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Formulation, Standardization and Evaluation of Bael (Aegle marmelos) Fruit Powder: A Nutraceutical Approach

Wagh Mansi D[1] , Sonawane Mansi S[1] , Jadhav Ritesh R[1]

Prof. Kedar Tejashree[2]

Dr. Prof. A.B.Darekar[3]

1-Students of KVN Naik Institute of Pharmaceutical Education and Research, Canada Corner, Nashik, Maharashtra 422005.

2-Prof.of KVN Naik Institute of Pharmaceutical Education and Research, Canada Corner, Nashik, Maharashtra 422005.

3-Principal of KVN Naik Institute of Pharmaceutical Education and Research, Canada Corner ,Nashik, Maharashtra 422005.

Abstract

Bael (Aegle marmelos) is a traditional medicinal fruit with significant gastrointestinal, antioxidant, and antimicrobial properties. This study focuses on the formulation of an instant health drink powder comprising bael fruit powder, dextrose, ascorbic acid, citric acid, magnesium carbonate, flavoring agents, and preservatives. *Aegle marmelos (L* belonging to family Rutaceae is one of the most useful medicinal plants of India. Various parts of Bel like leaves, roots, stems, fruit, and bark are composed of different phytochemicals like alkaloids, cardiac glycosides, terpenoids, saponins, flavonoids, steroids, and tannins. The product is designed for easy reconstitution in water and enhanced with functional ingredients to improve taste, stability, and health benefits. The final formulation provides nutritional support, hydration, and antioxidant activity, suitable for all age groups.

Keywords

Bael powder, nutraceutical, instant drink, pharmacological activity, formulation.

1. Introduction

Bael (Aegle marmelos), a native Indian fruit, is widely used in Ayurvedic and traditional systems of medicine for its ability to treat gastrointestinal disorders and boost immunity. Modern nutraceuticals seek to deliver these traditional benefits in convenient forms. This study aims to develop a bael-based instant drink using functional excipients like dextrose (as energy source), ascorbic acid (antioxidant), citric acid (acidulant), magnesium carbonate (mineral supplement and stabilizer), flavoring agents, and preservatives.

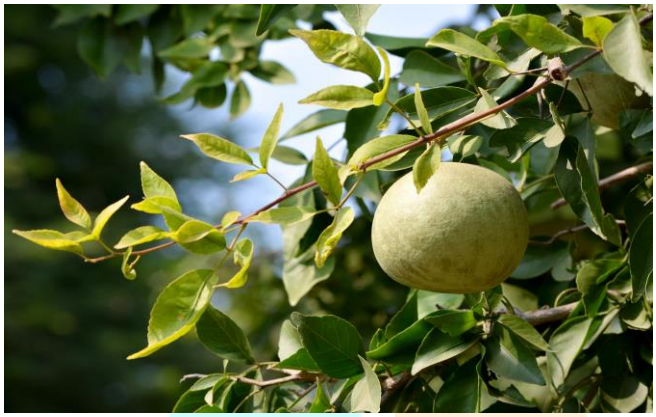

Fig 1: Bael fruit

➢ Ideal Characteristics of Bael-Based Nutraceutical Powder

1. Palatability:

i. Pleasant taste and aroma, typically sweet and slightly tangy.
ii. Acceptable color and mouthfeel to encourage regular consumption.

2. Water Solubility:

i. Should easily disperse or dissolve in water with minimal stirring.
ii. No lump formation or sedimentation.

3. Stability:

i. Retains color, taste, and nutritional properties during shelf life.
ii. Resistant to moisture absorption when stored properly.

4. Nutritional Value:

i. Provides dietary fiber, essential minerals (like magnesium), and antioxidants (like vitamin C).
ii. Supports digestion, hydration, and immune health.

5. Functional Benefits:

i. Offers antidiarrheal, gastroprotective, and anti-inflammatory effects.
ii. Useful in restoring electrolyte balance and managing mild dehydration.

6. Safety and Tolerance:

Free from harmful contaminants or allergens.

i. Well-tolerated across different age groups.

➢ Chemical composition

Alkaloids, coumarins, and steroids, among other chemical ingredients, have been extracted and identified from the plant. Various tree parts, such as leaves, Fruits, wood, root, and bark are all edible.

➢ Taxonomical classification of A. marmelos

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliopyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Sapindale
Family	Rutaceae
Genus	Aegle
Species	Marmelos

Table No. 1: Taxonomical classification of A. marmelos

➢ Ingredients Used

- Bael Powder (dried fruit pulp)
- Dextrose Monohydrate
- Ascorbic Acid (Vitamin C)
- Citric Acid
- Magnesium Carbonate
- Flavoring Agent (natural fruit flavor)
- Preservative: Sodium Benzoate / Potassium Sorbate

➢ Formulation Composition (Per 10g Sachet)

Ingredient	Quantity (g)
Bael Powder	5.0
Dextrose	3.0
Ascorbic Acid	0.4
Citric Acid	0.3
Magnesium Carbonate	0.3
Flavoring Agent	0.5
Preservative	0.5
Total	10.0

Table No. 2: Formulation composition

2. Preparation Method

i. Extract the Pulp:

- Obtain ripe bael fruits: Choose fully mature, yellowish fruits.
- Break open the fruit: Carefully break the rigid exocarp (outer shell) to access the pulp.
- Separate the pulp: Scoop out the pulp, discarding the seeds and fibrous parts.

ii. Prepare the Pulp:

- Mash the pulp: Add the pulp to a bowl and mash it well with a fork or spoon to extract the juice.
- Dilute and Strain: Add water to the pulp to dilute it and strain the mixture through a sieve to remove any solid bits.

iii. Drying Methods: Drying in Hot Air Oven

- Preheat the oven to 50-60°C.
- Place trays inside the oven with adequate air circulation.
- Keep the oven door slightly open (optional) for moisture escape.
- Rotate trays periodically to ensure even drying.

iv. Powdering:

- Grind the dried pulp: Once the pulp is completely dry, grind it into a fine powder using a grinder or blender.
- Bael powder, dextrose, and magnesium carbonate were blended in a dry mixer.
- Ascorbic acid, citric acid, preservative, and flavor were added gradually while mixing.
- Store the powder: Store the bael fruit powder in an airtight container in a cool, dry place.

Fig 2: Bael fruit powder

3. Pharmacological Action of Bael in Diarrhea

What is Diarrhea?

Diarrhea is a digestive condition characterized by frequent, loose, or watery stools, often accompanied by dehydration, abdominal cramps, and weakness.

It can be acute (short-term) or chronic (long-lasting).

1. Antidiarrheal Activity: Bael fruit, particularly the unripe pulp, is rich in tannins and marmelosin, which contribute to its strong astringent properties. These compounds reduce intestinal secretions and promote absorption of water and electrolytes in the intestine, thereby reducing stool frequency and liquidity.

2. Antimicrobial Action: The aqueous and alcoholic extracts of bael have shown inhibitory effects against diarrhea-causing pathogens such as Escherichia coli, Shigella, and Salmonella species. This action helps eliminate the infectious cause of diarrhea and prevents further progression.

3. Anti-inflammatory Properties: Flavonoids and coumarins in bael exhibit anti-inflammatory effects that help reduce irritation and inflammation of the gastrointestinal tract lining, which is often associated with infectious diarrhea.

4. Gastroprotective Effects: Bael protects the mucosal lining of the gut and supports healing. It reduces intestinal motility and supports the restoration of gut integrity.

5. Clinical Evidence: Traditional Ayurvedic texts and various preclinical studies support the use of bael in managing both acute and chronic forms of diarrhea. Clinical trials have also shown significant improvements in stool consistency, frequency, and pain in patients treated with bael-based preparations.

4. How to Use Bael Powder for Diarrhea

i. Bael Powder Drink:

Ingredients:

a. 1 tsp Bael powder
b. 1 cup warm water
c. ½ tsp honey (optional)

Method:

Mix well and drink twice a day for relief.

ii. Bael Powder with Buttermilk:

Ingredients:

a. 1 tsp Bael powder
b. 1 cup buttermilk

Method:

Mix well and drink after meals to soothe the stomach.

iii. Bael Powder & Banana Paste:

Ingredients:

a. 1 tsp Bael powder
b. ½ mashed banana

Method:

Eat the paste twice a day to firm up stools.

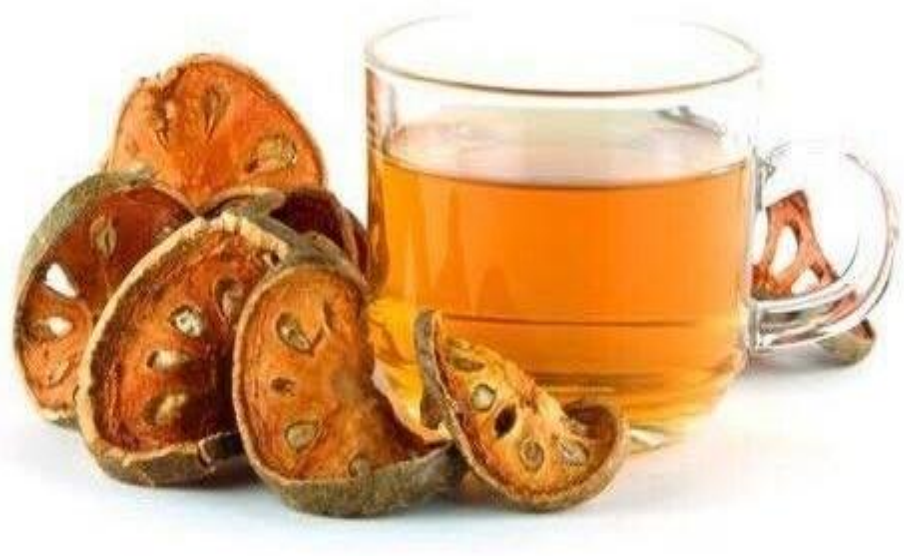

Fig 3: Nutraceutical drink of dried bael fruit

5. How Bael Powder Helps in Diarrhea

a. Rich in Tannins – Acts as an astringent to reduce intestinal inflammation.
b. Pectin Content – Helps absorb excess water and firms up stools.
c. Antibacterial Properties – Fights harmful bacteria in the gut.
d. Soothing Effect – Helps repair the intestinal lining and improves digestion.

6. Evaluation Parameters

To ensure quality, efficacy, and stability of the bael-based nutraceutical drink powder, the following evaluation parameters are assessed:

1. Organoleptic Evaluation:

Appearance: Fine, uniform, free-flowing powder.

Color: Light yellowish, consistent with bael pulp.

Odor and Taste: Characteristic sweet-tangy flavor with no off-odors.

2. Physicochemical Parameters:

pH (1% solution): Should be in the range of 3.5–4.5 to ensure stability and palatability.

Moisture Content: Less than 5% to prevent microbial growth.

Solubility/Dispersibility: Should disperse fully in 200 mL of water within minutes.

3. Shelf Life and Stability Testing:

Parameters monitored include color, taste, solubility, pH, and microbial load.

4. Flow Properties:

Bulk Density and Tapped Density

5. Reconstitution Time:

Time required for complete dispersion or dissolution in water without sedimentation.

6. Packaging Compatibility:

Ensures the powder remains stable and uncontaminated during storage and handling.

7. Result and Discussion

The formulated bael powder drink was evaluated based on organoleptic, physicochemical, and functional parameters. The findings are summarized below:

i. Organoleptic Properties
- Appearance: The powder was light brown in color, fine, and free-flowing.
- Taste and Aroma: The drink exhibited a sweet-tangy flavor and pleasant aroma, which was well-accepted in informal sensory evaluations.

ii. Solubility and Reconstitution
- The powder dispersed completely in 200 mL of water within 30–45 seconds with mild stirring.
- No significant sedimentation was observed, indicating good dispersibility.

iii. pH and Stability
- The pH of a 1% solution was approximately 4.2, within the acceptable range for flavored health drinks.
- The formulation retained stability in appearance, odor, and taste during a 3-month ambient storage period.

iv. Microbiological Quality
- Total microbial count was within permissible limits.
- No pathogenic microorganisms (E. coli, Salmonella, Shigella) were detected, confirming safety for consumption.

v. Nutritional Benefits
- Bael: Provided dietary fiber, tannins, and phenolic compounds with antidiarrheal and gut-protective effects.
- Ascorbic Acid: Functioned as a potent antioxidant, improving immune support.
- Magnesium Carbonate: Contributed to digestive function and electrolyte balance.
- Dextrose: Served as an instant energy source, improving palatability and hydration support.

Discussion:

The overall results demonstrate that the product is functionally and physically suitable for use as a nutraceutical health drink. Its ease of preparation, stability, and therapeutic value in gastrointestinal disorders especially diarrhea make it ideal for both children and adults. The combination of traditional ingredients and scientific formulation presents an effective model for herbal product development.

8. Conclusion

The formulated bael powder drink is a stable, palatable, and functional nutraceutical. It successfully combines traditional health benefits with modern formulation science.

It offers potential as an over-the-counter health supplement, especially for digestive health and general wellness. The inclusion of functional ingredients such as dextrose, ascorbic acid, citric acid, magnesium carbonate, flavoring agents, and preservatives enhances both the therapeutic efficacy and consumer acceptability of the product.

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