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### Bael (*Aegle marmelos*) a super fruit of an hour: A review

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#### Abstract

The focus on plant research has increased all over the world and a large body of evidence has collected to show great potential of medicinal plants used in various traditional systems. *Aegle marmelos* is commonly known as Bael belongs to Rutaceae family generally grown in India, tropical and subtropical countries. In India *Aegle marmelos* have great mythological significance for Hindus and medicinal significant in ancient system of medicine. Utilization of bael in day to day life has great nutritional, environmental and commercial importance. The present review aims to compile general, chemical profile and economic importance including medicinal and other uses of *Aegle Marmelos*.

**Keywords:** Bael, *Aegle marmelos*, Medicinal plant, Nutritional, Commercial aspects

#### Introduction

Bael fruit (*Aegle marmelos*) is well known in Indian traditional medicinal science due to versatile use for various purposes. The tree holds a sacred value among Hindus and its leaves are presented to the Lord Shiva and deities. The tree belongs to Kingdom: Plantae, Order: Sapindales, Family: Rutaceae, Sub family: Aurantioideae, Genus: *Aegle*, Species: *A. marmelos*. The tree bears its origin in Western Ghats of India and is found in tropical and subtropical regions. The tree is also found in many South East Asian countries including Nepal, Sri Lanka, Pakistan, Bangladesh, Vietnam, Cambodia Thailand, Malaysia, Java, Philippines and Fiji etc. and known by various names throughout the country and also outside of the country viz., Hindi (Bel, bael, sripal); Sanskrit (Bilva, sripthal, shivadruma, Shivapala); Telugu (Maredu); Bengali (Bel); Gujrati (Bil); Kannada (Bilpatra, kumbala, malura); Tamil (Kualum); Thai (Matum and mapin); Cambodia (Phneou or pnoi); Vietnamese (Bau nau); Malayan (Maja pahit); French (Oranger du Malabar); Portuguese (Marmelos); Java (Modjo) and any few other names are there to be identified bael tree throughout different parts of world (Chemexcil 1992) [2].

The trees are of great importance to the environment as they act as climatic purifier that is they release greater percentage of oxygen in comparison to other trees. They also act as a sink for chemical pollutants as it absorbs toxic gases from the atmosphere and make them inert or neutral (Sharma *et al.*, 2006). The tree is mostly valued for its beneficial fruit, which is oval or round shaped and the size ranges from 5-25 cm (2-10 inches) in diameter. The fruit has a hard, woody outer shell and inside is present a sweet, thick and aromatic pulp. In the pulp, the seeds are present in ridges and seed is surrounded by thick slimy and transparent mucilage. The colour of the pulp may vary from bright orange to sunset yellow. The pulp of the fruit is a natural source of natural antioxidants and bioactive compounds. The pulp contains laxative properties and is even considered as the best laxatives known so far. The parts of plants are used in case of gastrointestinal related problems such as diarrhoea, dysentery and diabetes. It has antibacterial and antifungal properties. Bael is known to have anticancer activity, pyretic and analgesic activities and also provides relief in constipation (Sharma *et al.*, 2006).

The fruit is eaten as a delicacy when it's ripe, either by cutting into pieces or the pulp is mixed with milk, water and sugar and make into a sweet sherbet. Both ripe and unripe fruits are used for their medicinal values. Bael tree is known extensively for its medicinal values. Various parts of the tree such as leaves, fruit, bark and seeds are a constituent of many ayurvedic medicines. Apart from being used in medicines, they are also used traditionally in many ailments. Different parts of the plants contain hypoglycaemic, hypolipidemic and blood pressure lowering factors (Lmbole *et al.*, 2010) [12]. A number of phytochemicals are present in

Bael that makes in useful in many ailments. Nutritional aspect of Bael fruit is much more significant as compared to other fruit.

### Nutritional aspects of *Aegle marmelos*

Bael (*Aegle marmelos*) is one of the most valuable Indian medicinal plants; it has numerous uses in day to day life. Chemical studies prove that Bael fruit is rich in nutritional value, and this is being used from several years ago. Fruit is rich source of mineral, vitamin and fibre. Nutritional value of the Bael fruit (*Aegle marmelos*) (% per 100 g pulp) The Bael fruit is highly nutritious. It contains 61.5 g water, 1.8 g protein, 0.39 g fat, 1.7 g minerals, 31.8 g carbohydrates, 55 mg carotene, 0.13 mg thiamine, 1.19mg riboflavin, 1.1 mg niacin, and 8 mg per 100 g of edible portion vitamin C (Gopalan *et al.*, 1971). No other fruit has such a high content of riboflavin (Mukherjee and Ahmed 1957). Also reported the riboflavin content of ripe fruit was very high. Bael fruit is highly nutritive with the richest source of riboflavin. Marmelosin (C<sub>13</sub>H<sub>12</sub>O<sub>3</sub>) a resinous substance is most probably the therapeutically active principle of Bael fruits (Roy and Singh, 1979) [20].

### Bioactive compound of Bael

The Bael fruit is a good source of many functional and bioactive compounds and indigenous natural antioxidants containing relatively high content of dietary fibre, carotenoids, phenolics, flavonoids, ascorbic acid, alkaloids, and also strong antioxidant activities. Additionally, it also has the attractive yellowish-orange pulp appearance as well as a fragrant and pleasant flavour. The main volatile compounds are monoterpenes and sesquiterpenes (Charoensiddhi and Anprung, 2008) [1]. Phytoconstituents isolated from of *Aegle marmelos* Fruit (Marmelosin, Luvangetin, Auraptin, Psoralen, Marmelide, Tannin). Bael gets its medicinal values on basis of the various bioactive compound present in it like alkaloids, coumarins, polysaccharides, essential oils etc.

### Alkaloids

Aegelin, aegelinine, fragine, o-methylhalfordinine, o-isopentanylhalfordinol, N-2-[4-(3',3'-dimethylallyloxy)phenyl]ethyl cinnamide, o-(3,3-dimethylallyl) halofodinol, Ethyl cinnamide (Sharma *et al.*, 2006)

### Carotenoids

Carotenoids are principle pigment responsible for imparting pale yellow colour to fruit. (Sharma *et al.*, 2006)

### Coumarins

The coumarins present in Bael fruit includes marmelosin, marmesin, imperatorin, marmin, alloimperatorin, methyl ether, xanthotoxol, scoparone, scopoletin, umbeliferone, marmelide and marmenol (Sharma *et al.*, 2006).

### Minor constituents

Ascorbic acid, sitosterol, crude fibers, α-amyrin, crude proteins (Farooq 2005) [5].

### Polysaccharides

Galactose, arabinose, uronic acid, L- rhamanose (Sharma *et al.*, 2006)

### Tannins

There is as much as 9% tannin in the pulp of wild fruits, less

in cultivated type. Tannin is also present in leaves as skimmianine. It is also named as 4, 7, 8-trimethoxyfuroquinoline (Daniel, 2006) [4].

### Health Benefits of Bael

The different parts of Bael are used for various therapeutic purposes, such as for treatment of Asthma, Anaemia, Fractures, Healing of Wounds, Swollen Joints, High Blood Pressure, Jaundice, Diarrhoea Healthy Mind and Brain Typhoid Troubles during Pregnancy (Paricha 2004).

### Therapeutic values of *Aegle marmelos*

**Diarrhoea and dysentery:** In case of chronic diarrhoea and dysentery without fever, half ripe or unripe fruit acts as a remedy. Half ripe fruit is considered best for the purpose but fully ripe fruits or even fruit powder has shown effective results. When the fruit is still unripe, it is cut, dried and ground into powder. The unripe fruit can also be consumed by baking and then consumption with brown sugar or jaggery. After use of fruit, the amount of blood passed in the faecal matter reduces and the faecal matter gets a more solid form. (Sharma *et al.*, 2006; Patel *et al.*, 2012) [18]

**Antidiabetic activity:** Diabetes has become a common disease around the world. When the body cannot produce sufficient amount of insulin the blood glucose level increases. Antidiabetic aim at reducing the blood glucose level by inducing the production of a higher amount of insulin. *Aegle marmelos* has been used as a herbal medicine for the management of diabetes mellitus in Ayurvedic, Unani and Siddha systems of medicine in India (Choudhry *et al.*, 2003) [3]. Bael extract, when administered at a dose of 250 mg/kg of body weight, shows better result than glycnamide (antidiabetic drug). This antidiabetic effect may be due to the coumarins present in the fruit which induce the beta cells of islet of Langerhans to produce insulin. Aqueous extract of bael seeds reduces blood glucose level in case of severe diabetic patients (Maity *et al.*, 2009; Kamalakkannan and Prince, 2003) [13, 9]

**Antioxidant activity:** Normal metabolic activities give rise to free radicals. These free radicals, mainly oxygen free radicals, referred as ROS (Reactive Oxygen Species) causes oxidative stress. ROS are harmful for the body as they damage macromolecules, DNA, proteins and lipids. Antioxidants are compounds that scavenge the free radicals and reduce oxidative stress. Bael fruit has proven to show antioxidant activity. On administration of Bael fruit extract of 250 mg/kg of body weight, the activity of ROS scavengers such as glutathione peroxidase, glutathione reductase, superoxide dismutase (SOD) and catalase is shown to increase considerably. Use of above mentioned dose of Bael fruit extract shows better results than glibenclamide(36 µg/kg). The antioxidant activity may be due to presence of flavonoids, alkaloids, sterols, tannins, phlobatannins and flavonoid glycosides (Kamalakkannan and Prince 2003; Singh *et al.*, 2000) [9].

**Anticancer activity:** The anticancer potential of folk medicine used in Bangladeshi and used extracts of *Aegle marmelos* for cytotoxic action using brine shrimp lethality assay; sea urchin eggs assay, and MTT assay using tumour cell lines. The extract of *Aegle marmelos* was found to exhibited toxicity on all used assays (Leticia and Costa 2005). Anticancer effect of hydroalcoholic extract of bael leaves in the animal model of Ehrlich ascites carcinoma and proposed that induction of apoptosis may be due the presence of Skimmianine in extract (Jagatia *et al.*, 2005) [8].

Constipation: Ripe fruit has been considered as the best of all known laxatives. In case of constipation, administration of ripe fruits cleans and tones up the intestines. Its regular use for 2-3 months has been effective in removal of even old and accumulated faecal matter from bowels. For best results, the pulp of ripe fruit is crushed and made into a sherbet. Seeds are removed for reducing the bitterness and sugar and/or milk can be added to make it more palatable (Roy and Singh., 1980)

#### Value added products from bael (*Aegle marmelos*)

In the view of the importance of bael fruit as a therapeutic, medicinal, and nutritional value, there is an urgent need to develop the processing technology of this neglected but valuable fruit into different commercial value added products having extended shelf life and also gives beneficial to the consumers. In order to reduce the post-harvest losses of Bael and retain better flavour and vitamins, it is obvious that ripened fruits should be preserved and processed into value added products.

The Various process technology for production of value added preserved products from Bael fruit. Fresh bael fruit can be stored for 15 days at 30°C when harvested at full maturity, for 1 week at 30°C when harvested ripe, for 3 months at 9°C. Fruit pulp can be stored for 6 months, when stored in heat-sealed containers. Fruit powder can be stored for a year when packed in 400 gauge polypropylene pouches and stored under dark, cool place, while fruit jam, squash and preserve can be stored for several months (ITDG, 2000). Value added products can be produced by using different process technology to reduce post-harvest losses, increase shelf life, value addition and increase the income which is commercial aspects of Bael fruit. A large number of bael processed products (Preserve, candy, panjiri, toffee, jam etc.) are prepared and some scientist and researcher are already worked on their processed products (Rakesh *et al.*, 2005) [19].

#### Pulp

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 fibre 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 fibre (Nidhi *et al.*, 2007) [16].

#### Squash

The squash prepared with 25 per cent level of pulp was found to be organoleptically overall acceptable and this formed the basis for standardization of recipe. However, the TSS was maintained at 40°Bx and acidity at 1.26 per cent to have proper sugar acid ratio in squash. The squash was prepared using artificial and natural sweeteners with 4.5° Bx TSS and 1.26 per cent acidity (Lahoti M.R.).

#### Bael powder

For preparation of powder the matured green Bael fruits were cut into 2-2.5 cm size shreds and subjected to differed treatment (without blanching, blanching and blanching + sulphitation) and dried in cabinet drier at 50-60°C till the moisture content was less than 10 per cent (Saini *et al.*, 2005) [21].

#### Bael preserve

The bael preserve was prepared by slow syrupeing method as this method was found to be suitable for the improvement of

colour, taste and overall acceptability. This method was found to be more suitable than any other reported in case of amla preserve. The desirable qualities are obtained in the bael preserve by using ingredients in specific proportions (Lahoti 2010) [11]

#### Innovative aspects of Bael

Bael fruit are available in many forms. These include raw and ripe whole fruits, fruit powder, fruit extract, fruit extract powder, bael seeds, dried unripe fruit slices, ripe fruit drink, bael fruit tea (either entirely made of bael or a blend of bael fruit and other ingredients such as ginger or lemon or others), bael fruit juice, fruit juice jelly and jam and probiotic chocolate. However, in recent years, there has been the increasingly observed demand for so called non –dairy-based probiotic products. Numerous functional foods that are consumed as part of a normal diet and provide consumers with well-documented, physiological benefits contain LAB, especially 'probiotic bacteria'. A functional food is a food that has been added with new ingredients or the present ingredients have be processed in a manner that it provides additional health benefits than the conventional form (Panda 2014) [23].

The innovative application of bael (*Aegle marmelos*) as prebiotic in the preparation of probiotic chocolate which are formulated using bael extract, beads and cocoa is a functional food which has the beneficial effects of bael as a prebiotic, encapsulation of probiotic culture to make this process symbiotic. The idea of combining all these ingredients and making a product with the goodness of each of the ingredients gives the synergistic effect in the functional food.

#### Conclusion

In view of the therapeutically and medicinal value of bael and to overcome postharvest losses of this fruit, there is a need to commercially exploit this neglected but valuable bael into different processed food products which will gives more returns to the growers and beneficial to the consumers with regards to its nutritional and therapeutical importance. The Processing of bael into variety of products offers various options for its satisfactory preservation and storage and makes the product available to the consumers under hygienic condition, to fulfill the healthy benefits.

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