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Review Article

Aegle Marmelos Linn: A Compressive Overview

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ABSTRACT

The valuable medicinal plant *Aegle marmelos* Linn. (Rutaceae), sometimes referred to as "bael" in Nepal and India, is revered by Hindus. In the Ayurvedic system of Indian traditional medicine, it is used to treat a number of ailments. For more than 5000 years, various ethnic groups living on the Indian subcontinent have also utilized it in a similar way. This tree's stem, bark, root, leaves, fruit, and seeds at every stage of maturity all have therapeutic qualities, and ethnomedicine has utilized them to their fullest potential. Many of *A. marmelos*'s traditional therapeutic benefits, such as its antibacterial, antiviral, antidiarrheal, gastroprotective, anti-ulcerative colitis, hepatoprotective, antidiabetic, cardioprotective, and radioprotective properties, have been supported by scientific research. Purified compounds from bael fruit have demonstrated biological potential against a number of illnesses, including hyperlipidemia, diabetes, and stomach ulcers. Therefore, this abstract's goal is to investigate the pharmacological potential of a few crude bael plant extracts.

INTRODUCTION

Humans have been using herbal medicine to prevent and treat a variety of illnesses since ancient times, and it served as the primary form of treatment until the development of contemporary allopathic, or synthetic, medicine.^[1] Nowadays, herbal medicine is practiced all over the world under various names, including Ayurveda on the Indian subcontinent, Japanese Kampo medicine, Korean oriental medicine, and Unani medicine in the Middle East.^[2] These complementary and

alternative medicine systems are popular because they are thought to be helpful and have few or no negative side effects.^[3] However, to give a complete picture of recent advancements from research and pharmacological studies, it is required to methodically document the effectiveness of these herbal medications.^[4] Northern India is the native home of this plant, which is also widely distributed throughout the Indian peninsula, as well as in Ceylon, Burma, Thailand, and Indo-China.^[5] Even in climates that

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are harsh and dry, the tree can grow up to 12 to 15 meters tall in the wild in well-drained soil. They have three to five oval, pointed, shallowly toothed leaflets that alternate with spiky branches. Clusters of fragrant flowers grow along the young branches.^[6] The oblong, oval, or round fruits are all edible. A thin or firm woody shell that is gray-green when raw and yellowish when mature may envelop the flesh of fruits, depending on the variety. A distinctively pleasant scent emanates from the shells. The pulp is sweet, resinous, pale orange, and very aromatic.^[7] The seeds, which are embedded in the pulp and have structures resembling woolly hairs, are about ten to fifteen in number. Each seed is encased in a sack of transparent, sticky mucilage that solidifies when it dries.^[8] The Chinese used the leaves and young fruits to adulterate Opium, and in Bengal, it is used



Fig 1: Bael Fruit

CHEMICAL CONSTITUENTS:

Important bioactive substances such as carotenoids, phenolics, alkaloids, pectins, tannins, coumarins, flavonoids, and terpenoids have been found in bael fruit pulp, according to studies.^[15] It is noteworthy that several Indian workers have reported the majority of reports on the isolation and compound characterizations.^[16] In general, the leaves of *Aegle marmelos* contained flavone, glycoside, O isopentenyl halfordiol, marmeline, phenylethyl cinnamamides, γ -sitosterol, aegelin, lupeol, rutin,

to treat dysentery.^[9] In Konkan, small, unripe fruits are used for piles, and the bark juice is used to treat seminal fluid poverty.^[10]

Since ancient times, people have used herbal medicine to prevent and treat a variety of illnesses. Prior to the development of contemporary allopathic, or synthetic, medicine, this was the primary form of treatment.^[11] Currently, herbal medicine is practiced all over the world under various names, including Ayurveda in the Indian subcontinent, Japanese Kampo medicine, Korean oriental medicine, and Unani medicine in the Middle East.^[12] These complementary and alternative medical systems are popular because they are thought to be helpful and have few or no negative side effects.^[13-14]



Fig 2: Bael Plant

marmesinin, and β -sitosterol^[17] Hexanal, isoamyl acetate, limonene, β -phellandrene, p-cymene, acetoin, (E)-2-octenal, (E,E)-2,4-heptadienal, citronellal, cineole, p-cymene, citronella, citral, cuminaldehyde, β -cubebene, β -caryophyllene, hexadecane, pulegone, α -humulene, verbenone, carvone, carvyl acetate, dihydro- β -ionone, (E)-6,10-dimethyl-5,9-undecadien-2-one, β -ionone, caryophyllene oxide, humulene oxide, and hexadecanoic acid.^[18] They also contain coumarins including aegeline, aegelenine, marmelin, o-methyl halfordinol,

alloimperatorin, furocoumarins, psoralen, o-isopentenyl halfordinol and marmelosin.^[19] Additionally, they contain furocoumarins, psoralen, o-isopentenyl halfordinol, marmelin, o-mtheyl halfordinol, alloimperatorin, aegeline, aegelenine, and marmelosin. Additionally, they contain flavonoid glycosides, leucoanthocyanins, anthocyanins, flavon-3-ols, tannins, phlobatannins, tartaric acid, and linoleic acid.^[20] Aegeline, aegelenine, aegelinosides, marmelin, marmelosin, malondialdehyde (MDA), anhydromarmeline, marmelide, umbelliferone β -

D-galactopyranoside, lupeol, halfordinol, butyl p-tolyl sulfide, 6-methyl-4-chromanone, butylated hydroxyanisole, imperatoin, xanthorrhizol, xanthoarnol, 1-methyl-5,7-dimethoxy-2-naphthalene-carboxaldehyde, 1-methyl 2-(3'-methyl-but-2'-enyloxy)-anthraquinone, and several others are the most significant isolated compounds that have been found to elicit important bioactivity.^[21-23]

PHARMACOLOGICAL ACTIVITIES:



1. Antidiabetic Activity:

The hypoglycemic effects of bael (*Aegle marmelos*), which enhance insulin sensitivity and antioxidant capacity, are the main reason for its antidiabetic qualities.^[24] Bael's alkaloids, flavonoids, and coumarins are among the compounds that assist decrease blood sugar levels and shield pancreatic cells from oxidative damage. Its traditional use in controlling diabetes and preserving stable blood sugar levels is supported by these qualities.^[25] The most prevalent endocrine condition, diabetes mellitus (DM), affects over 100 million people globally, or 6% of the total population. It is brought on by insufficient

or inefficient insulin production by the pancreas, which causes blood glucose levels to rise or fall.^[26] *Aegle marmelos* fruit extract's antidiabetic properties were assessed in a histological examination of diabetes produced by streptozotocin. The purpose of this study was to clarify how an aqueous extract of *Aegle marmelos* fruits protected the pancreatic histopathology in rats with streptozotocin-induced diabetes.^[27-28]

2. Antioxidant Activity:

Because of its abundance of bioactive substances, including flavonoids, phenolics, alkaloids, tannins, and vitamins (particularly C and A), bael (*Aegle marmelos*) has considerable antioxidant

activity.^[29] These antioxidants aid in reducing oxidative stress and neutralizing free radicals, both of which can harm cells and have a role in chronic illnesses.^[30] Antioxidants protect beta cells in the pancreas from oxidative damage, which is particularly helpful for managing diabetes. The antioxidants in bael assist to reduce inflammation, which lowers the risk of diseases like cardiovascular disease that are linked to chronic inflammation.^[31] Bael's other health advantages are enhanced by this antioxidant quality, which makes it useful in both conventional medicine and contemporary therapeutic uses.^[32]

3. Antiviral Activity:

Bioactive substances such as alkaloids, flavonoids, tannins, and phenolic compounds are the main cause of bael's (*Aegle marmelos*) remarkable antiviral qualities.^[33] These substances function by hindering the growth of viruses, decreasing their capacity to infect cells, and strengthening the immune system's defenses against viral infections.^[34] Bael contains phytochemicals that can prevent viruses from replicating, which hinders their ability to propagate throughout the body. The body's defenses against viral infections are strengthened by the antioxidant-rich bael.^[35]

4. Antidiarrhoeal Activity:

The fruit, leaves, and bark of bael (*Aegle marmelos*) include tannins, flavonoids, alkaloids, and pectin, which are the main causes of its traditional antidiarrheal uses. The capacity of bael to treat gastrointestinal disorders and diarrhea is facilitated by these substances.^[36] Chronic diarrhea and dysentery without fever can be effectively treated with unripe or half-ripe fruit. In patients with chronic dysentery who alternate between loose stool and occasional constipation, the fruit pulp of *A. marmelos* has been demonstrated to have antiprotozoal efficacy.^[37] Various formulations are made using the unripe fruit to treat persistent diarrhea. Following the use of fruit powder under these circumstances, the

blood progressively goes away and the stool returns to its more solid and feculent state. Additionally, the mucus goes away after a while of continuous use.^[38-40]

5. Anticancer Activity:

In numerous investigations, the bael plant (*Aegle marmelos*), which is well-known for its therapeutic qualities, has demonstrated encouraging anticancer action. Bioactive substances with cytotoxic, anti-inflammatory, and antioxidant properties, including tannins, coumarins, alkaloids, and flavonoids, are found in bael.^[41] It has the potential to prevent and treat cancer because of these chemicals. It has been discovered that bael extracts prevent the growth of cancer cells by causing apoptosis, or programmed cell death, and preventing cell division. In particular, research indicates that bael may be able to target a number of cancer types, such as liver, colon, and breast cancer. Its antioxidant qualities aid in lowering oxidative stress, which otherwise may accelerate the development of cancer.^[42] Apart from its direct cytotoxic effects, bael also boosts immunity, which may strengthen the body's defenses against cancer cells. Bael has potential as an oncology supplemental therapy, but more investigation, including clinical studies, is required to completely determine its safety and effectiveness in treating cancer.^[43-44]

6. Antiulcer Activity:

Bael (*Aegle marmelos*) contains bioactive substances such as pectins, mucilage, flavonoids, and tannins that are thought to have important antiulcer effects. By encouraging the healing of pre-existing ulcers, decreasing the production of gastric acid, and increasing mucus secretion, these substances aid in protecting the stomach lining, or gastric mucosa.^[45] Peptic ulcers can be effectively treated with a leaf infusion. Fruit that is consumed as a beverage also has a lot of healing potential because of its mucilage, which coats the stomach mucosa and aids in ulcer repair. Luvangetin, a



substance found in the fruit, is the cause of this behavior.^[46, 47]

7. Antibacterial Activity:

As an alternative, herbal medications can have beneficial antibacterial properties. The most multipurpose unicellular pathogens are bacteria, which typically spread through food, water, air, and soil and infect humans and animals through sickness.^[48] Bael is one of the natural products that can be used to treat cases of this kind. Bael fruit extracts, both methanolic and aqueous, have demonstrated significant antimicrobial activity against all strains of *Salmonella typhi*. The aqueous extract lacks the potency of the methanolic extract. Bael extracts have been demonstrated in studies to efficiently suppress a variety of bacterial pathogens, including both Gram-positive and Gram-negative bacteria.^[49] The rupture of bacterial cell walls, suppression of enzyme function, and interference with bacterial DNA synthesis are thought to be the mechanisms underlying the antibacterial action, which stops bacterial growth and reproduction.^[50-52]

CONCLUSION:

The review of *Aegle marmelos* highlights the plant's significant cultural, medicinal, and ecological importance. It is highly valued for its wide range of uses, from weaving and food production to traditional medicine. The results showed that *Aegle marmelos* plant parts had high levels of important bioactive substances such as carotenoids, phenolics, alkaloids, pectins, tannins, coumarins, flavonoids, and terpenoids that contributed to their potential health benefits. *Aegle marmelos* stands out as a versatile species with both practical and cultural relevance. Studies have shown that the plant exhibits various pharmacological properties, including antioxidant, antibacterial, anticancer, antiulcer activities etc. These effects are largely due to its bioactive compounds, such as flavonoids, phenolics, and essential oils. *Aegle* plant research reveals a great

deal of biological potential. More research on *Aegle marmelos* leaves will reveal other pharmacological properties, such as skin irritation.

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