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Formulation and evaluation of bael candy for constipation

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Abstract
Constipation is a common digestive problem that can affect people of all age groups. It happens when bowel movements become less frequent or difficult to pass. Constipation can have many causes, including diet, lifestyle, or underlying health issues. It can also be short-term (acute) or long-lasting (chronic), and its severity can range from mild to severe. Laxatives are commonly used to induce bowel movements, but their frequent use can disrupt gut motility and microbiota balance, potentially leading to dependency.
Bael, a fruit from the Aegle marmelos tree (part of the Rutaceae family), has been used in traditional Ayurvedic medicine for centuries because of its many health benefits. This fruit contains natural compounds that help with digestion and can relieve constipation. Bael is also known for its anti-diabetic, anti-microbial, anti-cancer, and wound-healing properties. Different parts of the bael tree, such as the fruit, leaves, bark, and seeds, are used to make various products like powders, candies, jams, and juices, making it a popular natural remedy worldwide.

Keywords: Constipation, bowel movement, gut motility, microbiota balance, bael fruit, ayurvedic product, digestion

Introduction

Constipation is a common digestive issue that can cause infrequent, difficult, and painful bowel movements. It can sometimes be severe enough to block the intestines, which may require surgery. Around the world, constipation affects a large number of people, with its prevalence ranging from 1% to 80%, depending on the region. This variation comes from different definitions of the condition and how it's diagnosed. Chronic constipation, which is more common in older people, can significantly affect a person's quality of life and increase healthcare costs.

In daily life, many people turn to herbal products for health benefits, and plants are important for providing essential nutrients. It is estimated that 80% of plant species on Earth are part of the Angiosperms (flowering plants), with about 21,000 of these species used for medicinal purposes, according to the World Health Organization (WHO). There has been a growing interest in researching plants and their potential health benefits. In India, the market for medicinal herbs is particularly large.

Bael, also known as *Aegle marmelos*, is an indigenous plant in India that is used for its medicinal properties. The bael tree belongs to the Rutaceae family and produces a fruit rich in bioactive compounds, including alkaloids, tannins, essential oils, resins, gums, and polysaccharides. Different parts of the bael tree—such as the roots, bark, leaves, flowers, seeds, and fruit—are used in traditional medicine.

The bael fruit, commonly used as a home remedy in India, is known to boost the immune system, relieve constipation, and support heart health. It is a dry land crop, and its tonic preparations, known as *sharbat*, are popular drinks. In ancient Ayurvedic medicine, bael was highly valued for its healing properties. The fruit contains many seeds covered in fibrous hairs and is associated with numerous health benefits, such as anti-diabetic, antimicrobial, anti-cancer, and wound healing effects.

Bael fruits are harvested from mid-April to May, and they hold economic value, as products like juice, candies, and other goods can be made from them.

Material and method

Table 1

Bael (Wood Apple)	Rich in fiber and laxative properties, helps soften stools and promote bowel movements.
Almond	Contains healthy fats and fiber, which aid digestion and support smooth bowel movements.
Castor Oil	Acts as a natural stimulant laxative, helping the intestines contract and push stools out.
Cinnamon	Stimulates digestion, reduces bloating, and promotes gut motility.
Jaggery	A natural detoxifier that stimulates digestive enzymes and promotes regular bowel movements.
Sodium Benzoate	Preservative

Ingredients
1. Bael fruit:
Kingdom: Plantae-plants

Family: Rutaceae

Biological name: *Aegle marmelos*

Biological source: Aegle marmelos L. (Family: Rutaceae) is a medium-sized deciduous tree cultivated in India with the common name "Bael" or "Wood apple.

Chemical constituent: Alkaloids, flavonoids, phenolic acids, coumarins, and terpenoids.

Uses: 1. Improve digestion
2. Effective in treating dysentery, diarrhoea and other gastrointestinal disorder

Physical properties

1. **Shape:** Oval or round
2. **Size:** Diameter 5cm to 10 cm
3. **Colour:** Yellowish orange rind and a sweet, orange colour pulp
4. **Taste:** Sweet, aromatic, and slightly tangy flavour

Description

Bael (Aegle marmelos) is a plant whose unripe fruit, root, leaf, and branch are traditionally used in herbal medicine. It has been historically used for a variety of conditions, particularly digestive disorders like constipation and diarrhea, although there is limited scientific evidence to robustly support these therapeutic claims. The plant also holds significance in traditional medicine for its tonic effects on the heart and brain, and it has been utilized in treating conditions such as hepatitis and tuberculosis.

Bioactive compounds and nutritional composition

Bael fruit is rich in several bioactive compounds, including alkaloids, flavonoids, glycosides, and tannins, which may account for its medicinal properties. The fruit's chemical constituents, such as essential oils, phenols, and vitamins, contribute to its potential therapeutic effects.

Bael is especially noted for its nutritional value, providing essential vitamins (A, B1, B2, and C) and minerals (calcium, potassium, and iron). The high fiber content in bael is significant, as dietary fiber has been associated with improved digestive health by promoting bowel regularity and alleviating conditions like constipation and diarrhoea.

Digestive health benefits

1. **Constipation and diarrhoea:** Bael are commonly used for the management of gastrointestinal disorders, including constipation and diarrhea. The unripe bael fruit, in particular, possesses constipating properties due to its high tannin content, which can help reduce intestinal motility. On the other hand, the ripe fruit contains a greater proportion of soluble fiber, which acts as a natural laxative and aids in softening stools. These properties make bael useful in regulating bowel movements and alleviating symptoms of indigestion.

2. **Dysentery and cholera:** The presence of tannins in bael may be beneficial in treating dysentery and cholera by exerting antimicrobial and anti-inflammatory effects on the intestinal lining, thereby reducing symptoms such as diarrhea, cramps, and inflammation. Tannins have been shown to inhibit the growth of pathogens like *Shigella* and *Vibrio cholerae*, the causative agents of dysentery and cholera, respectively.

2. Almond

Kingdom: Plantae-plants

Family: Rose family

Biological name: *Prunus dalcis*

Biological source: Prunus dalcis tree

Chemical constituent: Fatty acids, vitamins, minerals, fibers.

Uses: 1. Help to get rid of constipation problem
2. Provide relief from acidity and stomach ulcers

Physical properties

1. **Shape:** Oval shape
2. **Size:** 18/20 (largest) to 36/40 (smallest).
3. **Colour:** Brown
4. **Taste:** Mild, subtly sweet, and nutty flavour

Description

Almonds can be beneficial for alleviating constipation primarily due to their high fiber content, magnesium, and healthy fats, each contributing to the promotion of regular bowel movements and overall gastrointestinal health. Here is the breakdown of the relevant mechanisms:

1. **Dietary Fiber:** Almonds are an excellent source of dietary fiber, with approximately 3.5 grams per ounce (28 grams). Fiber plays a critical role in gastrointestinal function by adding bulk to the stool, increasing its water retention, and stimulating peristalsis—the coordinated contraction of intestinal muscles. This facilitates the easier passage of stool and helps prevent the development of constipation. Specifically, fiber passes through the small intestine undigested and reaches the colon, where it undergoes fermentation by gut microbiota, further enhancing bowel regularity.

2. **Magnesium:** Almonds are a rich source of magnesium, which has well-documented effects on bowel function. Magnesium acts as a natural osmotic laxative by attracting water into the intestines, thereby softening stool and enhancing motility. This can ease defecation by reducing the hardness of the stool and increasing its volume. Additionally, magnesium plays a role in smooth muscle contraction, further promoting colonic motility, which can alleviate symptoms of constipation.

3. **Healthy Fats:** The monounsaturated and polyunsaturated fats present in almonds contribute to improved digestion and intestinal motility. These fats are thought to support the production of bile, which aids in the emulsification and digestion of dietary fats. Additionally, healthy fats can stimulate the smooth muscles of the intestines, facilitating peristalsis and encouraging regular bowel movements.

4. **Additional Nutrients:** Almonds are rich in micronutrients such as vitamin E and potassium, which support overall health and may indirectly benefit bowel function by reducing inflammation and maintaining electrolyte balance, respectively.

3. Jaggery

Family: Poaceae

Biological name: *Sachharum officinarum L*

Biological source: Sugarcane juice or the sap of date palms

Chemical constituents: Sucrose along with smaller amount of invert sugars (fructose & glucose) moisture, various minerals & vitamins.

Uses: 1. Stimulate bowel movement and improve digestion
2. Acting as a natural laxative and digestive aid.

Physical properties

1. **Shape:** Blocks, cubes, powder, and liquid

2. **Size:** Block jaggery, powdered jaggery

3. **Colour:** dark brown colour, orange colour

4. **Taste:** Sweet

Description

Jaggery, often referred to as “Guda” in traditional medicine, is an unrefined form of sugar derived from sugarcane or date palms. Unlike refined sugar, which undergoes extensive processing, jaggery retains a significant amount of minerals, vitamins, and other bioactive compounds. It is commonly consumed as a natural sweetener and is believed to have several health benefits, including aiding digestion and preventing constipation.

1. Laxative properties and digestive stimulation

Jaggery is widely recognized for its digestive benefits, largely due to its ability to stimulate the secretion of digestive enzymes. It is believed to have a "Ushna" (hot) property in Ayurvedic medicine, which implies that it generates heat in the body and promotes the activation of digestive processes. This can enhance the breakdown of food and improve bowel movements.

The presence of sucrose in jaggery is one of the key components that contribute to its digestion-enhancing properties. When consumed, sucrose helps to increase the secretion of gastric juices and digestive enzymes, which accelerates the breakdown of food in the stomach and intestines. This can, in turn, help in preventing constipation by promoting more efficient digestion and facilitating the movement of food through the gastrointestinal tract.

2. Potassium and fluid balance

Jaggery contains potassium, an essential electrolyte that helps maintain fluid balance in the body. Potassium plays a crucial role in regulating the balance of water and electrolytes in cells and tissues, which can prevent water retention and bloating. In the context of digestion, proper fluid balance helps in softening the stool, making it easier to pass, and preventing constipation.

Additionally, the potassium in jaggery helps to balance sodium levels, which is important for maintaining proper bowel function. Potassium is also involved in the contraction of muscles, including those in the intestines (smooth muscle), promoting peristalsis—the wave-like muscle contractions that move food through the digestive tract.

3. Ghee and jaggery combination for digestive health

When jaggery is consumed in combination with ghee (clarified butter), as is traditional in many cultures, the synergistic effect may further enhance its digestive benefits. Ghee is rich in butyrate, a short-chain fatty acid that has been shown to promote gut health by supporting the integrity of the intestinal lining and reducing inflammation. Ghee can also lubricate the intestines, easing the passage of stool and further improving bowel movements.

The combination of jaggery's digestive stimulation and ghee's soothing properties can thus create an environment conducive to regular and smooth bowel movements.

4. No Fiber or water content

While jaggery contains significant amounts of minerals like iron, magnesium, and potassium, it is important to note that it does not contain dietary fiber or water, both of which are critical for promoting regular bowel movements. Dietary fiber absorbs water in the intestines, increasing stool bulk and improving the consistency of stool, making it easier to pass. Since jaggery lacks these fiber and water components, its effect on constipation relief is largely attributed to its ability to stimulate digestive enzymes and facilitate peristalsis, rather than by directly increasing stool bulk or hydration.

Therefore, while jaggery can support digestion and improve bowel movements, it should ideally be combined with a fiber-rich diet and adequate hydration to maximize its constipation-relief benefits.

5. Summary of scientific benefits of jaggery

- **Digestive Stimulation:** Jaggery enhances the secretion of digestive enzymes, promoting better digestion and preventing constipation.

- **Potassium Content:** Jaggery helps maintain fluid balance, preventing water retention and promoting smooth muscle contraction, which aids bowel movements.

- **Combination with Ghee:** When consumed with ghee, jaggery can further improve digestion and alleviate constipation by providing lubrication to the intestines and supporting gut health.

- **Limited Fiber and Water:** Jaggery lacks fiber and water, both of which are essential for improving stool bulk and hydration, so it should be complemented with fiber-rich foods and sufficient water intake for optimal digestion and constipation relief.

Cinnamon

Kingdom: Plantae –plants

Family: Laurels

Biological name: *Cinnamomum verum*

Biological source: The dried inner bark of trees belonging to the genus Cinnamomum

Chemical constituent: Cinnamaldehyde, linalool, eugenol

Uses: 1. Helps relieving constipation
2. Stimulates bodys natural defenses.

Physical properties

1. **Shape:** Rolled, quill-like shape

2. **Size:** 5 to 50 cm

3. **Colour:** Rich brown

Description

Cinnamon (*Cinnamomum spp.*) is widely recognized for its potential health benefits, including its role in digestive health. However, its efficacy as a primary treatment for constipation remains limited. Below is a scientific analysis of its potential benefits and risks concerning digestive function and constipation.

Potential Benefits of Cinnamon on Digestive Health

1. Gastrointestinal Modulation

Cinnamon contains bioactive compounds such as cinnamaldehyde, eugenol, and polyphenols, which may aid in digestion by stimulating the production of digestive enzymes. This can help alleviate symptoms of bloating, indigestion, and mild gastrointestinal discomfort.

2. Antioxidant and Anti-inflammatory Properties

The polyphenolic compounds in cinnamon exhibit strong antioxidant and anti-inflammatory activities. These properties may contribute to overall gut health by reducing oxidative stress and inflammation in the gastrointestinal tract, which can play a role in various digestive disorders.

3. Impact on Gut Microbiota

Some studies indicate that cinnamon may modulate the gut microbiome by promoting the growth of beneficial bacterial strains while inhibiting pathogenic bacteria. A well-balanced gut microbiota is essential for maintaining digestive function and overall gastrointestinal health.

5. Castor oil

Kingdom: Plantae- plants

Family: Spurges

Biological name: *Ricinus communis*

Biological source: The seeds of Ricinus communis plant also known as castor bean or castor oil plant.

Chemical constituent: Rinoleic acid

Uses: 1. Use to treat ocassional constipation.
2. It is used as a natural laxative.

Physical properties

1. **Shape:** Oval, shiny, and bean-like

2. **Size:** 2 to 5 inches

3. **Colour:** Black, gray, brown, yellow-brown, maroon, and white

4. **Taste:** Bitter and unpleasant

Formulation table

Table 2

Ingredient	Function	Quantity (for 300g batch)
Bael extract (pulp)	Base fruit & flavour	180 g
Jaggery	Sweetener, binder	90 g
Almonds (chopped)	Texture, nutrition	15 g
Castor oil (edible)	Anti-sticking agent, softness	6 ml
Sodium benzoate	Preservative	0.3 g
Cinnamon powder	Flavour enhancer	1.5 g
Total		~293.8 g

Method of preparation

1. Prepare the Bael Pulp

Break open ripe bael fruits and scoop out the pulp.
Remove seeds and fibers manually or by pressing through a sieve.
Ensure the pulp is smooth and thick.

2. Cook with Jaggery

Place the bael pulp and jaggery into a heavy-bottomed pan, allowing the rich ingredients to gently meld over low heat.
Heat on a low flame, stirring continuously until the jaggery melts and blends well.
Cook until the mixture thickens to a soft-candy consistency (semi-solid, like fruit leather).

3. Add Castor Oil

Once the mixture starts to cool slightly (not too hot), add castor oil.
Mix thoroughly to evenly distribute the oil. This helps avoid an overpowering taste.

4. Flavouring and Preservation

Add cinnamon powder for flavour and digestive benefit.
Stir in crushed almonds for texture and added mild laxative effect.
Dissolve sodium benzoate in 1 tsp warm water and mix into the mixture. This prevents spoilage.

5. Forming the Candy

Spread the thickened mixture onto a greased tray or parchment paper.
Allow it to cool and set.
Once the mixture sets and holds its shape, slice it into neat cubes or shape it into small, poppable balls for easy snacking.

Storage: Store in an airtight container.
Shelf life: Up to 1 month in cool, dry conditions (refrigeration can extend it).

Dosage (Adult):

1–2 pieces daily (preferably after meals).
For acute constipation: 1 piece at night with warm water.

Cautions: Not suitable for children under 10 years due to castor oil content.

Fig 1: Weighing Ingredients

Fig 2: Mixing

Fig 3: Bael Candy

Evaluation Test

1. Physicochemical Analysis

a. Moisture Content

The Oven Drying Method at 105°C was employed to determine the moisture content. A known quantity of bael candy (sample size: approximately 5–10 g, representative of the 300 g batch) was weighed and placed in a hot air oven. The sample was dried until a constant weight was achieved, indicating removal of moisture.

Observation and Calculation

- Initial weight of sample (W_1) = 10.00 g
- Final weight after drying (W_2) = 8.65 g

Moisture Content (%) = $(W_1 - W_2)/W_1*100$

Moisture Content = **(13.5%)**

b. pH (Using pH Paper)

To estimate the pH of bael candy using pH indicator paper (pH strips) and assess the acidity for quality and preservation.

Procedure

1. About 10g of the bael candy was taken and mixed with 50 ml of distilled water in a clean beaker.
2. The mixture was stirred thoroughly to form a uniform solution.
3. A pH paper strip was dipped into the solution for 2–3 seconds
4. The strip was removed and immediately compared with the color chart provided with the pH paper pack

c. Organoleptic Test

Conduced using a 9-point Hedonic Scale to rate:

Appearance, Colour, Texture, Flavour, Overall Acceptability

Formulated Sample Variants

Sample Composition Highlights

a. Balanced: Almonds, mild castor oil, cinnamon, jaggery
b. Extra cinnamon
c. More almonds, less jaggery

Observations

Sample A is the most accepted with a good balance of sweetness, aroma, and crunch from almonds.

Sample B was aromatic but slightly overpowering.

Sample C had a nutty, less sweet profile; niche appeal.

Result

Table 3: pH Test

Parameter	Observed Value	Acceptable Range
pH (using pH paper)	4.5–5.0	4.0–5.5 (for fruit-based products)

Table 4: Organoleptic Test

Parameter	Sample A	Sample B	Sample C
Appearance	8.3	7.6	7.8
Colour	8.1	7.3	7.6
Texture	8.5	8.0	7.2
Flavour	8.6	8.1	7.4
Overall Acceptance.	8.5	7.8	7.3

Moisture Content: The moisture content in the bael candy was found to be **13.5%,** which is below the acceptable limit of 15%

Conclusion

Bael candy serves as a natural gut health enhancer due to its fiber, prebiotic, antimicrobial, and anti-inflammatory properties. It helps:

- **Regulate bowel movements:** Prevents both constipation and diarrhoea.
- **Nourish gut microbiota:** Promotes a healthy balance of good bacteria.
- **Detoxify the gut:** Eliminates toxins and waste buildup.
- **Protect the stomach lining:** Helps with acid reflux and ulcer prevention.
- **Reduce inflammation and oxidative stress:** Prevents long-term gut damage.

Bael candy is a tasty, medicinal alternative to synthetic digestive aids, making it a functional food for daily gut health maintenance.

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