

Pharmacological advantages of Aegle marmelos bark- A Comprehensive Review

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Abstract: In the field of medicine, medicinal plants are employed in herbal medicine. They provide a simple source of health care in the tribal and rural regions. In this review, an effort is made to gather all the phytochemical as well as pharmacological research conducted on the important medicinal plant Aegle marmelos. A vast array of clinical and experimental studies have proven it is Aegle marmelos has antidiarrheal, antioxidant, antiviral, radio protective and anticancer properties, as well as anti-cancerous, antipyretic, IBD healing, antifertility, antigen toxic and anti-inflammatory properties. This plant plays a vital role in the prevention and treatment of a wide range of diseases. Thus, it is important to examine its therapeutic qualities to present a complete overview of its current status for scientists as well as ancient. This review also covers the possibility of using this plant in the field of pharmaceuticals because of its broad pharmaceutical activities.

Keywords: *Aegle marmelos, medicinal plants, IBD healing, pharmacological, Anti-inflammatory*

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Introduction

Aegle marmelos is among the most therapeutically accepted tree species among the 2.5 lacksnative plant species that inhabit the earth. Aegle marmelosis often referred to as begal-quince in local language; the fruitis called as stone apple. Aegle marmelos is

considered as sacred tree in India¹. Natural resources have provided us with a comprehensive supply of cures for every any ailment that humanity suffers. A majority of the population of the world relies completely or in part, on traditional medicines for its basic health requirements.

Aegle marmelos is commonly referred to as Bael belonging to the family of Rutaceae is extensively utilized in traditional Indian medicine because of its medicinal and therapeutic properties². *A. marmelos* is widespread in Northern India, but broadly located across in the south East Asia. The *A. marmelos* is an standard to large-sized deciduous glabrous and armed tree, with upper axillary, 2.6 cm long, alternate trifoliolate leaves, a small blossom, and large fruits³. Herbal remedies are extensively used and widely well-liked in the developing world. Bael leaves and fruits are utilized for treating dysentery, dyspepsia and mal-absorption as well as neurological disorders and vomiting, edema and rheumatism⁴. Alongside the important medicinal benefits, bael has been identified as an essential ingredient for industrial food processing, and is a great source of pharmaceuticals as well as various other essential herbal substances. Bael is being considered to be an under-utilized species of tree fruit throughout South East Asian countries, and its potential economic benefits are still yet to discover⁵.

Aegle marmelos is a moderate-sized tree that is 8-12 meters long with 2.5 centimeter long spines. Leaflets that is ovate. The flowers are short and have a greenish hue. The shape of the fruit is globose and yellowish-colored

with the rind being woody⁶. It's a source of phytochemical compounds, viz. alkaloids, coumarins as well as fatty acids and other essential oils⁷. The species also contains tannins (tannin and the riboflavin) organic acids, the phenolic. They also contain fatty acids, fatty acids, as well as ricinoleic acid⁸.

Ecology and Distribution

In light of the increasing interest of people for natural remedies the natural medical system is getting much more interest than conventional system⁹. Additionally, this method of medicine is non-pollutant and having negligible adverse effects¹⁰. It is a key component in daily use and having kinds of therapeutic and medicinal effects that are being assessed by the researcher¹¹. The majority of the parts of the Bael tree can be used for the preparation of herbal remedies. This plant is significant for religious and ethno medicinal purposes¹².

The wild tree is found in parched forests in plains and hills of southern and central India, Burma, Pakistan and Bangladesh as well as in dry and mixed deciduous dipterocarp forests. *A. marmelos* can be described as a subtropical plant¹³. It is widespread throughout India. In many hot regions of India, it can grow up to an altitude of 1200 meters, where temperatures can rise up to

49.79° C in the shade during summer and then drops down to -6.68° C in the winter and extended droughts can occur^{14,15}.

Rutaceae includes 1900 species and 158 genera. It is a sub-cosmopolitan species with significant areas of diversity across Southern Africa and Australia and extensively dispersed across zones of tropical and temperate regions of the modern as well as the older world¹⁶. In India it is comprised of more than 80 species, mostly found in the

subtropical and tropical Himalayas as well as the western peninsular region of India¹⁷.

It is found in almost every state of India including Andhra Pradesh, Bihar, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal¹⁸. Especially in West Bengal, there are 13 varieties of fruit in *Aegle marmelos*, based on the morphology of the fruit¹⁹.

Local Names in different languages^{20,21,22,23}

| Sn. | Language | Local Names |
|-----|------------|--|
| 1 | Burmese | Opesheet, Ohshit |
| 2 | English | Bael Fruit, Indian Bael, Holy Fruit, Golden Apple, Elephant Apple, Bengal Quince, Indian Quince, Stone Apple |
| 3 | German | Belbaum, Schleimapfelbaum, Baelbaum |
| 4 | Gujarati | bili |
| 5 | Hindi | baelputri, bela, sirphal, siri-phal, kooralam |
| 6 | Indonesian | majabatuh, maja |
| 7 | Javanese | modjo |

| | | |
|----|------------|-----------------------------|
| 8 | Khmer | bnau |
| 9 | Lao | Sino-Tibetan |
| 10 | Malay | bilak, bel, bila, majapahit |
| 11 | Portuguese | marmelos |
| 12 | Thai | matum, mapin, tum |
| 13 | Vietnamese | traï mam, mbaunau |

Phytochemical Composition

| Sn. | Phytochemicals | Chemical Name |
|-----|-------------------------------|---|
| 1 | Alkaloids ²⁴ | Agelin, aegelenine, marmeline, dictamine, fragrine, O-methylhalfordinine, O-isopentanylhalfordiniol, N-4-methoxy styrylcinnamide |
| 2 | Coumarins ²⁵ | Marmelosin, marmesin, imperatorin, marmin, alloimperatorin, methylether, xanthotoxol, scoparone, scopoletin, umbelliferone, psoralen and marmelide. |
| 3 | Polysaccharides ²⁶ | Galactose, arabinose, uronic acid and L-rhamnose was obtained on hydrolysis |
| 4 | Tannin ²⁷ | Skimmianine. Carotenoids were also reported, which impart pale colour to fruit |

Pharmacological properties

Nephroprotective activity

The nephroprotective activity was assessed by Dwivedi, J., 2017 et al. The extracts of *Aegle marmelos* leaves were assessed in the Cisplatin induced model of rat. Cisplatin is the anti-cancer drug which is widely used to assess the activity of the nephrotoxicity. The treatment 200 and 400 mg/kg was given to the animal for at least 5 days. Treatment was assessed by the group of the parameters i.e. blood urea nitrogen (BUN), serum creatinine, and antioxidant enzymes were expected in renal tissues. The extract was showed to be the excellent as per the recovery values.

The Renal anti-oxidants enzymes were redeemed and lipid level was decreased. The increases level of superoxide dismutase and glutathione showed the palpable recovery in the treated groups. This insures the activity regime was dramatically enhanced and IC_{50} were also increased. This shows the activity along with the treatment directly enhances the nephroprotective activity in the experimental animals²⁸.

K KJ, S. R., & Jadhav, P. (2011) identified that the extract of the *Aegle marmelos* leaves were administered in to the Wistar rats

against the Gentamycin as inducing agent. The results were fairly concluded that serum creatinine and blood urea level decreased as compared to the reference standard. MDA levels and increased GSH and catalase concentration were also decreased in the experimental animals. Thus, it can be concluded that *Aegle marmelos* does possess and protect the nephroprotective activity. However, it can also be concluded that the effects were shown in the results could be due to the phytochemicals²⁹.

Anti-inflammatory activity

The Anti-inflammatory activity was assessed by the Benni, J. M., 2011 et al. The hydrolic extort of the *Aegle marmelos* bark was prepared and administered in to the animals. The anti-inflammatory activity was performed in Swiss Albino rats. The inflammation was induced by the Carrageenan.

The *Aegle marmelos* activities were compared with the indomethacin (standard drug). The results showed up as reduction in the inflammation and pain. This model includes the parameters such as hot plate method and tail flick methods. The percentage of the removal of the paw was increased and flicks also improved. The percentage inhibition was recorded as 52.7%

and 46%. This PI was more relevant to the standard drug indomethacin³⁰.

Rajaram, A., 2018 et al., also examined the effect of the *Aegle marmelos* roots extract to analyze the activity on the inflammation. Total 191 extracts were prepared of the *Aegle marmelos* young root and matured one. In this study the 44 extracts were showed that *Aegle marmelos* does have the potential to block the COX-2 and COX-1 receptor as these are responsible for the nociception.

The study reveals that plants from the Gujarat and Odisha region could be used in Ayurvedic formulations to combat inflammation. The plants need to be properly evaluated for anti-inflammatory properties, and the region in which they are grown is an important factor³¹.

Antimicrobial Activity

The antimicrobial activity was analyzed by Balakumar, S., 2011 et al. In vitro antifungal activity was evaluated in isolates of dermatophytic fungi like *Trichophytonmentagrophytes*, *Trichophytonrubrum* etc. The fungicidal activity of various extracts and fractions of *Aegle marmelos* leaves was tested against dermatophytic fungi. The minimum

inhibitory concentration was found to be minimal in water and ethyl alcohol extracts, moderate in methanol fractions (200µg/mL), and maximum in chloroform (200µg/mL) extracts.

Aegle marmelos leaves suggestively repressed the growth of fungi. If research on the compound is confirmed in vivo and if it can be isolated and recognized, it possibly will be a therapy for dermatophytosis³².

Poonkothai, M., & Saravanan, M. (2008) Examined that extracts in the various extractors such as organic solvents and inorganic of the different parts of the plant could possibly have the antibacterial activities. This study was performed with the help of disc submerge method against the gram positive and gram negative bacteria. The outcome showed that organic extracts of the *A. Marmelos* of the leaves and roots were significantly reduced the amount of the colonies of the different bacteria. *A. marmelos* extracts were more prominently worked in the gram positive bacteria³³.

Anticancer Activity

Antioxidant properties of this plants are helpful and reducing the super oxides from the body. The targeted anti-oxidant therapies are much better than any cancer-radiation

therapy because it is not painful as well as it acts on the targeted cells. It enhances the ability of the cells to grow and sustain in the chemical environment by not reducing in to the metabolites. In some cases, it has been seen that antioxidants even reduces the cells death by necrosis the chemical induced death of the cells.

Chockalingam, V., 2012 et al., in one of his study Swiss albino mice were used to exhibit the tumor growth by inserting the tumor cells under the skin. *A. marmelos* extract in ethanol were used as the test item and administered intraperitoneally in the animals. The doses were administered at the 200 and 400 mg/kg daily for the 1 month before inserting the tumor cells in the animals. Histopathology results revealed that the 50% ethanolic extract of the *A. marmelos* could possibly inhibit the growth of the tumor cells in the experimental animals. Results showed that the body weight also stagnant at after 15 days of the dosing. This could be the possibly by the *A. marmelos* antioxidant activities³⁴.

Seemaisamy, R., 2019 et al., investigated that the administration of Administration of the *Aegle marmelos* could possibly down the regulation of the several pyridoxal phosphate-dependent transaminase enzymes

such as the Alanine Aminotransferase (ALAT), Aspartate Aminotransferase (ASAT), and alkaline phosphatase. The anti-cancer properties are lying behind the presence of the phenolic compound in the leaves of *Aegle marmelos*. These characteristics was brought down with the help of the gas chromatography, it was defined by the presence of the thiosulfates in the extract.

All these extracts were tested for antibacterial properties. Acetone was found to elicit maximum growth inhibition on bacteria *Serratiamarcescens*, giving it a profound anti-bacterial activity. Methanol extract of *A. marmelos* elicited cytotoxicity that highly affected MDA-MB-231, HEP-2 and Vero cells. MDA-MB-231 cells were more sensitive to Acetone Extracts than HEP-2 cells with an IC₅₀ value 79.62 µg/ml³⁵.

Antioxidant activity

Antioxidant properties of the *Aegle marmelos* were analyzed by the Rajan, S., 2011 et al. The pulp of the *Aegle marmelos* extracted and subjected to the phytochemical screening. The pulp have been using for the several years in the treatment of the gastrointestinal diseases and for the function smooth function of the body.

Among these Anti-oxidant properties of the Aegle marmelos were more significant when it was examined through the in vitro studies. The study showed the impeccable results in IC₅₀ determination and phytochemical screening of the different phytochemicals. This revealed that, it has adequate amount of the saponins, alkaloids, flavonoids, tannins and steroids and this could be the reason for its anti-oxidant properties³⁶.

Rautela, R., 2018 et al., examined that Aegle marmelos leaf extract effects were seen in the dairy cows when it given daily by oral route. Different parameters such as malondialdehyde (MDA), ascorbic acid (ASCA), reduced glutathione (R-GSH), superoxide dismutase (SOD), and total antioxidant capacity (TAC) were analyzed during the study. Results showed that the MDA quantity was decreased drastically and ASCA and R-GSH concentrations and TAC increased. It can be concluded with the results that it does have anti-oxidant activity³⁷.

Antidiabetic Activity

Ahmad, W., 2021 et al., examined that Aegle marmelos does have the Antidiabetic Activity which could be by the various kinds of the phytochemicals presents in the whole

plants. In vitro studies were performed to examine its effects on the blood glucose level and cytotoxicity. HepG2 cells were taken and grown in the culture media at the controlled temperature. The cells were grown at the maximum confluency. The test item were mixed with together with the solvent and exposed to the cells. The enzymes α -amylase and α -glycosidase were found to be substantially inhibited by A. marmelos, with IC₅₀ values of 46.21 and 42.07 mg/mL, respectively. It could be concluded that Aegle marmelos could control the blood glucose level as well as it can regulates the intake of the glucose in the cells³⁸.

Mustafa, S. B., 2019 et al., studied that Aegle marmelos could potentially inhibit and regulate glucose inside the body. The study was performed in the alloxan induces diabetic mice. The drug was administered in the body by the oral route and blood glucose levels were checked every day to look out the fluctuations. It was showed in the results that the extract of the Aegle marmelos could possibly regulate the level of the fasting blood glucose ($P < .05$). The extract showed the regulating the glucose level was dose dependent³⁹.

Conclusion

In the context of the pharmacological advantages offered by *Aegle marmelos* (Bael) bark, it is vital to recognize the immense potential this indigenous fruit tree holds in addressing various critical needs, including food security, healthcare, and economic development. Bael's multifaceted advantages make it a valuable and versatile resource that should not be underestimated.

Firstly, Bael possesses a rich pharmacological profile, with its bark containing a wealth of bioactive compounds with proven medicinal properties. These compounds, including alkaloids, flavonoids, and essential oils, can have a significant impact on public health by offering solutions to various ailments such as inflammation, infections, and diabetes, particularly in underserved communities.

Secondly, promoting the sustainable cultivation of Bael not only ensures a reliable source of nutritious fruit but also offers a sustainable supply of medicinal raw material. Bael trees are hardy, resilient, and adaptable to diverse environmental conditions, making them an excellent choice for resource-constrained regions. By encouraging the cultivation of Bael, we can simultaneously address food and healthcare needs, contributing to community resilience.

Moreover, the cultivation of Bael has the potential to spur economic growth in rural areas. It can serve as a cash crop, providing income opportunities for small-scale farmers and entrepreneurs. Additionally, the establishment of value-added industries, such as herbal medicine production and cosmetics manufacturing, can create jobs and enhance local economies. This comprehensive approach not only improves the livelihoods of those in need but also fosters sustainable development in underserved regions, ultimately benefitting both individuals and communities alike.

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