Review Article

A Review on Pharmacological Properties of *Aegle marmelos*

Ghumare Pramila, Dattatraya Jirekar*
Anandrao Dhonde Alias Babaji Mahavidyalaya Kada. Dist. Beed. (India).
***Corresponding author's E-mail:** dattajirekar1@gmail.com

Received: 14-09-2020; **Revised:** 22-11-2020; **Accepted:** 28-11-2020; **Published on:** 15-12-2020.

ABSTRACT

Aegle marmelos (Rutaceae) may be a vital ayurvedic tree plant referred to as Bael. *Aegle marmelos* is best referred to as the wooden fruit tree. it's a medium-sized tree that grows throughout the Indian forest at 1200 feet. it's found throughout India, from the Himalayan forest to Bengal, central and southern India. the varied components of this plant contain variety of coumarins, alkaloids, sterols and essential oils. Various parts of this plant like leaves, roots, seeds, bark and fruit, contain antioxidant, antimicrobial, antiviral, anti-micro filarial, antiarthritis, antithyroid, analgesic, anti-inflammatory, anticancer, antidiabetic, antiulcer, wound healing and contraception. Various pharmaceutical properties are reported in these books on the important skills of *Aegle marmelos*.

Keywords: *Aegle marmelos*, Pharmacological properties.

QUICK RESPONSE CODE →

DOI: 10.47583/ijpsrr.2020.v65i02.007

DOI link: http://dx.doi.org/10.47583/ijpsrr.2020.v65i02.007

INTRODUCTION

Since thousands of years *Aegle marmelos* have been used as a natural source of medicinal compounds. Man is using numerous herbs and plant extract to cures and relief from various physical and mental illness. These herbs are used in traditional Chinese, Ayurveda, Siddha, Unani and Tibetan medicines. Ancient literature such as Rigveda, Yajurveda, Atharvaveda, Charak Samhita and Sushrut Samhita also describes the use of herbs for the treatment of various health problems[1]. Bael is a deciduous sacred tree, associated with Gods having useful properties, especially as a healing agent This tree is popular in 'Shiva' and 'Vishnu' temples and Its leaves are trifoliate symbolizing the 'Thrimurthies'- Brahma, Vishnu, Shiva, with spear shaped leaflets resembling "Thrisoolam" the weapon of Lord Shiva. Many legends, stories and myths are associated with this tree. *A. marmelos* is a slow-growing, medium sized tree, 25 to 30 feet tall. The stem is short, thick, soft, flaking bark, and spreading, sometimes spiny branches, the lower ones drooping. Young suckers bear many stiff, straight spines. There are sharp, axial one-inch long spikes on this tree. The leaflets are oval or lancet shaped, 4- 10 cm long, 2-5 cm wide. Leaves composed of 3 to 5 leaflets in it[2]. In last five decades, these plants have been extensively studied by advanced scientific techniques and reported for various medicinal properties viz, anticancer activity, antibacterial activity, antifungal activity, antidiabetic activity, antioxidant activity, hepatoprotective activity, haemolytic activity, larvicidal activity and anti-inflammatory activity etc.

Table 1: Scientific classification of *Aegle marmelos*[3].

Kingdom: Plantae

Order: Sapindales

Family: Rutaceae

Subfamily: Aurantioideae

Genus: *Aegle*

Species: *A. marmelos*

Nomenclature: *Aegle marmelos* (L.) Corr. Serr.

Table 2: Names of *Aegle marmelos* in different languages[4].

Sr. No.	Name	Language
1	*Aegle marmelos*	Latin
2	Wood/Stone apple, Bengal Quince, Indian Quince	English
3	Mbau Nau, Trai Mam	Vietnamese
4	Bel, Gudu	Nepali
5	Toum	Lao (Sino-Tibetan)
6	Modjo	Javanese
7	Oranger du Malabar	French
8	Ohshit, opesheet	Burmese
9	Mapin, Matum, Tum	Thai
10	Shreephal, Bilva, Bilwa	Sanskrit
11	Bel, Shreefal	Bengali
12	Kaveeth	Marathi
13	Vilva Maram, Vilva Pazham	Tamil
14	Maredu	Telugu
15	Bel	Urdu

Traditional uses of *Aegle marmelos:*

Aegle marmelos is extensively described in the Vedic literature for the treatment of various diseases. *Aegle marmelos* is traditionally used to treat jaundice, constipation, chronic diarrhea, dysentery, stomachache, stomachic, fever, asthma, inflammations, febrile delirium, acute bronchitis, snakebite, abdominal discomfort, acidity, burning sensation, epilepsy, indigestion, eukode, myalgia, smallpox, spermatorrhoea, eukoderma, eye disorders, ulcers, mental illnesses, nausea, sores, swelling, thirst, thyroid disorders, tumors, ulcers and upper respiratory tract infections.

PHARMACOLOGICAL PROPERTIES

1. Antioxidant Activity:

Antioxidants are having free radicals scavenging activity and capability of protecting the cells in oxidative stress. Antioxidant activity of these plants is due to the presence of flavones, isoflavones, flavonoids, anthocyanin, coumarin, lignans, catechins and isocatechins. *Aegle marmelos* is extensively reported to possess antioxidant activity against a variety of free radicals[5]. Ethanolic leaves extract of *Aegle marmelos* possess antioxidant activity due to presence of flavonoids, alkaloids and terpenoids[6]. Another study revealed that antioxidant activity of leaf extract of *Aegle marmelos* was due to present of high levels of total phenolic content and total flavonoid content in the extract[7].

2. Antimicrobial and antiviral activity:

Antimicrobial activity of the plant was tested by agar wall diffusion method. The aqueous, petroleum ether and ethanol extract of the leaves presented efficient antimicrobial activity. It showed activity against Escherichia coli, Streptococcus pneumonia. Ethanolic extract showed an effect against Penicillium chrysogenum[8,9]. An oil of plant extract is proved antifungal against various fungi. They are Trichophyton mentagrophytes, Trichophyton rubrum, *Microsporum gypseum*, *Microsporum audouinii*, *Microsporum cookie*, *Epidermophyton floccosum*, *Aspergillus niger*, *Aspergillus flavus* and *Histoplasma capsulatum*[10]. It has worked against various dermatophytic fungi and showed high MIC and MFC. Actually, the extract interferes with Ca2+ dipicolinic acid metabolism pathway and thus prevents spore germination[11]. Antibacterial activity of the plant parts such as leaves, fruits and barks of *Aegle marmelos* is claimed and tested by disc diffusion method against Bacillus subtilis, Staphylococcus aureus, Klebsiella pneumoniae, Proteus mirabilis, Escherichia coli, Salmonella paratyphi A and Salmonella paratyphi B. Among chloroform, methanol extract and water-methanol extract showed significantly high activity against the bacteria[12]. Leaf extracts such as hexane, cold methanol, hot methanol and ciprofloxacin also showed antibacterial activity[13]. This plant extract showed impact against human coxsackieviruses B1-B6. It has even shown an effect against white spot syndrome in shrimp at IC150 concentration[14].

3. Anti-inflammatory activity:

He has evaluated anti- inflammatory, antipyretic, and analgesic activities of different extracts of the leaves of *Aegle marmelos*[15]. The extracts produced significant inhibition of the carragenin-induced paw edema and cotton pellet granuloma in rats. The leaves exhibited anti-inflammatory property due to presence of lupeol, skimmianine [16].

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4. Anticonvulsant activity

The aqueous leaves extract of *Aegle marmelos* possess anticonvulsant activity against Pentylenetetrazole induced seizures in mice. The anticonvulsant activity of aqueous leaves extract of A. marmelos was due to presence of Lupeollinoleate, Skimmianine, Eugenol which was identified by Liquid chromatography mass spectrometry[17]. Ethanolic extract of leaves of *Aegle marmelos* reveals anticonvulsant activity due to presence of flavonoid and it interfere with GABAergic mechanism to exert their anticonvulsant activity[18].

5. Wound healing activity:

Effect of topical and intraperitoneal administration of methanolic extract of *Aegle marmelos* ointment and injection was studied respectively on two types of wound models in rats, the excision and the incision wound model. Both the injection and the ointment of the methanolic extract of *Aegle marmelos* produced a significant response in both of the wound type tested. In the excision model the extract treated wounds were found to epithelialize faster and the rate of wound contraction was higher, as compared to control wounds. The extract facilitated the healing process as evidenced by increase in the tensile strength in the incision model. The results were also comparable to those of a standard drug nitrofurazone[19].

6. Antifertility activity:

It is described that leaf, seed and fruit of Bael plant may interfere with male fertility in a reversible manner. In *Aegle marmelos* bark, two chemical compounds such as marmin and fagarine are present which is claimed to be responsible for the reduction of male fertility[20,21] According to methanolic extract of *Aegle marmelos* reduces reproductive organ weight and serum testosterone levels (ibid). It can even reduce sperm density, motility, viability and sperm acrosomal integrity (ibid). Changes of elongated spermatids, nuclear chromatin condensation and degeneration were seen and significance histopathological changes such as necrosis are seen along with testicular cytotoxicity (ibid). But interestingly, on withdrawal it restores the morphological changes (ibid)[22].

7. **Antiarthritis activity**:

Leaves of *Aegle marmelos* were reported to possess antiarthritis activity against collagen induced arthritis in Wistar rats. Methanol extract treatment of rats showed the reduction of paw swelling and arthritic index. Radiological and histopathological changes were also significantly reduced in methanol extract treated rats[23].

8. Antithyroid activity:

Aegle marmelos leaves extract decreased thyroid hormone level. It was due to presence of scopoletin which have more dominant therapeutic activity than propylthiouracil drug[24].

9. Anticancer activity:

Cancer is the most concerned deadly disease in the whole universe. It will increase to 3-fold and scientists have predicted that in such crisis situation, anything that can heal or soothe this disease will the boon for us. *Aegle marmelos* can be an effective weapon to boost our healing process in fighting cancer disease. Studies showed that plant extract can control the increase of leukemic K 562, T-lymphoid Jurkat, B-lymphoid Raji, erythroleukemia HEL, melanoma Colo38, and breast cancer cell lines MCF 7 and MDA-MB-231. It can even prevent cell proliferation[25]. Constituents such as 1-hydroxy-5, 7-dimethoxy-2-naphthalene-carboxaldehyde (Marmelin) present in the plant can prevent the growth of epithelial cancer cell. Furthermore, phytochemicals present in the plant such as lupeol, eugenol, citral, cineole and d-limonene present can show antineoplastic effects[26-29].

10. Anti-microfilarial activity:

Methanolic extract of roots of *vitex negundo L*. and extracts of leaves of *vitex negundo L. Ricinus communis L.* and *Aegle marmelos corr.* were explored for possible antifilarial effect against Brugia malayi microfilariae. It was found that among the herbal extract, root extract of *vitex negundo L* and leaves extract of *Aegle marmelos Corr*. at 100 mg/ml concentration showed complete loss of motility of microfilariae after 48 hrs of incubation. Thin layer chromatography of the extracts revealed the presence of alkaloids, saponins and flavonoids in the roots of *vitex negundo L* and coumarin in the leaves of *Aegle marmelos Corr*.[30].

11. **Anti-ulcer activity:**

Methanolic extract of unripe fruit of *Aegle marmelos* reduced gastric ulceration and prevent the oxidative stress caused by Helicobacter Pylori-Lipopolysaccharide in rats[31]. Gastro protective effect of extract was due to the presence of luvangetin which lowers oxidative stress in the gastro duodenal mucosa[32]. Some other study suggested that ripe fruit of *Aegle marmelos* protect gastric mucosa in NSAID induced ulceration in rats by its antisecretory and cytoprotective property[33]. Methanolic and aqueous fruit seed extract of *Aegle marmelos* showed antiulcer activity due to presence of quercetin compound[34].

12. **Antipyretic potential:**

It is reported that, Bael shows antipyretic effect. In a rat model (albino rats) where yeast induced pyrexia attacked rats were treated with Bael extracts and ethanolic extract elevated body temperature. This antipyretic impact was similar to the impact of 100 mg/kg body weight of paracetamol[35-36].

13. Antidiabetic Activity:

Aegle marmelos has been use to control diabetes in traditional medicinal system. Many in vivo scientific studies have been conducted in animal models to evaluate the antidiabetic activity of different organic extracts and fresh juice of *Aegle marmelos*. Antidiabetic potential of the leaves and callus of *Aegle marmelos* was reported in streptozotocin induced diabetic rabbits. All the extracts reduced the blood sugar level in streptozotozin diabetic rabbits, however, among the various extracts, the methanol extracts of the leaf and callus brought about the maximum antidiabetic effect[37].

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Source of Support: None declared.

Conflict of Interest: None declared.