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# Therapeutic Potential of Medicinal Plants in Inflammation Management: A Review

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**ABSTRACT**

Inflammation is a biological response mechanism that has been identified as a major contributor to the development of various acute and chronic conditions. Although the use of conventional anti-inflammatory agents has been effective, their chronic use has been associated with adverse effects, thereby increasing the demand for alternative therapeutic approaches from medicinal plants. Medicinal plants have been used traditionally in the treatment of inflammatory conditions owing to their varied chemical composition. This review article compiles and critically evaluates experimental and pharmacological studies that have reported the anti-inflammatory activity of various medicinal plants. The plants reviewed have shown promising anti-inflammatory activity through various mechanisms like the inhibition of pro-inflammatory mediators, antioxidant properties, and the modulation of inflammatory pathways. The activity has been attributed to the phytochemical constituents of the plants, which include flavonoids, alkaloids, glycosides, terpenoids, and phenolic compounds.

**Keywords:** Anti-inflammatory, flavonoids, Alkaloids, Glycosides, Chemotaxins and Saponins.

## 1. INTRODUCTION:

Inflammation is a complex biological response of the body's immune system to harmful factors, such as pathogens, damaged cells, or irritants. It acts as a protective mechanism that removes these harmful agents and starts the healing process. During inflammation, immune cells activate, inflammatory substances like cytokines and chemokines are released, and blood flow increases to the affected area. This results in symptoms such as redness, heat, swelling, and pain.

Higher organisms developed inflammation as a defence mechanism in reaction to harmful insults like tissue damage, microbial infection, and other unpleasant circumstances. It is a crucial immune response by the host that permits both the healing of injured tissue and the elimination of dangerous stimuli.

Restoring cellular homeostasis in response to any harmful situation is one of the primary goals of inflammation as a defence mechanism for the host. Therefore, the physiological state of homeostasis is closely linked to the mechanism that initiates inflammation.

Inflammation causes acute pain, heat, redness, swelling, and healing that leads to scar formation. Tissue regeneration is a series of chemical reactions and cell processes that repair damaged tissue, like a small skin cut, tissue repair after childbirth, or recovery from severe burns. The inflammatory response at the tissue and cell level includes several steps: arterioles and venules widen, blood vessels become more permeable, and blood flow increases. Afterward, blood flow decreases, clots form, white blood cells move into the tissue, plasma leaks into the tissue, tissue breaks down due to enzymes and oxygen radicals, cells die, waste materials are removed by phagocytic cells, new cell growth regulators are made, and new functional and connective tissue is formed.

Acute and chronic inflammation are two types of immune responses in the body. Both activate the immune system and release substances that cause inflammation. However, they differ in duration, mechanisms, and symptoms.

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Acute inflammation happens quickly after tissue injury or infection, allowing for a fast immune response. This process usually resolves within a few days once the cause is gone. Blood vessels in the affected area expand and become more permeable. This change lets immune cells and proteins move from the bloodstream into the tissue, causing the swelling, redness, and heat seen in acute inflammation.

Neutrophils are the main immune cells involved in acute inflammation. They move to the site of injury or infection and produce substances to fight germs and clean up debris. The increased permeability of blood vessels allows fluid to leak into nearby tissues, leading to swelling. Once the harmful agent is removed and the tissue heals, acute inflammation decreases, and the area returns to normal.

Chronic inflammation lasts a long time and often occurs because of unresolved triggers or underlying diseases. It involves cycles of tissue damage and repair attempts. During wound healing, several processes work to restore the integrity of the injured area. These include inflammation, cell growth, and tissue remodeling. After an injury, initial inflammation happens due to various inflammatory substances. Then, there is an increase in fibroblast growth, new blood vessel formation, and tissue remodeling. This prolonged immune response can damage normal tissue and create scar tissue.

Unlike acute inflammation, chronic inflammation involves immune cells such as lymphocytes, macrophages, and plasma cells, in addition to neutrophils. New blood vessel formation and excess connective tissue are common features of chronic inflammation.

## 2. MECHANISM OF INFLAMMATION:

There are several cellular events related to the leucocyte adhesion cascade. The accumulation of leucocytes is a key feature. Leucocytes reach the site of inflammation by sticking to the walls of blood vessels and moving through them. This process is controlled by the leucocyte adhesion cascade. It involves the binding of complementary adhesion molecules on the membranes of leucocytes and endothelial cells.

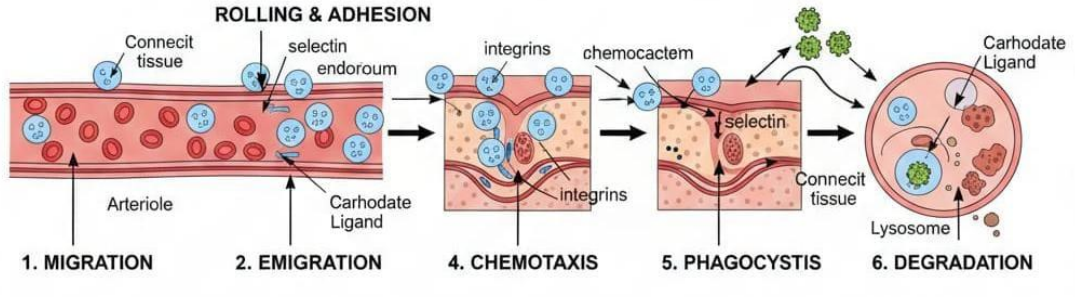


**Fig. No: 1. Mechanism of inflammation:**

### 2.1. MARGINATION:

There is slowing and stagnation of blood flow because of vasodilation, which involves widening blood vessels and relaxing smooth muscle, and increased vascular permeability. Leucocytes exit the major blood vessels until they touch the surface of endothelial cells, the main type of cell in the lining of blood vessels, in capillaries and post-capillary venules.

### 2.2. ROLLING AND ADHESION:

Marginated leucocytes sit along the endothelium. They begin to stick to the surface of the endothelial cells using different adhesion molecules. Once they adhere strongly, the leucocytes stay in place and can start to move through the endothelium to the site of inflammation.

### 2.3. EMIGRATION:

The process by which white blood cells leave the blood and move to the surrounding tissues during inflammation is known as emigration. This happens in post-capillary venules because they have enough gaps in the endothelium and histamine receptors. Neutrophils are the first cells to migrate, being the dominant figures on the scene for the first 6 to 24 hours, peaking at 4 to 6 hours. In viral infections, lymphocytes arrive first, while in some allergic reactions, eosinophils are the first to show up.

**2.4. CHEMOTAXIS:**

Cell migration based on a chemical gradient is mediated by chemo-attractant receptors. This facilitates the migration of leucocytes from the perivascular space, which is the fat tissue surrounding blood vessels, to the target area. All leucocytes are responsive to chemical stimuli. Neutrophils are the quickest to migrate, reaching the target area in 90 minutes. Monocytes migrate next, which takes several hours, while lymphocytes are the last to migrate. Chemo-attractants, also referred to as chemotaxins, may be of external or internal origin.

**2.5. PHAGOCYTOSIS:**

The purpose of phagocytosis is to engulf, kill and degrade foreign material, most commonly bacteria.

**2.6. DEGRADATION:**

After the microorganism has been phagocytosed, the pH in the phagolysosome decreases to 4-5. The pH is ideal for the functioning of degradative enzymes in lysosome.

**3. CURRENT TRENDS OF PHARMACOTHERAPIES IN INFLAMMATION**

**3.1 Standard Treatments for inflammation**

**a) NSAIDs & COX-2 Inhibitors**

Non steroidal anti-inflammatory drugs (NSAIDs) remain first-line for many acute and chronic inflammatory conditions (e.g., arthritis), often alongside gastroprotective agents. COX-2 selective inhibitors are used to reduce gastrointestinal side effects.

**b) Corticosteroids**
Rapid-acting anti-inflammatory agents used in moderate to severe inflammation or when NSAIDs are inadequate. They suppress multiple cytokines and immune pathways.

**3.2 Targeted & Biologic Therapies**

Modern therapies often target specific immune-signaling molecules:

**a) TNF and Cytokine Inhibitors**

Biologic drugs such as anti-TNF agents (e.g., infliximab, adalimumab) reduce inflammatory signalling in autoimmune diseases (rheumatoid arthritis, IBD, psoriasis).

**b) IL-specific & Immune-modulating Agents**

Monoclonal antibodies targeting interleukins, IL-1, IL-6, and other pathways help control chronic inflammation in disorders like uveitis and IBD.

**c) Anti-inflammatory drugs for cardiovascular inflammation**

Low-dose *colchicine* and other agents are used to reduce residual cardiovascular risk by targeting inflammasome-mediated inflammation.

**4. ROLE OF MEDICINAL PLANTS IN INFLAMMATION**

**4.1 PLANT PROFILE OF *Aconitum Heterophyllum*:**

*Aconitum Heterophyllum (A. Heterophyllum)* is an in- native Indian medicinal plant that is a member of the Ranunculaceae family. have several therapeutic benefits. This plant has been utilized in various ways in the past. The research on chemicals include proteins, carbs, amino acids, and alkaloids etc.

**Fig. No: 2. *Aconitum Heterophyllum***

**Scientific classification:**

| | |
|---|---|
| Botanical Name | Aconitum Heterophyllum |
| Family | Ranunculaceae |
| Kingdom | Plantae |
| Division | Magnoliophyta |
| Class | Magnoliopsida |
| Order | Ranunculales |
| Genus | Aconitum |

**Vernacular Names:**

Hindi: Atees

Unani: Atees

Ayurvedic: Ativisha

Trade Name: Atis

**PHARMACOLOGICAL ACTION**

**Anti inflammatory action:**

Preliminary phytochemical screening of *A. heterophyllum* extract revealed the presence of alkaloids, glycosides, flavonoids, and sterols, while steroids, fixed oils, gums, terpenoids, mucilage, and saponins were absent. In the cotton pellet–induced granuloma model, the extract significantly reduced granuloma weight in a dose-dependent manner, showing 17%, 26%, and 51% inhibition at doses of 225, 450, and 900 mg/kg, respectively. The highest dose (900 mg/kg) produced an anti-inflammatory effect comparable to diclofenac sodium. These findings support the traditional use of A. heterophyllum and suggest that its anti-inflammatory activity may be mediated through inhibition of prostaglandin synthesis and interference with arachidonic acid metabolism.

**Anti oxidant effect:**

Anti oxidant activity of different constituents of Aconitum species has free radicals scavenging potential.

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**4.2. PLANT PROFILE OF *Adhatoda vasica*:**

*Adhatoda vasica* Nees is a member of the Acanthaceae family of medicinal plants. It is an evergreen shrub with numerous long, opposing branches that grows to a height of one to three feet. Large, lance-shaped leaves are seen. The stem is woody below and herbaceous above. Exstipulate and leave in opposition. Panicles or flower spikes are tiny, asymmetrical, zygomorphic, bisexual, and hypogynous. Its fruits are capsular and have four seeds. The blossoms are either purple or white in hue. The Sanskrit word is the basis for its trade name, Vasaka. Dense-flowered inflorescences in axillary spicate cymes with short peduncles and widely oval, foliaceous bracts. The leaves, flowers, fruit, and roots are widely used as sedatives, expectorants, and antispasmodics to treat asthma, whooping cough, cold cough, and chronic bronchitis.

**Fig. No: 3. *Adhatoda vasica***

**Scientific Classification:**

| | |
|---|---|
| Kingdom | Plantae |
| Order | Lamiales |
| Family | Acanthaceae |
| Class | Magnoliopsida |
| Genus | Justicia |
| Species | Justicia adhatoda |
| Botanical Name | Justicia adhatoda |

**Vernacular name:**

Tamil: Adathodai

Telugu: Addasaramu

Kannada: Adusale

Malayalam: Adalodakam

Hindi: Vasa / Adusa

Sanskrit: vasa

English: Malabar nut, Vasaka

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**PHARMACOLOGICAL ACTIVITY**

**Anti-Inflammatory Activity:**

Various doses of the methanolic extract, non-alkaloid fraction, saponins, and alkaloids of *Adhatoda vasica* were evaluated for anti-inflammatory activity. All tested samples exhibited some degree of anti-inflammatory effect, as indicated by the absence of star-shaped blood vessels around granulomas. Bioassay-guided fractionation identified alkaloids as the primary active constituents, with the alkaloid fraction containing approximately 80% vasicine.

The isolated alkaloid fraction showed potent inhibition of membrane irritation at 50 mg/pellet, whereas lower doses exhibited weak activity and higher doses produced local irritation, reducing the anti-inflammatory effect. Similar dose-dependent effects were observed with saponins. The crude methanolic extract and non-alkaloid fraction displayed comparatively lower activity, while the aqueous extract, rich in saponins, showed moderate anti-inflammatory effects. Increasing the concentration of the irritant reduced the anti-inflammatory efficacy of the alkaloid fraction.

Overall, the study confirmed that alkaloids are the major anti-inflammatory constituents of *A. vasica*, and the extracts and fractions tested were found to be non-embryotoxic at the studied concentrations.

**4.3. PLANT PROFILE *OF Ocimum sanctum***

The plants of the genus *Ocimum,* which belong to the family Labiatae, are very significant for their therapeutic potential among the plants recognized for their medicinal use. Ocimum sanctum L. (Labiatae), often known as holy basil, Tulsi, or Tulasi, is a small annual herb with a powerful aroma that can reach a height of 18 inches and develop into a low bush.

**Fig. No: 4. *Ocimum sanctum***

**Scientific classification:**

| | |
|---|---|
| Kingdom | Plantae |
| Order | Lamiales |
| Family | Lamiaceae |
| Genus | Ocimum |
| Species | O. tenuitlarum |
| Binomial name | Ocimum tenuitlarum |

**Vernacular name:**

Tamil: (Tulasi / Thulasi)

Hindi: Tulsi

Sanskrit: Tulasi

English: Holy Basil

Telugu: Tulasi

Kannada: Tulasi

Malayalam: Tulasi

Bengali: Tulsi

**PHARMACOLOGICAL ACTION:**

**Anti inflammatory action:**

*Ocimum sanctum* (3.0 ml/kg) fixed oil presented a statistically independent inhibition of paw edema in both adrenalectomized (AX) and non-adrenalectomized (NAX) rats, producing comparable results to that of phenylbutazone. The oil inhibited multiple phlogistic agents (e.g., histamine, serotonin, prostaglandin E2, bradykinin, hyaluronidase) with the greatest level of inhibition occurring against histamine. In rats with castor oil-induced diarrhea, O. sanctum fixed oil delayed the onset of diarrhea and provided moderate protection when compared to aspirin; however, it failed to exhibit any protective effects when compared to dexamethasone. The O. sanctum fixed oil also inhibited both leukotriene and arachidonic acid-induced inflammation, whilst aspirin and indomethacin did not show such effects. The action of the O. sanctum fixed oil on leukotriene inflammation was comparable to that of lipoxygenase inhibitors such as caffeic acid and cyclooxygenase and lipoxygenase inhibitors, indicating a predominant inhibition of the lipoxygenase pathway.

**4.4. PLANT PROFILE OF *Cassia fistula linn***

The *Cassia fistula Linn.* (Cassia) family Caesalpiniaceae, also known as Amulthus or "Indian Laburnum" in English, is widely used in Ayurvedic medicine to treat a wide range of illnesses. It is found in deciduous and mixed-monsoon forests across most of India, rising to 1300 meters in the outer Himalaya. It is extensively utilized in India's traditional medical system and has been shown to have hepatoprotective, anti-inflammatory, antitussive, antifungal, and antibacterial properties.

**Fig. No: 5. *Cassia fistula linn***

**Scientific classification:**

| | |
|---|---|
| Kingdom | Plantae |
| Subkingdom | Tracheobinota |
| Super Division | Spermatophyta |
| Division | Mangoliophyta |
| Class | Magnoliopsida |
| Sub Class | Rosidae |
| Order | Fabales |
| Family | Fabacae |
| Genus | Cassia |
| Species | fistula |

**Vernacular name:**

Bengali: Bundaralati, Sonalu, Soondali, Sondal

English: Indian Laburnum, Purging Fistula, Cassia, Golden Shower.

Guajarati: Garmala

Hindi: Sonhali, Amultus

Marathi: Bahava

Tamil: Shrakkonnai, Konai, Irjviruttam

**PHARMACOLOGICAL ACTION:**

**Anti-inflammatory action:**

Carrageenan injection produced a significant increase in paw oedema volume in control rats, beginning at 1 h, peaking at 4 h, and persisting up to 24 h. Diclofenac and indomethacin treatment significantly reduced paw oedema from 1 to 8 h ($p < 0.001$) and restored paw volume to near normal by 24 h. ethanolic extract of cassia fistula treatment produced a dose-dependent anti-inflammatory effect, with significant reduction in oedema observed at doses of 500 and 750 mg/kg from 4 h onwards. At higher doses, paw oedema returned toward normal levels at 24 h, comparable to standard drugs, whereas lower doses showed no significant effect.

**4.5. PLANT PROFIFE OF *Lanata cambra***

*Lantana camara.* is a flowering ornamental plant that is a member of the Verbenaceae family. L. Camara was most likely brought to India prior to the 19th century. *L. Camara* is currently found all over India in areas with well-drained slopes and moderate to high summer rainfall. More desirable species may be displaced by the plants when they develop in dense thickets or separately in clusters.The primary weed *Lantana camara* is found in over 60 countries and comes in roughly 650 different varieties.

**Fig. no. 6: *Lanata cambra***

**Scientific classification:**

| | |
|---|---|
| Kingdom | Planate |
| Division | Magnoliophyta |
| Class | Magnoliopsida |
| Order | Lamiales |
| Family | Verbenaceae |
| Genus | Lantana |
| Species | *Lantana camara* |

**Vernacular name:**

English: Lantana Weed

Hindi: Raimuniya

Marathi: Ghaneri, Tantani

Family: Verbenaceae

Plant Form: Shrub

**PHARMACOLOGICAL ACTION**

**Anti-inflammatory activity:**

Carrageenan induced paw edema

Bark and leaf extracts led to a notable reduction in paw edema at doses of 100 and 200 mg/kg ($P < 0.01$, $P < 0.05$) beginning at 2 hours post-administration, with effects lasting for up to 5 hours. The anti-inflammatory effect was observed to be dependent on the dosage.

**4.6. PLANT PROFILE OF *Adenanthera pavonine***

In India it is found in Sub Himalayan tract, ascending upto an altitude of 1,200 meters in Sikkim, West Bengal, Assam, Meghalaya, Gujarat, Maharashtra and South India. It is also found in Peurto Rico, Cuba, Jamaica, Trinidad, Venezuela, Brazil, Costa Rica, Honduras and Southern Florida.

**Fig. No: 7. *Adenanthera pavonine***

**Scientific classification:**

| | |
|---|---|
| Kingdom | Plantae |
| Phylum | Spermatophyta |
| Subphylum | Angiospermae |
| Class | Dicotyledonae |
| Order | Fabales |
| Family | Fabaceae |
| Subfamily | Mimosoideae |
| Genus | Adenanthera |
| Species | pavonina |

**Vernacular names:**

English: False sandalwood, Crab's eyes, Coral wood, Red wood, red .

Hindi: Raktakambal, Manjadi, Anikundumani, Lopa.

Sanskrit: Kunchandana.

Bengali: Rakta kambal.

Telegu: Gurivenda

Tamil: Yanai Kuntamani

Punjabi: Torki

**PHARMACOLOGICAL ACTION:**

**Anti-inflammatory action:**

Ethanolic extract of *Adenanthera pavonine* was found to be safe up to 5000 mg/kg, showing a good safety profile. It significantly reduced inflammation in a dose-dependent manner, with stronger and faster effects at the higher dose. The maximum anti-inflammatory effect observed during the later phase of inflammation suggests that EEAP mainly works by inhibiting prostaglandin production through the cyclooxygenase pathway.

This mechanism was further supported by the delayed onset of castor oil–induced diarrhea, which is closely linked to prostaglandin activity. In the cotton pellet granuloma model, EEAP effectively reduced both fluid accumulation and granuloma formation, indicating its ability to suppress chronic inflammation as well.

**4.7. PLANT PROFILE OF *Boswellia serrata***

*Boswellia serrata* (Kundur), commonly known as Salai guggal, belongs to the family Burseraceae. It is widely distributed in Southern Arabia, West Asia, Oman, Yemen, South Africa, and several parts of India, including the Western Himalayas, Madhya Pradesh, Gujarat, Rajasthan, Bihar, Odisha, and Maharashtra. The plant is a medium-sized deciduous tree with a papery bark that peels easily and exudes a white to yellow aromatic oleo-gum resin upon incision. This resin has a balsamic odor and bitter taste. In Ayurveda, B. serrata resin is traditionally used to treat various inflammatory conditions affecting the skin, eyes, gums, gastrointestinal tract, and respiratory disorders such as asthma, bronchitis, and laryngitis.

**Fig. no: 8. *Boswellia serrata***

**Scientific classification:**

| | |
|---|---|
| Species | Serrata |
| Genus | Boswellia |
| Family | Burseraceae |
| Class | Anacardiales |
| Over class | Rutanae |
| Sub tribe | Rosidae S. lat |
| Tribe | Rosopsida |
| Subdivision | Angiospermae |
| Division | Spermatophyte |

**Vernacular name:**

English - Indian frankincense

Hindi - Salai, Kundur

Gujarati - Gugali, Dhup

Malayalam - Saambraani, Parangi

Telugu - Saambraani, Phirangi

Sanskrit - Kunduru, Ashvamurti,

Tamil - Saambraani, Parangi

Kannada - Guguladhuph, Chitta

**Pharmacological Action:**

**Anti-Inflammatory action:**

The carrageenan-induced paw edema model effectively demonstrates acute inflammation and is widely used for screening anti-inflammatory agents. The present findings confirm that Boswellia serrata significantly reduces paw edema and inflammatory cell infiltration in a dose-dependent manner. Its anti-inflammatory action is likely mediated through inhibition of inflammatory mediators and leukotriene synthesis. These results support B. serrata as a promising herbal anti-inflammatory agent with potential therapeutic value and fewer side effects compared to conventional drugs.

**4.8. PLANT PROFILE OF *Mikania cordata:***

*Mikania cordata* is Fast-growing perennial creeping/climbing herb. Stem of the herb Slender, green, twining, slightly hairy. Flowers are Small, white to pale green.

Arranged in terminal or axillary panicles and the odour of the herb Characteristic smell when crushed.

**Fig. No: 9. *Mikania cordata***

**Scientific classification:**

| | |
|---|---|
| Kingdom | Plantae |
| Division | Angiosperms |
| Class | Eudicots |
| Order | Asterales |
| Family | Asteraceae |
| Genus | Mikania |
| Species | Mikania cordata |

**Vernacular name:**

Tamil: Climbing Hemp Weed / American kodi (usage varies locally)

English: Climbing hemp weed

Hindi: German bel

Bengali: Assam lota

Malayalam: Vathakodi

**PHARMACOLOGICAL ACTION:**

**Anti-inflammatory action:**

*Mikania species (MC = Mikania cordata, MM = Mikania micrantha, MS = Mikania scandens)* exhibited concentration-dependent anti-inflammatory activity, with increasing protection at higher concentrations. In the heat-induced RBC haemolysis assay, MC showed higher inhibition than MM and MS at both 31.25 and 500 µg/ml, though aspirin remained the most effective. Similarly, in the hypotonic solution-induced RBC membrane stabilization test, MC demonstrated superior activity among the plant extracts and showed activity comparable to aspirin at lower concentrations. Overall, the anti-inflammatory activity followed the order: Aspirin > MC > MM > MS.

**Conclusion:**

The current review emphasizes the anti-inflammatory property of different medicinal plant extracts. The plants reviewed showed a substantial decrease in the inflammatory response in various models, such as acute and chronic inflammation, which was observed to be concentration and dose-dependent in most of the studies. The anti-inflammatory activity is ascribed to the presence of bioactive phytochemicals like flavonoids, alkaloids, glycosides, phenolic compounds, and terpenoids, which work through mechanisms like the inhibition of inflammatory mediators, antioxidant properties, and stabilization of biological membranes. The review thus supports the use of medicinal plants as a potential source of anti-inflammatory agents based on experimental evidence.

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