



Beal (aegle marmelos) An Astonishing Herb Of India

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ABSTRACT

Aegle marmelos (linn.) Correa ex roxb. (family rutaceae) possesses tremendous therapeutic potentials as every part of the plant like fruit, seed, bark, leaf and root are most effective remedy for controlling diarrhea, dysentery, constipation, peptic ulcer and respiratory infections. Medicinal properties include anti-diabetic, anti-microbial, anti-inflammatory, anti-pyretic, analgenic, cardioprotective, anti-spermatogenic, anti-cancer and radio-protective. The fragrant tree is a climate purifier as it emits high percentage of oxygen in sunlight compared to other plants and absorbs poisonous gases from atmosphere and makes them inert or neutral.

Considering wide prospects and potentials of this sacred tree, it is suggested to cultivate on large scale, especially on unproductive and wasteland and systematic as well as scientific research are required to explore the maximum potentials of this underutilized plant for upliftment of rural poor.

Bael (*aegle marmelos* l. Correa) is an economically valuable tree species in south asia. The ripen bael fruits are popular among people because of the delicious fruit pulp, which is ideal for making jam, syrup, and pudding. Bael possesses many medicinal values and therefore used as an ingredient in ayurvedic herbal medical preparations. The fruits, bark, leaves, seeds, and roots of bael contain bioactive compounds such as coumarin, imperatorin, aegeline, and marmeline, alkaloids.

Key Words : *Aegle Marmelos* , Sacred Tree

- Fragrant Species
- Climate Purifiers
- Constituents
- Medicinal Properties

1. INTRODUCTION

Bael, (*Aegle marmelos* L. Correa) is one of the medicinally treasured tree species out of the 250,000 living terrestrial plant species on earth. Bael is also known as begal-quince, golden apple, and stone apple in India and a sacred tree in places where Hindus live. Bael trees are usually planted near temples dedicated to Lord Shiva and routinely worshiped by the devotees.

According to the historical records, bael is used as a medicinal and food item since 5000 B.C. and known to human beings even when writing the famous Sanskrit epic poem Ramayana. Bael mentioned in the renowned book Charaka Samhita.

The tree is aromatic, and all the parts are medicinally important. Fruits, leaves, bark, roots, and seeds are used in Ayurvedic and folk medicine systems to treat various ailments. Herbal medicines are heavily used and immensely popular in developing countries. Bael fruits and leaves are used to treat dysentery, dyspepsia, mal-absorption, neurological diseases, edema, vomiting, and rheumatism.

Bael fruit is nutritionally rich in protein, fat, minerals such as Ca and Fe and vitamins mainly riboflavin, β carotene and Vitamin C.

Fruits are used to improve digestion and cure stomach diseases. Fruits can be processed into various beverages and preserves. Despite its Indian origin and utilization for its high medicinal and nutritional values, in India, flowering occurs in April and May soon after the new leaves appear and the fruit ripens in 10 to 11 months from bloom March to June.

2. PLANT PROFILE

Scientific Classification ■ Kingdom

— Plantae.

- Order — Sapindales.
- Family — Rutaceae.
- Subfamily — Aurantioideae.
- Genus — Aegle.
- Species — Aegle Marmelos.
- Botanical Name - Aegle Marmelos.

Local Names

- English: Bengal Quince, Beal Fruit, Golden Apple, Indian Quince, Stone Apple.
- Tamil: Aluvigam, Iyalbudi, Kuvilam, Mavilangai, Vilwam, Villuvam.
- Telugu: Bilvamu, Maluramu, Maredu, Sailushamu, Sandiliyamu, Sriphalamu.

- Hindi: Bel, Bili, Sripthal, And Bela.
- Sanskrit: Adhararutha, Asholam, Atimangaliya.
- Bengal: Bael, Bel.
- Gujarat: Billi.
- Kannada: Bela Bilva.
- Malayalam: Koovalam, Vilwam.
- Orissa: Belo.

3. SACRED VALUE

Hindus hold Aegle marmelosin great Venerations as one of the most sacred trees of India. The leaves are ternate and hence one of the vernacular Names is Tripatra (Dey and Bahadur, 1973). It is generally Cultivated near temples and offered to Lord Shiva whose Worship cannot be completed without the leaves of this Tree. Lord Shiva is believed to live under Bael tree. It is Also called Shivadurmethe tree of Shiva. According to Hindu mythology, the tree is another form of Lord.

It is also Sacred to Parvati and is the Vilvarupra, one of the Patricas, or nine forms of Goddess Kali. Its leaves are Also used as enchantments. It is incumbent upon all Hindus to cultivate and cherish this tree and it is sacrilege To cut it down. The mentions of plant have also been Found in ancient Indian scriptures such as Vedas and Purana (Atal and Kapur, 1997) like Yajurveda and Mahabharata (Purohit and Vyas, 2004).

4. CULTIVATION AND COLLECTION

Aegle marmelos is cultivated all over India, often sending up off-shoots from the roots which later on become trees. Also found wild in sub-Himalayan forests and south India. The plant is widely cultivated particularly in Uttar Pradesh, Bihar and Chhattisgarh.

Soil type : Good sandy loam soil, sunny condition, warm humid climate are suitable for cultivation of this plant. It requires pH ranging from 5 to 8. Use warm soil i.e. 75- 90F.

Seed propagation : For raising seedlings, freshly extracted seeds from healthy fruits should be obtained and sown immediately.

➤ IRRIGATION :

Young plants need to be watered regularly in summer and one month interval in winter for their rapid vegetative growth and establishment. In bearing trees irrigation is not required in dry summer, as it sheds leaves and resists hot dry summers. Irrigation can be applied at the time of new leaf emergence.

➤ HARVESTING :

Plants start giving fruits in 6 to 7 years after transplantation. Harvesting is done in the month of January when fruits start giving yellowish-green appearance. The yellowish-green fruit is kept for 8 days so they lose its green tint. Handle with care so that the fruits will not fall otherwise minor cracks occur in the shell. For processing, fully ripe fruits with soft flesh are used.

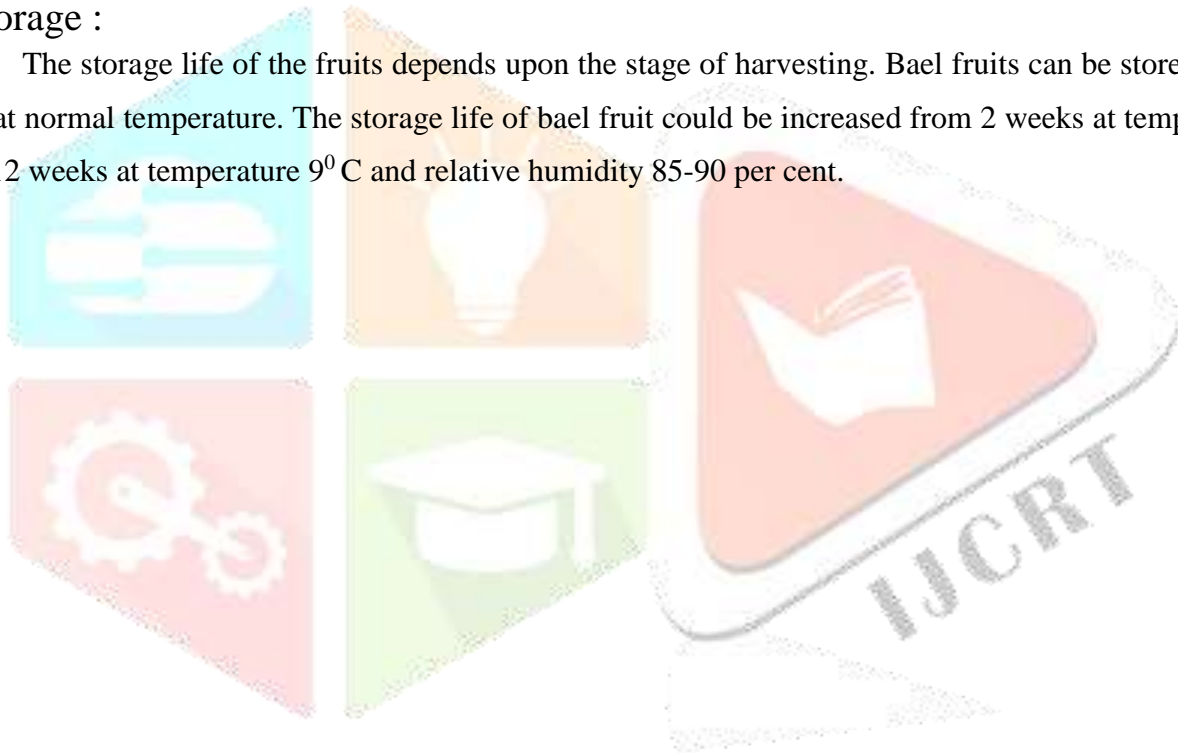


➤ Grading & Packaging :

Bael fruits owing to variation in shapes and sizes, require proper grading. The deshaped/small and cracked fruit should be discarded. Bigger sized and medium/small sized fruits, depending on the varieties should be separated. Not much work has been conducted on packaging of bael fruits. Generally these are packed in gunny bags, basket or wooden boxes and sometimes just laoded unpacked. However, it is essential that cushioning material i.e., straw, paper, saw dust, news paper liner, paper cuttings etc. are used for packaging bael fruits. Care should be taken that the fruit should not develop any cracks or damage during packing, transportation, marketing and storage.

➤ Storage :

The storage life of the fruits depends upon the stage of harvesting. Bael fruits can be stored for 10-15 days at normal temperature. The storage life of bael fruit could be increased from 2 weeks at temperature 30⁰ C to 12 weeks at temperature 9⁰ C and relative humidity 85-90 per cent.



5. Pest and disease their control

- Lemon butterfly : It is caused by *Papilio demoleus*. It can be cure by the spray of Spinosad@60ml at the interval of 8 days in nursery seedlings.



- Bael butterfly : It is caused by *Bactrocera zonata*.



- Leaf eating caterpillars : It causes major problems when new leaves arise and it is cured by application of Thiodan @ 0.1%.



- **Alternaria leaf spot** : Typical concentric rings are formed in spots/ lesions of brown colour on leaves . Severe defoliation may take place, if not managed at right time. High humidity must be avoided in shade net houses and precautionary spray on seedlings, grafts and trees should be done with copper oxychloride (0.2%) or hexaconazole (0.1%) at 15-20 day interval during monsoon and heavy dew periods.



Fig.: Alternaria leaf spot

- **Black leaf spot** : *Isaropsis* sp. Is the cause of this disease, which develops on both the surfaces of leaves as 2-3 mm black spot (Fig). For management of the disease, spraying of hexaconazole (0.1 %) is recommended.



Fig.: Isaropsis black leaf spot

- Stalk end rot : Stalk end rot of bael is caused by *Fusarium solani* (Mart.) Sacc. The dropping of Immature young fruits takes place due to the infection stem end portion. The disease can be managed by spray with propiconazole or hexaconazole @ 1.0 ml/l at fortnightly interval when fruits are small.



Fig.: Stalk end rot

6. MORPHOLOGICAL CHARACTERIZATION

- Leaf Morphology.: the leaves are alternate, single, occasionally two pairs of shortly stalked opposite leaflets. the leaf petioles are glabrous and long, and with no wings absent. A leaflet is 4—10 cm long and 2—5 cm wide. the leaflets are thin, and their midribs are prominent from the beneath. the terminal leaflet has a longer petiole. the new foliage emerging after a dormant or a reproductive phase is glossy in appearance and pink or burgundy in color.



Fig.:Bael Leaves

- Flower Morphology.: the flowers are fragrant and form 4—7 clusters along the new branches. A flower has four or five recurved and fleshy petals (the exterior color is green, and the inside color is yellow) with 50 or more greenish-yellow stamens.



Fig.: Bael Flowers

- Fruit Morphology.: The fruits have a hard, smooth-Woody shell. the crust is gray-green at early stages, turns yellowish or orange at the ripening stage and becomes very hard and Orange-red when dried. the bael Fruit exists in diverse shapes ranging from round, pyriform, oval, or oblong. The fruits are 5—20 cm

in Diameter. Inside the fruit, There is a hard central core with 8 to 20 indistinctly apparent Triangular segments with thin, dark-orange walls.

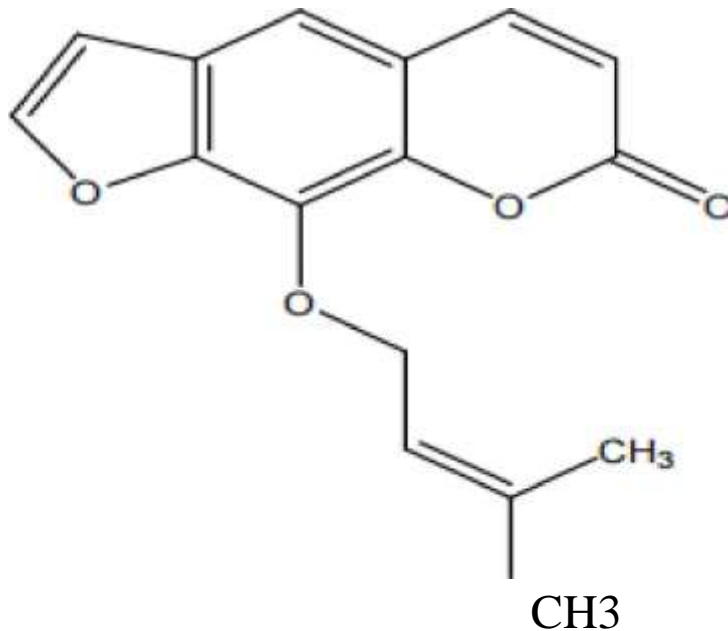


Fig.: Bael fruit

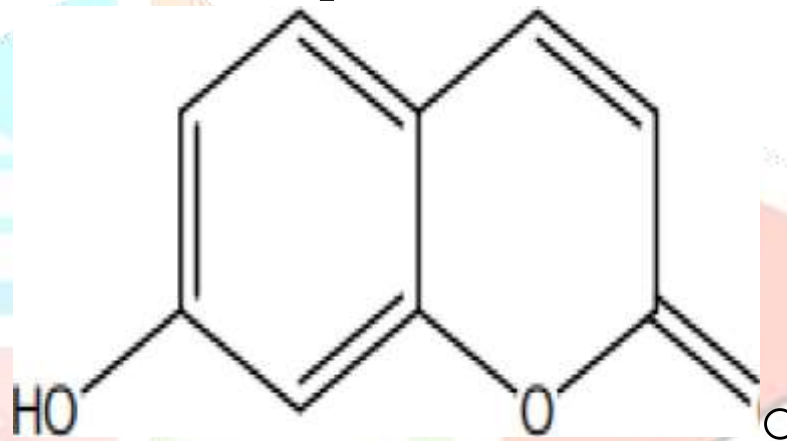
7. CHEMICAL CONSTITUENTS

Various chemical constituents like alkaloids, coumarins, polysaccharides, tannins, carotenoids etc have been isolated and identified from different parts of tree such as leaves, fruits, wood, root and bark.

- (a) Alkaloids: Leaves mainly contain rutacine, γ -sitosterol, aegeline and aegeline, marmeline, fragrine, dictamine, cinnamide and different derivatives of cinnamide.
- (b) Coumarins: Marmin, marmesin, umbelliferone, umbelliferone, skimmianine, Scoporone, scopoletin, psoralen, marmelide, xanthotoxol and impertonin were identified from the bark leaves, fruit and root of plant.



Impertonin



Umbeliferone

- (c) Seed oil: seed oil is bitter and contains 15.6% palmitic acid, 8.3% stearic acid, 28.7% linoleic and 7.6% linolenic acid while seed residue contains about 70% protein
- (d) Polysaccharide: reducing sugars such as galactose, arabinose and L-rhamnose are found in fruit (e) Carotenoids: are present in fruit and responsible for characteristics color of fruit. It was found that root of Aegle marmelos tree contain psoralin, xanthotoxin and scopolotein.

8. PHYSICOCHEMICAL CHARACTERISTICS

, PHYSICAL PROPERTIES OF BAEL FRUIT :

The physical characteristics of Bael fruit were studied. Matured green and ripe, healthy fruits with uniform size, colour, and maturity were selected. The length, width, diameter, and average weight were measured. Specific gravity, volume, and total soluble solids were also measured. The flesh was removed with the help of knife or the spoon manually and separated rind and seeds and their weights were recorded separately.

1. Average weight

The weight of randomly selected three fruits was taken individually on an electronic weighing balance. Then average weight of fruit was calculated and expressed in grams.

2. Average length

The length of five fruits measured with help of Vernier Caliper and average calculated and expressed in cm.

3. Average diameter

The diameter of five fruits was measured and then average was calculated and expressed in cm.

4. Number of seeds per fruit

The number of seeds per fruit of five fruit was measured manually then average was calculated and expressed in number.

5. Thickness of rind

Thickness of rind of five fruits was measured by Vernier Caliper and then average was calculated and expressed in mm.

6. Volume

For measuring the volume, the fruits were put in a measuring cylinder. The water was poured in this measuring cylinder up to the mark (A ml). After a few minutes the water was drained in another measuring cylinder and noted the volume of water (B ml). Volume displaced by fruits = (A - B) ml.

7. Specific gravity

The specific gravity of the fruits was calculated by applying the formula as given below:

$$\text{Specific gravity (g/cc)} = \frac{\text{Weight of fruits}}{\text{Volume of water displaced}}$$

8. Pulp yield

It is ratio of edible part of fruit i.e. pulp to total weight of fruit multiplied by 100. Pulp yield was calculated and expressed in percent.

$$\text{Percent edible index} = \frac{\text{Pulp weight}}{\text{Total weight of fruit}} \times 100$$

9. Waste index

It is ratio of waste part of fruit i.e. pomace to the total weight of fruit multiplied by 100 and expressed in percentage.

$$\text{Percent waste index} = \frac{\text{Weight of waste}}{\text{Total weight of fruit}} \times 100$$

Table 1: Physical parameter of Bael fruit

Sr. No.	Parameter	Value
1	Fruit Colour	Greenish yellow
2	Fruit Shape	Roundish oval
3	Fruit Taste	Sweet, Aromatic, pleasant
4	Average weight(g)	210
5	Average length (cm)	9.3
6	Average diameter (cm)	6.4
7	Specific gravity(g/cc)	0.94
8	Volume (CC)	192
9	Edible index (%)	55.43
10	Thickness of rind (mm)	4.3
11	Rind (%)	22.83
12	Number of seeds per fruit	88
13	Seed	3.31
14	Waste index (%)	44.57

CHEMICAL PROPERTIES OF BAEL FRUIT PULP :

Extraction of pulp from bael fruits firstly ripe Bael fruits of uniform maturity, having greenish yellow color were selected. Then flesh of fruit was separated manually from rind, fiber, and seeds. The Bael fruits were thoroughly washed in running tap water and broken by striking against hard surface. The fruit flesh along with its seeds and fiber were scooped out with the help of stainless steel spoon. An equal amount of water to the weight of pulp was mixed which was kneaded, heated for 1 minute at 80°C and passed through pulper to obtain homogenized pulp free from seeds and fiber.

For analysing chemical properties of the fruit, the fruit were broken and pulp, seed and pericarp of fruit were separated. Moisture, titrable acidity, crude fibre, crude fat, crude protein and ash content were estimated by employing the standard methods of analysis.

1. Moisture

Moisture refers to the amount of free water and volatile substances that are lost by drying the food under controlled temperature in Hot air oven. It is expressed in g per 100 g sample.

2. Crude fat

5 g sample was weighed accurately in thimble and defatted with petroleum ether in Soxhlet apparatus for 6-8 hrs. at 70 °c. The resultant ether extract was evaporated and crude fat content was calculated.

3. Total ash

Total ash was determined according to. 5 gm sample was weighed into crucible and ignited at low flame till all the material was completely charred. Then it was kept in muffle furnace for 6 hrs. at 550 °c and further cooled in desiccators and weighed. This was repeated till two consecutive weights were constant and percent ash was calculated.

4. pH

pH was measured by control dynamic digital pH meter.

5. Carbohydrate

The nature of the carbohydrate was confirmed by Molisch tests. The total carbohydrate content was determined by anthrone method.

• Molisch's test:

1. Take 2ml of sample in dry test tube.
2. Take 2ml of distilled water in another tube as control.
3. Add 2-3 drops of molisch's reagent to the solution.
4. Gently pipette 1ml conc. H₂SO₄ along the side of the tube so that two distinct layers are formed.

5. Observe color change at the junction of two layers.
6. Appearance of purple color indicates the presence of carbohydrates.

6. Acidity as percent citric acid

The acidity of sample was calculated by standard A.O.A.C. method (1990). Acidity was expressed as percent citric acid.

$$\text{as citric acid} = \frac{\text{Titer} \times \text{Normality of NaOH} \times \text{Volume made up} \times 64 \times 100}{\text{Volume of sample taken} \times 1000} \text{ Percent acidity}$$

7. Ascorbic acid

The ascorbic acid was determined by method of Ranganna (1986).

Dye factor = 0.5 Titer value

$$\frac{\text{Aliquot of extract taken} \times \text{Weight or volume of sample for estimation} \times \text{taken for estimation}}{\text{Ascorbic acid mg/ 100 ml} -}$$

$$\frac{\text{Titer} \times \text{Dye factor} \times \text{Volume made up} \times 100}{}$$

8. Dietary Fiber

Total dietary fiber were analysed according to standard AOAC methods (AOAC, 1995).

9. Total sugar

Total sugar content was estimated by the phenol-sulfuric acid analysis using glucose as standard.

Table 2: Chemical composition of Bael fruit

Sr. No.	Parameter	Observation
1	Moisture (%)	62.04
2	Fat	0.39
3	Protein	1.57
4	Ash	1.7
5	Crude fibre	3.07

6	pH	
7	Acidity (%)	0.43
8	Ascorbic acid (mg/ 100 g)	16.80
8	TSS	18
10	Reducing sugar (%)	5.19
11	Total sugar (%)	15.76

9. TRADITIONAL USES

All parts of *Aegle marmelos* are medicinally useful like leaves, fruit pulp, flower, stem bark, root bark etc.

- I. Leaves: Leaves are used as mild laxative or the inflammation of the mucous membrane having a free discharge and for asthma. The decoction of the leaves is febrifuge, or helps in eliminating fever and is an expectorant, or promotes the removal of mucous secretion from the bronchial tubes.
- II. Root: The decoction of the root and sometimes the stem bark is useful in intermittent fever, also in hypochondriasis and palpitation of the heart. Root is a one of the ingredients of Dasamoola a standard Ayurvedic remedy for loss of appetite and puerperal diseases e.g. Inflammation of uterus.
111. Flower: Distillation of flowers yielded a drug used as tonic for stomach and intestine antidiabetic, antidiabetic, diaphoretic and as local anaesthetic. it is also used in epilepsy and as expectorant.
- IV. Fruit: Fruit is eaten during convalescence after diarrhea. It is valid for its mild astringency and as remedy for dysentery. Fruits also used in gastric troubles, constipation, laxative, digestive. Stomachic, brain and heart tonic, ulcer, antiviral intestinal parasites, gonorrhoea, epilepsy.
- V. Ripe fruit: The ripe fruit promotes digestion and is helpful in treating inflammation of rectum. The ripe fruit extract showed antiviral activity against dengue disease virus. Pulp of ripe fruit is sweet, Cooling, aromatic and nutritive when taken fresh

10. PHARMACOLOGICAL ACTIVITIES

- a) Hypoglycemic/anti-diabetic activity : Leaf extract of *Aegle marmelos* has been used in Ayurveda as a medicine for diabetes. It enhances the ability to utilize the external glucose load in the body by stimulation of glucose uptake similar to insulin. Bael extract significantly lowers blood urea and cholesterol in experimental diabetic animals.

- b) Diarrhoea and dysentery : The unripe or half ripe fruit of *Aegle marmelos* is the most effective remedy for chronic diarrhoea and dysentery without fever. Best results are obtained by the use of dried fruit or its powder.
- c) Constipation : Ripe fruit of *Aegle marmelos* is regarded as best of all laxatives as it cleans and tones up the intestine. Its regular use for two to three months helps in evacuation of even the old accumulated faecal matter from the bowels.
- d) Anti-pyretic and analgesic activities : *Aegle marmelos* extract exhibits antipyretic, antiinflammatory and analgesic activities as it has shown a significant inhibition of the carrageen an induced paw odema, cotton pellet granuloma and paw itching in mice and rats.
- e) Peptic ulcer : An infusion of *Aegle marmelos* leaves is an effective remedy for peptic ulcer. The leaves are soaked overnight in water which is strained and taken as a drink in the morning. The pain and discomfort are relieved.
- f) Anticancer activity: Studies showed that Indian bael (*Aegle marmelos*) extract possess significant antiproliferative effect. It inhibits in vitro proliferation of human tumor cell lines including the leukemic K562 and Tlymphoid Jurhat.
- h) Antiemetic: A decoction of the flowers and roots of *Aegle marmelos* is used as an antiemetic.
- i) Cardiotoxic activity : fresh fruit juice of *aegle marmelos* plant with different dilutions were used for Cardiotoxic activity. The present preliminary studies confirm the better cardiotoxic activity of *aegle marmelos* than digoxin.
- j) Anti-microbial and anti-fungal activity : *Aegle marmelos* extract manifests anti-viral and anti-microbial activities. It has been found active against various species such as *Staphylococcus aureus*, *S. epidermidis*, *Proteus vulgaris*, *Escherichia coli*, *Salmonella typhimurium* and *Bacillus subtilis*. It has also been used for Ranikhet disease virus and intestinal parasites. The essential oil isolated from the leaves of *Aegle marmelos* exhibits variable efficiency against different fungal isolates and causes concentration as well as time dependent inhibition of spore germination of all the fungi tested, including most resistant fungus, *Fusarium udum*.
- k) Haemostatic: The unripe fruit of the plant are used in the form of powder or paste as haemostatic.

11. PRODUCTS AND FROMULATIONS

(A) Products made from mature but unripe bael fruits

1. Powder (churan)



Materials:

Pieces of mature bael fruits 20 g

Benzoic acid (preservative) - 0.02 g

Method:

Take mature bael fruits

Remove the shell and seeds and cut into pieces

Mix preservative with the pieces and dry at 60⁰ C

Grind the pieces and pass the powder through 80-100 mesh sieve

Pack the powder in containers or pouches and store



Grind pieces pass the powder through 80-100 mesh sieve



Benzoic acid (preservative) 0.02g



Powder (churan)

12.MARKETING AND ECONOMICS

Bael fruits are mainly sold in domestic market exclusively for processing. Due to its hard outer shell, it can be transported to longer distances for marketing. Now-a-days, its demand is increasing in Ayurvedic system of medicines. It is used in many ayurvedic preparations and there is need to create more awareness about its medicinal attributes internationally to increase its demand globally.

Under north Indian conditions, a five year old tree of commercial variety NB-5 gives about 30-40 fruits per tree. The average weight of fruits is about 0.8-1.0 kg. With this level, yield is about 30-40 kg per tree. As per estimate from bael orcharding the net return is of about Rs. 1,00,000 per ha. There is good demand of bael products in the domestic market and one can fetch good income by establishing a small scale processing unit.

CONCLUSION

Indigenous fruit trees are significantly contributing to alleviate hidden hunger, and bael is significant in this regard. Given the numerous food, pharmacological, and other bael values, it could be considered a promising fruit tree species in large-scale agriculture. In addition to the large-scale cultivation, proper harvesting practices, apposite storage, and transportation facilities are required for the efficient industrial processing of the fruits for efficient food and pharmaceutical industries. This would ultimately uplift bael from its underutilized status as an important cash crop to improve rural people's livelihood and develop the economy through value-added food and pharmaceutical industries.

It is quite evident that *Aegle marmelos* contains a number of phyto-constituents with potential uses for various therapeutic purposes. The plant or its individual parts can be used for the treatment of various disorders in human being such as, diabetes, liver toxicity, fungal infection, microbial infection, inflammation, pyrexia and to relieve pain.

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