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Anilkumar KK
Assistant Professor,
Department of Botany, NSS
Hindu College,
Changanacherry, Kottayam,
Kerala, India

Exploring the therapeutic potential: A comprehensive review on the medicinal uses of *Aegle marmelos* Correa, ex Roxb

Anilkumar KK

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Abstract

Aegle marmelos, a versatile medicinal plant belongs to Rutaceae family indigenous to India, has been a prominent component in traditional medicine for centuries. The plant, commonly referred to as Bael, exhibits a range of therapeutic properties attributed to its diverse chemical constituents. The medicinal uses of *Aegle marmelos* encompass its roots, bark, leaves, and fruits, each contributing unique bioactive compounds. The pharmacological activities associated with this plant include anti-inflammatory, antimicrobial, antioxidant, and anti-diabetic effects. The plant has been traditionally utilized for gastrointestinal disorders, with the fruit and its extracts recognized for their efficacy in managing conditions such as diarrhoea and dysentery. The presence of bioactive compounds like marmelosin and flavonoids contributes to its anti-inflammatory and antioxidant potential. Furthermore, *Aegle marmelos* has demonstrated anti-diabetic properties by modulating glucose metabolism. Its immunomodulatory effects and antimicrobial activity against various pathogens add its therapeutic potential. Additionally, extracts from different parts of the plant have shown promise in cardiovascular health and as a potential anti-cancer agent. Further research is warranted to elucidate its mechanisms of action and to explore its potential in modern pharmacology for the development of new therapeutic agents.

Keywords: *Aegle marmelos*, antimicrobial, antidiabetic, anti-inflammatory, anti-spermatogenic

Introduction

Aegle marmelos, commonly known as Bael or Bilva, has been a cornerstone in traditional medicine systems, particularly in Ayurveda, owing to its extensive medicinal properties. indigenous to India, this plant has a rich history of therapeutic applications, with various parts of the plant, including its roots, bark, leaves, and fruits, contributing to a diverse array of bioactive compounds. As we delve into the medicinal applications of *Aegle marmelos*, it becomes evident that this botanical treasure holds great promise in the realm of natural healthcare. Throughout centuries, practitioners of traditional medicine have harnessed the healing potential of *Aegle marmelos* for a wide range of ailments. The pharmacological significance of this plant is rooted in its multifaceted chemical composition, which includes alkaloids, flavonoids, essential oils, and other secondary metabolites. Such constituents not only contribute to the distinct aroma and flavour of the plant but also underlie its various therapeutic effects. This review aims to comprehensively explore and evaluate the medicinal uses of *Aegle marmelos* based on existing scientific literature and traditional knowledge. The plant's anti-inflammatory, antimicrobial, antioxidant, and anti-diabetic properties have garnered significant attention in recent years. Additionally, its applications in managing gastrointestinal disorders, cardiovascular health, and anti-cancer effects have sparked interest in the scientific and medical communities. As we navigate through the current state of research on *Aegle marmelos*, it is crucial to discern the gaps in knowledge, highlight areas of ongoing investigation, and discuss the translational potential of these findings in contemporary medicine. By shedding light on the therapeutic benefits of *Aegle marmelos*, this review aims to contribute to the growing body of evidence supporting the integration of traditional medicinal knowledge with modern healthcare practices.

Corresponding Author:
Anilkumar KK
Assistant Professor,
Department of Botany, NSS
Hindu College,
Changanacherry, Kottayam,
Kerala, India

In doing so, we aspire to foster a deeper understanding of the medicinal potential of this plant and stimulate further research aimed at unlocking the full spectrum of its healing capabilities.

Taxonomical classification

Kingdom: Plantae
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Sapindales
Family: Rutaceae
Genus: *Aegle*
Species: *marmelos*
Synonyms: *Feronia pellucida* Roth, *Crateva marmelos* L

Table 1: Shows the Vernacular names

Language	Name
Bengali	Bel, Bela, Bilvam, Belbilva
English	Stoneapple, Beal tree, Bengal quince, Golden apple,
Gujarati	Bilobilu, Beelo
Hindi	Beal, Bel, Siriphal, Sirphal
Kannada	Belavu, Velapathre, Bilvatre
Malayalam	Koovalam
Marati	Bela, Bili, Baela
Sanskrit	Bilwam, Sripthal, Vilvah
Tamil	Vilwam, Koovilai, Villuvam
Telugu	Vilvom, Vilo, Bilova, Maradipandu, Maredu

Plant description

A medium sized armed deciduous tree that grows up to a height of 10m, profusely branched with straight, sharp, axillary thorns and yellowish brown shallowly furrowed corky bark that grows throughout India. Leaves trifoliate, light to dark green, aromatic, alternate, leaflets ovate or ovate-lanceolate, crenate, pellucid-punctate, the laterals sessile and the terminal one with long-petiole. Flowers greenish white, sweet scented, in axillary panicles. Fruits globose woody berry with yellowish ring; seeds numerous, oblong, compressed, embedded in orange brown colored sweet gummy pulp.

Parts used: roots, bark, leaves, and fruits

Bio chemical constituents

Several phytochemicals have been identified and isolated from different parts of *Aegle marmelos* and are listed below (Maity *et al*, 2009) [19].

Table 2: Shows the Plant Part and Phytochemicals Present

Plant Part	Phytochemicals Present
Fruit	Psoralen, Aurapten, Tannin, Marmelide, Marmelosin, Luvangetin
Bark	Marmin, Fagarine, Skimmianine
Leaf	Eugenol, Marmesinine, Skimmianine, Lupeol, Cineol, Citronella, Citral, Aegeline, Cuminaldehyde

Gastrointestinal Disorders and Anti-Ulcer Activity

The fruit pulp of *Aegle marmelos* is traditionally used to treat various gastrointestinal disorders, including diarrhoea and dysentery. It is believed to have anti-diarrheal properties and helps in regulating bowel movements. The oral administration of pyranocoumarin isolated from the seeds of this plant showed significant protection against artificially induced gastric ulcers in rats and guinea pigs. (Brijesh *et al*,

2009; Maheswari *et al*, 2009; Dhuley, 2007; Mazumder *et al*, 2006; Goel *et al*, 1997) [3, 18, 5, 21, 7].

Anti-inflammatory Activity

Aegle marmelos exhibits anti-inflammatory properties, which may be beneficial in the treatment of inflammatory conditions. (Ghangale *et al*, 2008; Arul *et al*, 2005) [6, 1].

Hepatoprotective Activity

The different extracts of leaves, fruits and seeds of *Aegle marmelos* showed hepatoprotective activity in experimental organisms against hepatic toxicity induced through alcohol or CCl₄. (Singanan *et al*, 2007; Singh and Singh, 2008)

Antimicrobial Properties

Various parts of the plant have demonstrated antimicrobial activity against bacteria, fungi, and parasites. The plant is used traditionally to combat infections and promote overall immune health. (Maheswari *et al*, 2009; Kaur *et al*, 2009; Venkatesan *et al*, 2009; Singh and Singh, 2008; Citarasu *et al*, 2003; Badam *et al*, 2002) [18, 13, 26, 4, 2].

Antioxidant Effects

Aegle marmelos contains compounds with antioxidant properties, which may help in neutralizing free radicals in the body. Antioxidants play a role in protecting cells from oxidative stress and may contribute to overall health. (Kuttan *et al*, 2004; Upadhyaya *et al*, 2004; Kamalakkannan *et al*, 2003) [16, 30, 11].

Anti-diabetic Potential

Some studies suggest that *Aegle marmelos* may have hypoglycemic effects, making it potentially useful in managing diabetes. It may help in regulating blood glucose levels and improving insulin sensitivity. (Sundaram *et al*, 2009; Kesari *et al*, 2006; Marzine and Gilbert, 2005; Kuttan *et al*, 2004; Upadhyaya *et al*, 2004; Kamalakkannan *et al*, 2003; Kar *et al*, 2003; Karunanayake *et al*, 1984) [28, 15, 20, 16, 30, 11, 12, 14].

Cardioprotective Effects

Aegle marmelos has been investigated for its potential cardioprotective effects, including its role in reducing cholesterol levels and supporting cardiovascular health. (Vimal and Devaki, 2004) [32].

Anti-spermatogenic Activity

It was reported that the ethanolic extract of *Aegle marmelos* leaves in experimental rats showed anti spermatogenic activity and the sperm motility was adversely affected by the extract in invitro studies. (Remya *et al*, 2009; Pramanik *et al*, 2002; Sur *et al*, 1999) [24, 23, 29].

Respiratory Disorders

In traditional medicine, *Aegle marmelos* is used for respiratory conditions. It is believed to have bronchodilator effects and may be used in the management of conditions like asthma.

Anti-cancer Properties

Some studies have explored the potential anti-cancer properties of *Aegle marmelos*. It may have inhibitory effects on the growth of certain cancer cells. (Subramaniam *et al*, 2008; Jagetia *et al*, 2005; Lampronti *et al*, 2003) [27, 10, 17].

Wound Healing

The paste made from *Aegle marmelos* leaves is applied topically to wounds. It is believed to have wound-healing properties.

Anti-Thyroid Activity

It was reported that the Scopoletin (7- hydroxy-6-methoxy coumarin) isolated from the leaves of *Aegle marmelos* showed, decreased serum thyroid hormones in experimental animals treated with levothyroxine (Panda and Kar, 2006) [22].

Immunomodulatory Effects

Aegle marmelos is thought to modulate the immune system, potentially enhancing the body's natural defence mechanisms.

Radioprotective Activity

Reports are available on the effect of different extracts of *Aegle marmelos* in experimental mice against the radiation of gamma rays and was found that the oral administration of extract resulted in an increase in radiation tolerance and have reduced the deleterious effect of radiation in intestine and bone marrow of mouse. (Jagetia and Venkatesh, 2007; Jagetia *et al*, 2006; Jagetia and Venkatesh, 2005) [8, 9, 10].

Conclusion

The review of the medicinal uses of *Aegle marmelos* underscores the plant's immense potential as a source of therapeutic agents. The rich traditional knowledge surrounding this botanical gem aligns with the growing body of scientific evidence, highlighting its multifaceted pharmacological properties. *Aegle marmelos* has proven itself as more than a cultural symbol, it stands as a repository of bioactive compounds with diverse health benefits. The anti-inflammatory, antimicrobial, and antioxidant properties exhibited by *Aegle marmelos* validate its traditional applications in managing a spectrum of health conditions. The plant's effectiveness in gastrointestinal disorders, particularly in the treatment of diarrhoea and dysentery, aligns with its historical use and opens avenues for further exploration in modern gastroenterology. Moreover, the anti-diabetic potential of this plant attributed to its ability to modulate glucose metabolism, holds promise for the development of novel therapeutic interventions in the field of diabetes management. As cardiovascular diseases continue to pose significant health challenges globally, the cardiovascular benefits associated with *Aegle marmelos* warrant focused research to elucidate the mechanisms and potential clinical applications. The exploration of this plant in the context of anti-cancer properties opens an intriguing avenue for further investigation. While preliminary studies suggest its potential in inhibiting cancer cell proliferation, more extensive research is needed to unravel the underlying mechanisms and assess its efficacy in diverse cancer types. In bridging the gap between traditional knowledge and modern science, this review emphasizes the need for continued research to validate and refine the applications of *Aegle marmelos* in evidence-based medicine. Standardization of extraction processes, identification of active compounds, and rigorous clinical trials are essential steps to harness the full therapeutic potential of this botanical species. As we look toward the future, the integration of *Aegle marmelos* into mainstream healthcare

practices holds promise not only for its historical and cultural significance but also for its potential to contribute to the development of novel drugs and therapeutic strategies. This review serves as a call to action, encouraging researchers, healthcare professionals, and policymakers to collaborate in unlocking the full spectrum of medicinal benefits offered by *Aegle marmelos* for the betterment of global health.

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