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PHYTOCHEMICAL AND BIOLOGICAL REVIEW OF *AEGLE MARMELOS*

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ABSTRACT

One of the world's oldest traditions of plant-based medicine is found in India. Scientists have tested compounds derived from plants to treat a range of illnesses. A review of the literature reveals that basic plant parts are used to treat a variety of illnesses. The antidiarrheal, antimicrobial, antiviral, anticancer, chemopreventive, antipyretic, ulcer healing, antigenotoxic, diuretic, antifertility, and anti-inflammatory qualities of *A. marmelos* are demonstrated by numerous investigations. The ancient Indian traditional medical system, known as Ayurveda, is the origin of the continuous use of *Aegle marmelos* (L.), often known as *bael*, in Southeast Asian traditional medicine. All of its parts, particularly the fruits, leaves, roots, stem, and bark, have therapeutic properties.

KEYWORDS: Chemoprevent, *A.marmelos*, bael, antigenotoxic, antifertility.

INTRODUCTION

Aegle marmelos (L.) Correa *(Family Rutaceae)*, most frequently referred to as *bael* in northern India, is one of the many plants that have been utilized in traditional medical procedures for over 5000 years in India and other Asian nations. Créations littéraires anciens comme le Rigveda, le Yajurveda, l'Atharvaveda, le Charak Samhita et le Sushrut Samhita relate likewise l'application des plantes pour soigner divers problèmes de santé.[1] These herbs have been thoroughly investigated using cutting-edge scientific methods over the past 50 years, and numerous medicinal qualities such as antioxidant, hepatoprotective, hemolytic, larvicidal, anti-inflammatory, anticancer, antibacterial, antifungal, and antidiabetic characteristics.[2] This plant is known by several names, including wood apple, golden apple, Bengal quince, and bael. The leaves of *Aegle marmelos* L. are used to pray to Lord Shiva, and it is grown as a garden plant in temples.

According to Ayurveda, *bael* is believed to balance the three doshas of vata, pitta, and kapha.

❖ **Plant Profile**

❖ **Biological Source**

Aegle marmelos L., a member of the *Rutaceae* family, is a plant that grows widely in India *A. marmelos* is widely dispersed throughout India and known by a number of names in different locations.

❖ **Synonyms**

Bael, Bengal quince, golden apple, stone apple

❖ **Images.**[28]

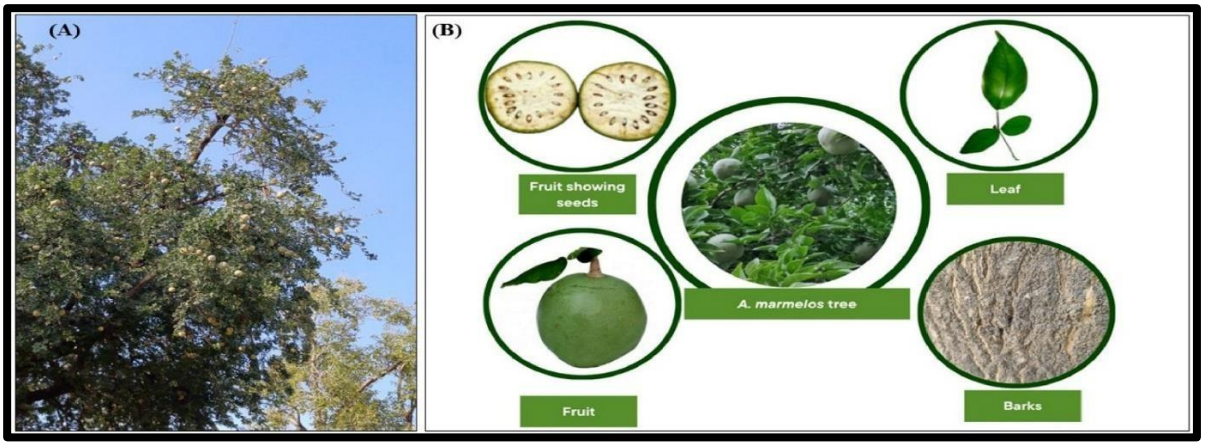

Fig. 1: *Aegle marmelos*: (A) Tree with fruits; and (B) Different parts of the tree.

Fig. 2: Various parts of *Aegle marmelos.*

Fig. 3: Powder of *Aegle Marmelos.*

❖ **Morphology**

Fully grown leaves from the middle section of the current season's shoots were seen morphologically. Among the characteristics measured were leaf width (LW), leaf length (LL), Significant diversity in growth, fruit, and quality features is highlighted by the study of morphological variation in *bael* variants, which is important for both agricultural practices and medicinal applications.[7]

❖ **Taxonomical Classification.**[5,6]

- Kingdom: *Plantae*
- Subkingdom: *Tracheobionta*
- Superdivision: *Spermatophyta*
- Division: *Magnoliophyta*
- Order: *Sapindales*
- Family: *Rutaceae*
- Subfamily: *Aurantioideae*
- Genus: Aegle
- Species: *A. marmelos*

❖ **Botanical and Geographical Distribution**

It is typically found in arid woodlands and hilly regions. Nearly every state in India has it, including Kerala, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Uttar Pradesh, Tamil Nadu, West Bengal, Himachal Pradesh, Andhra Pradesh, Bihar, and Jammu and Kashmir.[8] *A. marmelos* is a member of the *Rutaceae* family. It is a medium-sized tree that grows slowly and reaches a height of 25 to 30 feet. There are a few spiky branches and the steam is thick and soft.[9]

❖ **Phytochemical Evaluation *Aegle Marmelos*[31]**

Table1: Observation table for phytochemical screening.

Phytochemical	Fat sample	Defated sample
Alkaloids	+	+
Flavonoids	+	+
Tannins	-	-
Saponins	-	-
Terpenoids	+	-
Cardiac glycosides	-	-

❖ **Chemical Constituents**

Aegelin, the chemical marmesinin, β-sitosterol, marmeline, lupeol, γ-sitosterol, phenylethyl cinnamamides, and O-isopentenyl halfordiol are all found in A. marmelos leaves Marmenol (7- geranyloxycoumarin) was extracted from the leaves. According to Ali and Pervez (2004), NMR spectroscopy was used to isolate and identify the following compounds from the same methanolic extract: cis- and trans-coumaroyltyramine, praealtin D, valencic acid, 4-methoxy benzoic acid, betulinic acid, montanine, and rutaretin. 9% tannin and skimmianine (4,7,8- trimethoxyfuro-quinoline) are found in *A. marmelos* fruits. While seed oil includes 15.6% palmitic acid, 28.7% linoleic acid, 8.3% stearic acid, and 7.6% linolenic acid, leaf oil contains α-phellandrene (56%), limonene (82.4%), and p-cymene (17%).

❖ **Therapeutic Uses**

One of the main dietary and therapeutic plants is *A. marmelos*. Numerous ethnomedical applications, including antibacterial, antiviral, antidiarrheal, anti-ulcerative, antioxidative, gastroprotective, hepatoprotective, antidiabetic, cardioprotective, anticancer, and radioprotective benefits, have also been demonstrated by studie.[3] AM leaf extracts have a good margin of medication safety because they do not cause toxicity at dosages of 50, 70, 90, and 100 mg/kg body weight.[4]

❖ **Advantages**

- **Digestive Health**: Aegle marmelos is known for its ability to improve digestion and allevia te digestive issues. It is often used in Ayurveda to balance the digestive system and treat conditions like diarrhea and dyspepsia.
- **Blood Sugar Control**: The fruit of Aegle marmelos is being explored for its potential to he lp control blood sugar levels, making it useful for individuals with diabetes.
- **Anti-inflammatory Effects**: Aegle marmelos has anti-inflammatory properties that can help reduce inflammation in the body, which is benefici al for various conditions.
- **Immune Support**: The tree is valued for its immune-boosting properties, making it a popular choice for those looking to enhance their immu ne system.
- **Nutritional Value**: Aegle marmelos is rich in vitamins, minerals, and dietary fiber, contrib uting to a healthy diet and overall well-being.

❖ **Review of Literature**

1. Anti-inflammatory & antipyretic activity

The study looked at the repeated extracts from *A. marmelos* leaves' possible anti- inflammatory properties. The antipyretic and analgesic properties of the leaf extracts were established by showing an apparent analgesic effect in mouse models of cotton-pellet granuloma and carrageenan-induced paw edema. Furthermore, there was a decrease in hyperpyrexia and paw licking in both the early and late periods.[10] Wistar rats are used to test the aqueous extract of dried flowers from *A. marmelos* for its anti-inflammatory qualities. Two hours after delivery, water extract's anti-inflammatory effects peaked at 200 mg/kg.[11]

2. Antimicrobial activity

Using multi-resistant bacterial strains, the disc diffusion method was used to study the antibacterial activity of the various *A. marmelos* leaf extracts. It may be demonstrated from there that the pet ether extract works better than ordinary streptomycin.[12] Bacillus subtilis exhibited the highest level of antibacterial activity, followed by Staphylococcus aureus, E. coli, and Pseudomonas aeruginosa. The quinine component found in the ethyl acetate extract of *A. marmelos* leaf was found to have strong antibacterial action against both gram-positive and gram-negative bacteria.[13]

3. Anticancer activity

AM extracts may be utilized in alternative therapies for anticancer treatments since many of its bioactive components specifically act on dividing cells (cancer cells) by stopping the cell cycle through various signaling pathways. A 400 mg/kg hydroalcoholic extract of *A. marmelos* was injected intraperitoneally into Swiss albino mice suffering from Ehrlich ascites carcinoma as part of an in-vivo investigation. When compared to the control group that received a saline injection, that considerably extended the median survival period up to 28 days following tumor inoculation.[14]

4. Antidiabetic activity

A marmelos fruit aqueous extract reduces blood sugar in a rat model of diabetes induced by streptozotocin. By partially regenerating the β-cells of the pancreatic islets, it increases the release of insulin.[15] With an IC50 of 3.36 µg/ml, a fruit lectin extract was more effective than the common drug metformin at increasing yeast cells' absorption of glucose. Because of its high level of active components and antioxidant activity, this research indicated that the fruit extract

from *A. marmelos* has hypoglycemic activity.[16]

5. Antioxidant activity

Organic complexes known as antioxidants can interact with free radicals in a safe way to stop the chain reaction before damaging the basic molecules. Molecular substances with one or more unpaired electrons that are extremely reactive are known as free radicals. They are produced by normal metabolism when food is burned for energy utilizing oxygen.[17] The antioxidant qualities of marmelosin were shown to be superior to those of regular gallic acid.[18] Rat is used in experimental model. Using standard ascorbic acid, the fruit decoction from *A marmelos* displayed good antioxidant activity in this study, with an IC50 of 17.37 ± 2.71 mg/ml and 379.9 ± 28.28 mg AEAC/100 g.[19]

6. Antimalarial activity

A marmelos may be one of the traditional herbs that treat malaria because of its effective antioxidant and antiplasmodial qualities.[20] When compared to crude leaf extracts of *A. marmelos* Correa, standard Temephos exhibits superior larvicidal activity against Anopheles stephensi, with an IC50 of 500.06 ppm.[21] The leaf methanol extract of *A. marmelos* showed the best antimalarial activity against Plasmodium falciparum in vitro, with minimal cytotoxicity. The Albino mice is used in experimental model. Additionally, the leaf methanol extract shown amazing antiplasmodial activity, with an IC50 of 7 g/ml.[22]

7. Antiulcer activity

The trial found that 500 mg/kg of methanolic extract reduced stomach ulcers by 93.98%. Reduced gastric ulcers were the result of inhibiting gastric secretory parameters, including free and total acidity, acid output, stomach juice volume, and pepsin concentration. Wister Albino rat is used in experimental model. A dose of 500 mg/kg of methanolic extract was shown in the trial to reduce stomach ulcers by 93.98%. Using ranitidine as a reference (50mg/kg), methanolic and aqueous extracts of *A. marmelos* seeds were evaluated for antiulcer efficacy in ulcers caused by indomethacin, stress, and pylorus ligation.[23]

8. Wound healing effect

Coagulation, inflammation and wound debridement, cellular proliferation and repair, tissue remodeling, and collagen deposition are the four phases of wound healing. AM leaf extract in methanol speeds up wound healing in both surgical and cutting wounds.[24,25,26] Through a similar mechanism, the fruit extract additionally showed improved wound healing.[27]

CONCLUSION

According to these studies, *A. marmelos* has therapeutic promise and contains components that could be utilized to create novel drugs for the treatment, prevention, or reduction of cancer, diabetes, and a number of other harmful diseases. India and a few other Southeast Asian nations have reported the majority of the research on identifying the bioactive ingredients and their mode of action. *A. marmelos* contains a number of parts that have been used traditionally to cure a variety of human diseases. Several chemical categories of biologically active chemicals were identified from different sections of *A. marmelos*. The separated constituents are terpenoids, alkaloids, a variety of other substances, including vitamins, coumarins, tannins, carbohydrates, flavonoids, fatty acids, and essential oils.

Future scope

- Aegle marmelos loaded Herbosome will be prepared successfully for safe and efficacious delivery of the formulations.
- Micro-sphere as a drug carriers for controlled drug delivery of formulation containing *A. marmelos* in treatment of diseases such as diabetes.
- **Pharmaceutical Development**: Continued research into Aegle marmelos' potential in medication formulation, especially for newly emerging illnesses or ailments not adequately treated by existing therapies.
- **Functional Foods:** Investigating how Aegle marmelos can be used to make functional foods that support wellbeing and health, particularly in areas where it is not customarily consumed.

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