

**FORMULATION AND EVALUATION OF BAEL BASED HERBAL GUT HEALTH ORAL
JELLY FOR IMPROVING GUT HEALTH****Sakshi Prabhakar Modhave^{1*}, Shraddha Khaladkar Madan², Modhave Rutuja Satish³, Matade Jayashree Ravindra⁴**^{1,3,4}Student, Samarth Institute of Pharmacy, Belhe, Pune, Maharashtra, India.²Assistant Professor, Department of Quality Assurance Technique, Samarth Institute of Pharmacy, Belhe, Pune, Maharashtra, India.***Corresponding Author: Sakshi Prabhakar Modhave**

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ABSTRACT

Bael fruit contains various bioactive phytoconstituents including alkaloids, flavonoids, tannins, coumarins, phenolic compounds, dietary fibers, and pectin that support intestinal health and regulate digestive functions. The high fiber and pectin content of bael improves bowel regularity, enhances intestinal motility, and promotes the growth of beneficial gut microbiota, while its antimicrobial activity inhibits pathogenic intestinal microorganisms responsible for gastrointestinal disturbances. Additionally, the antioxidant properties of bael reduce oxidative stress and intestinal inflammation, thereby maintaining gastrointestinal homeostasis. The present study aimed to formulate and evaluate a bael-based herbal gut health oral jelly using bael pulp extract as the principal active ingredient. The oral jelly was prepared using suitable gelling agents such as pectin, gelatin, sodium alginate, and carrageenan along with sweetening agents, preservatives, citric acid, and flavoring agents to improve texture, stability, and palatability. The prepared formulations were evaluated for various physicochemical parameters including appearance, pH, viscosity, spreadability, syneresis, gel strength, texture analysis, weight variation, content uniformity, and stability under different storage conditions. Organoleptic properties such as taste, color, odor, and mouthfeel were also assessed to determine patient acceptability and consumer preference.

KEYWORDS: Bael, Aegle marmelos, Herbal oral jelly, Gut health, Nutraceutical, Gastroprotective activity, Antioxidant activity, Antimicrobial activity, Functional food, Digestive wellness, Shodhana, Vrana, Ropana, Ayurveda.**INTRODUCTION**

Gut health is an essential component of overall human health because the gastrointestinal tract performs major functions related to digestion, nutrient absorption, metabolism, and immune regulation. The human gut contains a complex microbial ecosystem known as gut microbiota, which consists of beneficial bacteria, fungi, and other microorganisms that help maintain intestinal homeostasis. These microorganisms contribute to vitamin synthesis, fermentation of dietary fibers, maintenance of intestinal barrier function, and protection against pathogenic microorganisms. Disturbances in gut microbiota composition, commonly referred to as dysbiosis, are associated with several gastrointestinal disorders such as constipation, diarrhea, irritable bowel

syndrome (IBS), inflammatory bowel disease (IBD), gastric ulcers, and metabolic disorders. Therefore, maintaining a healthy gut environment through dietary and herbal interventions has become an important area of research in nutraceutical and pharmaceutical sciences.

Herbal medicines have been extensively utilized in traditional systems of medicine due to their therapeutic efficacy, natural origin, and minimal side effects. Among various medicinal plants, Aegle marmelos, commonly known as bael or Bengal quince, is one of the most important medicinal plants used in Ayurveda for the management of digestive disorders. Bael belongs to the family Rutaceae and is widely distributed throughout India and Southeast Asian countries. Different parts of

the plant including fruit, leaves, roots, bark, and seeds possess medicinal properties; however, the fruit pulp is particularly valued for gastrointestinal health applications. Traditionally, bael fruit has been used in the treatment of diarrhea, dysentery, constipation, indigestion, peptic ulcer, and other gastrointestinal ailments. Bael fruit is nutritionally rich and contains carbohydrates, proteins, vitamins, minerals, dietary fibers, pectin, tannins, flavonoids, coumarins, alkaloids, phenolic compounds, and antioxidants. These phytochemicals are responsible for various

pharmacological activities such as antimicrobial, anti-inflammatory, antioxidant, antidiarrheal, gastroprotective, antiulcer, hepatoprotective, and immunomodulatory effects. The high dietary fiber and mucilage content of bael fruit supports bowel regularity and promotes the growth of beneficial intestinal microorganisms, thereby exhibiting prebiotic potential. In addition, tannins and phenolic compounds present in bael help reduce intestinal inflammation and inhibit pathogenic bacteria associated with gastrointestinal infections.

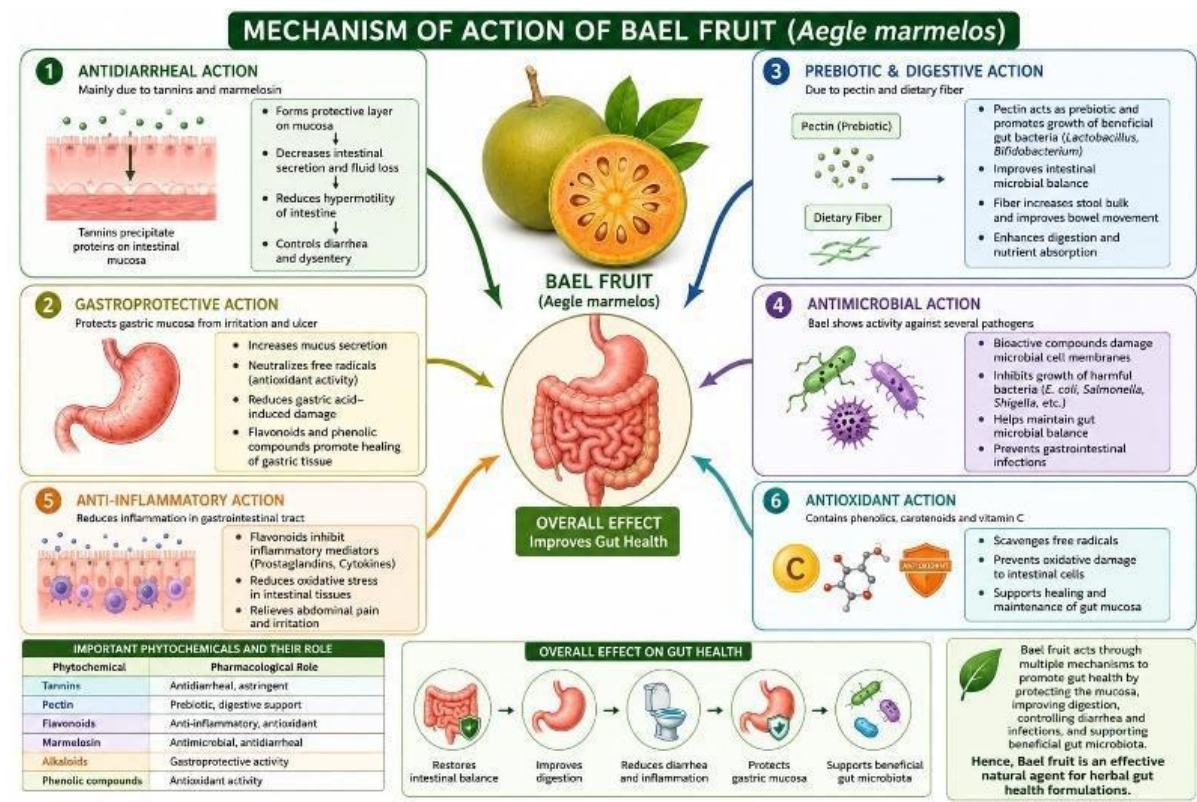


Fig. 1: Mechanism Of Action of Bael Fruit.

AIM AND OBJECTIVES

AIM

To formulate and evaluate a bael-based herbal oral jelly using *Aegle marmelos* fruit extract for improving gut health.

OBJECTIVES

- To prepare bael fruit pulp for formulation use.
- To develop herbal oral jelly formulations using suitable excipients.
- To optimize formulation for desired consistency and stability.
- To evaluate physicochemical properties (pH, viscosity, spreadability, syneresis).
- To perform organoleptic evaluation.
- To conduct stability studies.
- To assess suitability for gut health improvement.

Plant Profile

Parameter	Information
Biological Source	Aegle Marmelos
Family	Rutaceae
Common Name	Bael, Bengal quince
Synonyms	Bel Fruit, Stone Apple
Part Used	Fruit Pulp(ripe/unripe)
Geographical Source	India, Nepal, Bangladesh
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Kingdom	Plantae

Division	Magnoliophyta
Order	Sapindales
Genus	Aegle
Morphological Classification	Tree: Medium Size Leaves: Trifoliolate, Green Fruit: Round, Hard-Shell, Yellow When ripe Pulp: Orange, Sweet
Chemical Constituent	Alkaloids, Flavonoids, Tannins, Coumarin
Pharmacological Activity	Anti-diarrheal activity Anti-microbial activity Anti-oxidant activity Anti-inflammatory
Uses	Digestive Support, dysentery, constipation, irritable bowel, gut health maintenance

MATERIAL AND METHOD

MATERIALS

Fully ripe bael (*Aegle marmelos*) fruits were selected as the primary raw material for the preparation of herbal gut health oral jelly. Other ingredients included refined sugar, pectin (as gelling agent), citric acid (for pH adjustment), and purified water. All chemicals and excipients used were of food or pharmaceutical grade. The study was carried out using standard laboratory glassware and stainless-steel processing vessels.

METHODS

1. Selection and Preparation of Fruit

Fresh, fully ripe bael fruits with a characteristic aroma were selected. The fruits were thoroughly washed with clean running water to remove adhering dirt and impurities. The hard outer shell was carefully broken, and the pulp was separated from seeds and fibrous materials.

2. Preparation of Bael Pulp Extract

The separated pulp was manually mashed to obtain a uniform mass. A small quantity of warm water was added to facilitate extraction. The mixture was then filtered through muslin cloth to obtain a smooth bael pulp extract. The obtained extract was heated at 70–80°C for 5–10 minutes to reduce microbial load and to enhance the stability of natural constituents.



3. Preparation of Sugar Syrup Base

Refined sugar was dissolved in purified water in a stainless-steel vessel. The solution was heated under continuous stirring until a clear syrup was formed. The

temperature was maintained at 100–105°C to achieve the required concentration suitable for jelly formation.



4. Incorporation of Active Extract

The prepared bael pulp extract was added to the hot sugar syrup. The mixture was stirred continuously to ensure uniform distribution of the active herbal component throughout the base.

5. Addition of Gelling Agent and pH Adjustment

Pectin was added gradually into the mixture, preferably pre-dissolved in a small quantity of warm water to avoid lump formation. Continuous stirring was maintained to ensure homogeneity. Citric acid was added at the final stage to adjust the pH of the formulation in the range of 2.8–3.5, which is essential for proper gel formation and stability.



6. Gel Formation and Heating

The mixture was further heated until it reached the gel point, maintaining a temperature of approximately 104–106°C. The endpoint of gelation was confirmed using the sheet test, in which the formulation forms a sheet-like

structure when allowed to fall from a spoon instead of flowing as droplets.

1. Molding and Storage

The hot jelly mass was poured into sterilized molds or containers. It was allowed to cool at room temperature for initial setting, followed by refrigeration at 4–8°C to ensure complete gel formation and improved texture and stability of the final product.



Formulation Table

Ingredient	F1	F2	F3
Bael extract	5	10	15
Gelatin	1.0	1.5	2.0
Xanthum gum	0.3	0.5	0.7
Sucrose	35	40	45
Citric acid	0.2	0.2	0.2
Sodium benzoate	0.1	0.1	0.1
Orange oil	q.s	q.s	q.s
Purified water	upto 100 ml	upto 100 ml	upto 100 ml

Evaluation Parameter

Organoleptic Properties

1) Appearance

smooth, clarity, homogeneity

2) color

Light -brown to orange -brown colored jelly obtained. The formulation should exhibit a uniform light brown to yellowish-brown colour due to the presence of bael pulp and herbal ingredients. No discoloration or dark spots should be observed.

3) Texture

Soft, smooth, and uniform texture. The texture of the jelly was soft and uniform with good consistency. The pH of the formulation was found to be 6.2 ± 0.1 , which is suitable for oral administration and indicates compatibility with the oral cavity without causing irritation. The jelly should exhibit a smooth, soft and elegant texture without lump formation, grittiness or stickiness.

4) Odour

Pleasant fruity odor observed. Odour The jelly should possess a pleasant fruity and characteristic odour of bael with a mild aromatic smell of flavouring agent such as orange oil. No unpleasant or rancid odour should be present.

5) Taste

The formulation should show a sweet and slightly tangy taste with acceptable palatability. Bitterness or irritation should be absent.

Physiochemical properties

6) PH

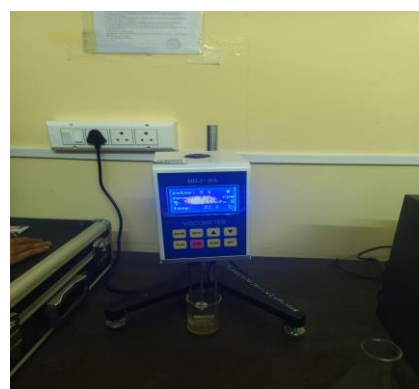
PH found to be 6.13. The pH of oral jelly is evaluated to ensure compatibility with oral mucosa and stability of formulation. The pH should remain within the range of

5.5-6.13 which is considered suitable for oral administration. Extreme acidic or alkaline pH may cause irritation and instability of herbal constituents.



7) Viscosity

Viscosity observed as 1000 to 22.2 cp, with reverse 6, showing good consistency and stability. Viscosity determines the flow behaviour and consistency of the jelly preparation. The oral jelly should possess optimum viscosity to maintain proper texture and spreadability while retaining shape during storage. Excessive viscosity may make swallowing difficult whereas very low viscosity may result in poor gel formation.



8) Spreadability

Spreadability indicates the ease of application and uniformity of jelly texture. The jelly should spread uniformly with slight pressure and should not show cracking or phase separation during spreading.



9) Homogeneity

Homogeneity is evaluated by visual inspection to determine uniform distribution of ingredients. The jelly should appear uniform throughout without aggregation, coarse particles or air bubbles.

RESULT

Parameter	F1	F2	F3
Appearance	Slightly soft gelly	Smooth gelly	Hard jelly
Color	Light brown	Orange-brown	Dark brown
Odor	Characteristics	Pleasant fruity	Slightly strong
Taste	Sweet	Sweet & acceptable	Highly sweet
Texture	Soft	Elastic & smooth	Hard & rubbery

2. PH Determination

The pH of all formulations ranged between 5.2 and 6.1, which is suitable for oral administration and compatible with the oral cavity. Slight acidity was observed due to citric acid and natural fruit acids present in bael pulp.

Formulation	PH
F1	5.2 to 0.03
F2	5.8 to 0.05
F3	6.1 to 0.04

3. Viscosity

Viscosity studies demonstrated that polymer concentration directly influenced jelly consistency. Formulation F2 showed optimum viscosity, ensuring easy molding, adequate firmness, and good patient acceptability.

Formulation	Viscosity
F1	2100 to 15
F2	2850 to 18
F3	3520 to 20

DISCUSSION

The present study focused on the formulation and evaluation of a bael-based herbal gut health oral jelly intended to improve gastrointestinal health and patient

The formulated bael-based herbal gut health oral jelly was successfully prepared using bael pulp, gelatin, sodium alginate, xanthan gum, sugar syrup, citric acid, and sodium benzoate. The prepared jelly showed satisfactory organoleptic characteristics, acceptable physicochemical properties, and good stability during the study period. Bael fruit is rich in tannins, flavonoids, coumarins, polyphenols, and dietary fibers, which contribute to its antioxidant, antimicrobial, gastroprotective, and antidiarrheal activities.

1. Organoleptic Evaluation

The prepared oral jelly exhibited a smooth, glossy, and uniform appearance with a light brown to orange-brown color due to the natural bael pulp. The jelly possessed a characteristic pleasant fruity odor and sweet taste with slight herbal flavor. The texture was soft, elastic, and easily chewable without grittiness. The optimized formulation (F2) showed the best acceptability among all trial batches due to balanced consistency and pleasant mouthfeel. Excess gelatin concentration in F3 produced a harder jelly, whereas lower polymer concentration in F1 resulted in softer consistency.

compliance. Oral jelly was selected as the dosage form because of its ease of administration, pleasant mouthfeel, rapid dissolution, and suitability for pediatric and geriatric patients who may experience difficulty swallowing conventional tablets or capsules. The incorporation of bael fruit pulp into the jelly formulation was found to be effective due to the fruit's natural medicinal and nutritional properties.

Bael (*Aegle marmelos*) is a well-known medicinal fruit traditionally used in the management of gastrointestinal disorders such as diarrhea, constipation, dysentery, indigestion, and gastric irritation. The therapeutic activity of bael is mainly attributed to the presence of phytoconstituents such as tannins, flavonoids, alkaloids, marmelosin, coumarins, pectin, and dietary fibers. These compounds exhibit antioxidant, antimicrobial, anti-inflammatory, and gastroprotective activities that support digestive health and improve gut function. Previous studies have also reported that bael possesses significant nutraceutical potential and beneficial effects on the gastrointestinal tract.

During formulation development, different concentrations of gelatin, sodium alginate, and xanthan gum were used to optimize jelly consistency and stability. Among all the prepared formulations, F2 showed the best overall performance in terms of texture,

firmness, spreadability, and stability. The balanced concentration of gelling agents in F2 produced a smooth, elastic, and easily chewable jelly with acceptable patient-friendly characteristics. In contrast, F1 showed softer consistency due to lower polymer concentration, while F3 became comparatively hard and rubbery because of excess gelatin content.

CONCLUSION

The present study successfully formulated and evaluated a bael-based herbal gut health oral jelly using natural bael pulp and suitable pharmaceutical excipients. The developed oral jelly showed satisfactory physicochemical characteristics, good stability, acceptable organoleptic properties, and rapid dissolution behavior, indicating its suitability as an effective herbal oral dosage form. Among the prepared formulations, formulation F2 was found to be the optimized batch based on evaluation parameters such as appearance, texture, pH, viscosity, spreadability, syneresis, content uniformity, and in-vitro dissolution profile. The optimized formulation exhibited smooth texture, pleasant taste, adequate firmness, minimum water separation, and rapid release of active constituents, thereby enhancing patient acceptability and compliance.

Bael fruit (*Aegle marmelos*) contains various bioactive phytoconstituents including tannins, flavonoids, alkaloids, coumarins, and dietary fibers, which possess antioxidant, antimicrobial, anti-inflammatory, gastroprotective, and digestive properties. These medicinal properties contribute significantly toward improving gastrointestinal health, regulating bowel movement, supporting gut microflora, and relieving digestive disorders.

The prepared oral jelly also demonstrated good microbial stability during storage due to the incorporation of suitable preservatives and proper formulation techniques. The jelly dosage form offers several advantages over conventional solid dosage forms, such as ease of administration, improved palatability, rapid disintegration, better patient compliance, and suitability for pediatric and geriatric patients.

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