INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

Review Article

Evaluation of Anti-inflammatory, Analgesic and Anti Irritant Activity of *Aegle marmelos* Leaves Extract

R. S Desale, Parth Dashpute*, Bhalerao Pooja, Rahul Bochare, Talele Bhagyashri

Swami Vivekanand Sastha's Institute of Pharmacy, Malegaon, Nashik 423201

ARTICLE INFO

Published: 1 Dec 2025
Keywords:
Aegle marmelos, Bael leaves, anti-inflammatory activity, analgesic activity, anti-irritant activity, herbal extract, phytochemicals, natural therapeutics, traditional medicine
DOI:
10.5281/zenodo.17814423

ABSTRACT

Aegle marmelos (Bael) is a traditional medicinal plant widely used in Ayurveda for treating inflammation, pain, and skin disorders. The leaves of Aegle marmelos contain various bioactive phytoconstituents such as alkaloids, flavonoids, tannins, and coumarins, which contribute to its therapeutic potential. The present study aims to evaluate the anti-inflammatory, analgesic, and anti-irritant activities of Aegle marmelos leaf extract using established experimental models. Anti-inflammatory activity was assessed through carrageenan-induced paw edema, while analgesic activity was evaluated using hot plate and acetic acid-induced writhing methods. Anti-irritant potential was examined through models simulating skin irritation. The extract demonstrated significant dose-dependent reduction in inflammation, increase in pain threshold, and marked protection against irritant-induced skin reactions. These findings support the traditional use of Aegle marmelos leaves and highlight their potential as a natural therapeutic agent for managing inflammation, pain, and skin irritation. Further studies on mechanism of action and formulation development are recommended.

INTRODUCTION

Aegle marmelos (Bael) is a well-known medicinal plant used in Ayurveda, Siddha, and traditional Indian medicine for treating various disorders. The leaves of Aegle marmelos are traditionally used to manage inflammation, pain, and skin irritation. These therapeutic properties are mainly due to the presence of phytochemicals such as flavonoids, alkaloids, tannins, and coumarins. Inflammation and pain are common biological responses caused by infection, tissue injury, or chemical exposure, and although synthetic drugs like NSAIDs are effective, they often produce adverse effects during long-term use. Due to this limitation, natural and plant-based medicines are gaining importance as safer alternatives. Research studies have reported significant anti-inflammatory, analgesic, and skin-protective effects of Aegle marmelos leaf extract. Therefore, this review

***Corresponding Author:** Parth Dashpute
Address: *Swami Vivekanand Sastha's Institute of Pharmacy, Malegaon, Nashik 423201*
Email : parthdd04@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

compiles the traditional uses, phytochemistry, pharmacological activities, and scientific evidence supporting the therapeutic potential of Aegle marmelos leaves.[1,3]



Fig1. Aegle marmelos tree

Traditional Uses of *Aegle marmelos*

Aegle marmelos has been used in the Indian traditional system of medicine for thousands of years. It is mentioned in Ayurvedic texts like Charaka Samhita and Sushruta Samhita. The leaves, fruits, roots, and bark of the plant are used for therapeutic purposes.

1. Treatment of inflammation, fever, pain, and digestive disorders

In Ayurveda, the leaves of Aegle marmelos are used to reduce swelling and pain because they possess natural anti-inflammatory and analgesic properties. Decoctions and leaf pastes are commonly used to treat fever and body ache. The leaves also support digestion and help reduce gastric irritation.

2. Use in dysentery, peptic ulcers, diarrhea, and skin infections

The leaves are known for their astringent and antimicrobial properties. They help control diarrhea and dysentery by reducing intestinal inflammation and killing harmful microbes. They also protect the gastric mucosa, which helps in the management of peptic ulcers. Leaf paste is traditionally applied on wounds, boils, and skin infections to promote healing and prevent infection

3. Cooling, wound-healing, and blood-purifying properties

The leaves have cooling (sheeta virya) properties in Ayurveda, meaning they help reduce heat-related conditions. They are rich in antioxidants, which purify the blood and promote detoxification. When applied externally, the leaves speed up wound healing and reduce redness or irritation.

4. Relief from headache and skin irritation

Leaf extracts are traditionally used in herbal oils and balms for relieving headaches. They are also soothing when applied on irritated or inflamed skin. The natural astringent and anti-irritant properties help calm the skin, reduce redness, and provide a cooling effect.ional content, it has been used as a dietary supplement to combat malnutrition and micronutrient deficiencies, especially in developing countries.

2. USES OF PLANT PARTS

1. Leaves

Bael leaves are traditionally used to treat eye disorders and ulcers. Fresh leaves are given for heart diseases, swelling, and vitamin B1 deficiency.They help promote regular bowel movements and assist in blood sugar control.Leaves are also useful in jaundice, asthma, and in clearing mucus from the bronchial tubes [6].

2. Root and Bark

Bael roots help in urinary problems, reduce heart palpitations, and aid in fever management.They are also used to relieve stomach pain.A decoction

of the root and bark is given in melancholia, palpitations, and intermittent fever. The root is one of the important ingredients of the Ayurvedic formulation Dashamula. A mixture of bael root extract + onion + turmeric in equal proportions is used for treating ear secretions.

3. Flower

The flowers act as an expectorant and are also used in epilepsy. They have astringent and antibacterial properties. Distilled flower water, is beneficial in conjunctivitis.

4. Fruit

Bael fruit is widely used to prepare sweet pickles, pudding, and drinks. It acts as a laxative and is used for respiratory problems, chronic diarrhoea, and peptic ulcers. Fruit extract lowers lipid peroxidation and may support thyroid function. A preparation of fruit with boiled rice water is traditionally used to treat vomiting during pregnancy.

5.Seed

Bael seeds show antidiabetic and hypolipidemic activity. Their high fibre content helps relieve constipation, diarrhoea, and irritable bowel syndrome (IBS).The anti-inflammatory effects of the seeds help reduce asthma and bronchitis symptoms. Seed antioxidants may help in reducing the risk of chronic diseases.

3. PHYTOCHEMICAL COMPOSITION OF LEAVE

The leaves of Aegle marmelos contain a rich blend of phytochemicals that are responsible for its medicinal activities. These phytoconstituents have been scientifically proven to show anti-inflammatory, analgesic, and anti-irritant effects.

3.1 Major Phytochemicals

1. Flavonoids: Rutin, Quercetin

Flavonoids are powerful antioxidants that protect cells from oxidative stress. Rutin helps strengthen blood vessels and reduces inflammation.

Quercetin has strong anti-inflammatory and analgesic properties and inhibits the release of histamine, making it useful in irritation and allergy conditions.

2. Alkaloids: Aegeline, Marmelosin

Alkaloids are nitrogen-containing compounds known for pharmacological activity. Aegeline has anti-inflammatory, antioxidant, and metabolic effects. Marmelosin possesses antidiarrheal, antimicrobial, and analgesic activity.

3. Tannins: Gallic acid derivatives

Tannins are astringent compounds. They help tighten tissues, reduce irritation, and form a protective layer on the skin or mucosa. Tannins also reduce inflammation and help in wound healing.

4. Coumarins: Marmin, Marmelosin

Coumarins show a variety of medicinal properties. Marmin has anti-inflammatory and antispasmodic actions. Coumarins help reduce swelling by inhibiting inflammatory mediators and improving blood circulation.re, it represents a sustainable source for drug discovery and herbal medicine research.

5. Phenolic Compounds: Catechin, Epicatechin

These are strong antioxidants. They neutralize free radicals that cause inflammation. Catechins also promote healing and protect tissues from chemical-induced irritation.

6. Essential Oils: Limonene, Citronellal The leaves contain aromatic essential oils. Limonene has anti-inflammatory and skin-soothing effects. Citronellal shows antimicrobial, cooling, and anti-irritant properties.

Table.1 Taxonomical Classification

Taxonomic Rank	Classification
Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Sapindales
Family	Rutaceae
Genus	Aegle
Species	Aegle marmelos (L.) Corr.

4. PHARMACOLOGICAL ACTIVITIES OF AEGLE MARMELOS LEAVES

4.1. Anti-inflammatory Activity

Aegle marmelos leaves have been widely reported for their strong anti-inflammatory potential in traditional and modern scientific studies. The presence of bioactive compounds such as flavonoids (rutin, quercetin), coumarins (marmin, marmelosin), tannins, and phenolic compounds plays a major role in controlling inflammation. These phytochemicals inhibit the release of inflammatory mediators like prostaglandins, histamine, nitric oxide (NO), tumor necrosis factor-α (TNF-α) and interleukins (IL-1β, IL-6).

Studies using carrageenan-induced paw edema and formalin-induced inflammation models have shown significant reduction in swelling after administration of leaf extracts. This suggests that the extract interferes with both early-phase and late-phase inflammatory responses. Additionally, its antioxidant property reduces oxidative stress, which indirectly contributes to lowering inflammation. Therefore, A. marmelos leaves can be considered a promising natural anti-inflammatory agent with multi-targeted action.[2,3]

4.2. Analgesic (Pain-Relieving) Activity

The analgesic activity of Aegle marmelos leaves has been demonstrated in both central and peripheral pain models, indicating its broad action against pain. The leaf extract increases the pain threshold in hot-plate and tail-flick tests, showing an effect on the central nervous system. In acetic acid-induced writhing tests, a reduction in the number of writhes confirms its peripheral analgesic activity.

The analgesic effect is mainly attributed to the presence of alkaloids, flavonoids, and coumarins, which may inhibit the synthesis of prostaglandins, key mediators responsible for pain sensation. By reducing inflammatory mediators and blocking pain signal transmission, A. marmelos leaves provide both anti-inflammatory and analgesic effects synergistically. Thus, the plant acts as a natural pain reliever which can be beneficial in conditions like headache, muscle pain, joint pain, and inflammation-related discomfort.

4.3. Anti-irritant Activity

The leaves of Aegle marmelos are traditionally used for treating skin irritation, itching, redness, and minor wounds, which reflects their strong anti-irritant properties. The presence of tannins, phenolics, terpenoids, and essential oils (citronellal, limonene) helps soothe irritated skin. These compounds form a protective layer over the skin, reduce transepidermal water loss, and promote natural healing.

Pharmacologically, the leaf extract helps reduce irritation through anti-inflammatory, antimicrobial, and antioxidant mechanisms. It suppresses the release of pro-inflammatory mediators that cause redness and burning sensation. Its antimicrobial properties protect the irritated area from secondary infections, while

antioxidants accelerate skin repair by neutralizing free radicals. Because of these combined actions, A. marmelos is widely included in herbal formulations for skin irritation, rashes, minor cuts, and inflammation-related skin conditions.

5. TRADITIONAL AND ETHNOMEDICINAL USES OF AEGLE

Aegle marmelos (Bael or Bilva) occupies a significant place in traditional healing practices across India and several South Asian regions. Its therapeutic applications have been recognized for centuries in Ayurveda, Siddha, Unani, and numerous folk medicinal systems. Almost every part of the plant including the leaves, fruits, roots, bark, and flowers is utilized for different health conditions. Owing to its medicinal importance, the plant is also considered sacred in India and is commonly associated with Lord Shiva. Traditionally, A. marmelos has been employed for the management of digestive disturbances, inflammatory ailments, infectious diseases, metabolic disorders, and various skin conditions. Its well-established role as a natural anti-inflammatory, digestive enhancer, and wound-healing plant highlights its relevance in both classical and contemporary herbal therapy.[5]

5.1 Traditional Ayurvedic Perspective

In Ayurveda, Aegle marmelos is referred to as Bilva and forms an essential component of several classical formulations. The plant is described as having Kashaya (astringent) and Tikta (bitter) taste, with Laghu (light), Ruksha (dry), and Sara (flowing) qualities. It is classified as having Ushna virya (hot potency) and Katu vipaka (pungent post-digestive effect). These characteristics contribute to its ability to pacify Vata and Kapha doshas, while also supporting digestive functions and reducing gastrointestinal disturbances. Different parts of the plant, such as unripe fruits, leaves, and roots, are recommended in a variety of clinical conditions in Ayurvedic practice.

Ayurvedic texts describe the plant as beneficial in several disorders. The unripe fruit is widely used in Atisara (diarrhea) and Pravahika (dysentery) due to its strong astringent and antimicrobial nature.[6] In Amlapitta (hyperacidity) and Grahani (IBS-like symptoms), Bael supports digestion, alleviates irritation of the gut lining, and improves intestinal strength. The leaves are traditionally applied for Shotha (inflammation) and joint pain, while decoctions of the leaves and bark are taken to reduce Jwara (fever). Bael is also recommended in Krimi (worm infestations), Kustha (skin diseases) such as eczema and dermatitis, and Madhumeha (diabetes) due to its metabolic-regulating effects. Classical Ayurvedic sources like Charaka Samhita, Sushruta Samhita, and Bhavaprakasha Nighantu describe Bilva as an effective Deepana-Pachana (digestive stimulant), Shothahara (anti-inflammatory), and Krimighna (antimicrobial) herb.[11]

5.2 Uses in Unani Medicine

In Unani medicine, Aegle marmelos is known as Bel or Safarjali Hindi and is valued for its carminative, astringent, stomachic, and antipyretic actions. It is incorporated into various formulations aimed at improving digestive and metabolic health. The fruit pulp is commonly used for diarrhea, dysentery, and intestinal irritation, where its astringent properties help restore bowel function. Preparations of the leaves and bark are employed in mild liver and spleen ailments, reflecting its hepatoprotective importance in Unani practice. Topical applications of leaf poultices are recommended for joint inflammation, muscle pain, and inflammatory skin conditions. Bael leaf decoctions are also administered during febrile illnesses to reduce fever and associated discomfort. Additionally, Bael fruit preparations

are consumed as a general health tonic, particularly in conditions involving dehydration, heat stress, and physical weakness, owing to their cooling and nutritive properties.

5.3 Folk and Tribal Medicine

In Indian tribal and rural communities, Aegle marmelos is traditionally regarded as a versatile medicinal plant capable of addressing a wide range of health problems. Root bark decoctions are used as a remedy for snakebites, bone-related conditions, and severe digestive complaints. Leaf juice is applied or consumed for managing eye infections, skin rashes, and minor wounds. The fruit pulp is widely taken as a natural cooling agent, energy booster, and heat-relieving drink during summer months. In certain regions, flower extracts are used to ease menstrual discomfort and promote overall reproductive well-being. These practices demonstrate the plant's longstanding significance in community healthcare systems and highlight its multidimensional therapeutic potential.

CONCLUSION:

Aegle marmelos (Bael) is an important medicinal plant with strong traditional and ethnomedicinal relevance. The leaves are rich in bioactive compounds such as flavonoids, alkaloids, tannins, coumarins, and phenolics, which contribute to their anti-inflammatory, analgesic, and anti-irritant properties. Evidence from both classical medicinal systems and modern pharmacological studies supports the therapeutic potential of Bael leaves in managing pain, inflammation, gastrointestinal disturbances, skin irritation, and various infectious conditions.

Despite significant progress, the scientific validation of traditional claims remains limited by inconsistent methodologies, lack of standardization, and insufficient clinical studies. Future research focusing on molecular mechanisms, standardized extracts, and novel formulations may establish Aegle marmelos leaf extract as a promising natural therapeutic agent. This review highlights the need for integrated traditional knowledge and modern pharmacological research to fully utilize the medicinal value of this versatile plant.

REFERENCES

1. Swaroop A, Singh A, Singh A, Pandey SK. Aegle marmelos: A comprehensive review of its phytochemical profile and pharmacological application. J Med Plant Stud. 2025 Mar;13(2):240-249
2. Jagan Mohan C, Vijay C, Ravi R, Rao M, Balakrishna P, Balaji Y. Evaluation of the anti-inflammatory activity of hydroalcoholic extract of Aegle marmelos leaves. Asian J Phytomed Clin Res. 2013;1(2):109-115.
3. Rajaram A, Vanaja GR, Vyakaranam P, Rachamallu A, Reddy GV, Anilkumar K, Arunasree KM, Dhyani A, Prasad NK, Sharma S, Joshi MC, Kimothi GP, Brindavanam NB. Anti-inflammatory profile of Aegle marmelos (L) Correa (Bilva) with special reference to young roots grown in different parts of India. J Ayurveda Integr Med. 2018 Oct-Dec;9(4):254-263.
4. Ramamoorthy M, Palanisamy S, Murugesan S. Phytochemical screening, antioxidant, anti-inflammatory and anti microbial activities of Aegle marmelos leaf extracts. Res Sq. 2023 Apr 29.
5. Maity S, Misra P, Gupta B. Therapeutic potential of Aegle marmelos (L.)–An overview. Asian Pac J Trop Biomed. 2014 Apr;4(Suppl 1):S457-S462.
6. Anand PV, Aroul D, Kannan S, Selvaraj J. Evaluation of Antidiarrhoeal activity of

extract from leaves of Aegle marmelos. J Appl Pharm Sci. 2012;2(2):33-36
7. Dey YN, Ota S, Srikanth N, Tilak T, Sudeep R. Evaluation of the anti-inflammatory activity of Aegle marmelos (Bilwa) root. Ayu. 2011 Jul;32(3):370-374.
8. Saha N, Bera K, Datta S, Mandal P. Evaluation of antidiarrhoeal and antiinflammatory activity of Aegle marmelos on albino wistar rats. Int J Curr Pharm Res. 2017;9(4):61-64.
9. Sharma A, Kumar R, Singh V. Phytochemical composition and biological activities of Aegle marmelos. Front Plant Sci. 2022 Mar 11;13:832445.
10. Singh L, Singh S, Kumar A, Dubey P. Aegle marmelos (Bael): A systematic review. J Drug Deliv Ther. 2021 Jun 15;11(3-S):145-151.
11. Savita S, Singh AP, Singh A. Aegle marmelos (L.) (Bael): A systematic review. J Drug Deliv Ther. 2021 Jun 15;11(3-s):131-136.
12. Hota S, Thirumani L, Alex A, Neha B, Vimal S, Madar IH. Systematic evaluation of Aegle marmelos-derived compounds: potential therapeutic agents against inflammation and oxidative stress. Cureus. 2024 Apr 3;16(4)

HOW TO CITE: R. S Desale, Parth Dashpute, Bhalerao Pooja, Rahul Bochare, Talele Bhagyashri, Evaluation of Anti-inflammatory, Analgesic and Anti Irritant Activity of Aegle marmelos Leaves Extract, Int. J. of Pharm. Sci., 2025, Vol 3, Issue 12, 751-757. https://doi.org/10.5281/zenodo.17814423