



***Aegle marmelos*: A Review on its Medicinal Properties**

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ABSTRACT

Present generation is a fast moving generation and no doubt about the potency of allopathic medicine, they provide fast result, but the darkest side of this medicine is their several side effects and contraindications. On the other hand the plants are good substitution for those medicines because of their less or no side effect and their ability to cure the problem from their root. The present study is based on the pharmacological activity of *Aegle marmelos*, commonly known as a bael in India. This plant is having great potential to cure the disease like diabetes, cholesterol, peptic ulcer, inflammation, diarrhoea, and dysentery, anticancer, cardio protective, anti bacterial, anti fungal, radio protective, anti pyretic, analgesic, constipation, respiratory infection, antioxidant, hepatoprotective, wound healing and many more. The present review summarizes the scientific information of various aspects of *Aegle marmelos* plant used in traditional system of medicine for variety of purpose.

Key Words: *Aegle marmelos*, Bael, Herbal medicine, Peptic ulcer.

INTRODUCTION

The universal role of plants in the treatment of disease is exemplified by their employment in all the major system of medicine irrespective of the underlying philosophical premise¹. Plants have at one time supplied virtually all cultures with food, clothing, shelter and medicine. It is estimated that approximately 10 to 15 percent of roughly 300,000 species of higher plant, have a history of use in traditional medicine². In terms of both quantity and value of the medicinal plant exported India ranks second in the world³. Plants are the very important for the human, because they possess several active constituents which are the precursor for synthesis of many drug⁴. Due to the value of plants in the medicine several attempts and have been done to identify and validate the plant derived substance for the treatment of various disease, and the result is that today more than 25% of the modern medicine are directly or indirectly derived from plants⁵. From the different source of medicine like plant, minerals, animals and synthetic chemicals, only plant are good as availability and safety point of

view. There are several incidents of adverse effect and side effect with the synthetic drug but limited number with plant source. India has a rich source of plant as a natural or herbal medicine and it is being used from thousands of years ago. Indian medicinal plants are considered a vast resource of several pharmacologically active principles and active constituents, which are commonly used in home remedies against multiple ailments⁶. Because of the traditional knowledge of developing countries, the world health organisation is now actively encouraging them to use the herbal remedies which they have been traditionally used for centuries⁷. On a recent survey conducted by W.H.O. globally, around 20,000 medicinal plants are being profusely either in pharmaceutical Industry or in folk medicine system⁸. The Majority of Alternative medicine user are now turning back towards the herbal medicine not so much because they feel dissatisfied with conventional medicine, but largely because they find these natural medicine more safe and effective⁹. Modern allopathic medicine has developed many

sophisticated and costly diagnostic methodologies, which is little difficult to afford by the middle and lower class family, and on the other hand these medicine can harm the health of the patient than they cure the problem, by their toxic side effect and adverse effect¹⁰. The use of herbal or alternative system of medicine is increasing day by day because of its safety¹¹. All culture has long folk medicine histories that include the use of plants. Egyptian, Indian and Chinese traditional system are considered as oldest system of medicine¹².

Bael, *Aegle marmelos*, a plant of Indian origin having tremendous therapeutic potential, it is belong to family Rutaceae, it is known by the several other names in the different parts of the country and also outside of the country³. Bael is a much known plant for the people of any part of India, as it is related to the Hindu Religious. It is believed that the bael fruit is the symbol of lord Shiva and its leaf is top of the demand in the season of 'Sawan'. The bael tree is mostly seen near the temple and other Hindu homes. The utility of bael is mention in the Indian ancient system of medicine, every part of the bael tree such as root, bark, leaf, flower, fruits, seed and even its latex are also important in several traditional system of medicine, that's why it is one of the most important plant in the India. Bael is a medium-sized, armed, deciduous tree, in India it grows wild, especially in dry forest, outer Himalayas, Shivaliks and in south India with altitude from 250-1200 m and also cultivated throughout Indian subcontinent for its fruits⁵. The bael fruit is having lots of pharmacological activity, fruit of it possesses anti dyspepsia, anti diarrhoea and anti dysentery. The fruit is also used as a dietary supplements, it is also used to cure intermittent fever, mental disease, hypoglycaemic effect, anti fungal effect, anti microbial, analgesic, anti inflammatory, antipyretic, anti dyslipidemic activity, Immunomodulatory activity, anti proliferative activity, wound- healing activity, anti fertility, insecticidal activity and many more^{13,14}

DIFFERENT NAMES

English (Bael fruit, Indian bael, holy fruit, golden apple, elephant apple, Indian quince, stone apple); Burmese (Opesheet, ohshit, bel Indian); German (Belbaum, Schleimappelbaum); French (Oranger du Malabar, cognassier du bengale, bel Indian); Gujrati (Billi); Hindi (baelputri, bela, sriphal, kooralam); Indonesian (maja batuh, maja); Japanese (modjo); Thai (matum, mapin, tum); Vietnames (tar imam, mbau nau) Arab (Bull, Quiththa el hind); Urdu (bel); Tamil (Vilvam); Sanskrit (Bilwa, sriphal); any few other names are there to identify bael tree in different parts of world^{4,14-18}

HABITAT AND DISTRIBUTION

The bael tree has its origin from eastern ghat and central India. It is native to India and bael tree is usually available in the range of Himalaya to west Bengal, in central and south Asia. It grows around foot hill of Uttar Pradesh, Bihar, Chhattisgarh, Madhya Pradesh, Uttaranchal, Jharkhand, The Deccan Plateau, the East coast, Myanmar, srilanka^{2,14,16,19}

BOTANICAL DESCRIPTION AND IDENTIFICATION

Aegle marmelos is a slow-growing sharp tree and medium in size, about 12 to 15 meter in height with short trunk, thick, soft, flaking bark, and the lower ones drooping. Tree is armed with straight sharp axillaries thorns, 2.5 cm long, ferete, and leaflets 5-10 by 2.5-6.3 cm, ovate or ovate-lanceolate, flower greenish white, sweet scented about 2.5 cm across, 2 sexual. New foliage is glossy and pinkish-maroon in colour. Mature leaf emits a disagreeable odour when bruised. Fragment flowers, in clusters of 4 to 7 along young branch lets, have 4 recurved, fleshy petals, green outside, yellowish inside and 50 or more greenish-yellow stamens. The fruits are round, pyriform oval, or oblong, 5-20 cm in diameter, may have a thin, hard, woody shell or a more or less soft rind, grey green until the fruit is fully ripe, when it turns yellowish^{3,4,6,14,16}.

PHYTOCONSTITUENTS

Scientist has long known the importance of the plants and chemicals they produce in overcoming disease. Over 25% of all prescriptions drugs still use plants as their principal ingredients²⁰. Bael is reported to have number of coumarins, alkaloids, steroids, and essential oils. Root and fruits contain coumarins such as scoparone, scopoletin, umbelliferone, marmesin and skimming. Fruits in addition contain xanthotoxol, imperatorin and alloimperatorin and alkaloids like aegeline and marmelline. It also contains polysaccharides like galactose, arabinose, uronic acid and L-rahaminose, which may obtain after hydrolysis. Different types of carotenoids have been reported in the Aegale Marmelose, these are responsible for the imparting yellow pale colour to fruit. Marmelosin, skimmianine and umbelliferone are the therapeutically active principale of bael plant. Minor constituents are like ascorbic acid, sitosterol, crude fibers, tannins, α - amyryn, carotenoids, and crude proteins are also resent. Apart from these chemical constituents more than 100 compounds have been isolated these are skimminine, aegelin, lupeol, cineole, citral, citronellal, cuminaldehyde, eugenol, marmesinin, marmelosine, luvangetin, aurapten, psoralen, marmelide, fagarine, marmin, and tennins have been proved to be biologically

active against various major and minor disease^{3-6,14,20-30}. The list of chemical constituents present in different parts of *Aegle marmelos* is summarised in table-1. Structures of few important chemical constituents present in Bael are represented in Fig.1.

PARTS WITH MEDICINAL PROPERTIES

The Bael is a holy plant (Fig.2) and its all parts are very useful, generally it is seen that if one part of any plant show any pharmacological effect then there is a major possibility that the other part give the same or related activity. The same principle is applied here with the bael tree. The pharmacological uses of different parts of *Aegle marmelos* is listed in the table-2^{4,31-36}.

NUTRITIONAL USE

Bael, *Aegle marmelos*, is one of the most useful Indian medicinal plants; it has numerous of use in day to day life. Physicochemical studies prove that bael fruit is rich in nutritional value, and this is being used from several years ago. Bael pulp is a rich source of glucose, sugar, and fiber. In the traditional medicine system the pulp of bael is used as an energy drink with milk. That drinks is very useful to excrete the hair from the stomach. Other nutritive elements of bael are-protein, fat, minerals, fibers, carbohydrates, calcium, phosphate, potassium, iron, vitamins A, vitamin B₁, nicotinic acid, riboflavin, vitamin C^{3,5}.

MEDICINAL USE

Diarrhoea and Dysentery

The unripe and half ripe fruit of bael is most effective remedy for the diarrhoea and dysentery. Generally the ripe fruit is used for this purpose, but the dried fruit powder is also showed the same activity³. Gastrointestinal infections encompass a wide variety of symptoms and recognized infectious agent. Among the GI infections the diarrhoea is a common symptom of the intestinal disorder and has remained a global threat to human health. It cause morbidity and mortality with over 1000 million episode and over 4 million death annually in children under five years of age^{19,37}.

Antidiabetic Activity

Diabetes mellitus is a common metabolic disease around the world. A large percentage of the global population is suffering from the same. The modern life style like taking stress and several fast food consumption, and alcohol drinking are the responsible for it. Leaf extract has been used in Ayurvedic system of medicine for diabetes. It enhances the ability to utilize the external glucose load in the body by stimulation of glucose uptake

similar to insulin³. Oral and intraperitoneal administration of the aqueous extract of bael fruit shows hypoglycemic effect against streptozotocin induced diabetic rats. Oral administration of aqueous and alcoholic extract in dose of 500 mg/kg significantly induced hypoglycemia in normal fasted rabbit³. Hypoglycemic activity of bael is also proved in the alloxane induced diabetes in male albino rats^{6,14,33,35}. Several other research workers had also proven the hypoglycemic activity of *Aegle marmelos*³⁸⁻⁴⁰.

Anticancer Activity

Gastric ulcer resulted from persistent erosion and damage of the stomach wall that might become perforated and develop into peritonitis and massive haemorrhage as a result of inhibition of synthesis of mucus, bicarbonate and prostaglandins^{41,42}. Bael inhibits in vitro proliferation of human tumors cell lines including the leucemic K562, T-lymphoid³. Most of the potent anti cancer drug are expensive, mutagenesis, and teratogenic. Administration of extract in 400 mg/kg has shown anticancer effect in animal model of Ehrlich ascites carcinoma^{4,5}. Researchers were evaluated the anticancer potential of folk medicine used in Bangladesh, India. *Aegle marmelos* for cytotoxic action using brine shrimp lethality assay. The extract of *Aegle marmelos* was found to be exhibited toxicity on all used assay⁶. The fruit extract of bael is also used to improve the immune system that will finally increase the anti cancer activity of the body^{43,44}.

Cardio Protective Activity

The leaf extract of *Aegle marmelos* has preventing effects in isoprenaline induced myocardial infarction in rats. The activity of creatine kinase and lactate dehydrogenase was significantly increased in serum and decrease significantly in heart of isoprenaline-treated rats. Use of bael as a cardiac depressant and in palpitation has also been reported³.

Antimicrobial and Antifungal

Anti microbial drugs are used in medicinal practice for treating food borne disease. Use of medicinal plants extract that are rich in antimicrobial compound could be an alternative way to eliminate these bacteria. The extract of *Aegle marmelos* posses antimicrobial activity. It has been found active against various species such as *Staphylococcus aureus*, *S. epidermidis*, *Proteus vulgaris*. It has also been used for ranikhet disease virus and intestinal parasites. The essential oil obtained from the leaves of bael exhibits variable efficacy against different fungal isolates and cause concentration as well as time dependent inhibition

of spore germination of all the fungi tested, including the resistance fungus, *Fusarium udum*³. The essential oil from bael leaves may interfere with the Ca^{+2} dipicolonic acid metabolism. Thus it inhibits the antifungal activity by lowering the vegetative fungal body inside the host or in solid medium⁴. Fungal disease including candidiasis and ring worm infection are cosmetic problem that may become fatal due to secondary or super infection as commonly occurs in AIDS patients⁵. Other co worker reported the antifungal activity of ethanolic extract of bael leaves including anti-diarrhoeal activity^{6, 12, 32, 45}.

Radio Protective Activity

Treatment with extract of bael reduces the severity of symptoms of radiation induced mice. The radio protective action might be due to free radical scavenging and arrest of lipid per oxidation accompanied by an elevation in glutathione concentration in liver, kidney, stomach and intestine³. Its activity has also been evaluated in cultured human peritoneal blood lymphocytes. The irradiation of HPBLs with different doses of gamma-radiation caused a dose dependent increase in the frequency of lymphocyte bearing micronuclei of radio protective induced radical. Treatment with the bael fruit extract before irradiation caused a significant decrease in lipid per oxidation accompanied by a significant elevation in the GSH concentration in liver, kidney, stomach, and intestine of mice⁴. This activity has also been useful in the treatment of cancer particularly for those who are suffering from vital visceral malignancies^{5, 6}.

Antipyretic and Analgesic

Bael extract exhibit antipyretic and analgesic activity, as it has shown a significant inhibition of a carrageenan induced paw edema, cotton pellet granuloma and paw itching in mice and rats^{3, 6, 14, 36}. The use of other synthetic antipyretic drugs is not as safe as the herbal one. That's the reason why Bael is useful in treatment of fever and pain^{46, 47}. Antipyretics reduce body temperature in fever but do not cause hypothermia in normothermic individual. Fever during infection is produced through the generation of pyrogens including, ILs, TNF α , interferon which induced PGE₂ production in hypothalamus- rise its temperature set point.

Constipation

Constipation is a problem due to the loss of water from the fesses, that's why the person feel difficulty, the ripe fruit of *Aegle marmelos* is a great remedy for the constipation patient, as it is a rich source of fiber, and fiber are essential for the forcing the GIT material towards the excretion. The fiber of bael cleans the intestine. Its regular use up

to three months help in the evacuation of even the old accumulated fecal matter from the bowels. In the villages it is mostly consumed as a energy food and in the summer season its ripe pulp is mixed with water or milk to serve as a great drink and as well as a treatment for the constipation suffering person³.

Peptic Ulcer

An ulcer is a result of the defensive failure of mucosal layer of the GIT, it is due to imbalance between defensive and attacking factor like acid. There are several factors which induced peptic ulcer like *H.pylori* bacteria, acid secretion, drinking of alcohol, smoking and many more. Moreover the recurrence of ulcer after stopping medicine is high. About 70% of ulcer could recur. An infusion of leaves is an effective remedy for peptic ulcer. The leaves are soaked overnight in water and this water is strained and taken in morning, this really works to treat the ulcer and give relive to patients. The ripe fruit of Bael is a rich source of fiber and mucilage that create a protective layer over the stomach and resist the attack of strong acid^{3, 5, 6, 31, 46}. Aqueous extract of *Aegle marmelos* leaves was prepared and used for investigation. A daily dose of 1 gm/kg body weight of extract administration orally for 21 days. The volume of gastric secretion, ulcer lesion count, pepsin count, PH total activity, hexoseamine content were estimated^{48, 49}. The possible anti ulcer mode of action of *Aegle marmelos* is depicted in Fig.3.

Respiratory Infection

The oil obtained from the leaves of *Aegle marmelos* is useful in the treatment of the cold and respiratory infection. The juice extracted from leaves is mixed with equal quantity of sesame oil and heated thoroughly; a few seeds of black pepper and half a teaspoonful of black cumin are added to the hot oil and then it is removed from the fire and stored for use in future³.

Antioxidant and Hepatoprotective Activity

Oxidative stress is produced during normal metabolic process in the body as well as induced by a variety of environmental and chemical factor, which cause a generation of a various reactive free radical and subsequent change in DNA and lipids^{40, 50}. The reducing capacity of a compound may serve as a significant indicator of its potential antioxidant activity^{51, 52}. There are two possible mode of work of antioxidant. One is by getting oxidized itself or by creating a protective layer around the active constituents of the material. The antioxidant activity present in the *Aegle marmelos* confirms the hepatoprotective activity in the same, and it has also been reported⁵³.

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 incision model. Both the injection and ointment of the methanolic extract of *Aegle marmelos* produced a significant response in both. The extract facilitates the healing process as evidenced by increasing in the tensile strength in the incision model. The result was also compared to those of the standard drug nitrofurazone^{14, 54}.

Miscellaneous Properties

Bael tree is a holy tree and it has several medicinal properties, some of them have been evaluated and others are on the line for their turns to come. Apart from the activity listed above there is little more important activity. The leaves of *Aegle marmelos* are useful in the treatment of the jaundice and leucorrhoea, conjunctivitis and defences. Fruits give energy and nutrition. It is used in the carminative and astringent and also a good remedy for snake bite. Application are also been reported in anemia, fractures, typhoid, coma, colitis³. The methanolic extract of *Aegle marmelos* gives the anxiolytic and antidepressant effect⁵⁵. It also gives the contractile effect⁵⁶. Due to these several

beneficial medicinal properties of *Aegle marmelos*, one must pay attention for its in vitro propagation⁵⁷.

CONCLUSION

On this fast moving generation, man wants to stay ahead and never wants to be in the last row. Because of these neck cutting competition, we face new and complex health related problems, and day by day we are getting addicted to modern medicine or the synthetic medicine, which definitely gives the fast result but brings several new problems with them like side effect and adverse effect. On the other hand the herbal drugs like *Aegle marmelos* (Bael) is much more valuable and safe comparatively to those chemicals. Looking upon the wide prospect of Bael tree, one should either cultivate it or try to preserve it for the proper utilization and to discover the new and effective herbal medicine.

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Table-1: Chemical constituents Present in different parts of *Aegle marmelos*

Sr.No.	Plant Part	Chemical Constituents
1	Leaf	Skimmianine, Aeglin, Rutin, γ -sitosterole, β -sitosterol, Flavone, Lupeol, Cineol, Citral, Glycoside, O-isopentenyl, Hallordiol, Mameline, Citronellal, Cuuminaldehyde phenylethyle cinnamamides, Eugenol, Marmesinin, Aegelin, Glycoside
2	Fruit	Marmelosin, Luvangetin, Aurapten, Psoralen, Marmelide, Tannin, Phenol
3	Bark	Fagarine, Marmin, Furoquinoline, Alkaloids
4	Seed	Essential oil – D- limonene, A-D-phellandrene, Cineol, Citronellal, Citral, P-cymene, Cumin aldehyde
5	Root	Alkaloid, Halopine, Coumarins, Terpenes.

Table-2: Pharmacological uses of different parts of *Aegle marmelos*

Sr.No.	Part	Pharmacological Use
1	Leaves	Anti inflammatory, Ulcer, Cause Sterility, or abortion, laxative, asthma, Ophthalmia and eye affection, expectorant, cold and respiratory infection, backache, abdominal disorder, vomiting, cut and wounds, dropsy, beriberi, weakness of heart, cholera, diarrhea, cardiac tonic, control blood sugar, nervous disorders, hair tonic, acute bronchitis, veterinary medicine for wound healing, anti worms, stimulation of respiration.
2	Root Bark	Intermittent fever and fish poison, palpitation, melancholia, anti dog bite, gastric troubles, heart disorders, fever, anti amoebic, hypoglycemic, rheumatism.
3	Flower	Stomach tonic, anti dysenteric, Antidiabetic, diaphoretic and as a local anesthetic, epilepsy and as an expectorant.
4	Fruit	Dysentery, diarrhea, gastric troubles, constipation, laxative, tonic, digestive, stomachic, brain and heart tonic, ulcer, antiviral
	Ripe	Treatment of rectum inflammation, antiviral, sweet, cooling, aromatic, nutritive, dysentery.
	Unripe	Astringent, dysentery, stomachache in diarrhea, tonic, digestive, demulcent, treatment of piles.
5	Seed	Antibacterial, antifungal.

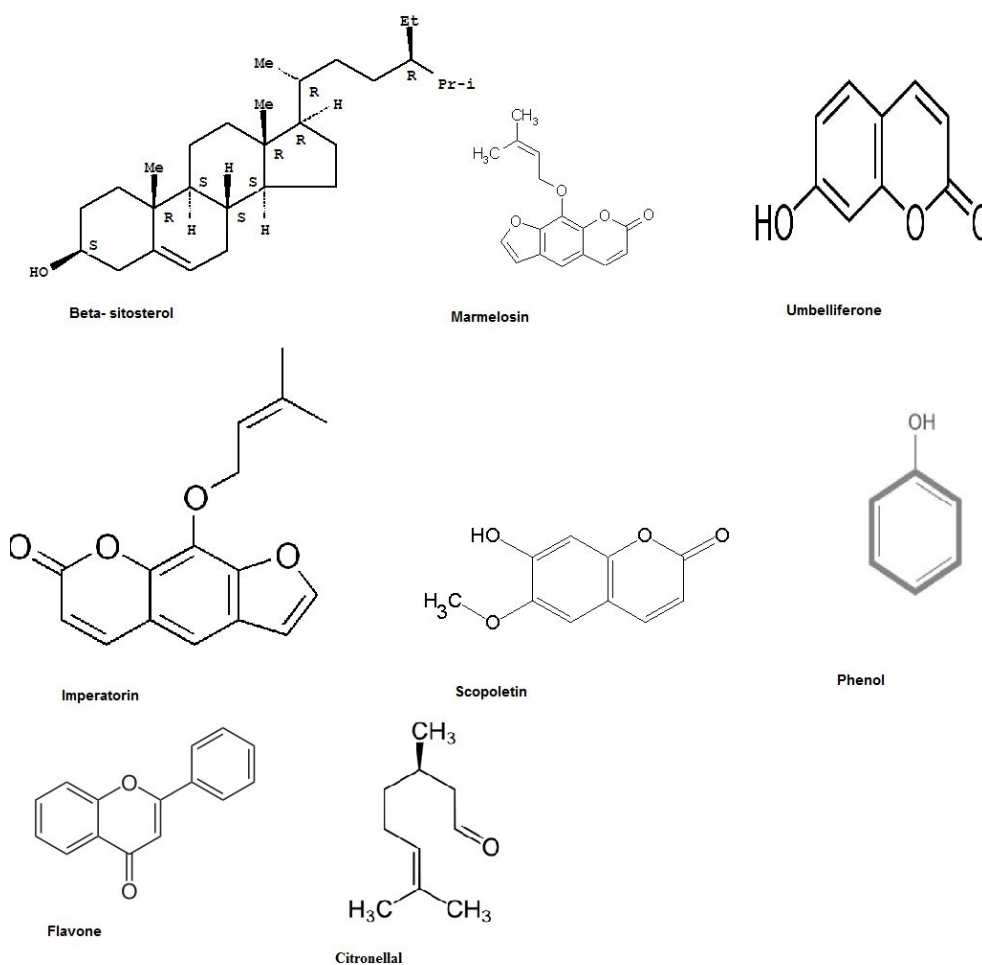


Fig.1: Structures of few important chemical constituents of Bael



Fig. 2: Leaves and fruit of *Aegle marmelos*

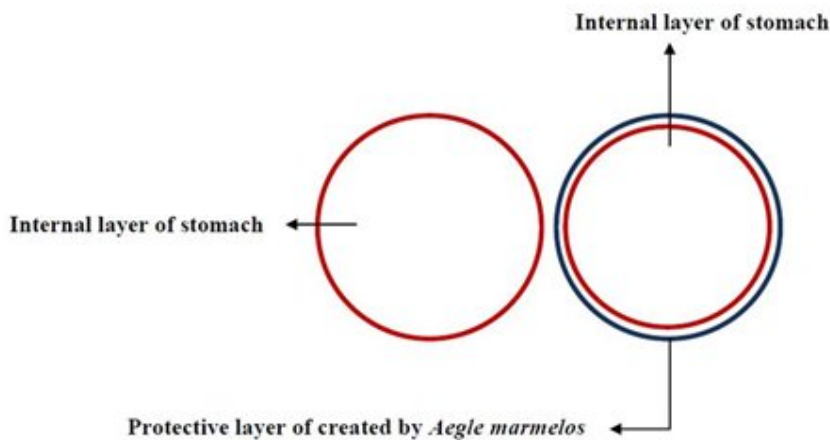


Fig. 3: Anti ulcer mode of action of *Aegle marmelos*

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