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Medicinal properties and uses of *Aegle marmelos* (Bel) plant: A review

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Abstract: In almost all cultures, medicinal plants have been utilized as a source of medicine. Plants have been used to flavor and store food for thousands of years, as well as to heal health issues and prevent diseases, including epidemics. Among them, Bel is one of the plants that has a long history of usage in the treatment of a variety of disorders. The aim of this paper is to identify the medicinal properties and uses of this Bel. For this purpose, different publications published from 1979 to 2021 were assessed through online portals. A total of 73 articles were reviewed for this purpose. Bel has been proven to offer a useful role in ethnomedicine. Various parts of Bel like leaves, roots, stems, fruit, and bark are composed of different phytochemicals like alkaloids, cardiac glycosides, terpenoids, saponins, flavonoids, steroids, and tannins. They are used as medicine due to their medicinal properties, including anti-diarrhoeal, anti-dysentric, antipyretic, antimicrobial, wound healing, diuretic, antifertility, antioxidant, analgesic, anti-inflammatory, hepatoprotective, etc. In addition to being a medicinal plant that grows on hillsides, the worship of Lord Shiva requires the offering of Bel leaves as an obligatory ceremony in Hindu culture. Bel possesses a variety of characteristics that reflect the significance of a variety of attributes, whether religious or therapeutic. More studies need to be undertaken to detect and investigate the plant's unexplored properties and uses.

Keywords: Bhel, *Aegle marmelos,* medicinal properties, ethnomedicinal values,

INTRODUCTION

Plants support the life systems on earth (Miya & Gautam, 2021) through their various curative properties. The natural medical system is pollution-free and less toxic with no side effects. That's why it is gaining more attention than the allopathic system (Sharma & Dubey, 2013). Medicinal herbs have been used for healing since the dawn of civilization (Petrovska, 2012). They are considered rich sources of traditional

remedies, and many contemporary drugs are derived from them (Dar et al., 2017). Medicinal plants are the source of income for many people in rural communities too (Lamichhane et al., 2021). However, use of medicinal plants is decreasing due to the availability of modern medicine (Poudel et al., 2021). Because of the COVID-19 pandemic, use of medicinal plants is again increasing (Chhetri et al., 2021).

A. marmelos is an herbal traditional remedy in South East Asia that is also known as "bhel" or "bael" (Pant et al., 2019). The fruit is like pale yellow to golden orange when ripe known as stone apple in English (Bobade et al., 2020). It is a subtropical, deciduous, fruit-bearing tree growing in the hills and plains of Nepal, India, Sri Lanka, Bangladesh and many other sub-Himalayan areas (Satyal et al., 2012). It is the single plant in the genus *Aegle* and even in tough and arid areas; the tree grows wild in well-drained soil to a height of 12–15 m (Manandhar et al., 2018). It can grow at high altitudes up to 1,200 meters, and can tolerate temperatures as low as 7°C and as high as 50°C without tremendous growth retardation but in the event of severe droughts, fruiting may halt, even though the plant may live with shallow soil moisture (Pathirana et al., 2020). It has a short, thick, soft stem with peeling bark and spreading, occasionally thorny branches, with the bottom ones bending down whereas the spines of young suckers are rigid and straight (Sekar et al., 2011). It has white flowers with a sweet aroma whereas the diameter of a bael fruit is normally between 5 and 12 cm (Gupta et al., 2019). Almost all parts of this plant have been used in traditional medicines and usually chronic diarrhea & dysentery can be treated from the ripe fruits of bael (Nemkul et al., 2018). The fruit is rich in tonics, vitamins, carbs, proteins, oils, and a number of curative elements, and it has a high nutritional value (Bhattrai, 2001). Bael is regarded as a fertility emblem and is said to be a therapeutic tree that nourishes the body (Baliga et al., 2013).

Many Ayurvedic remedies for the treatment of tuberculosis use the root as a key component (Suja et al., 2017). Because it absorbs toxic fumes and deleterious components from the environment and turns them to neutral, the bael plant functions as a sink for chemical pollutants (Jhajhria & Kumar, 2016). *A. marmelos* is also a religious tree attributed to Lord Shiva, in addition to being a therapeutic plant & in the hillsides, the worship of Lord Shiva mandates the offering of bael leaves as an obligatory ceremony (Dutta et al., 2014). The bael fruit was recognized throughout the 'Ramayana' period, and its trees were seen growing in the 'Chitrakuta' hills and 'Panchvati' (Singh & Roy, 1984). All Hindus are committed to caring and respect this tree, and chopping it down is desecration (Sharma et al., 2007; Trivedi et al., 2006).

Several studies describe the characteristics and benefits of *A. marmelos* but the information related to the medicinal properties is still lacking. The study aims to find out the medicinal properties and uses of *A. marmelos*. The morphology, phytochemistry, traditional usage, and therapeutic benefits of *A. marmelos* are all highlighted in this study for future exploration and production of active ingredients. This article will provide information related to the medicinal properties and uses of *A. marmelos*.

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Taxonomical classification of *A. marmelos* (Bhar et al., 2019)

Kingdom : Plantae
Subkingdom : Tracheobionta
Super division: Spermatophyta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Rosidae
Order: Sapindales
Family: Rutaceae
Genus: *Aegle*
Species: *Aegle marmelos*

METHODOLOGY

All of the information gathered for this manuscript were from secondary sources (Sharma and Gautam, 2022). Online portals were used to collect the literatures published from the year 1979 to 2022. Seventy-two papers were utilized to extract the relevant information and data, and all of the articles that were published in English were inspected. In the same way, other reports were used to gain relevant data. Mainly those articles were selected which contain the information of *Aegle marmelos*. The key words used for the search of articles are Bael, *Aegle marmelos,* medicinal properties, uses, ethnomedicinal values, etc.

RESULTS & DISCUSSION

From different portions of the *A. marmelos* tree, phytoconstituents have already been separated and studied (Sharma et al., 2011). Alkaloids, Cardiac glycosides, Terpenoids, Saponins, Tannins, Flavonoids and Steroids were found in the crude extract after phytochemical screening (Venkatesan et al., 2009)**.** Its leaves contain alkaloids, of which aegeline is known ingredient and is consumed as a dietary supplement whereas fruit contains several bioactive compounds such as marmrlosin, luvangetin, aureptene, psoralen, marmelide and tannins (NithyaDevakrupa & Raghavan, 2014). Various biological, chemical properties are there and this species is very important according to medicinal as well as religious points of view**.**

Biological description: The leaflets of *Aegle* are oblong to lanceolate with Pellucid – punctuate scented oil glands, and the leaves are trifoliate alternating where the terminal leaf is a long petiole and the lateral leaves are subsided (Kaviyarasi et al., 2017). Fruits are enclosed with a hard shell, and have mucilaginous texture and numerous seeds so that it is difficult to eat and is highly nutritive (Roy & Singh, 1979). It takes 10 to 11 months to sprout to ripening (Lomate et al., 2021). Matured fruit is

green yellowish in color shows ripening of fruit (Sawale et al., 2018). The stem is brief, thick, soft, chipping bark, and spreading, in some cases with sharp branches where lower one hanging out (Sekar et al., 2011). Flower is of greenish-white color, characterize as having bisexual, ebracteate, hypogynous, and actinomorphic stalk, giving a sweet fragrance (Sarkar et al., 2020). Seeds are embedded with pulp that is in hairy structure and each seed are enclosed in an adhesive, transparent mucilage sack that sets on drying (Manandhar et al., 2018).

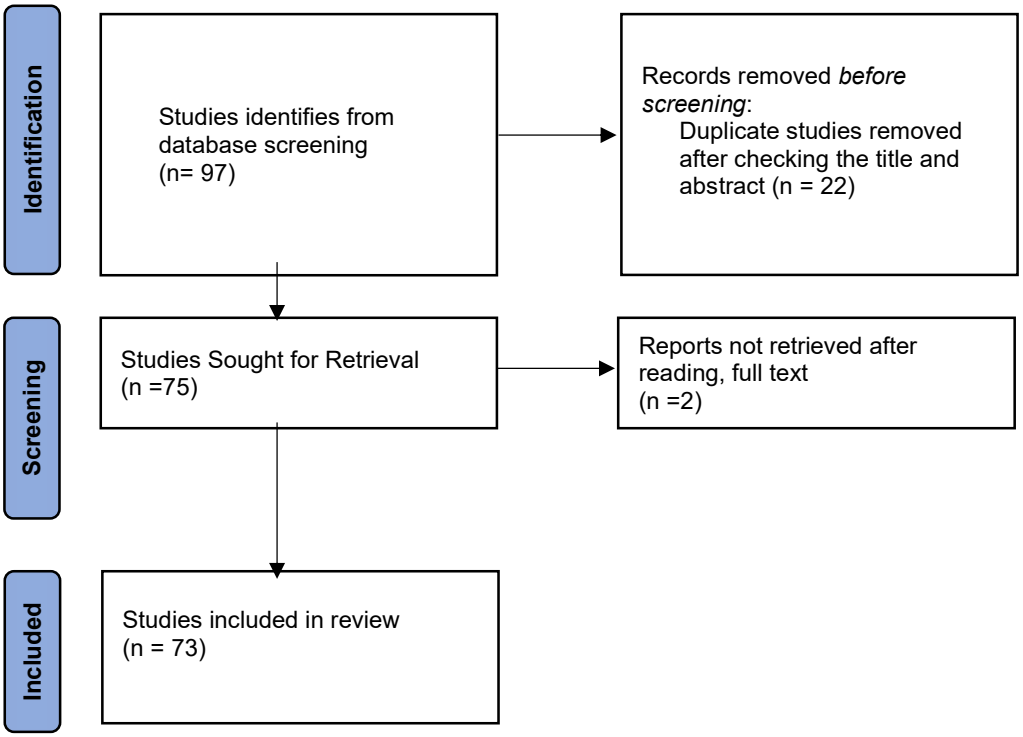

Figure 1: PRISMA flow chart for studies related to Medicinal properties and uses of *A. marmelos* plant: A review

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Figure 2: Leaves and fruit of bel

Phytochemistry: More than 100 phytochemical substances, including saponins ,phenol, flavonoids, alkaloids, cardiac glycosides, tannins, steroids, and terpenoids, have been isolated from various portions of the plant (Mujeeb et al., 2014). Pectin is abundant in bael fruit and ripe Bael fruits were used to extract Bael fruit pectin (BFP) (Jindal et al., 2013). Bael has a sweet, fragrant, and pleasant flavor, yet it can be acidic and slightly astringent in some kinds (Mani et al., 2017).The antioxidant movement of therapeutic plants can be due to the presence of phenolic compounds (Rajan et al., 2011). The phytochemicals and antioxidant properties completely different extricates inferred from fried clears out of *A. marmelos*- an esteem expansion to waste bael-Patra (Veer & Singh, 2019).Seed consists of essential oil like : D-limonene, A-D-phellandrene, Cineol, Citronellal, Citral, *p*-Cyrene, Cumin aldehyde (Ruhil et al., 2011)

Medicinal value: Almost every part of the Bael tree is used to make herbal medication and prevalent application of Bael is for the treatment of gastrointestinal problems (Kala, 2006). Various part of *Aegle* like leaves, root, stem, fruit and bark are used as ethnomedicine to abuse its medicinal properties, including antidiarrhoeal, antidysenteric, antipyretic, antimicrobial, anticonvulsant, wound healing, hepatoprotective, diuretic, antifertility, chemopreventive, radiopreventive, antioxidant, analgesic, and antiinflammatory activities to cure diseases (Singh et al., 2013 ; Rahman & Parvin, 2014). Bael protects the body from the harmful effects of radiation (Baliga & Bhat, 2010). *A. marmelos's* essential oils exhibit promising inhibitor activity against key enzymes associated with diabetes, neurological, and skin disorders, as well as weak antioxidant activity, emphasizing the ability to quench excess reactive oxygen species associated with these disorders (Mahomoodally et al., 2018).

Various parts of *A. marmelos* according to their therapeutic potential are described below:

S.N	Plant parts	Therapeutic potential
1.	Leaves	Bael leaves are acetic, laxative, and an expectorant that are used to treat diseases like ophthalmia, deafness, inflammations, cataract, diabetes, diarrhea, dysentery, heart palpitation, and asthmatic difficulties (Kirtikar & Basu, 1993). It is vital to concentrate on the particular phytochemical intensifies liable for hepatoprotective impact or to control liver diseases (Singanan et al., 2007)
2	Fruits Unripe- Ripen-	Fruits are effective to one's health and the organic product mash is utilized to plan delights like murabba, puddings and juice (Baliga et al., 2011). It is mainly used as treatment for diarrhea (Brijesh et al., 2009). It helps in curing scurvy and heal ulcerated intestinal surface (Bhardwaj & Nandal, 2015). It acts as an antibacterial, antifungal and antiviral activity and fight against microorganisms like *E.coli, Bacillus subtilis*, etc. (Das et al., 2012).
3	Flower	Traditional medical systems have employed flower distillation to create a medicine that is used as tonic for stomach and intestine (Chandrasekara et al., 2018).
4	Bark and root	Root of this plant can be utilized against diarrhea, fever, a seminal shortcoming, ear infection , dysentery, cardiopalmus, uropathy, gastric irritability in infants, stomachalgia, vitiated cobdition of vata, vomiting , increase fertility power of men and bark decoction is used to cure malaria (Khandare, 2016; Singh & Chaurasiya, 2014).
5	Seed	Bael seeds are rich source of good quality of protein and are used as protein dietary and food supplements (Lakht-e-zehra et al., 2015). Seeds are successful within the treatment and anticipation by CC14- induced hepatic cytotoxicity (Singh & Rao, 2008).

Antibacterial activities: Bioactive constituents such as tannins, saponins, terpenoids, alkaloids, skimminine, aegelin, lupeol, cineole, ferulic acid, citronellal, cuminaldehyde, geraniol, marmesin, marmelosin, and polyphenols were explored in numerous portions of the bael tree, and their antibacterial activity differed. (Kuchay et al ., 2021). The active elements of plant material were found to seep out into organic

solvents and demonstrate biological activity (Ramya et al., 2012). Leaf extracts from *A. marmelos*, along with aqueous crude of petroleum ether, methylene chloride, chloroform, methanol, and leaves, were analyzed for antibacterial activity against gram-positive and gram-negative microbes. (Rajasekaran, 2008). Methanolic and aqueous extracts from Bael fruit showed a strong effect on multidrug resistance on *Salmonella Thypii* caused Typhoid fever (Gupta et al., 2011).

Antiinflammatory, antipyretic, and analgesic activities: Leaf extract has been investigated for anti-inflammatory activities, and the majority of the extracts reduced carrageenan-induced paw swelling and cotton-pellet ulceration in rats (Rajeshkannan et al., 2014). Antipyretics drugs can be extracted from different parts, especially leaves (Ghangale et al., 2008). Bael extract contributes to its pain-relieving effect by weakening the inflammatory mediator like 5-hydroxytryptamine, bradykinin, histamine, prostaglandins, etc (Rao et al., 2008).

Hepatoprotective activity: Through the experiment done by Prince & Rajadurai, (2005) with four classes of animal by administrating 30percent ethyl alcohol for 40 days and fine leaf powder for another 32 days and the result shows that bael leaves has good hepatoprotective activities.

3.4 Antifungal activity

Leaf extract *A. Marmelos* showed 100% fungal toxicity to *Rhizoctonia solani* Renu, (2005). Antifungal properties have been reported in essential oils derived from the foliage of *A. marmelos* (Gupta et al., 2006; Rana et al., 1997).

Antidiarrheal activity: Chloroform extract of *A. Marmelos*, showed a suppressive effect on diarrhea caused by castor oil (Mazumder et al., 2006).

3.6 Antiulcer activity

Shoney et al. (2012) employed rats to study the impact of a methanolic extract of bael leaves on digestive problems generated by aspirin and pylorus ligatin.

Antidiabetiec activity: The experiment done by Saha et al., (2016) shows that the *A. marmelos* fruits were more effective at enhancing glucose uptake by yeast cells as compared to the common medicine 'metformin'.

Radio preventive activity: The extract of Bael leaf increases the amount of macrophages that helps to increase immunomodulatory effect (Lamia et al., 2018).

Other uses: Besides medicinal properties, we can get other benefits from Bael trees. Its wood is very hard, yellowish or grayish in color and has fine polish, which is suitable for home construction, carts construction, farm tools, sculptures, pestle, tool handles, combs, etc. and trees are cut for timber (Venudevan & Srimathi, 2014). Freshly harvested ripe fruit is edible as well as processed into juice, squash, cream, jelly, marmalade, and cream. Freshly harvested ripe fruit is edible as well as processed into juice, squash, cream, jelly, marmalade, and cream (Islam et al., 2011). Canned

products made from Bael fruit pulp are a good food product, rich in antioxidants, and have marketing prospects as medicinal canning products and candy products (Singh & Chaurasiya, 2017).

CONCLUSION

Bel has multiple qualities that reflect their significance for a range of attributes, whether religious or therapeutic. Diabetes, liver toxicity, folliculitis, chronic infections, tissue repair, antifungal analgesic, antipyretic, and other ailments can be cured with this herb. It is desirable to farm this plant on a wide scale, particularly in harsh and wilderness areas due to the tremendous potential of Bel for a range of uses. More study may be undertaken to detect and investigate this plant's hidden potential and uses.

CONFLICT OF INTERESTS

There are no conflicting flaws with this article, according to the writers.

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