Chapter 3

Aegle marmelos (L.) Correa.; a nutraceutical plant species

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ABSTRACT

Aegle marmelos, commonly known as Bael, also known as Bengal quince, Golden apple, Japanese bitter orange, Stone apple, and Wood apple, is a species of tree native to the Indian subcontinent and Southeast Asia. Bael possesses many nutraceutical values and is therefore used as an ingredient in ayurvedic herbal preparations as well as in the food industry, where ripened fruits are popular because of the delicious fruit pulp, which is ideal for making jam, syrup, and pudding. The leaves, bark, seeds, and roots contain several bioactive compounds that can provide antidiabetic, anticancer, antimicrobial, immunogenic, and insecticidal activities. The population of Bael in the wild is declining. Keeping in mind the importance of Bael, an attempt has been made to document its food, ethnomedicinal, ecological, mythological, and economic values through field and literature, which are presented here along with photographs.

Key words: *Aegle marmelos*, nutraceutical, medicinal, mythological, conservation.

Introduction: Food is one of the basic needs of life (Kumar et al. 2012). Food contains nutrients—substances essential for the growth, repair, and maintenance of body tissues and for the regulation of various important biological and metabolic processes (Kumar et al. 2013). Nutrients provide the

energy that our bodies need to function. Human beings obtain food and nutrients from diverse plant species, either directly or indirectly (Baliga et al. 2011). So, plants that contain both food and medicinal values are considered as nutraceuticals (Kumar and Jena 2017). One such important nutraceutical plant species is *Aegle marmelos,* belongs to the Rutaceae family. It is known as Bilva, Sriphal, or Shivadruma in Sanskrit, Bael in Hindi, and Wood Apple in English. This tree is indigenous and found growing abundantly in several countries, including India (Sharma et al. 2011). It is one of the most medicinally important sacred trees in India. Bael is usually planted near temples dedicated to Lord Shiva and routinely worshiped by the devotees (Singhal et al. 2011). *A. marmelos* has been used as an herbal medicine for the management of several ailments in the Ayurvedic, Unani, and Siddha systems. Herbal medicines are heavily used and immensely popular in developing countries (Chanda 2008). Bael fruit has been a major topic for studies in recent years, mainly due to its high nutritional values and the presence of various phytochemicals, which contribute to its high nutraceutical potential. The tree is aromatic, and all the parts are medicinally important (Kintzios 2006). The fruits and leaves are used to treat dysentery, dyspepsia, neurological problems, vomiting, and rheumatism. In addition to its essential medicinal values, Bael is reported as an important item in industrial food processing and an excellent source for extracting pharmaceuticals and many other economically important herbal products. The present survey focused on summarizing the details of Bael for its nutraceutical properties with the other potentials as well.

Distribution and ecology: It thrives well in dry, mixed deciduous, and dry dipterocarp forests of India, Sri Lanka, Thailand, Pakistan, Bangladesh, Myanmar, Vietnam, the Philippines, Cambodia, Malaysia, Java, Egypt, Surinam, Trinidad, and Florida. *A. marmelos* is a subtropical species, although it can grow well in tropical environments (Pathirana et al. 2020). It generally requires well-drained soil and thrive well in high altitude and withstand without any significant growth retardation. In prolonged droughts, fruiting may cease, but the plant can survive with shallow soil moisture. In India and Sri Lanka, it is famous as a fruit species, which can grow in very tough soils where other trees and other crops cannot grow (Roy and Singh 1979).

Morphology: It is deciduous, and the crown is compact or dense, with no weeping branches. The tree is tough and widely adaptable to adverse soil and climatic conditions. It can grow up to 10 m or higher with medium or large sizes with numerous branches (Chanda 2008). The fruit mainly occurs in the

periphery of the canopy. The trunk is short and thick with narrow oval shape ends. The wood is rigid and slow growing. The young wood has a central pith. Bark of the tree is flacking, bluish-grey, soft, and contains irregular furrows on the younger branches. It possesses dimorphic twigs. The regular twigs have 3-5 cm long internodes with a leaf at each node and one to two spines.



Figure 1: Leaves and fruit of *Aegle marmelos* plant

The other type of twigs, the foliage spurs, are arising on the primary branches (Pathirana et al. 2020). The leaves are alternate, single, or compound, with one or occasionally two pairs of shortly stalked opposite leaflets, trifoliate and aromatic (Figure 1). The flowers are fragrant and form 4-7 clusters along the new branches. A flower has four or five recurved and fleshy petals with around 50 or more greenish-yellow stamens (Baliga et al. 2011). The flower is 2 cm wide, sweet scented, stalked, lax, erect, and occurred axillary or terminal cymes. The fruits have a hard, smooth-woody shell, a soft rind at immature stages. The crust is grey green in early stages, turns yellowish or orange at the ripening stage, and becomes very hard and orange-red when dried. The fruits

are 5-20 cm in diameter and exists in diverse shapes ranging from round, pyriform, oval, or oblong (Saxena and Brahmam 1994; Singhal et al. 2011).

Food values: In the contemporary world, fruits are often appreciated as rich sources of health promoting nontoxic natural food additives (Okwu and Emenike 2006). *A. marmelos* nicely fit into this context as a nutritionally rich fruit species. It is majorly consumed as a fresh fruit in which the internal fleshy layer of the pericarp and placenta are edible (Figure 2; Seth 2003). This fruit is rich in colorants and flavouring agents, which could be used as additives in the food and beverages industries (Charoensiddhi and Anprung 2009). These parts are also used to make pudding, juice, jam, and cakes (Baliga et al. 2011). The fruits are also characterized by a higher abundance of soluble dietary fibre, volatile compounds with reducing sugars, carotenoids, and antioxidants (Charoensiddhi and Anprung 2009).

Phytochemicals: It contains tannins, alkaloids, xanthotoxol, imperatorin, alloimperatorin, and β-sitosterol (Saha and Chatterjee 1957). Tannin was found to increase during ripening, where the highest tannin content was found in fully ripe fruits (Mandal and Mukherjee 1981). It has phenyl proponoids, which are proven to be anticancerous (Kintzios 2006). The main volatile compounds are present in bael are marmelin, monoterpenes and sesquiterpenes. Another compound known as shahidine is also present, which is a newly reported molecule having very high labile oxazoline activity against few gram-positive bacteria (Faizi et al. 2009). The leaves contain alkaloids, mermesinin, rutin, phenylethyl cinnamides, anhydromarmeline, and aegelinosides, sterols and essential oils (Chatterjee et al. 1977). Stem barks, and roots contain a coumarin as aegelinol. Roots also contain xanthotoxin, coumarins, tembamide, mermin and skimmianine (Basak et al. 1981).

Pharmacological values: All parts of this plant consist of immense medicinal properties. Bael fruits, leaves, and other parts of the tree have phytochemicals that possess numerous pharmacological activities. The herbal medicinal preparations are used to treat chronic diarrhoea, dysentery, peptic ulcers, laxative for astringency, and respiratory ailments (Baliga et al. 2011). The anti-inflammatory activity was demonstrated by preparations of bael roots (Benni et al. 2011).



Figure 2: Ripen fruit is popular as a nutraceutical food

Antioxidant potential of alcoholic and aqueous extracts of bark was able to scavenge target radical species (Gacche and Dhole 2011; Kumari and Kakkar 2008). It has considerable significance for the presence of many bioactive compounds with anticancer properties.

Anticancer activity: Several studies reported that bael has anticancer activity and has cell and tissue protectant activity, which is vital in saving healthy cells when patients are undergoing chemo and radiotherapies (Jagetia et al. 2004).

Antidiabetic activity: Bael extracts are shown to have significantly higher antidiabetic activities (Anandharajan et al. 2006) when tested using animal models. According to study (Gireesh et al. 2008), bael leaf extracts can decrease M1 receptor gene expression and inhibit aldose reductase activity, anticataract activity, and free radical scavenging activity, and all of them are related to diabetes.



Figure 3: Religious values (the bael leaves are used to Lord Shiva)

Antimicrobial activity: Bael extracts have shown antibacterial (Rani and Khullar 2004), antifungal, and antiviral (Balasubramaniam et al. 2007) activities. The antibacterial effect of bael was found on pathogenic *Shigella dysenteriae*, and the inhibitory activity was believed to be from coumarin compounds present in the extract (Raja et al. 2008).

Ecological importance: Bael is highlighted as a natural purifier of the environment and can be used as a supporting tree for wildlife and key species in reforestation of urban, rural, and dryer areas, and it is useful as a shedding tree for nutrient recycling (Seth 2003).

Mythological values: It is a sacred tree in India. Leaves are used to worship lord Shiva (Figure 3; Present study).

Economic values: The fruits are sold in local markets especially during summer. Per 1 fruit cost may be 15-20 only (Present study). Also, it is available in more numbers in the market during the festival or occasion of Pana Sankranti majorly celebrated in Odisha.

Conclusion

Present study concludes that Bael has lot of health benefits along with it is also a source of livelihood. In wild, its parts are consumed by different types of wildlife and an important tree of sacred groves in India. It relates to religious believes in India. Therefore, need more plantation of Bael tree in tribal, rural, and urban areas.

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