

A Review on Pharmacological Studies and Phytochemistry of *Aegle marmelos* (L.) Correa

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ABSTRACT

The traditional medicinal herb *Aegle marmelos* (L.) Correa, also referred to as bilva or bael, has a long history in India's Ayurvedic system. Ancient writings such as the Charka Samhita and the Vedas describe its medicinal applications. The substantial study on its phytochemistry, pharmacological characteristics, and therapeutic potential is compiled in this review. Bioactive chemicals are abundant in the plant's leaves, bark, fruits, and roots, among other sections. More than 100 different phytonutrients have been identified, with coumarins (such as Luvangetin and Marmelosin), alkaloids (like Fagarine and Skimmianine), phenols, and flavonoids being important components. In terms of nutrition, the fruit pulp is a significant source of vitamin C and carbs. Many of its traditional uses have been verified by pharmacological investigations. Because it inhibits the absorption of glucose and increases the synthesis of insulin, the plant has strong antidiabetic effects. With extracts exhibiting cytotoxic activities against breast cancer cells and chemopreventive activity in skin tumor models, it has shown encouraging anticancer characteristics. Strong antidiarrheal and antiulcer properties, the latter of which are ascribed to bolstering the mucosal defense, justify its traditional usage for gastrointestinal problems. *A. marmelos* also has strong anti-inflammatory, antibacterial, antioxidant, wound-healing, retroprotective, and cardioprotective properties. According to toxicological research, the plant is usually thought to be safe. In order to improve its effectiveness in treating diseases like diabetes and cancer, *A. marmelos*'s future prospects include creating cutting-edge drug delivery systems including phytosomes, microspheres, and nanoparticles. According to this review, *A. marmelos* is a multipurpose medicinal plant with potential for contemporary therapeutic uses that is supported by science.

Keywords *Aegle marmelos*, Pharmacological review, Phytochemistry, Ayurveda.

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INTRODUCTION

Aegle marmelos (L.) Correa, commonly referred to as Bilva in Sanskrit, is a traditional medicinal plant that has been widely utilized in India for centuries. Various parts of the plant, including leaves, roots, bark, and fruits, are traditionally employed in the preparation of Ayurvedic medicines and cultural remedies. These applications have been handed down through generations and continue to hold significant importance in the realm of traditional Indian medicine.^[1] *Aegle marmelos* is commonly known by several names in India, including begal-quince, golden apple, stone apple, and wood apple. The term bael is used to describe the unripe or half-ripe fruits, as well as their slices or irregular pieces, of *Aegle marmelos*.^[2] The Traditional system of

medicine recognizes approximately 6000 plants, that are believed to have some form of medicinal value. However, from these 6000 plants, only around 350 are actually utilized for various purposes. *Aegle marmelos*, scientifically known as (L.) Corr., is one of these 350 species. It is classified under the family *Rutaceae*, which has a significant role in everyday life.^[3] The medicinal uses of the bael fruit are mentioned in the Vedas, particularly the Yajurveda, as well as in the Puranas. It is also illustrated in the paintings found in the Ajanta Caves. The healing properties of the fruit from the Bael tree are described in the ancient texts known as the Brihat Samhita and Charka Samhita.^[4] Bael is commonly used in traditional medicine to treat conditions such as chronic diarrhea, dysentery, peptic ulcers, and as a laxative. Earlier studies have demonstrated that it possesses antifungal, antibacterial, antiprotozoal, and hypoglycemic properties. Moreover, its impact on the heart has been investigated, and beneficial outcomes have been noted when using lower concentrations of bael leaf extract.^[5] A thorough chemical examination of different sections of the tree revealed the presence of nearly 100 distinct bioactive phytonutrients.^[6]



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Monograph of *Aegle marmelos*

The Indian *Aegle marmelos* L., commonly referred to as the bael tree, holds a sacred status in India. It falls under the Plantae kingdom. The fruit produced by this tree is known by several names, including bael fruit, Indian bael, holy fruit, and golden yellow apple tree in English. In Sanskrit, the tree is called Bilva, Sripthal, or Shivadruma, with the latter term translating to "the tree of Shiva." In the Hindi language, the tree is known as Bael, Baelputri, or Bela.^[7] Bael is prepared using the unripe or slightly ripe fruits, or slices and uneven pieces of *Aegle marmelos* Corr., a plant that belongs to the Rutaceae family.^[8] Over 100 phytochemical compounds have been separated from different parts of the plant, including phenols, flavonoids, alkaloids, cardiac glycosides, saponins, terpenoids, steroids, and tannins.^[9]

Morphology

Leaves

The leaves of *A. marmelos* grow individually on the stem, and each leaf consists of three to five small, oval-shaped sections that are pointed and have shallow teeth (Table 1). Each section is approximately 4 to 10 cm in length and 2 to 5 cm in width. The leaf at the tip of the stem has a long, slender stalk, while the other leaves do not. The main vein of the leaf is long and has a smooth texture. When the leaves are damaged, they emit an unpleasant odor.

Flower

The flowers of *A. marmelos* have a sweet fragrance, are approximately 2 cm wide, and appear in clusters of 4 to 7. Each flower has 4 to 5 soft, curved petals that are yellow on the inside and green on the outside. They also contain more than 50 green stamens, a shallow calyx with five short and broad teeth, an oblong-ovoid ovary, a short and thick style, and a capitate stigma.^[4]

Fruit

The fruit has a greenish-yellow color and changes to yellow when it is ripe. It emits a nice scent. Its shape is nearly round, resembling a berry, and it measures between 5 to 10 cm in width. The outer covering is firm and tough, with a reddish-brown appearance. Inside, the flesh is either orange or reddish-brown. There are numerous seeds, which are flat and elongated. Each part of the fruit, known as a carpel, contains several flat, hairy seeds.^[10]

Collection, Identification and Cultivation

Fresh leaves from eighteen distinct varieties of *A. marmelos* were collected from the orchard at Narendra Deva University of Agriculture and Technology, situated in Kumarganj, Faizabad, India. The scientific classification of the plant was verified. The collected leaves were then processed by grinding them into a fine

powder and allowing them to dry in the open air prior to their use in the experiments.^[11]

Bael, scientifically known as *Aegle marmelos* (L.) Correa, is a sacred fruit tree that is originally from India. It is commonly found in eight major Indian states and is also grown on a smaller scale in parts of South and Southeast Asia. Even though it comes from a subtropical region, it can grow well in tropical, arid, and semi-arid areas. It can thrive in various environments like forests, gardens, and even temples, whether in wild, semi-wild, or cultivated settings. In terms of culture, bael holds a special place in Hindu traditions, especially in the worship of Lord Shiva. Historical records show that it has been important since the time of the Vedic period. It is seen as a symbol of prosperity and is often linked to ideas related to the divine trinity. From an agricultural perspective, bael is a robust and environmentally friendly tree. It can grow in a variety of soil types, including sandy, clayey, alkaline, and even wastelands. It can survive in a wide range of soil pH levels, from 5 to 10, and can withstand harsh weather conditions such as high temperatures and long periods of dryness.^[12]

Geography

Aegle marmelos is a subtropical plant that can grow up to an altitude of 1,200 meters above sea level. It thrives in dry forest areas, both on hilly and flat terrain. This plant is widely distributed and can be found in various regions including India, Ceylon, China, Nepal, Sri Lanka, Myanmar, Pakistan, Bangladesh, Vietnam, Laos, Cambodia, Thailand, Indonesia, Malaysia, Tibet, Java, the Philippines, and Fiji.^[13] It is found all throughout India, but it is concentrated in the eastern Gangetic plains and surrounding regions, especially in Uttar Pradesh, Bihar, Madhya Pradesh, Chhatisgarh, and Jharkhand. It is also growing in West Bengal, Odisha, Punjab. Bael trees are seen growing naturally in Gujarat's highly diverse forests. The majority of the genotypes found in Gujarat's forests have small fruits, but travelers, saints, and pilgrims from northern India brought the plants that flourish in temple premises or in home courtyards with large fruits (Table 2).^[14] *A. marmelos* is capable of thriving in a variety of habitats and can be grown in different parts of the world. The fruits are

Table 1: Taxonomical Classification of *Aegle marmelos*.

Kingdom	Plantae
Sub-kingdom	Tracheobionta
Super Division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Sapindales
Family	Rutaceae
Genus	<i>Aegle</i>
Species	<i>Marmelos</i>

classified into five main categories: oval, flat, spherical, oblong, and pear-shaped. Within each category, the fruits are further divided into three subgroups based on their size: small, medium, and large (Figures 1 and 2).^[15]

Taxonomy

The *Rutaceae* family, which has recently been studied using a phylogenetic analysis that includes 135 genera (accounting for 87.7% of all recognized genera), is divided into six subfamilies: *Haplophyloideae*, *Amyridoideae*, *Aurantioideae*, *Cneoroideae*, *Rutoideae*, and *Zanthoxyloideae*. This family is well known for its essential oils, its ornamental plants, and its culinary herbs. Some common fruits that belong to this family include oranges, limes, lemons, grapes, and satinwood. Plants in the *Rutaceae* family contain a variety of bioactive compounds such as alkaloids, terpenoids, and especially coumarins like Marmelosin and Luvangetin. These compounds have various health benefits, including antihelminthic, antiulcer, antibacterial, and antispasmodic properties.^[9]

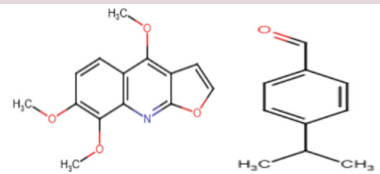
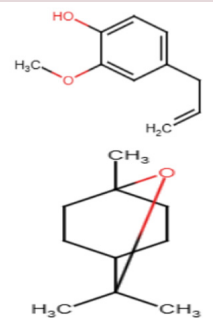
METHODOLOGY

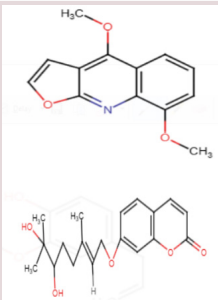
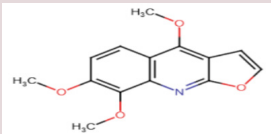
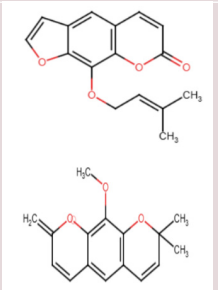
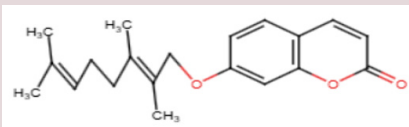
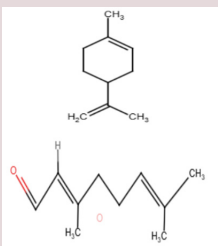
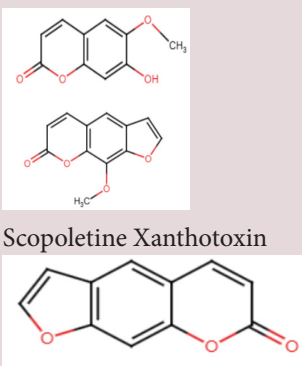
Aegle marmelos (Bael) leaves were sampled in Himayat Bagh, Aurangabad, Maharashtra, India. The leaves were air-dried, cleaned two or three times with distilled water, and then ground into a powder using a mixer grinder. Prior to analysis, the powdered sample was kept in a plastic bag. Before being used, all equipment was cleaned with distilled water and all

chemicals were of Analytical Reagent (AR) grade. pH, total ash, acid-soluble ash, acid-insoluble ash, and extractive values using water, methanol, chloroform, and petroleum ether were among the physicochemical parameters that were examined. In accordance with protocols from the Ayurvedic Pharmacopoeia of India, fluorescence examination of the crude leaf powder was performed under visible light and ultraviolet light (254 nm and 365 nm). Methanol, chloroform, and aqueous extracts were used for FTIR screening. Using water, methanol, chloroform, and petroleum ether extracts, preliminary phytochemical analysis was carried out in accordance with conventional procedures. A calibrated pH meter was used to measure the pH after 5 g of the sample was submerged in 100 ml of water. 5 g of the sample were burned in a silica crucible for three to 4 hr at progressively higher temperatures up to 500°C in order to determine the total ash. The sample was then cooled in a desiccator and weighed. For acid-insoluble ash, the total ash was treated with 2N hydrochloric acid, filtered, ignited again at 500°C, cooled, and weighed to calculate the percentage of insoluble ash. 10 g of the sample were refluxed with one hundred milliliters of double-distilled water for 6 hr, filtered, and the solvent was evaporated in order to extract the water. The extractive value was determined after the extract was dried for 12 hr at 40°C. 10 g of the material and 100 mL of methanol were extracted using microwave radiation for 20–30 min at 50% power (420 W) and 150°C in a round-bottom flask.

Phytoconstituent

Table 2: Phytoconstituents isolated from various parts of *Aegle Marmelos*.

Parts	Phytoconstituents	Structures	IUPAC Name	References
Leaf	Skimmianine Aegeline Citral Lupeol Cineole Citronellal Cuminaldehyde Eugenol	 Skimmianine Cuminaldehyde  Eugenol Cineole	1)Skimmianine :- 4,7,8-trimethoxyfuro [2,3-b] quinoline 2)Cuminaldehyde :- 4-(propan-2-yl) benzaldehyde 3) Eugenol :- 4-Allyl- 2-methoxyphenol 4)Cineole :- 1,3,3-trimethyl- 2-oxabicyclo [2.2.2]octane	[16] [17]

Parts	Phytoconstituents	Structures	IUPAC Name	References
Bark	Marmin Fagarine Skimmamine	 Fagarine Marmin  Skimmamine	1)Fagarine :- 4,8-dimethoxyfuro [2,3-b]quinoline 2)Marmin :- 7-[(E,6R)-6,7-dihydroxy- 3,7-dimethyloct-2-enoxy]chromen-2-one	[18]
Fruits	Marmelosin Luvangetin Auraptin Psoralen	 Marmelosin Luvangetin  Auraptin	1)Marmelosin:- 9-[(3-Methyl-2-buten-1-yl) oxy]-7H-furo[3,2-g]chromen-7-one 2)Luvangetin:- 10-methoxy- 2,2-dimethylpyrano[3,2-g]chromen-8- one 2)Auraptin:- 7-[(2E)-3,7-dimethylocta- 2,6-dien-1-yl]oxy-2H-chromen-2-one	[19]
Seed	d-limonine Cineole Citral	 d-limonine Citral	1)d-limonine:- (R)-4-isopropenyl-1-methylcyclohexene 2)Citral:- (2E)-3,7-dimethylocta-2,6-dienal.	[20]
Roots	Psoralene Scopoletin Xanthotoxin	 Scopoletin Xanthotoxin Psoralene	1)Scopoletin 7-Hydroxy-6-methoxy-2H-1-b enzopyran-2-one 2)Xanthotoxin 9-methoxy-7H-Furo[3,2-g][1] benzopyran-7-one 3)Psoralene: 7H-Furo[3,2-g][1]benzopyran-7-one	[16]

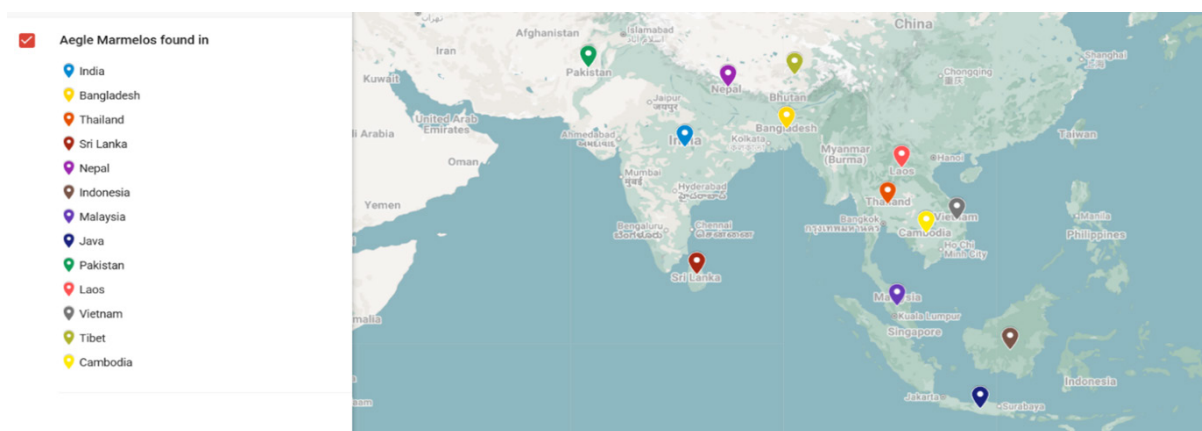


Figure 1: Geographical distribution of *Aegle marmelos* (L.).

PHARMACOLOGICAL PROPERTIES

Antidiabetic Activity

Aegle marmelos, commonly known as bael, is a medicinal plant belonging to the *Rutaceae* family. It has been traditionally used for the treatment of several health conditions, including inflammation, asthma, digestive issues, fever, and infections. Recent scientific research has highlighted its potential in managing diabetes. This is attributed to its ability to increase insulin production, block the absorption of glucose, inhibit the activity of the enzyme alpha-amylase, and lower blood sugar levels. The plant contains important chemical compounds such as p-cymene, oleic acid, linolenic acid, myristic acid, and retinoic acid, which are known for their antidiabetic, heart-protective, antioxidant, and anti-inflammatory benefits.^[21] Although medical advancements have been made, diabetes mellitus is still not curable and impacts approximately 6.4% of the world's population. In the ancient system of Ayurveda, this condition is referred to as mudhumeha.^[18] Studies have indicated that bael fruit juice is more effective than the antidiabetic drug glibenclamide when taken at a dose of 250 mg per kilogram of body weight (Figures 3-6). The fruit contains a type of sugar called l-arabinose, which specifically inhibits the activity of sucrase in the intestines. This inhibition helps prevent a sharp rise in blood glucose levels following the consumption of sucrose. Moreover, l-arabinose plays a role in maintaining stable blood glucose levels, which can also contribute to a decrease in obesity.^[22] The antidiabetic effect observed could be attributed to the presence of coumarins in the fruit. The aqueous extract of bael seeds has been found to lower blood glucose levels in patients with severe diabetes.^[23]

Anticancer Activity

Aegle marmelos fruit extracts have demonstrated significant potential in combating cancer. When tested on rats with DMBA-induced breast tumors, ethanolic extracts effectively reduced tumor size and improved markers related to liver and kidney function. Both aqueous and methanolic extracts showed cytotoxic effects against breast cancer cells, with IC_{50} values

of 47.92 μ g/mL for MCF-7 cells and 144 μ g/mL for SKBR3 cells. In mice, the methanolic extract significantly decreased the number of DMBA-induced skin tumors by up to 70%. Overall, *A. marmelos* exhibits promising anti-proliferative and chemopreventive properties against various forms of cancer.^[24] The IC_{50} value for the methanol extract of *A. marmelos* was 47.08 g/ml, while the IC_{50} for the acetone extract was 79.62 g/ml, indicating that Hep-2 cells are more sensitive to the methanol extract. Both extracts from *A. marmelos* showed toxicity towards cancer cells.^[25] Auraptene, a naturally occurring compound found in *Aegle marmelos*, demonstrates significant potential as an anticancer agent. It effectively blocks angiogenesis triggered by VEGF, promotes programmed cell death in gastric cancer cells by inhibiting the Akt/mTOR signaling pathway, and boosts the efficacy of chemotherapy agents such as cisplatin, paclitaxel, and 5-fluorouracil in esophageal cancer cells.^[26]

Wound Healing

The study examined the effects of topical application and intraperitoneal administration of methanolic extract of *Aegle marmelo*, in the form of ointment and injection, on two types of wound models in rats, namely the excision and incision models. Both the ointment and injection of the methanolic extract showed significant responses in both wound models. The extract was found to support the healing process, as evidenced by an increase in tensile strength in the incision model. The results were also compared with those of the standard drug nitrofurazone.^[27] The ointment was applied to the wound until full healing occurred, with measurements recorded on days 0, 4, 8, 12, 16, and 20 following day 101 of the wounding process.^[28]

Radioprotective

Bael (*Aegle marmelos*) fruit extract shows significant potential in protecting against radiation. When Swiss albino mice were given the extract before being exposed to gamma radiation, their survival rates increased, along with higher levels of Glutathione (GSH), and lower levels of lipid peroxidation in important



Figure 2: *Aegle Marmelos* (Bael Fruit).

organs. In human lymphocyte cultures, similar protective effects were seen, which depend on the dose given. This indicates that the extract has strong antioxidant and free radical-scavenging properties. These findings suggest that bael fruit extract could help reduce damage to cells caused by radiation and may be useful in managing radiation-related illnesses and certain types of cancer affecting internal organs.^[29] Radiotherapy is an important treatment for cancers affecting internal organs, but it can lead to harmful side effects. A study looked into how a hydroalcoholic extract from the fruit of *Aegle marmelos*, also known as bael, could protect against radiation damage. The research used Swiss albino male mice that were given intraperitoneal injections of the extract at doses ranging from 5 to 40 mg per kilogram of body weight, every day for 5 days before they were exposed to 10 Gy of gamma rays from a 60 Co source. The results indicated that giving the extract before radiation helped improve survival rates, with the best level of protection seen 30 days after the radiation exposure.^[30]

Antimicrobial and Antibacterial

Because of the continuous use of current therapeutic drugs, drug resistance has become a significant issue. As a result, there is a need to explore alternative sources. The plant demonstrates antimicrobial activity against various types of bacteria. The antibacterial properties of the leaf extracts from the bael tree are more effective against gram-positive bacteria, specifically *E. faecalis**, compared to gram-negative bacteria. Both methanolic and aqueous extracts show minimum inhibition activity. However, the methanol extract shows lower antibacterial activity against the tested microorganisms when compared to the aqueous extract. The aqueous extract has shown potential antibacterial effects against *E. coli**, *Staphylococcus aureus**, and *K. pneumoniae**.^[31] The presence of compounds found in leaves, like cuminaldehyde and eugenol, might be the reason for the antimicrobial effects observed.^[32]

Antioxidant and Hepatoprotective

Aegle marmelos demonstrates significant antioxidant and liver-protecting properties. Extracts from its leaves, fruits, and

seeds help shield the liver against oxidative stress and damage caused by toxins such as alcohol, carbon tetrachloride, and *Staphylococcus aureus*. These extracts work by decreasing lipid peroxidation, improving the activity of antioxidant enzymes, and reducing the levels of enzymes in the blood that indicate liver injury.^[33] Bael (*Aegle marmelos*) is known for its strong antioxidant properties, which are attributed to the presence of compounds such as beta-carotene, glutathione, beta-tocopherol, ascorbic acid, polyphenols, and flavonoids. These compounds help in reducing oxidative stress by preventing the formation of free radicals and slowing down the process of autoxidation. Different methods, such as DPPH, ABTS, and superoxide radical scavenging tests, have been used to evaluate the antioxidant potential of Bael. Both the chloroform and aqueous extracts of Bael display antioxidant activity, with extracts from unripe fruits showing higher effectiveness compared to those from ripe fruits. When comparing different parts of the plant, the methanolic extract from the leaves showed the highest free radical scavenging activity, which was approximately ten times greater than that of the standard antioxidant BHT.^[34] A review of existing literature shows that the fruits of *Aegle marmelos* are traditionally used in the treatment of tuberculosis and hepatitis. However, there is a lack of scientific research on its hepatoprotective properties. Therefore, this study was carried out to examine the hepatoprotective activity of *Aegle marmelos*.^[35]

Antidiarrheal

In the traditional Ayurvedic system of medicine, the bael fruit is regarded as a highly effective remedy for diarrhea, as noted by (Das and Das in 1995). The unripe fruit has a bitter, acrid, sour, and astringent taste, and is known to support digestion and help in treating stomach infections. The half-ripe fruit, on the other hand, is considered astringent, digestive, and beneficial for relieving diarrhea.^[36] Fruit containing tannins or other mucilaginous substances that have a demulcent effect, which makes the fruit appear unripe or only partially ripe can be sliced, roasted, sun-dried, or processed into a preserve or powder. When there is no fever, this fruit is recommended for treating intestinal issues such as intestinal weakness, chronic diarrhea, and

dysentery.^[37] The chloroform extract from *A. Marmelos* exhibited a suppressive effect on diarrhea induced by castor oil.^[38]

Anti-Inflammatory

Ghangale *et al.*, (2008) investigated the aqueous extract of *A. marmelos* using the rat paw oedema model and confirmed that *A. marmelos* exhibits anti-inflammatory properties. Additionally, different extracts from the leaves of bael were tested for their anti-inflammatory effects.^[39] The extracts obtained from Bael leaves using petroleum ether, chloroform, diethyl ether, ethanol, acetone, and methanol were found to reduce paw edema caused by carrageenan and granuloma formation induced by cotton pellets in rats. All the extracts showed a significant decrease in both paw edema and granuloma, with the methanol extract demonstrating the highest level of effectiveness.^[40] The anti-inflammatory effects of the aqueous extract from Bael root were evaluated using two models in albino rats: carrageenan-induced paw edema and cotton pellet-induced granuloma. The results showed that the extract significantly reduced both the paw edema caused by carrageenan and the granuloma formation induced by cotton pellets in these rats.^[41] Marmelosin, which was extracted from the Bael fruit, showed anti-inflammatory effects by decreasing the production of nitric oxide and proinflammatory cytokines such as TNF- α , Nuclear Factor Kappa B (NF- κ B), tyrosinase, and galectin-3 in Raw 264.7 mouse leukemic macrophage cells.^[42] The fruit of *A. marmelos* showed abilities to reduce inflammation, fight oxidative stress, and prevent mast cells from releasing their contents. This was indicated by higher levels of Superoxide Dismutase (SOD) and lower levels of Malondialdehyde (MDA), along with protection against mast cell degranulation.^[43]

Antiulcer

Bael exhibits a significant gastroprotective effect, which is attributed to the presence of specific compounds such as luvangetin, a pyranocoumarin, cineole, and tannins found in the

fruit. Oxidative stress is a common factor that contributes to the development of gastric ulcers. Luvangetin helps reduce oxidative stress in the gastric and duodenal mucosa, thereby preventing the formation of ulcers. Phenolic compounds are known to be strong antioxidants and have effective antiulcer properties.^[44] The methanolic extract from the unripe fruit of *Aegle marmelos* was found to reduce gastric ulcer formation and prevent oxidative stress caused by *Helicobacter pylori* and its lipopolysaccharide in rats. Another study suggested that the ripe fruit of *A. marmelos* helps protect the gastric mucosa in cases of NSAID-induced ulceration, due to its antisecretory and cytoprotective properties. Both methanolic and aqueous extracts from the fruit seeds of *A. marmelos* showed antiulcer activity, which is attributed to the presence of quercetin. *Aegle marmelos* has been shown to have significant gastroprotective effects, making it a promising option for managing and preventing ulcers. It has also been reported to strengthen mucosal defense mechanisms, thereby supporting the integrity of the stomach lining. This wide range of protective actions highlights its potential as a natural remedy for ulcer conditions.^[45]

Cardioprotective

Cardiovascular disease is a major cause of death around the world. The presence of cell-derived microparticles and high levels of cholesterol are important factors that contribute to the development of various cardiovascular conditions, including atherosclerosis, heart attacks, and high blood pressure.^[46] *A. marmelos* was also found to have various cardiovascular protective effects during myocardial injuries. One of its active components, the linear furanocoumarin marmesinin at a dose of 200 mg/kg, was shown to reduce lipid peroxidation through its antioxidant activity in an experiment involving male albino Wistar rats. The myocardial injury was induced by administering isoproterenol at a dose of 150 mg/kg intraperitoneally twice, with a 24-hr interval between the doses (Table 3).^[47]

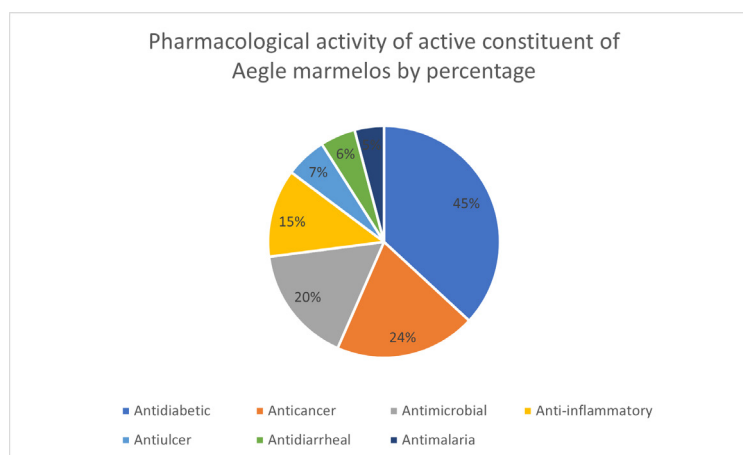


Figure 3: Pharmacological Activities of *Aegle marmelos*.

NUTRITIONAL CHARACTERISTIC OF AEGLE MARMELOS



Figure 4: Bael Tree.



Figure 5: Bael Leaf.



Figure 6: Bael Fruit.

Table 3: Nutritional constituent of *Aegle marmelos* (Fruit pulp).

Component	Percentage (%)	References
1. Carbohydrates	34.35%	
2. Protein	1.87%	
3. Fat	0.28%	[48]
4. Fibre content	2.78%	
5. Vitamin C	73.2%	
6. Moisture content	63.04%	
7. Acid content	0.30%	
8. Reducing sugar	4.42%	
9. Non reducing sugar	9.93%	[49]
10. Total sugar	13.25%	
11. Potassium	603%	
12. Phosphorus	51.6%	
13. Calcium	78%	
14. Iron	0.55%	[50]
15. Copper	0.19%	
16. Magnesium	0.82%	
17. Zinc	0.28%	

Toxicological Studies

A. marmelos is generally regarded as safe, and only a limited number of studies have been conducted to assess its toxic effects. Veerappan and colleagues investigated the toxicological impact of *A. marmelos* leaves. Their findings indicated that no significant histopathological changes were observed in the heart, liver, kidney, testis, spleen, and brain following the administration of 50 mg/kg body weight of the plant extract through intraperitoneal injection over a period of 14 days.^[51] They play a crucial role in producing energy (ibid). The type and combination of natural acids are important factors affecting the sensory qualities of a natural product. The ripe *A. marmelos* fruit serves as a potential source of energy, mainly because of the presence of carbohydrates.^[52]

Future Perspective of *Aegle Marmelos*

1. The herbosome laden with *Aegle marmelos* will be successfully prepared for the formulation's safe and effective administration.
2. When phytosomes are prepared with the methanolic extract of *Aegle marmelos* leaves, the following outcomes will be seen: Antioxidants and anti-proliferative agents.
3. Using microspheres as drug carriers, formulations containing *Aegle marmelos* can be administered under controlled conditions to treat conditions like diabetes.
4. Nanoparticles are colloidal particles that are biodegradable and biocompatible. They range in size

from roughly 10 nm to 1000 nm. Formulations based on *Aegle marmelos* can be administered through them to treat illnesses like malaria.

CONCLUSION

Bael, also known as *Aegle marmelos* (L.) Correa, is a staple of traditional Indian medicine and has long been prized for its many therapeutic applications. This review reaffirms that it is a powerful medicinal plant that contains more than 100 bioactive phytonutrients, such as phenolic compounds, alkaloids, and coumarins. With notable antidiabetic, anticancer, antidiarrheal, antiulcer, anti-inflammatory, and antioxidant qualities, scientific validation backs up its traditional uses. Additionally, toxicological research indicates that the plant is generally safe to use. With research now concentrating on creating cutting-edge drug delivery systems like herbosomes, microspheres, and nanoparticles to capitalize on its wide range of pharmacological activities for clinical applications, including possible treatments for diabetes and cancer, the future of *A. marmelos* appears bright.

REFERENCES

- Sharma GD A., "Ethnopharmacological Profile. Phytochemistry and therapeutic potential of *Aegle marmelos* L. for the treatment of neurological disorders. *J Nutr Metab*. 2025; 21.
- Pathirana MT. C.K. Bael (*Aegle marmelos* L. Corr'ea), a Medicinal Tree with Immense Economic Potentials," *Advances in Agriculture*, 2020; p. 13.
- Bobade SS. H., Indian bael, Ludhiana, Punjab, India Nayik GA, Gull A, editors, 2020.
- Choudhary CG S., "AEGLE MARMELOS (BAEL PATRA). An ayurvedic plant with ethnomedicinal value. *Int J Res Ayurveda Pharm*. 2021; 12(3)(2021):10.
- Asghar MZ N., "Phytochemical composition, antilipidemic and anti hypercholesterolemic perspectives of Bael leaf extracts," *Asghar et al. Lipids Health Dis*. 2018; 2018(17:68):9.
- EA, Rangarajan CD H., "Traditional fruits of South India: Bioactive components and," *Journal of Food Biochemistry*. 2021;45(3):11.
- F.M.A.A.P.M.A. mane A., "Phytochemical Screening and FTIR analysis of Indian *Aegle marmelos* L. (Bael) Extracts," *International Journal of Creative Research Thoughts (JCRT)*. 2022;10(2):13.
- Abdul TJ, Rahoop RM. *Aegle marmelos*: a review paper. *Int J Pharm Sci*. 2024;2(2):12.
- Mujeeb BP F., "Phytochemical Evaluation. Antimicrobial activity, and determination of bioactive components from leaves of *Aegle marmelos*. *BioMed Res Int*. 2014;2014(11):11.
- A.P. a. S.G. C.K. Kokate, pharmacognosy, Pune: Nirali Prakashan, 2024.
- Mujeeb KA F., "Phytochemical Study of *Aegle marmelos*: Chromatographic Elucidation of Polyphenolics and Assessment of Antioxidant and Cytotoxic Potential," *Pharmacognosy Magazine*. 2017;13(52):10.
- Pandey DM. Production, protection and processing of bael, Lucknow. ICAR-Central Institute for Subtropical Horticulture; 2020.
- Neeraj VB. Bael (*Aegle marmelos*), an extraordinary species of India: a review. *Int J Curr Microbiol Appl Sci*. 2017;6(3):18.
- a. k. s. s. P. L. Singh. The Bael (Production technology). Bikaner: INDIAN COUNCIL OF AGRICULTURAL RESEARCH-Central institute for arid horticulture; 2018.
- S.N. a. D. & W., "History and Taxonomy of *Aegle marmelos*: A Review," *International Journal of Pure & Applied Bioscience*. 2013;1(6):7.
- Muley LN. K.D., "Phytochemistry, pharmacology and ethnomedicinal uses of *Aegle marmelos* plant: a compendious review." *World J Pharm Res*. 2021;10(5):16.
- Sharma BV. P.C., "A review on Bael tree." *Nat Prod Radiance*. 2007;6(2):8.
- Phytochemistry and medicinal uses of the bael fruit (*Aegle marmelos* Correa): A concise review *Food Research International*. B H.P.J.N.F.F. Baliga M.S. 2011;44, no:8.
- Sharma DS G. N., "Medicinal Values of Bael (*Aegle marmelos*) (L.) Corr.: A Review," *International Journal of Current Pharmaceutical Review and Research*. 2011;1(3):11.
- Tripathi PC. Medicinal and therapeutic properties of minor fruits – a review *International Journal of Minor Fruits*. *Med Aromat Plants*. 2021;7(2):28.
- Ansari P, Khan JT, Chowdhury S, Reberio AD, Kumar S, Seidel V, et al. Plant-based diets and phytochemicals in the management of diabetes mellitus and prevention of its complications: a review. *Nutrients*. 2024;16(21):3709. doi: 10.3390/nu16213709, PMID 39519546.
- Sharma BA M., "Bioactive polysaccharides from *Aegle marmelos* fruit: Recent trends on extraction, bio- techno functionality, and food applications," *Food Science & Nutrition*, 2024;12:14.
- Lamkhade KA. A.K., "Formulation development and evaluation of herbal effervescent tablet." *World J Pharm Res*. 2023;12(9):19.
- Sharma N, Radha MK, Kumar M, Zhang B, Kumari N, Singh D et al. *Aegle marmelos* (L.) Correa: an underutilized fruit with high nutraceutical values: a review. *Int J Mol Sci*. 2022;23(18):10889. doi: 10.3390/ijms231810889.
- K.K.P.S.J.S.V. Malabadi R.B. Bael (*Aegle marmelos* (L.): Ethnobotany, Phytochemistry and Pharmacology: Cultivated varieties in India -An Update," *World Journal of Biology Pharmacy and Health Sciences*. 2024;20(2):42.
- SF, Bibak GK B. A review of the pharmacological and therapeutic effects of auroptene. *BioFactors*, 2019; 13.
- S. J. S. L. P. N. D. B. K. Patel P.K., "*Aegle marmelos*: a review on its medicinal properties." *Int J Pharm Phytopharmacol Res*. 2012;1(5):10.
- K.S. a. G.P., "A review: Therapeutic profile of *Aegle marmelos* (Bael)," *Journal of Pharmacognosy and Phytochemistry*. 2025;14(2):5.
- Dahiya KR. *Aegle marmelos* a review of its phytochemical profile and pharmacological application. *J Med Plants Stud*. 2025;13(2):5.
- Savita SA. *Aegle marmelos* (L.) (bael): A systematic review. *J Drug Deliv Ther*. 2021;11, no. 3-s56.
- N.P.R.M.J.K.P.Vijay Pradhap Singh. M1, "In vitro Antioxidant and Antimicrobial Activities of Flowers Extract of *Aegle marmelos*," *Res J Pharm Technol*. 2023;16(2):773-6.
- Pawar PS T., "A COMPREHENSIVE REVIEW OF MEDICINAL USES AND PHARMACOLOGICAL PROPERTIES OF AEGLE MARMELOS," *INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD)*. 2024;9(5):85-99.
- Mujeeb KA F., "Significance, pharmacological properties, and industrial applications of bael (*Aegle marmelos*): A review of current knowledge," *Journal of Agriculture and Food Research*, 2025;19:pp. 1-11.
- Khanal DS A., "Bael (*Aegle marmelos*), an Underutilized Fruit with Enormous Potential to Be Developed as a Functional Food Product: A Review," *Journal of Food Processing and Preservation*, vol. 2023. No. -, pp. 1-11, 2023.
- Singh RH R., "Hepatoprotective effect of the pulp/seed of *Aegle marmelos* correa ex Roxb against carbon tetrachloride induced liver damage in rats," *International Journal of Green Pharmacy*. Vols. -, no. -, p. 232–234, 2008.
- Gudadhe GaD. S.P., "A review on medicinal uses of *Aegle marmelos*." *World J Pharm Res*. 2024;13(1):1009-19.
- Patil CU M., "Bael (*Aegle marmelos*). An overview of its nutritional value, phytochemical composition, and medicinal uses. *Vidyapharma Peer Reviewed J Pharm Chem Sci Ayurveda*;2, no. 1, pp. Vidyapharma: Peer Reviewed Journal for Pharmaceutical, Chemical Sciences and Ayurveda, 2024.
- Subedi BB A., "Medicinal properties and uses of *Aegle marmelos* (Bel) plant: A review," *ASIAN JOURNAL OF PHARMACOGNOSY*. 2022;6(1):10-20.
- Singh SA R., "Ethno-medicinal and Pharmacological activities of *Aegle marmelos* (Linn.) Corr: A review," *The Pharma Innovation Journal*. 2019;8(6):176-81.
- Medicinal and Phytopharmacological Properties of Bael *Aegle marmelos* correa Family Rutaceae *Pharmaceutical Sciences & Analytical Research Journal*. *J GC*. 2024;6(2):1-35.
- Benni JM, Jayanthi MK, Suresha RN. Evaluation of the anti-inflammatory activity of *Aegle marmelos* (Bilwa) root. *Indian J Pharmacol*. 2011;43(4):393-7. doi: 10.4103/0253-7613.83108, PMID 21844992.
- Pynam DS. Antioxidant and anti-inflammatory properties of marmelosin from Bael (*Aegle marmelos* L.); Inhibition of TNF- α mediated inflammatory/tumor markers. *Biomed Pharmacother*. 2018; 106, no. -, pp. 98-108:98-108. doi: 10.1016/j.biopha.2018.06.053, PMID 29957472.
- Banerjee JS A., "A Review: Medicinal Properties and Health Benefits of Bael (*Aegle marmelos*)," *Journal of Scientific Research and Reports*. 2024;30(6):773-86.
- Dutta LN A., "Ethnological and Ethno-medicinal Importance of *Aegle marmelos* (L.) Corr (Bael). Among indigenous people of India. *Am J Ethnomed*. 2014;1(5):290-312.
- Naik PP. N.R., "A review on phytochemical and pharmacological properties of *Aegle marmelos*," *International Journal of Scientific Development and Research (IJSDR)*. 2024;9(1):368-72.
- Manandhar PR B., "Phytochemical profile and pharmacological activity of *Aegle marmelos* Linn.," *Journal of Integrative Medicine*. Vols. -, no. -, pp. 1-23, 2018.
- Vimal V, Devaki T. Linear furanocoumarin protects rat myocardium against lipidperoxidation and membrane damage during experimental myocardial injury. *Biomed Pharmacother*. 2004;58(6-7):393-400. doi: 10.1016/j.biopha.2003.12.007, PMID 15271422.
- Lakht-e-Zehra AD. Nutritional exploration of leaves, seed and fruit of bael (*Aegle marmelos* L.) grown in Karachi region. *Pak J Biochem Mol Biol*;48(3). *Pak p. J Biochem Mol Biol*. 2015.

49. JGC. Ethnomedicinal properties of Bael *Aegle marmelos* Corrêa family Rutaceae: a review. Trends Hortic. 2023;6(2):1-16.
50. R. v., "Nutritional composition and value addition of bael fruit: A review,"The Pharma Innovation Journal. 2023;12(5):2271-3.
51. Rahman S, Parvin R. Therapeutic potential of *Aegle marmelos* (L.)-An overview. Asian Pac J Trop Dis. 2014;4(1):71-7. doi: 10.1016/S2222-1808(14)60318-2.
52. S.M.S.R.S.S.B. Iamia S.S., "Phytochemistry and pharmacological properties of *Aegle marmelos* L. (Rutaceae): a review,"International Journal of Research in Pharmacy and Pharmaceutical Sciences. 2018b;3(3):45-54.

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