulation approaches. The most effective trial emerged from Trial 3 because it demonstrated perfect moisture content and required pH level and suitable sweetness and strong gel strength. The sensory evaluation showed that Trial 3 achieved the highest acceptability for its appearance and color and aroma and taste and texture characteristics. The jelly nutritional value increased through functional ingredient addition while potassium sorbate application resulted in better product shelf life. The accelerated storage study confirmed that the developed jelly remained stable and acceptable for up to 3–4 months under normal storage conditions. The optimized formulation serves as a recommended product for commercial production as a functional hydration jelly product.

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