

A review: Potential source of phytoconstituents with pharmacological activities of aegle marmelos

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ABSTRACT: Aegle marmelos is a sacred plant in Hindu culture and it is having several medicinal as well as nutraceutical properties. It is popular in Indian traditional systems of medicines in ayurveda, siddha and folk medicine used to treat various disease. The present study states that the aegle marmelos is broadly studied for its various medicinal properties with the help of various advance scientific techniques, it is having various names in different countries, states, and region's such as in Nepal it is known by the name of 'Gudu', in Vietnam it is known by the name 'Bau Nau' and in India it known by different names in various state according to native language such as Marathi- belphal, Gujrati-Bilphata, Bengali – bil, also it having various classes of phytochemicals such as alkaloids, phenylpropenoids, terpenoids, phenolic compounds, glycosides, tannins etc. which are efficacious for many disease, disorders and beneficial for various different pharmacological activities studies such anticancer, antidiabetic, antimalarial, antioxidant, antiulcer, antiviral, antihyperlipidemic, antifungal, antibacterial. So, this presented review summarizes the information concerning the phytochemicals, botany, biological activities, pharmacological activities, and toxicity of Aegle marmelos plant.

Keywords: Aegle Marmelos, Phytoconstituents, Biological activities, Traditional uses, ethnopharmacology, phytochemistry.

INTRODUCTION:

India is a largest producer of medicinal herbs hence India is widely known as botanical garden of the world and now a days also known as pharmacy of world. aegle marmelos is known by various names in different countries, regions, states, and cities. In India its names are differs state by state such as Maharashtra – Belpal, Telangana – Bilvamu, Tamil – Aluvigam, etc. it belongs into family Rutaceae^[6] this plant is widely found in India, Thailand, China, Burma, Pakistan, Bangladesh, Sri Lanka, and various parts of South-eastern Asia and in India it mostly found in northern India. According to Hindu the tree of aegle marmelos is sacred and its leaves are offered in prayers of lord shiva and Parvati hence this tree is known as shivaduma it means the tree of shiva.^[7] This plant is considered significant in Indian traditional systems of medicine, it having lots of medicinal values, it used in the treatment of various disease and disorders such as its leaf extract is used in the treatment of diabetes because the leaf extract of aegle marmelos has been found effective in regeneration of β -cells of pancreas,^[8] its roots and bark having antipyretic properties, its ripe fruit having antimalarial properties, also dried unripe fruits has are used in the treatment of diarrhoea and dysentery. also, its young leaves are used as a vegetable.^[14] According to chemical investigation it is having various bioactive compounds such as skimmianine, aegelin, lupeol, citronellal, luvangetin, marmelide .Etc., which are widely used to treat verities of diseases and disorders such as use for the purpose to treat brain and heart disorders, dysentery, stress disorders .Etc.^[15] From last some decades this plant has been widely studied for its various medicinal properties by using latest advance scientific techniques and reported for its various medicinal properties such as anti-inflammatory, antioxidant activity, anticancer activity, antidiabetic activity, antifungal activity, hepatoprotective activity, haemolytic activity, antibacterial activity, immunomodulator activity, anti-diarrheal activity. Etc.^[19] So this review aims to summaries the botany, phytochemical study, morphological and medicinal properties of aegle marmelos for the further scientific investigation and further prospects for the development of effective therapeutic compounds.^[20]

PLANT DESCRIPTION:

In India Bael trees have been mentioned in writing as far from 800 BC. It founds in India, Burma, and other parts of SE Asia in wild. It is considered as a sacred tree in Hindu culture due to its mythological importance it is mainly planted near the temples. Aegle marmelos originated from Eastern Ghats and central India. It is found mainly in Himalayas, Madhya Pradesh, Chhattisgarh, Bihar, Rajasthan, Uttar Pradesh The Deccan plateau and along the East coast.^[27] Generally, the fruits of aegle marmelos is harvested when they form yellowish or green colour, after that kept for 8 days while it loses its green tint. Then the stem readily separates from the fruit. A tree may yield as many as 700-800 fruits in a season, but an average crop is 150 to 200, or, in the better cultivars, up to 300-400, normally it is cultivated in the month of march and April.^[28] Aegle marmelos is slow growing tree normally is up to 6.0 to 10 m in height and 1.0 to 1.2 m in girth, with straight, sharp, axillary thorns and trifoliate aromatic leaves, its Fragrant flowers are in clusters of 4 to 7 along the young branches, The fruit is round, oval, or oblong in shape which having diameter up to 5-20 cm, and its seeds having Embedded in pulp which are 10-15 in numbers and having length about 1 cm.^[29] based on the morphology of fruits, In West Bengal, there are 12-13 types of Aegle marmelos fruits are found, were they are grouped under five categories, flat, spherical, oval oblong and pear shaped and in each group three subgroups are found such as small, medium, big were separated^[16] in Indonesia the fruit is eaten in breakfast

Table:01 Various names of *Aegle marmelos*

English	Bengal Quince, Beal Fruit, Golden Apple, Indian Quince,
Hindi	Bel, Bili, Sirphal, Bela
Sanskrit	Adhararutha, Asholam, Atimangaliya, Bilva
Tamil	Aluvigam, Kuvilam, Mavilangai, Vilvam, Villuam
Telugu	Bilvamu, Maluramu, Maredu, Sailushamu, Sripthalamu
Marathi	Bel, Belphal
Nepali	Gudu
French	Oranger du Malabar
Vietnamese	Trai mam
Indonesian	Moja tree

Table:02 Taxonomical classification of *Aegle marmelos*

Kingdom	Plantae
Sub Kingdom	Tracheobionta
Super division	Spermatophyta
Class	Magnoliopsida
Division	Magnoliophyta
Order	Sapindales
Family	Rutaceae
Genus	<i>Aegle</i>
Species	<i>Aegle marmelos</i>

Phytoconstituents present in aegle marmelos:

Alkaloids :- There are various new class of alkaloids are founded in Aegle marmelos were reported viz., O-methylhalfordinine, N-2-ethoxy-2-(4-methoxyphenyl) ethylcinnamamide, aegelenine, fragrine (C₁₃H₁₁O₃N), dictamine, Aeglin, N-2-methoxy-2-[4-(3',3'-dimethylallyloxy)phenyl]ethylcinnamamide, N-2-hydroxy-(4-hydroxyphenyl) ethyl cinnamide, marmeline, etc. also as α glucosidase inhibitors there are various series of phenylethyl cinnamides included as new compound which named as aegelinosides, anhydromarmeline, which are isolated from Aegle marmelos leaves as α glucosidase inhibitors.^[22]

Phenylpropanoids :- According to the current studies aegle marmelos also founds various Phenylpropanoids such as hydroxycoumarins, phenylpropenes, lignans, Coumarin is the parent compound which founds in more than twenty-seven various plant families also Marmesin is a new constituent of bael which are obtained from heartwood, leaves, and roots also phenylpropanoids are naturally occurring phenolic compound which contain three-carbon side chain attached aromatic ring.^[25]

Terpenoids :- Since 1950 The essential oil of A. marmelos leaves were studied very much comprehensively in India by various workers, From leaves, twigs, and fruits of aegle marmelos the α -Phellandrene is found to be a common constituent of the essential thus α -Phellandrene (56%) and p-cymene (17%) were reported from leaf oil. Later on, leaf essential oil various reports are published by many workers also p-Menth-1-en-3,5-diol was obtained and characterized from Aegle marmelos leaves^[24]

Coumarins :- Various coumarins are reported from the aegle marmelos are dictamine, Aeglin, aegelenine, isopentenylhalfordinol, N-2-[4-(3', 3'-dimethylallyloxy) phenyl] ethyl cinnamide, N-2-hydroxy-2-[4-(3', 3'-dimethylallyloxy) phenyl] ethyl cinnamide, N-2-hydroxy-(4-hydroxyphenyl) ethyl cinnamide, O-(3, 3dimethylallyl) halofordinol, N-2-ethoxy-2-(4-methoxy)^[23]

Tannins :- Most of the Tannin is present in leaves of aegle marmelos in the form of skimmianine which named as 4,7,8-trimethoxyfuroquinoline and also there is Approximately 9% tannin is reported in the pulp of Bael fruits.^[15]

Flavonoids :- The flavonoid is measured by the aluminium chloride colorimetric were between 8.248 \pm 0.029 mg/kg flavonoids is obtained from the leaves, 1.400 \pm 0.029 mg/kg from stem and 1.087 \pm 0.002 mg/kg from roots^[30]

Carbohydrates :- There is a reducing and non-reducing sugar are present in various parts of aegle marmelos which are varies to parts. were the total soluble sugar 4.3 \pm 0.12 g/100g in leaf, 7.6 \pm 0.18 g/100g in pulp and 6.6 \pm 0.09 g/100g in seeds also The leaf of aegle marmelos contains seven monoterpene hydrocarbons (90.7%), three oxygenated monoterpenes (2.9%), four sesquiterpene hydrocarbons (3.1%)^[31]

Glycosides :- By using Keller-Killani test various cardiac glycosides are identified from the bael in which 2 ml of filtrate is treated with glacial acetic acid and few drop of FeCl₃. Conc. H₂SO₄ and added to the above mixture giving green-blue colour shows the presence of glycosides.

Phenolic Compounds :- By using Folin-Ciocalteu reagent as method The maximum phenolic content was found in methanolic extract between two (aqueous and methanol),^[21]

Miscellaneous compounds:- Researchers also investigated various other chemical phytoconstituents Valencic acid, betukinic acid, trans-cinnamic acid, praealtin D, 4-methoxybenzoic acid, montanine, rutaretin, N-P-cis- & trans coumaroyl tyramine from the leaves of methanolic extract of Aegle marmelos.^[25]

Table:03 **Phytochemicals present in parts of aegle marmelos and their biological activity**^[33-34]

Sr. No.	Part of plant	Phytochemicals	Therapeutic Effects
1	Fruit	Marmelosin, Luvangetin, Aurapten, Psoralen, Marmelide, Tannin	Cardio-protective, anti-ulcer, Heartbeat inhibitor, Antispasmodic, Anti-diarrheal
2	Leaf	Skimmianine, Aegeline, Lupeol, Cineol, Citral, Citronella, Cuminaldehyde, Eugenol, Marmesinine	Anti-cancer, cardio active, Anti-inflammatory, Antiseptic, Antiallergic
3	Bark	Skimmianine, Fagarine, Marmin	Abortifacient, Anti-ulcer, antidiarrheal
4	Roots	Coumarin, xanthotoxol, imperatorin, aegeline, and marmeline	Antidiabetic, Anticancerous, Antifertility, Antimicrobial, Immunogenic, and Insecticidal

5	Seeds	Coumarin, xanthotoxol, imperatorin, aegeline, and marmeline	Antimicrobial, Antifertility, Insecticidal, Immunogenic, Antidiabetic, Anticancerous
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Fig.01: Fruit

Fig.02 : Leaves



Fig.03 : Seeds



Fig.04 : Bark



Fig.05 : Flower

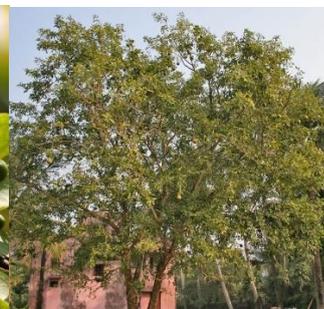


Fig.06 : Tree

Traditional uses:

- The ripe fruit of bael is eaten in the breakfast in Indonesia
- A popular Indian drink 'Sharbat' is made up by using seeds of bael with the help of sugar
- The beverages and jams are made by using bael fruit and tamarid and citric acid
- The young leaves of bael are used a vegetable in day-to-day life
- The strong woods of bael are used in the cart making and constructions
- Also used to polish cravings of small-scale turnery tools, knife, handles, pestles, and combs
- Gum of bael is used as a household gum and also used in the jewelleryes
- Considered that due to the leaves of bael the abortion and sterility in women is cause
- The leaves are used to lowers the rate of respiration and depress the heart action and also cause sleep
- The fruit of bael is used to wash cloths as a detergents
- Also, hard shells of fruit are used for the purpose of decoration in some cases
- It also used for the purpose of flavouring agent in household recipes

REPORTED BILOGICAL ACTIVITIES OF AEGLE MARMELOS:

Analgesic activity :- The extract of aegle marmelos contains the analgesic activity. It inhibits the mediators which are responsible for inflammation. Such as prostaglandins, histamines, bradykinin, 5-hydroxytrptanine etc. and this resistance against the pain shows the potency of aegle marmelos towards the analgesic properties hence the present studies conforms that the analgesic activity of aegle marmelos^[1]

Anti-diarrhoeal activity :- Aegle marmelos is used traditionally for the purpose to cure the diarrhoeal infection and diseases but due to the presence of mucilage in large quantity which act as a demulcent in aegle marmelos it is having potency to cure chronic diarrhoea, and this is proved by using irritable bowel syndrome and physiological models^[2,7]

Antibacterial Activity :- The phytoextracts of leaf, bark, and fruits of aegle marmelos is having inhibitory effect with chloroform and methanolic, also leaf, bark and fruit of aegle marmelos found to be effective against bacterial test. As compared to commercial antibiotics the zone of inhibition of methanolic extracts of bark, fruits, and leaves are found to be less effective but any fruit extract shows inhabitation of zone against chloroform extract against klebsiella pneumoniae^[3]

Anticancer Activity :- The extract of aegle marmelos and some phytochemicals of it such as butyl p-tolyl sulfide, 6-methyl-4-chromanone, lupeol, citral, cineole, butylated hydroxyanisole are effective against the selectively inhibiting proliferation of neoplastic cells^[4]

Antidiabetic Activity :- The current study states that the various methanolic extract of aegle marmelos shows some important antidiabetic properties by decreasing serum glucose level in the hyperglycaemic animals.^[5] The methanolic extract of leaf and callus drops the blood sugar levels in diabetic rabbit, the leaf and callus powder contain some compounds which is having the potency of anti-diabetic activities ^[6]

Antifungal Activity :- The leaf extract and fractions of aegle marmelos were found to be fungicidal properties against various isolates of dermatophytes fungi the essential oil of aegle marmelos can inhibits the growth of dermatophytes and fusarium species at a concentration of 500 ug/ml ^[8,9]the crude extracts which is made up of water and ethanol and methanol fractions of aegle marmelos plant having potency antifungal activities the various constituents are responsible for antifungal activity of aegle marmelos plant such as alkaloids, aegelenine, tannins, flavan-3-ols, leucoanthocyanins, anthocyanins, flavonoids etc.^[36]

Antihyperlipidemic Activity :- The aegle marmelos having the lipid lowering properties which is clearly by present studies in that the fruit of aegle marmelos shows lipid lowering activity in STZ-induced diabetic rats, also extracts of the leaves of A. marmelos in Triton induced hyperlipidaemic rats. The oral administration of the extracts, at dose of 250mg/1kg bodyweight in hyperlipidaemic rats, dose dependently decreases the cholesterol, triglycerides, high density lipoproteins (HDL), low-density lipoproteins (LDL), very low-density lipoproteins (VLDL), Chylomicrons significantly^[37]

Antimicrobial Activity :- Aegle marmelos contains the various phytoconstituents such as tannins, saponins, flavonoids, alkaloids, terpenoids, carotenoids, cardiac glycosides also it shows The presence of different phytochemicals and the antimicrobial activity of ethanolic, petroleum ether, chloroform, and methanolic extract which is reported previously.^[12] by the GC-MS analysis of the methanolic extract of Aegle marmelos it is clear that the Spectrum of compound shows strong antibacterial, antioxidant, and anti-inflammatory activities in aegle marmelos. Hence it is having potency to treat the microbial infection.^[32]

Antiviral Activity :- The various parts of aegle marmelos contains different phytochemical in such as alkaloids, flavonoids, terpenoids, coumarins etc. but there is a marmelide is also present in fruit of aegle marmelos possess the activity of antiviral. It inhibits the viral replication of six antigenic types of human coxsackieviruses by plaque inhibition which involves in the replication cycle of virus hence the marmelide is having high potency against the virus cycle as compared to ribavirin.^[13]

Immunomodulator Activity :- The experimental studies proved that the aegle marmelos having the immunomodulator properties in experimental model in cellular and humoral immunity, the various doses of fruit extract of aegle marmelos possess effective in experimental models where the 100mg/kg, p.o shows low efficacy and at 500mg/kg, p.o shows high efficacy.^[18]

Wound Healing Activity :- The wound healing process is based on some phases such as coagulation which prevents blood loss, inflammation and debridement of wound, repair including cellular proliferation, tissue remodelling and collagen deposition and if any agent that promotes the these process is called as wound healing promoter and some plants having therapeutic potential to promote and accelerate the above process also the aegle marmelos having such a active principles which is responsible for wound healing such as phenolic base containing oxazole and pyridine moieties, tannins, phlobatannins, flavan-3-ols, leucoanthocyanins, anthocyanins, flavonoids and glycosides accelerates the healing process and confers breaking strength to the healed wounds^[26]

CONCLUSION:

This review summarises and conclude that the aegle marmelos contains various phytochemicals such as carotenoids, phenolic, alkaloids, pectin's, tannins, coumarins, flavonoids, terpenoids, glycosides, phenolic compounds etc. and reveals that this phytoconstituents having their own therapeutic value, potency, efficacy and biological activity and the individual parts can be used for the treatment of various diseases and disorders in human being such as diarrhoea, diabetes, cancer, peptic ulcer, inflammation, analgesic activity, liver toxicity, microbial infection, pyrexia, microbial infection etc. also conclude that the various parts such as fruit, leaves, stem, roots, barks and flower used for various ethnobotanical purposes. And all assemble information suggest that aegle marmelos has various activities and significant herb.

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