IJBPAS, July, 2025, 14(7): 4066-4083

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

AN OVERVEIW ON MEDICINAL PLANT: AEGLE MARMELOS

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Received 24th March 2024; Revised 30th April 2024; Accepted 27th Aug. 2024; Available online 1st July 2025

https://doi.org/10.31032/IJBPAS/2025/14.7.9255

ABSTRACT

Plants are an excellent alternative to medications since they have fewer or no side effects and may treat illnesses from the ground up. The current study provides a comprehensive profile of *Aegle marmelos*, a member of the Rutaceae family that is referred to as a bael in India. The phytochemistry and pharmacological activities of *Aegle marmelos* are covered in detail in this review. Many chemical groups' worth of biologically active substances, including alkaloids, terpenoids, vitamins, coumarins, tannins, carbohydrates, flavonoids, fatty acids, and essential oils, have been isolated from different portions of *Aegle marmelos*. Diabetes, cholesterol, peptic ulcers, inflammation, dysentery, diarrhoea, antibacterial, cardioprotective, antifungal, radioprotective, hepatoprotective, antipyretic, anticancer, wound healing, analgesic, respiratory infections, constipation, antioxidant, and many other conditions have great potential to be cured by this plant. Therefore, for scholars who are prepared to start looking into *Aegle marmelos* further, this review might be a useful resource.

Keywords: *Aegle marmelos*, Rutaceae, Ethnobotanical description, Phytochemistry, Pharmacological activity

INTRODUCTION

Regardless of the underlying philosophical tenet, the use of plants in all major medical systems serves as an example of their ubiquitous importance in the treatment of sickness. Almost all cultures have historically derived their food, clothing, housing, and medicine from plants. Of the approximately 300,000 species of higher plants, 10 to 15 percent are thought to have been used traditionally in medicine **[1]**. India is ranked second globally in terms of the number and value of medicinal plants exported. Because they contain a number of active ingredients that are used to make numerous medications, plants are extremely useful to humans. Of all the creatures that exist on Earth, humans are thought to be the most advanced. Since ancient times, they have used plants not only as a source of food but also as remedies for a variety of human maladies. Numerous plants and plant components are used to treat a variety of illnesses, both physical and emotional, and they also enable us to persevere **[2, 3]**.

Aegle marmelos, "**Figure 1**," is an Indian plant that is part of the Rutaceae family and has a great deal of therapeutic potential. Numerous names for this plant are known, including Wood apple, Golden apple, Bengal quince, and Bael. Plant parts including fruit, seeds, bark, leaves, and roots are all utilised as ingredients in a variety of traditional formulas. This makes it one of India's most valuable medicinal herbs because of its healing qualities **[4]**. The highly medicinal substance derived from bael is gaining popularity in both the Indian and global markets. This subtropical plant is found in Bihar, Chhattisgarh, Uttar Pradesh, Uttarakhand, Jharkhand, and Madhya Pradesh. It thrives in dry forests of hilly and plain areas **[5-8]**. Hindus fear the bael tree because they send their wishes to Lord Shiva through its leaves. The tree represents fertility. The leaves of *Aegle marmelos* L. are used to worship to Lord Shiva and are grown as a temple garden plant **(Figure 2)**. Its fruits are used in traditional medicine and as food **[5, 6, 7] (Figure 3)**. This review's particular emphasis is on the morphology, phytochemistry, traditional use, and medicinal applications of *Aegle marmelos* in order to support future research and the characterization of its active ingredients **[9-12]**.

Taxonomical Classification: The detailed taxonomical classification of *Aegle marmelos* is given in **Table 1 [6, 14, 15]**.

Vernacular Names of *Aegle Marmelos*: *Aegle marmelos* is extensively distributed all over India and is acknowledged by various names at various places. The details of vernacular names are listed in **Table 2 [6, 13, 14]**.

Figure 1: *Aegle marmelos* plant

Figure 2: *Aegle marmelos* leaves

Figure 3: *Aegle marmelos* fruit

Table 1: Taxonomical classification of *Aegle marmelos*.

Kingdom	**Plantae**
Subkingdom	**Tracheobionta**
Super division	**Spermatophyta**
Division	**Magnoliophyta**
Class	**Magnoliopsida**
Subclass	**Rosidae**
Order	**Sapindales**
Family	**Rutaceae**
Genus	**Aegle**
Species	**Aegle marmelos**

Table 2: Vernacular names of *Aegle marmelos*

Sr. no.	Different languages	Names
1	Bengali	Bel, Shreefal
2	Burmese	Ohshit, Opesheet
3	English	Wood/Stone apple, Bengal Quince, Indian Quince
4	French	Oranger du Malabar
5	Indonesian	Mojo tree
6	Javanese	Modjo
7	Khmer	Banu
8	Lao (Sino-Tibetan)	Toum
9	Latin	Aegle marmelos
10	Malay	Pokok Maja Batu
11	Marathi	Kaveeth
12	Nepali	Bel, Gudu
13	Old Hindi	Sir Phal
14	Sanskrit	Shreephal, Bilva, Bilwa
15	Tamil	VilvaMaram, VilvaPazham
16	Telugu	Maredu
17	Thai	Mapin, Matum, Tum
18	Urdu	Bel
19	Vietnamese	MbauNau, Trai Mam

Habitat And Distribution: The semitropical plant *Aegle marmelos* grows best at an elevation of around 1200 metres above sea level. It is mainly found in arid woodlands and hilly places. The tree originated in central India and the eastern Ghats. The bael tree is indigenous to India and can be found in central and southern Asia, from the Himalaya to west Bengal. It grows along the eastern coast, in Myanmar and Sri Lanka, and along the foothills of Uttar Pradesh, Bihar, Chhattisgarh, Madhya Pradesh, Uttaranchal, and Jharkhand **[2, 7, 16-18]**.

Botanical Description: *Aegle marmelos* is a medium-sized tree that grows slowly, reaching heights of 12 to 15 metres. It has a short trunk, thick, soft bark that flakes, and spreading branches that are spiky. From injured branches, a clear, sticky fluid that resembles gum Arabic drips down in long threads and gradually solidifies. It tastes delicious at first, but soon it irritates the throat. **Table 3** provides an extensive botanical description of *Aegle marmelos* **[6, 14, 19, 20]**.

Table 3: Botanical description of *Aegle marmelos*

Sr. no.	Plant part	Morphological characterization
1	Bark	The bark is brownish or grey in colour, contains a number of straight long spines. It contains gums, which often comes out from wounded branches and then becomes solid. These gums can be explained as a clear, gummy sap. It is sweet at first taste and then irritating to the throat.
2	Leaf	Its leaves are trifoliate, having round base and pointed tip. Young leaves are light green and matured leaves are dark green in colour
3	Flower	The flowers are greenish or yellowish in colour and bisexual in nature. Generally, it is visible with new leaves.
4	Fruit	The bael fruit has a hard-outer jacket and having a diameter of approximately 5 to 12 centimeters. It is green in unripe condition and changes to yellowish brown when ripen. It contains up to 20 orange pulp in the inside.
5	Seed	The seeds are small (nearly 1 cm)

Ethnobotanical Description: One of the most practical medicinal herbs in India is *Aegle marmelos*, which has many applications in daily life. Many remedies can be prepared from any portion of the plant. Fruit is one of the essential elements that has the most potential for disease cures among all other parts. When taken twice daily, bael leaf extract is used to treat intestinal worms, ulcers, and ophthalmia. Poultices made from bael leaves are needed to treat eye disorders. Taking heated rice water mixed with unripe fruit pulp twice a day helps prevent vomiting during pregnancy. Fruit is consumed while recovering from diarrhoea. The ripe fruit aids in rectum inflammation treatment and aids in digesting. Unripe fruit powder in fine powder form demonstrated notable effectiveness against intestinal parasites, as well as against Entamoeba histolytica and Ascaris lumbricoides. The decoction of root and occasionally stem bark is helpful for treating hypochondriasis, palpitations, and intermittent fever. **Table 4** provides the comprehensive explanation **[6, 21-38]**.

Table 4: Ethnobotanical description of *Aegle marmelos*

Sr. no.	Plant part	Ethnobotanical use
1	Leaf	Abscess, backache, eye complaints, abdominal disorders, vomiting, cut and wounds, ulcer, dropsy, beriberi, weakness of heart, cholera, diarrhea, cardio tonic, blood sugar, injuries caused by animals, nervous disorders, hair tonic, acute bronchitis, childbirth. Veterinary medicine for wounds, killing worms, fodder for sheep, goat and cattle, stimulation of respiration and contraction of defervesced nictitating membrane in anaesthetized cats.
2	Fruit	Astringent, diarrhea, gastric troubles, constipation, laxative, tonic, digestive, stomachic, dysentery, brain and heart tonic, ulcer, antiviral, intestinal parasites, gonorrhea, epilepsy. Toys, edible, jam, preserve.
3	Root	Dog bite, gastric troubles, heart disorders, intermittent fevers, antiamoebic, hypoglycemic, rheumatism.
4	Bark	Stomach disorder, intermittent fevers, heart disorder.
5	Seed	Febrifuge.
6	Flower	Expectorant, epilepsy.
7	Whole plant	Abdominal pain, abscess, astringent, backache, dog bite, breast pain, cholera, constipation, convulsions, cramp, diabetes, diarrhea, dysentery, fever, eye complaints, gastric trouble, abdominal disorders, jaundice, laxative, nausea, night fever, heart disorders, snakebite, stomach disorder, vomiting, tonic, cut and wounds.
8	Root, Bark	Fish poison.
9	Seed mucilage	Plaster for walls.
10	Seed oil	Laxative.
11	Wood	Beads worn by low caste, special couches for rheumatic patients.
12	Gum around seed	To improve adhesive strength of water paints.
13	Unripe fruit rind, Bark	Yellow dye.
14	Stem	Pestles of oil and sugar mills.

Phytochemistry of *Aegle marmelos*: Numerous components of *A. marmelos* have been the subject of in-depth research, which has led to the isolation of several families of compounds, including fatty acids, amino acids, coumarins, terpenoids, and alkaloids. **Table 5** provides information on the chemical components that were extracted from *Aegle marmelos* **[39-50]**.

Table 5: Phytochemical constituents of Aegle marmelos.

Sr. no.	Name	Compound	Plant part
1	Alkaloids	Aegelenine Aegeline Aegelinosides A Aegelinosides B Dictamine Ethyl cinnamamide Ethyl cinnamate Fragrine Halfordinol	Fruits, leaves
2	Coumarins	Alloimperatorin Imperatorin Isoimperatorin Marmelide Marmelosin Marmesin Marmin Psoralen Umbelliferone Methyl ethrer Xanthotoxol	All parts

		Zanthotoxol	
3	**Terpenoids**	**Caryophyllene** **Cineol** **cis-Limonene oxide** **cis-Linalool oxide** **Cubedol** **Elemol** **Epi-cubebal** **Hexanylhexanoate** **Humulene** **Isosylvestrene** **Limonene** **Linalool** **Methyl perilate** **Myrcene** **P-cymene** **Terpinolene** **Valencene** **Caryophyllene** **Cineol** **cis-Limonene oxide** **cis-Linalool oxide** **Cubedol** **Elemol** **Epi-cubebal** **Hexanylhexanoate** **Humulene** **Isosylvestrene** **Limonene** **Linalool** **Methyl perilate** **Myrcene** **P-cymene** **Terpinolene** **Valencene**	**Fruit,leaves, and bark**
4	**Vitamins**	**Thiamin** **Riboflavin** **Niacin** **Ascorbic Acid**	**Fruits,** **leaves**
5	**Tannins**	**4,7,8-trimethoxyfuro-quinoline**	**Fruits,** **leaves**
6	**Carbohydrates**	**Galactose** **Arabinose** **Uronic acid** **L-Rhamnose** **Aralrinose** **D-galacluronic Acid**	**Fruits**
7	**Flavonoids**	**Rutin** **Flavone** **Flavone-3-ols** **flavone glycosides**	**Antidepressent,** **Anticonvulsant,** **Antidiabetic**
8	**Fatty Acids**	**Palmitic Acid** **Stearic Acid** **Oleic Acid** **Linoleic acid** **Linolenic Acid**	**Seeds**
9	**Essential Oils**	**Alpha-Pinene** **Beta-Myrcene** **Alpha-Phellandrene** **Isosylvestrone** **Delta-Carene** **Beta-Ocimene** **Linalool** **Terpenolene** **Alpha-Cubebene** **Alpha-Terpineol** **Delta-Elemene** **Gama-Elemene**	**Leaves**

Table 6: Nutritional value of *Aegle marmelos* (% or per 100gm) [49-50]

Sr. no.	Components	Value(%)
1	Water (moisture)	64.2
2	Protein	1.8
3	Fat	0.2
4	Mineral	1.5
5	Fiber	2.2
6	Carbohydrate	30.6
7	Calcium	0.09
8	Phosphorus	0.05
9	Potassium	0.6
10	Iron	0.3
11	Vitamin A	186
12	Vitamin B1	0.01
13	Nicotinic acid	0.9
14	Riboflavin	1.2
15	Vitamin C	0.01
16	Calorific value	129

Reported Pharmacological Studies

Antioxidant activity: The inclusion of flavones, isoflavones, flavonoids, anthocyanin, coumarin lignans, catechins, and isocatechins is what gives the *Aegle marmelos* plant its antioxidant action. It has been widely documented that *Aegle marmelos* exhibits antioxidant action against a range of free radicals. Unripe fruit had a higher percentage of free radical inhibition than ripe fruit did. Using the DPPH radical scavenging method, reducing power assay, H_2O_2 radical scavenging assay, superoxide radical scavenging assay, nitric oxide scavenging assay, and ABTS radical scavenging assay, methanol and aqueous extract of A. marmelos fruit pulp was screened for antioxidant activity. Good antioxidant activity was shown by both the alcoholic and aqueous extracts **[41, 51, 52]**.

Antimicrobial Activity: The agar well diffusion method was used to test the *Aegle marmelos* leaves' antibacterial properties. *Aegle marmelos* leaf extracts in water, petroleum ether, and ethanol demonstrated effective antibacterial action against Escherichia coli, Salmonella typhi, Klebsiella pneumonia, Proteus vulgaris and Streptococcus pneumonia, The petroleum ether and aqueous extract exhibits efficacy against *Fusarium oxysporum*, while the ethanolic extract is active against *Penicillium chrysogenum*. The antibacterial activity of leaves may be due to the presence of eugenol and cuminaldehyde. Compared to gramme positive strains, gram-negative strains exhibited greater antimicrobial activity **[51, 52, 53]**.

Antifungal activity: It has been observed that *Aegle marmelos* leaves have antifungal efficacy against dermatophyte clinical isolates. Fungicidal efficacy against T. *rubrum, Trichophyton mentagrophytes, M. gypseum, Microsporum canis,* and *Epidermophyton floccosum* was observed in leaf extracts and fractions of *A. marmelos* **[52]**.

Antidiarrheal Activity: It was observed that *Aegle marmelos* dried fruit pulps have antidiarrheal properties in vitro. The MIC technique was used to measure the antidiarrheal activity against the diarrhoea-causing pathogens. The ethanolic extract exhibits modest action against *S. dysenteriae* but good activity against *S. sonnei, S. flexneri,* and *S. boydii* **[52, 54]**.

Anti-constipating effect: Fruits from *Aegle marmelos* are typically used to cleanse and tone the intestines. The majority of ripe fruits that are readily available are used as natural laxatives. Frequent consumption of this fruit for two to three months causes the bowels to empty of stored, old faeces. It is typically consumed as "sherbat," which is formed from ripe fruit pulp **[3, 6]**.

Antidiabetic activity: Although all of the *Aegle marmelos* extracts were effective against diabetic rabbits, the methanolic extract of the leaves had the strongest anti-diabetic effect. When alloxan-induced diabetic rats were given methanolic extract (120 mg/kg, p.o.), their blood sugar levels were reported to have decreased by 54% by the 12th day **[6, 55]**.

Antiproliferative activity: It has been reported that the ethanolic extract of *Aegle marmelos'* stem bark exhibits antiproliferative action against a range of human tumour cell lines. The findings demonstrated that human tumour cell lines, such as leukemic K562, T lymphoid Jurkat, Blymphoid Raji, erythroleukemic HEL, melanoma Colo38, and breast cancer MCF7 and MDAMB-231 cell lines, were inhibited in vitro from proliferating **[6, 52]**.

Cytoprotective effect: It has been observed that *Aegle marmelos* leaves have this effect on freshwater fish, specifically *Cyprinus carpio*. After being exposed to heavy metals, *Cyprinus carpio* was treated with *Aegle marmelos* leaf powder that had been dried. Through the stabilisation of the plasma membrane and the modification of the antioxidant enzyme system, this treatment had a cytoprotective effect **[52, 56]**.

Hepatoprotective Effect: Research on the effects of *Aegle marmelos* leaf extract on alcohol-induced liver damage in albino rats demonstrates remarkable hepatoprotective properties. Similarly, CCI_4-induced liver toxicity can be effectively treated and prevented with an aqueous extract of bael fruit pulp and seeds **[57]**.

Antifertility Effect: Male Albino rats treated with aqueous extracts of *Aegle marmelos* leaves have antifertility effects. For 45 days, aqueous extracts (250 mg/kg body weight) were given to the rats. The testis, epididymes, and seminal vesicle weights decreased as a result of this treatment. In addition, the extract decreased the number of aberrant sperm, sperm motility, and sperm count in the testicles **[58]**.

Analgesic activity: Using a writhing and tail immersion test on mice, the antinociceptive response of the methanolic extract of *Aegle marmelos* leaves was reported. In comparison to other doses, the maximum achievable effects of methanolic extract (200 mg/kg p.o.) were more statistically significant. The study finds that there is a notable analgesic effect from the methanolic extract of *Aegle marmelos* leaves **[59]**.

Anti-arthritis activity: It has been observed that *Aegle marmelos* leaves exhibit anti-arthritic properties against Wistar albino rats produced by collagen. Rats treated with methanol extract also showed a significant reduction in radiological and histological alterations **[60]**.

Contractile activity: Because alcoholic extract of *Aegle marmelos* leaves is traditionally used to treat asthma and related conditions, its contractile activity was documented on guinea pig isolated ileum and tracheal chain. Due to the depression of H1 receptors, the alcoholic extract of *A. marmelos* leaves demonstrated maximum relaxation of the guinea pig ileum and tracheal chain at 1 mg/ml and 2 mg/ml, respectively, at low and high doses **[61]**.

Antihyperlipidemic activity: *Aegle marmelos* was tested at 125 and 250 mg/kg in diet-induced hyperlipidemic Wister albino rat models. Oral use of fruit and seed aqueous extracts dramatically lowers serum and tissue lipid profiles in streptozotocin-induced diabetic mice **[62-63]**.

Counteracting Cardiotoxic effect: It was shown that an alcoholic extract from the unripe fruit of *Aegle marmelos* has a cardioprotective effect on myocardial infarction caused by isoproterenol. Auraptene, a highly powerful chemical, is the cause of this action **[64]**.

Anticancer activity: The cytotoxic impact of *Aegle marmelos* extracts was tested utilising tumour cell lines, brine shrimp lethality assays, sea urchin eggs assays and MTT assays to determine the anticancer potential of traditional medicine used in Bangladesh. The Aegle marmelos extracts demonstrated toxicity in every assay that was utilised **[65]**.

Antiviral activity: *Aegle marmelos* hydroalcoholic extract has antiviral properties against the virus that causes Ranikhet sickness. There have also been reports of interferon-like activity against the same pathogen. As a result, *Aegle marmelos* has improved viricidal potential and could soon be employed as a strong antiviral drug **[66]**.

Anti-ulcer activity: Pyranocoumarin was extracted from *Aegle marmelos* seeds, and when given orally to rats, it significantly prevented stomach ulcers caused by aspirin, pylorus ligation, and cold restraint stress in both rats and guinea pigs **[67]**.

Antimalarial activity: Using the Trager and Jensen method, *A. marmelos* root extract exhibits antimalarial efficacy against the parasite *Plasmodium falciparum* (K1, multidrug resistant). This quantitative evaluation of the antimalarial activity in vitro was achieved using the micro culture radioisotope technique. The in-vitro uptake of [3 H]-hypoxanthine by *P. falciparum* revealed the concentration that resulted in a 50% reduction in parasite development, which is known as the IC50 or inhibitory concentration. Dihydro artemisinin (IC50 4.1 nmol L) was used as the reference chemical **[68, 69]**.

Anti-micro filarial activity: The potential antifilarial action of methanolic extract of *Vitex nigundo* L. roots and leaves, *Ricinus communis* L., and *Aegle marmelos* Corr. against *Brugia malayi* microfilariae was investigated. By laving the peritoneal cavities of young individuals who had an intraperitoneal filarial infection lasting three months or longer, microfilariae were recovered. After 48 hours of incubation, the extracts from *Vitex nigundo* L. roots and *A. marmelos* Corr. leaves, at a concentration of 100 mg/ml, exhibit the complete loss of motility of microfilariae among all the extracts that were detected **[70]**.

Anticonvulsant activity: Male mice were used to test the anticonvulsant effects of an ethanolic extract of *Aegle marmelos* leaves on maximum electroshock (MES) and pentylenetetrazole (PTZ). Mice were given oral dosages of 100 and 200 mg/kg of the extracts. The extract exhibited a protective effect against PTZ-induced seizures and decreased hind limb tonic extensions (HLTE) caused by MES at a dose of 200 mg/kg. It can be inferred that the ethanolic extract of *Aegle marmelos* leaves interferes with gabanergoc pathways to produce anticonvulsant effect and demonstrates the presence of flavonoids that are responsible for their anticonvulsant action because it delayed the appearance of MES and PTZ convulsions **[71]**.

Antihistaminic activity: Testing is done to see how skimmianine, which is derived from *Aegle marmelos* roots, affects the release of histamine in rat mast cells. Rat peritoneal mast cells (RPMCs) and rat basophilic leukaemia (RBL-2H3) were the two cell lines used in this investigation. Rat mast cells were exposed to DNP24-BSA, thapsigargin, ionomycin, and compound 48/80 as inducers of histamine release. Skimmianine significantly reduced histamine release from RBL-2H3 cells via acting on the histamine H1 receptor, which is activated by DNP24-BSA, thapsigargin, and ionomycin, according to the docking scores **[72]**.

Antidepressant and anxiolytic activity: Using the tail suspension test and elevated plus maze in mice, it was found that the methanolic extract of *Aegle marmelos*

leaves exhibits antidepressant and anxiolytic properties, as well as interactions with antidepressant and anxiolytic medications. The findings included the amount of time spent on, the quantity of entrances into, the quantity of stretch poses, the quantity of head dips in the arms of the elevated plus labyrinth, and the length of immobility in the tail suspension test. Multiple approaches have confirmed that the increased levels of monoamines at postsynaptic locations may be the cause of these activities. Based on the results, it can be said that a methanolic extract of *Aegle marmelos* leaves has strong anxiolytic and antidepressant properties, and it also strengthens the effects of fluoxetine and imipramine **[73]**.

Anti-stress and adaptogenic activity: In albino rats of either sex, the anti-stress and adaptogenic properties of an aqueous extract of *Aegle marmelos* were investigated through the use of swimming endurance and post-swimming motor function tests, cold swimming endurance tests, and forced swim tests. Rats' blood cholesterol and serum triglyceride levels did not rise when extracts were put through a forced swim paradigm to test for adaptogenic activity; however, the increases did not last in the following groups. It improves post-motor function such as rota rod falling time and spontaneous motor activity in addition to swimming endurance time. These extracts improve the amount of time one can swim in the cold and may limit the rise in these markers during stressful situations **[74]**.

Radio protective effect: Mice were exposed to several doses of gamma radiation to investigate the radioprotective impact of *Aegle marmelos* extract. The results showed that oral administration of extract increased radiation tolerance by 1.6 Gy. Once more, research demonstrates how plant extract affects Swiss albino mice's small intestine and peripheral blood. They exposed the animals to gamma radiation, and data were gathered regarding changes in the intestinal mucosa, spleen colony forming units, and peripheral blood caused by radiation. It was found that *Aegle marmelos* extract significantly lessens the harmful effects of radiation in mouse bone marrow and intestine **[75, 76]**.

Wound healing activity: Male Wister rats with excision wound models were used to observe the effects of an injection and ointment made from the methanolic extract of *Aegle marmelos* seeds. Up until the wounds were fully healed, ointment was applied topically to cure them. After the wounds were closed, they were observed and measured on days 0, 4, 8, 12, 16, and 20. Male Wister rats were used to perform incision wound models using the Ehrlich and Hunt procedure. For ten days, extract ointment was applied to the wounds every day. After the ninth day, the sutures were taken out and the wound was measured

using a tensiometer according to Lee's procedure. When compared to the control, the extract in the excision model epithelializes more quickly and exhibits a higher rate of wound contraction **[77, 78]**.

Anti thyroid Activity: *Aegle marmelos* leaves were used to isolate scopoletin (7-hydroxy-6-methoxy coumarin), and its ability to control hyperthyroidism was studied. It was found that giving levothyroxine-treated animals scopoletin (at 1 mg/kg, p.o. for 7 days) reduced the level of thyroid hormones in their serum. Additionally, it has been demonstrated that scopoletin exhibits better therapeutic effect than propylthiouracil, the antithyroid medication of choice **[79]**.

Toxicity studies: *Aegle marmelos* leaves were examined for their acute and subacute cytotoxic characteristics. The LD50 values and acute and subacute toxicity effects of various *Aegle marmelos* leaf extracts were evaluated in Wistar albino rats. The findings showed that the various extracts' LD_{50} values ranged from 1300 mg to 1700 mg/kg body weight. Dead animals typically showed up with their hearts stopped in a systolic standstill during acute poisoning. The histological investigations showed no appreciable alterations following 50 mg/kg body weight (daily, 14 days) **[80]**.

FUTURE ASPECTS

Because *Aegle marmelos* has a high concentration of phytoconstituents, it can be utilised to cure a wide range of human ailments. The majority of the compounds have not been thoroughly assessed in order to find novel lead molecules or pharmacophores. Still, only a few bioactive chemicals' mechanisms of action have been determined thus far. Therefore, *Aegle marmelos* may be further utilised as a source of beneficial phytochemical compounds in the near future and may be crucial to the development of contemporary medical systems.

CONCLUSION

One of the significant plants with a variety of therapeutic and nutraceutical uses is *Aegle marmelos*. It has a number of therapeutic qualities that are employed in the conventional medical system to treat a variety of illnesses. *Aegle marmelos* has been the subject of intense scientific research in the past few decades regarding its potential medical benefits. Numerous bioactive chemicals have been extracted from various parts of the plant and have undergone pharmacological analysis. Its numerous botanical descriptions, phytoconstituents, and pharmacological activities-such as those that are antibacterial, antifungal, antiviral, antidiabetic, antimalarial, and antioxidant were thoroughly summarised in this review.

ACKNOWLEDGEMENT

I am very thankful to my supervisor Dr. Pankaj Mishra for their support during the

work of my review. In addition, a special thanks to Dr. Pushpendra Kannojia for the great cooperation throughout the writing of review.

CONFLICT OF INTEREST

There are no conflicts of interest.

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