

# Design and Evaluation of Functional Gummies with Cognitive-Enhancing Brahmi Extract

Varadaya Palli Khadirunnisa<sup>\*1</sup>, Dr. A. Swaroopa Rani<sup>1</sup>, MSV Phani Prakash<sup>2</sup>

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

<sup>1</sup>Professor, Food Technology Department, Oil Technological and Pharmaceutical Research Institute, JNT University, Ananthapuramu, Andhra Pradesh, India

<sup>2</sup>Managing Director, Smart food Lab, Racon Hub, Beside Aleap main gate, Pragathi nagar , Bachupalli, Hyderabad, Telangana, India

\*Corresponding author email: [vkhadirun786@gmail.com](mailto:vkhadirun786@gmail.com)

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## ABSTRACT

The increasing demand for functional and nutraceutical foods has stimulated the development of value-added confectionery products with enhanced health benefits. The present study aimed to formulate and evaluate nutraceutical gummies enriched with natural fruit extracts of amla (*Emblica officinalis*), guava (*Psidium guajava*), and pomegranate (*Punica granatum*), along with Brahmi extract (*Bacopa monnieri*), a well-known medicinal herb recognized for its cognitive-enhancing and neuroprotective properties. Fructooligosaccharide (FOS) was incorporated as a low-calorie functional sweetener to provide prebiotic benefits and improve sensory acceptability. The gummies were formulated using optimized concentrations of gelling agents and bioactive components to achieve desirable physicochemical and organoleptic properties. The developed formulations were evaluated for moisture content, pH, and texture profile, along with sensory attributes such as color, flavor, taste, and overall acceptability. The results indicated that the optimized formulation exhibited satisfactory textural quality, good storage stability, and high sensory acceptance. The incorporation of fruit-derived antioxidants and Brahmi extract significantly enhanced the functional and therapeutic potential of the product without adversely affecting its palatability. Therefore, the developed nutraceutical gummies can serve as an effective delivery system for bioactive compounds, with promising applications in the functional food and nutraceutical industries.

**KEYWORDS:** Nutraceutical gummies; Functional foods; *Bacopa monnieri*; Brahmi extract; Amla (*Emblica officinalis*); Guava (*Psidium guajava*); Pomegranate (*Punica granatum*); Fructooligosaccharide (FOS); Prebiotic sweetener; Antioxidant activity; Phytochemicals; Product formulation; Sensory evaluation; Functional confectionery; Bioactive compoundsVV

## 1.INTRODUCTION:

The growing consumer demand for functional and nutraceutical foods has led to the development of innovative products that provide health benefits beyond basic nutrition. Among these, nutraceutical gummies have gained considerable attention due to their palatability, convenience, and high consumer acceptance compared to conventional dosage forms such as tablets and capsules. Their ability to incorporate multiple bioactive compounds in a stable and appealing matrix makes them an effective delivery system for functional ingredients (Granato et al., 2020). Fruits such as amla (*Emblica officinalis*), guava (*Psidium guajava*), and pomegranate (*Punica granatum*) are recognized for their rich composition of vitamins, minerals, and phytochemicals with strong antioxidant properties. Amla is particularly valued for its high vitamin C content and potent free radical scavenging activity, while guava and pomegranate contribute significant amounts of phenolic compounds and flavonoids associated with reduced oxidative stress and improved overall health (Baliga & Dsouza, 2011; Viuda-Martos et al., 2010). The incorporation of these fruit extracts into functional foods enhances both nutritional quality and therapeutic potential.

In addition to fruit-derived bioactives, *Bacopa monnieri* (Brahmi) plays a crucial role in nutraceutical formulations due to its well-documented cognitive-enhancing and neuroprotective properties. The presence of active compounds such as bacosides has been reported to improve memory, reduce anxiety, and support brain function. Furthermore, the use of fructooligosaccharide (FOS) as a functional sweetener adds prebiotic benefits by promoting beneficial gut microbiota, thereby enhancing digestive health and overall functionality of the product (Kongkeaw et al., 2014; Roberfroid, 2007).

Despite the increasing interest in functional confectionery, limited studies have explored the combined incorporation of fruit extracts, herbal bioactives, and prebiotic sweeteners in a single gummy formulation. Therefore, the present study aims to develop and evaluate nutraceutical gummies enriched with amla, guava, pomegranate, and Brahmi extract using FOS as a functional sweetener, and to assess their physicochemical and sensory properties to establish their potential as a value-added functional food product.

## 2.MATERIALS:

Fresh amla (*Emblica officinalis*), guava (*Psidium guajava*), and pomegranate (*Punica granatum*) were procured from the local market and used for the extraction of fruit pulp. *Bacopa monnieri* (Brahmi) extract was obtained from a certified herbal supplier. Fructooligosaccharide (FOS) was used as a functional sweetener due to its prebiotic properties. Agar-agar was used as the primary gelling agent for the preparation of gummies, while citric acid was incorporated as an acidulant to enhance flavor and maintain pH. Potassium Sorbate for shelf-life improvement.



Guava juice

Amla Juice

FOS (Fructo-oligosaccharide)

Pomegranate juice

Brahmi Extract

**Figure-1:** Raw Materials for Neuro-boost Gummies with Brahmi extract

### 3.METHODOLGY:

#### 3.1 Preparation of Fruit Extracts:

Fresh amla (*Emblica officinalis*), guava (*Psidium guajava*), and pomegranate (*Punica granatum*) were procured and processed under hygienic conditions. Amla fruits were washed thoroughly and subjected to blanching in hot water (80–90°C for 3–5 minutes) to inactivate enzymes and reduce astringency, followed by immediate cooling in chilled water to preserve color and nutrients. The blanched fruits were then pulped using a mechanical blender, and the juice was extracted and filtered through a muslin cloth to obtain a clear extract. A similar procedure was followed for guava, including washing, pulping, and filtration to obtain a uniform juice extract. In the case of pomegranate, the arils were manually separated, washed with clean water, and directly subjected to juice extraction and filtration without blanching to preserve heat-sensitive bioactive compounds (Baliga & Dsouza, 2011; Viuda-Martos et al., 2010).

#### 3.2 Preparation of Gummy Formulation

A xanthan gum solution was prepared by dispersing xanthan gum in distilled water and allowing it to hydrate completely to form a uniform viscous solution. The extracted fruit juices were combined and subjected to controlled heating with continuous stirring until a slight increase in viscosity was observed. At this stage, the hydrated xanthan gum solution was incorporated to improve texture and stability. Subsequently, *Bacopa monnieri* (Brahmi) extract (20%) dissolved in water was added to the mixture under continuous stirring to ensure uniform distribution of bioactive components (Kongkeaw et al., 2014).

Further, agar-agar solution was prepared separately by dissolving agar in water and heating until a clear, transparent solution was obtained. This solution was then added to the fruit mixture once the desired thickness was achieved, followed by continued heating to ensure proper gel formation. Fructooligosaccharide (FOS) was incorporated as a functional sweetener to enhance taste and provide prebiotic benefits. Finally, citric acid was added to adjust pH and improve flavor, and potassium sorbate was included as a preservative to enhance shelf stability. The mixture was stirred thoroughly to ensure homogeneity and then poured into molds for setting under controlled conditions (Roberfroid, 2007).



**Figure-2:** The Final Product Gummies with Brahmi Extract

**Table – 1:** Formulation of Gummies

| INGREDIENTS                  | TRAIL - 1 | TRAIL - 2 | TRAIL - 3 | TRAIL - 4 |
|------------------------------|-----------|-----------|-----------|-----------|
| Guava Juice                  | 50        | 50        | 50        | 50        |
| Amla Juice                   | 20        | 20        | 25        | 30        |
| Pomegranate Juice            | 15        | 10        | 10        | 10        |
| FOS (Fructo-oligo-sacchride) | 14        | 20        | 14        | 20        |
| Agar - agar powder           | 0.7       | 0.8       | 0.9       | 1.2       |
| Xanthan Gum                  | 0.3       | 0.2       | 0.3       | 0.2       |
| Brahmi Extract (ml)          | 0.03      | 0.02      | 0.03      | 0.03      |
| Citric Acid Solution         | 0.3       | 0.2       | 0.3       | 0.3       |
| Potassium Sorbate            | 0.05      | 0.05      | 0.05      | 0.05      |

#### 4. PHYSICO-CHEMICAL ANALYSIS

Physicochemical analysis is crucial in gummy formulations as it provides essential information on product quality, stability, and safety by evaluating parameters such as total soluble solids, water activity, pH, and moisture content. These parameters directly influence texture, microbial stability, and shelf-life, particularly in functional gummies where ingredients like fructooligosaccharides may alter the matrix properties. Proper control of these factors ensures desirable sensory characteristics and extends product stability through combined preservation effects. Similar importance of physicochemical properties in confectionery and functional foods has been widely reported in previous studies (*Gómez-Guillén et al., 2011; Burey et al., 2009; Imeson, 2010*).

##### 4.1 Determination of pH:

The pH of the sample was determined using a digital pH meter calibrated with standard buffer solutions (pH 4.0 and 7.0) (AOAC 981.12, 2016). The electrode was immersed in a homogenized sample solution, and the reading was recorded after stabilization. The pH value represents the hydrogen ion concentration of the sample.

$$\text{pH} = -\log [\text{H}^+]$$

##### 4.2 Determination of Brix:

The total soluble solids (TSS) content of the sample was measured using a digital refractometer (Milwaukee MA871) following standard procedures (AOAC 932.12, 2016; Ranganna, 2010). The prism surface was cleaned with distilled water and wiped dry. A few drops of the sample extract were placed on the prism, and the reading was recorded from the digital display. The results were expressed in degrees Brix (°Brix).

##### 4.3 Determination of Moisture content:

The moisture content of the sample was determined using a halogen moisture analyzer (Aczet MB series) based on the loss on drying principle (AOAC 925.10, 2016). The sample pan was cleaned and dried before analysis. Approximately 2–3 g of the sample was evenly spread on the pan and subjected to heating at 105°C until a constant weight was achieved (FSSAI, 2016). The instrument continuously monitored weight loss and displayed the moisture content directly as percentage.

##### 4.4 Determination of Water Activity:

Water activity (aw) was measured using a water activity meter (Novasina Lab Start-aw) based on equilibrium relative humidity measurement (ISO 21807:2004; Labuza, 1980). A small quantity of the sample was placed in

the sample cup and inserted into the instrument chamber. The aw value was recorded after equilibrium was reached.

#### 4.5 Determination Of Titratable Acidity:

Titrateable acidity of the sample was determined by acid-base titration (Ranganna, 2010; AOAC, 2016). A known quantity of the sample was homogenized with distilled water and filtered to obtain a clear extract (Rahman, 2007). An aliquot of the filtrate was titrated against standard 0.1 N sodium hydroxide using phenolphthalein as an indicator (Skoog et al., 2014). The endpoint was indicated by the appearance of a light pink color, and the acidity was calculated and expressed as percentage of citric acid (Ranganna, 2010).

$$\text{Titrateable Acidity (\%)} = \frac{\text{Volume of NaOH used (mL)} \times \text{Normality of NaOH} \times \text{Equivalent weight of acid} \times 100}{\text{Weight of sample (g)} \times 1000}$$

#### 4.6 Determination of Ash content:

Ash content measures the total mineral matter present in gummies and is an important indicator of its nutritional value and quality. The method involves weighing a known amount of gummy in a clean, dry crucible and incinerating it in a muffle furnace at approximately 550°C until all organic matter is completely burned, leaving only inorganic residue (ash). After cooling the crucible in a desiccator, the remaining ash is weighed. The percentage of ash is calculated using the formula:

$$\text{Ash (\%)} = \frac{\text{Weight of crucible + ash (W3)} - \text{Weight of empty crucible (W1)}}{\text{Weight of crucible + sample (W2)} - \text{Weight of empty crucible (W1)}} \times 100$$

### 5.MICROBIAL ANALYSIS

Microbial analysis of the developed gummy samples was carried out to evaluate their microbiological safety and shelf stability using standard plate count methods. Total viable count (TVC) was determined by serial dilution of the sample followed by pour plate technique using Plate Count Agar (PCA), and the plates were incubated at 37°C for 24–48 hours. Yeast and mold counts were estimated using Potato Dextrose Agar (PDA) after incubation at 25°C for 3–5 days. The microbial load was expressed as colony-forming units per gram (CFU/g) of the sample. The analysis is essential to ensure that the product meets food safety standards, particularly in low-moisture confectionery products like gummies. The combined effect of low water activity, high soluble solids, and acidic pH contributes to inhibiting microbial growth, thereby enhancing the shelf-life and safety of the product. All procedures were performed following standard microbiological methods reported in previous studies (APHA, 2015; ICMSF, 2011; FSSAI, 2016).

### 6.NUTRITIONAL ANALYSIS

The nutritional and physicochemical parameters of the developed nutraceutical gummies enriched with amla, guava, pomegranate, and *Bacopa monnieri* extract were evaluated. The analysis included carbohydrates, dietary fiber, protein, and fat content to determine the nutritional profile of the product. The results of the nutritional and physicochemical composition of the formulated gummies are presented in Tables.

#### 6.1 Determination of Protein Content:

Protein content was determined using the Kjeldahl method, which involves digestion of the sample with concentrated sulfuric acid to convert nitrogen into ammonium sulfate, followed by distillation and titration. The

total nitrogen content obtained was multiplied by a conversion factor (generally 6.25) to estimate protein content. The developed gummies showed low protein content (~1.20 g/100 g), as the formulation mainly consists of fruit extracts and hydrocolloids, which are naturally low in protein.

$$\text{Protein (\%)} = \text{Nitrogen (\%)} \times \text{Conversion factor (6.25)}$$

$$\text{Where Nitrogen (\%)} = \frac{(V_{\text{sample}} - V_{\text{blank}}) \times N_{\text{HCl}} \times 14.01}{\text{Weight of sample (g)}} \times 100$$

## 6.2 Determination of Fat Content:

Fat content was analysed using the Soxhlet extraction method, where the sample was extracted with a non-polar solvent such as petroleum ether. The extracted fat was then quantified gravimetrically. The fat content of the gummies was found to be very low (~0.50 g/100 g), which is desirable for a low-fat functional confectionery product.

$$\text{Fat (\%)} = \frac{\text{Weight of extracted fat}}{\text{Weight of sample}} \times 100$$

## 6.3 Determination of Carbohydrate Content

Carbohydrate content was calculated by the difference method, subtracting the sum of moisture, protein, fat, and ash from 100. The gummies exhibited high carbohydrate content (~68.5 g/100 g), primarily due to the presence of fructooligosaccharide (FOS) and natural sugars from fruit extracts, contributing to energy value and sweetness.

$$\text{Carbohydrates (\%)} = 100 - [\text{Moisture (\%)} + \text{Protein (\%)} + \text{Fat (\%)} + \text{Ash (\%)} + \text{Crude fiber}]$$

## 6.4 Determination of Dietary Fiber

Dietary fiber content was determined using standard enzymatic-gravimetric methods. The presence of fiber (~2.10 g/100 g) is mainly attributed to fruit components and FOS, which also acts as a prebiotic, supporting gut health.

$$\text{Dietary Fiber (\%)} = (\text{Weight of residue} - \text{Weight of ash}) / \text{Weight of sample} \times 100$$

## 7.Sensory Analysis:

Sensory evaluation of the developed fruit leather roll 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).

## 8.Results And Discussions:

The developed nutraceutical gummies were successfully formulated using amla, guava, pomegranate extracts, and *Bacopa monnieri* extract, along with fructooligosaccharide (FOS) as a functional sweetener. The results of physicochemical, nutritional, and sensory evaluation indicate that the product possesses desirable quality characteristics and functional potential.

Trial 4 was found to be the most successful formulation among all the trials. It exhibited optimal physicochemical properties, including desirable pH, moisture content, and texture. The gummies showed superior sensory acceptability with balanced taste, appealing color, and soft chewy consistency. The incorporation of fruit extracts, *Bacopa monnieri* extract, and FOS resulted in a stable and functionally enriched product.

**Table -2: Physicochemical Analysis**

| Parameter                    | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|------------------------------|---------|---------|---------|---------|
| pH                           | 3.4     | 3.3     | 3.2     | 3.1     |
| Moisture Content (%)         | 26.5    | 25.2    | 24.1    | 23.68   |
| Water Activity               | 0.72    | 0.69    | 0.66    | 0.64    |
| Total Soluble Solids (°Brix) | 68.2    | 71.5    | 74.0    | 76.1    |
| Ash Content (%)              | 1.50    | 1.60    | 1.70    | 1.80    |
| Titrateable Acidity (%)      | 0.50    | 0.60    | 0.70    | 0.75    |

**Table- 3: Microbial Analysis**

| Parameter                  | Trial 1           | Trial 2           | Trial 3           | Trial 4           |
|----------------------------|-------------------|-------------------|-------------------|-------------------|
| Total Plate Count (CFU/g)  | $2.5 \times 10^3$ | $1.8 \times 10^3$ | $1.2 \times 10^3$ | $0.8 \times 10^3$ |
| Yeast & Mold Count (CFU/g) | $1.5 \times 10^2$ | $1.2 \times 10^2$ | $0.9 \times 10^2$ | $0.5 \times 10^2$ |
| Coliform Count (CFU/g)     | Present (low)     | Absent            | Absent            | Absent            |

**Table – 4: Nutritional Analysis**

| Parameter     | Amount (g/100 g) |
|---------------|------------------|
| Carbohydrates | 68.5             |
| Dietary Fiber | 2.10             |
| Protein       | 1.20             |
| Fat           | 0.50             |

**Table -5: Sensory Evaluation**

| Attributes            | Trial 1 | Trial 2 | Trial 3 | Trial 4 |
|-----------------------|---------|---------|---------|---------|
| Color & Appearance    | 6       | 7       | 8       | 9       |
| Flavor                | 7       | 8       | 8       | 9       |
| Taste                 | 8       | 7       | 8       | 9       |
| Texture               | 7       | 6       | 7       | 8       |
| Overall Acceptability | 7       | 7       | 8       | 9       |

The sensory evaluation of the developed nutraceutical gummies showed noticeable variation among the four trials with respect to color, flavor, taste, texture, and overall acceptability. Trial 1 exhibited moderate scores, indicating acceptable but less optimized characteristics, particularly in color and texture. Trial 2 showed improvement in color and flavor; however, slight inconsistencies in taste and texture suggested the need for better formulation balance. Trial 3 demonstrated further enhancement in most attributes, especially color and overall acceptability, indicating progressive refinement of the formulation and improved balance between sweetness and acidity. (Gómez-Guillén et al., 2011; Burey et al., 2009; Imeson, 2010).

Trial 4 (optimized formulation) achieved the highest scores across all sensory attributes, with maximum ratings in color, flavor, taste, and overall acceptability, and a notable improvement in texture. The superior flavor profile can be attributed to the balanced incorporation of fruit extracts and fructooligosaccharide (FOS), along with effective masking of the bitterness of *Bacopa monnieri* extract. The improved texture reflects the optimal use of agar-agar and xanthan gum, resulting in a desirable soft and chewy consistency. Overall, the results confirm that Trial 4 exhibited excellent organoleptic properties and the highest level of consumer acceptability.

## CONCLUSION

The present study successfully developed nutraceutical gummies enriched with amla, guava, pomegranate, and *Bacopa monnieri* extract using fructooligosaccharide (FOS) as a functional sweetener. The formulated product demonstrated desirable physicochemical properties, including optimal pH (3.1), moisture content (23.68%), water activity (0.64), and total soluble solids (76.1°Brix), indicating good stability and suitability for extended shelf life. The nutritional analysis revealed that the gummies were rich in carbohydrates with moderate dietary fiber and low fat content, making them a suitable functional food product.

Among the different formulations, Trial 4 was identified as the optimized formulation, exhibiting superior physicochemical characteristics, minimal microbial load, and excellent sensory acceptability. The sensory evaluation confirmed that the product was highly preferred by panelists, with maximum scores in flavor, taste, and overall acceptability, indicating a well-balanced formulation and effective masking of the bitterness of *Bacopa monnieri*. Overall, the developed nutraceutical gummies show significant potential as a convenient and palatable delivery system for bioactive compounds, with promising applications in the functional food and nutraceutical industry.

## REFERENCES

1. Baliga, M. S., & Dsouza, J. J. (2011). Amla (*Embllica officinalis*): A review of its phytochemistry and pharmacological properties. *Food Research International*, 44(7), 1768–1775.
2. Granato, D., et al. (2020). Functional foods and nutraceuticals: Innovation trends and market opportunities. *Trends in Food Science & Technology*, 102, 1–10.
3. Kongkeaw, C., et al. (2014). Cognitive effects of *Bacopa monnieri*: A systematic review. *Journal of Ethnopharmacology*, 151(1), 528–535.
4. Roberfroid, M. (2007). Prebiotics: The concept revisited. *The Journal of Nutrition*, 137(3), 830S–837S.
5. Viuda-Martos, M., et al. (2010). Pomegranate and its functional components. *Food Chemistry*, 119(2), 1–8.
6. Gómez-Guillén, M. C., et al. (2011). Functional and bioactive properties of collagen and gelatin. *Food Hydrocolloids*, 25(8), 1813–1827.

7. Burey, P., et al. (2009). Confectionery gels: A review on structure and functionality. *International Journal of Food Properties*, 12(1), 176–210.
8. Imeson, A. (2010). *Food Stabilizers, Thickeners and Gelling Agents*. Wiley-Blackwell.
9. AOAC (2016). *Official Methods of Analysis* (20th ed.). Association of Official Analytical Chemists.
10. Ranganna, S. (2010). *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.
11. FSSAI (2016). *Manual of Methods of Analysis of Foods*. Food Safety and Standards Authority of India.
12. APHA (2015). *Compendium of Methods for the Microbiological Examination of Foods*. American Public Health Association.
13. ICMSF (2011). *Microorganisms in Foods: Use of Data for Assessing Process Control and Product Acceptance*. Springer.
14. Labuza, T. P. (1980). The effect of water activity on food stability. *Food Technology*, 34(4), 36–41.
15. ISO 21807 (2004). Microbiology of food and animal feeding stuffs — Determination of water activity.
16. Rahman, M. S. (2007). *Handbook of Food Preservation*. CRC Press.
17. Skoog, D. A., et al. (2014). *Fundamentals of Analytical Chemistry*. Cengage Learning.
18. FAO (2013). *Dietary protein quality evaluation in human nutrition*. Food and Agriculture Organization.
19. Slavin, J. (2013). Fiber and prebiotics: Mechanisms and health benefits. *Nutrients*, 5(4), 1417–1435.
20. Shahidi, F., & Ambigaipalan, P. (2015). Phenolics and polyphenolics in foods. *Journal of Functional Foods*, 18, 820–897.
21. Gómez-Guillén, M. C., et al. (2011). Functional and bioactive properties of collagen and gelatin in food systems. *Food Hydrocolloids*, 25(8), 1813–1827.
22. Burey, P., et al. (2009). Confectionery gels: A review on formulation, rheology, and texture properties. *International Journal of Food Properties*, 12(1), 176–210.