World Journal of Pharmaceutical and Life Sciences

www.wjpls.org

Impact Factor: 7.409 Coden USA: WJPLA7

A REVIEW: ANTI-INFLAMMATORY ACTIVITY OF HERBAL PLANTS

Siddhika Anil Phadtare*, Akanksha Dilip Thorat, Pawar Rutuja Rajendra, Prof. Rutuja Dattatray Shitole

India.

***Corresponding Author: Siddhika Anil Phadtare**
India.
DOI: https://doi.org/10.5281/zenodo.17748076

How to cite this Article: Siddhika Anil Phadtare*, Akanksha Dilip Thorat, Pawar Rutuja Rajendra, Prof. Rutuja Dattatray Shitole (2025). A REVIEW: ANTI-INFLAMMATORY ACTIVITY OF HERBAL PLANTS World Journal of Pharmaceutical and Life Science, 11(12), 26-32.

Article Received on 22/10/2025 **Article Revised on 12/11/2025** **Article Published on 01/12/2025**

ABSTARCT

Medicinal plants and their secondary metabolites are increasingly used as complementary medicines for inflammatory conditions. Inflammation underlies a wide range of diseases, including rheumatic disorders, autoimmune conditions, diabetes, and cardiovascular diseases. Conventional anti-inflammatory drugs, such as non-steroidal anti- inflammatory drugs (NSAIDs) and corticosteroids, are associated with significant adverse effects, necessitating the search for safer and effective alternatives. This review highlights herbal extracts, formulations, and phytochemicals— particularly from Indian Medicinal Plants (IMP)—with proven anti-inflammatory activity (AIA). Key phytochemical classes, including alkaloids, glycosides, flavonoids and terpenoids, exert their effects through multiple mechanisms, including selective COX-2 inhibition, NF-κB suppression, and cytokine modulation. Clinical evidence supports the efficacy of herbs such as Curcuma longa, Boswellia serrata, and Zingiber officinale in disorders like rheumatoid arthritis (RA) and osteoarthritis (OA).

KEYWORDS: Anti-inflammatory activity, Medicinal plants, Phytochemicals, Herbal medicine, Natural products, Flavonoids, Phenolic compounds, Traditional medicine.

INTRODUCTION

Inflammation is a complex biological response of vascular tissues to harmful stimuli, pathogens serving as a protective mechanism to remove injurious stimuli and initiate healing. If uncontrolled, inflammation can lead to tissue damage and chronic conditions such as RA and atherosclerosis. Acute inflammation is characterized by redness, warmth, swelling, pain, and loss of function. Key mediators include kinins, prostaglandins, and histamine, while cyclooxygenase (COX) enzymes mediate prostaglandin synthesis. Nitric oxide (NO), produced via inducible nitric oxide synthase (NOS), also plays a crucial role.

Conventional therapies such as NSAIDs and corticosteroids inhibit COX activity but are associated with adverse effects such as gastric ulcers, gastrointestinal bleeding, renal impairment, hepatotoxicity, and increased cardiovascular risk. Approximately 80% of the global population still relies on plant-based medicines for primary health.

MECHANISM OF ACTION

1. Inhibition of Pro-Inflammatory Enzymes

Inflammation is largely mediated by arachidonic acid metabolism through cyclooxygenase (COX) and lipoxygenase (LOX) pathways.

COX enzymes convert arachidonic acid into prostaglandins, which are responsible for pain, swelling, and fever.

LOX enzymes produce leukotrienes, which mediate bronchoconstriction and immune cell recruitment.

Herbal drugs like Curcuma longa (curcumin) and Glycyrrhiza glabra (glycyrrhizin) have been reported to inhibit these enzymes, thereby reducing prostaglandin and leukotriene production.

2. Suppression of Pro-Inflammatory Cytokines

Cytokines such as tumor necrosis factor- alpha (TNF-α), interleukin-1 beta (IL-1β), and interleukin-6 (IL-6) are central regulators of acute and chronic inflammation.

Overproduction of these cytokines contributes to arthritis, asthma, inflammatory bowel disease, and neuroinflammation.

Herbal constituents suppress cytokine production, leading to downregulation of inflammatory cascades

3. Modulation of Transcription Factors

Nuclear factor kappa B (NF-κB) and activator protein-1 (AP-1) are key transcription factors that regulate the expression of pro-inflammatory genes.

Activation of NF-κB leads to increased synthesis of cytokines, chemokines, adhesion molecules, and inflammatory enzymes (COX-2, iNOS).

Herbal agents like curcumin, resveratrol (Vitis vinifera), and boswellic acids (Boswellia serrata) block NF-κB and AP-1 activation, reducing inflammatory gene expression.

4. Antioxidant Activity

Oxidative stress triggers inflammation by damaging cell membranes, DNA, and proteins.

Reactive oxygen species (ROS) activate signaling pathways such as MAPK and NF- κB, amplifying inflammation.

Herbal antioxidants such as polyphenols, tannins, and flavonoids scavenge free radicals, enhance endogenous antioxidant enzymes (SOD, catalase, glutathione peroxidase), and protect tissues from oxidative damage.

Example: Quercetin (Allium cepa, onions) is a potent ROS scavenger with proven anti-inflammatory effects.

5. Stabilization of Cell Membranes

During inflammation, lysosomal membranes rupture, releasing hydrolytic enzymes that damage tissues. Herbal drugs stabilize these membranes, reducing enzyme leakage.

Sr.No	Scientific name	Synonym	Common Name	Part used	Mechanism of action
1	Zingiber officinale	Shunthi, Adraka	Ginger	Rhizome	Inhibits COX and LOX → ↓ prostaglandins & leukotrienes; antioxidant & anti-inflammatory
2	Curcuma longa	Haridra, Haldi	Turmeric	Rhizome	Curcumin inhibits NF- κB, COX-2, NOS; strong antioxidant & cytokine suppression
3	Salix alba	Nature's aspirin	Willow Bark	Bark	Contains salicin → metabolized to salicylic acid → inhibits COX → ↓ prostaglandins
4	Camellia sinensis	Thea sinensis	Green Tea	Leaves	EGCG suppresses NF- κB, scavenges ROS, inhibits inflammatory cytokines
5	Withania somnifera	Ashwagandha, Indian ginseng	Ashwagandha	Roots, Leaves	Withanolides inhibit NF-κB, COX-2, iNOS; immunomodulatory & antioxidant
6	Daphne pontica Linn.	Garland Flower	Daphne	Leaves, bark	Contains flavonoids & coumarins → anti-inflammatory via NF- κB inhibition
7	Bacopa monnieri Linn.	Brahmi, Jalabrahmi	Bacopa	Whole plant	Bacosides act as antioxidants, reduce ROS, modulate neurotransmitters & inflammation
8	Adhatoda vasica	Vasaka, Malabar nut	Vasaka	Leaves	Alkaloids (vasicine) inhibit histamine release, bronchodilator, anti- inflammatory
9	Ocimum sanctum	Tulasi, Holy Basil	Tulsi	Leaves	Eugenol inhibits COX & LOX, reduces cytokines, antioxidant & immunomodulatory
10	Aloe vera	Ghritkumari, Kumari	Aloe	Leaves (gel, latex)	Polysaccharides reduce TNF-α & IL-1β, promote healing, antioxidant

- **Turmeric**

Active Constituents

The rhizome of turmeric is rich in curcuminoids, primarily curcumin, demethoxycurcumin, and bisdemethoxycurcumin. It also contains volatile oils such as turmerone, atlantone, and zingiberene.

Mechanism of Action

Turmeric exerts its anti-inflammatory activity through multiple pathways. It inhibits the cyclooxygenase (COX-2) and lipoxygenase (LOX) enzymes, leading to reduced synthesis of prostaglandins and leukotrienes. It also downregulates the nuclear factor-κB (NF-κB) signaling pathway, there by decreasing the expression of pro-inflammatory cytokines including TNF-α, IL-1β, and IL-6. Additionally, turmeric suppresses inducible nitric oxide synthase (NOS), which lowers the production of nitric oxide, a mediator of inflammation.

- **Ginger**

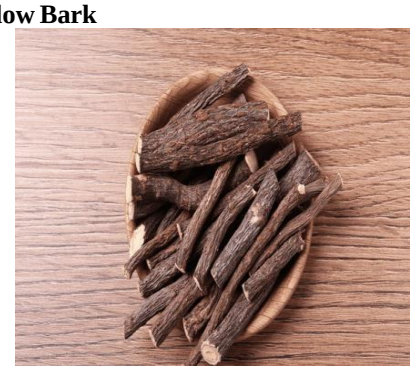
Active Constituents

The rhizome of ginger contains several bioactive compounds, including gingerols, shogaols, paradols, and zingerone.

Mechanism of Action

Ginger exerts anti-inflammatory activity through multiple pathways. It inhibits cyclooxygenase (COX) and lipoxygenase (LOX) enzymes, resulting in decreased synthesis of prostaglandins and leukotrienes. It also suppresses the activation of nuclear factor-κB (NF-κB), thereby reducing the production of pro- inflammatory cytokines such as tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), and interleukin-6 (IL-6). In addition, ginger decreases the expression of inducible nitric oxide synthase (NOS), leading to reduced nitric oxide-mediated inflammation. Its antioxidant properties further contribute by protecting tissues.

- **Willow Bark**



Active Constituents
Willow bark contains salicin, which is metabolized in the body to salicylic acid. In addition, it possesses flavonoids and polyphenolic compounds that contribute to its pharmacological activity.

Mechanism of Action
The salicylic acid formed from salicin inhibits cyclooxygenase (COX) enzymes, leading to decreased synthesis of prostaglandins that are responsible for pain, fever, and inflammation. Flavonoids and polyphenols further enhance the anti- inflammatory effect through their antioxidant properties, which help reduce free radical–induced tissue injury. The overall suppression of inflammatory mediators also decreases the recruitment of immune cells to inflamed sites, thereby reducing tissue inflammation.

- **Green Tea**

Active Constituents
Green tea is rich in catechins, among which epigallocatechin gallate (EGCG) is the most active, followed by epicatechin gallate (ECG), epigallocatechin (EGC), and epicatechin (EC). It also contains flavonoids such as quercetin and kaempferol, along with small amounts of caffeine.

Mechanism of Action
The anti-inflammatory activity of green tea is attributed to several mechanisms.

Catechins inhibit the activation of nuclear factor-κB (NF-κB), leading to a reduction in the production of pro-inflammatory cytokines including tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), and interleukin-6 (IL-6). Green tea constituents also block cyclooxygenase-2 (COX-2) and lipoxygenase (LOX) enzymes, resulting in decreased synthesis of prostaglandins and leukotrienes. Their antioxidant properties enable scavenging of reactive oxygen species (ROS), thereby protecting against oxidative stress–induced inflammation. In addition, green tea modulates immune function by regulating the activity of T- cells and macrophages.

- **Ashwagandha**

Active Constituents
Withania somnifera contains withanolides (Withaferin A, Withanolide D, E), alkaloids (anaferine, cuscohygrine), and saponins, which are responsible for its pharmacological effects.

Mechanism of Action
Cytokine inhibition: Suppresses TNF-α, IL-1β, and IL-6 via NF-κB inhibition.

Enzyme inhibition: Reduces prostaglandin and leukotriene synthesis by blocking COX-2 and LOX.

Antioxidant effect: Scavenges reactive oxygen species (ROS).

Immunomodulation: Regulates T-cells and macrophage activity.

Nitric oxide reduction: Inhibits NOS, lowering nitric oxide levels.

- **Daphne Pontica linn**

Active Constituents
Daphnetin (7,8-dihydroxycoumarin) is the major anti-inflammatory compound, supported by its glucoside daphnin and steroidal lactones such as withanolides.

Mechanism of Action
These constituents act by inhibiting pro- inflammatory cytokines (TNF-α, IL-1β, IL-6), suppressing NF-κB signaling, scavenging reactive oxygen species, and blocking COX/LOX enzymes, thereby reducing prostaglandin and leukotriene synthesis.

Furthermore, inhibition of cyclooxygenase (COX) and lipoxygenase (LOX) enzymes decreases the synthesis of prostaglandins and leukotrienes, which are key mediators of the inflammatory response.

Bacopa Monnieri Linn

Active Constituents
Bacosides (A and B): Major bioactive saponins Bacopasaponins
Alkaloids: Brahmine, herpestine
Flavonoids/Polyphenols: Quercetin, apigenin, luteolin

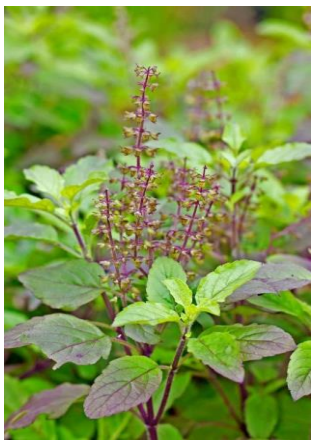
Mechanism of Action
Suppresses pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6
Inhibits NF-κB signaling pathway
Exhibits antioxidant activity by scavenging reactive oxygen species (ROS)
Inhibits cyclooxygenase (COX) and lipoxygenase (LOX) enzymes
Modulates immune cell functions, including macrophages and T-lymphocytes

Adhatoda vasica

Active Constituents
Vasicine: Major quinazoline alkaloid
Vasicinone: Oxidized derivative of vasicine
Other alkaloids: Minor quinazoline compounds Flavonoids and tannins

Mechanism of Action
Suppresses pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6
Inhibits NF-κB signaling pathway
Exhibits antioxidant activity by scavenging reactive oxygen species (ROS)
Inhibits cyclooxygenase (COX) and lipoxygenase (LOX) enzymes
Modulates immune cell functions, including macrophages and lymphocytes

- **Tulsi**



Active Constituents
Eugenol: Major phenolic compound Ursolic acid: Triterpenoid Rosmarinic acid: Polyphenol
Other compounds: Linalool, carvacrol, apigenin, luteolin, flavonoids, tannins.

Mechanism of Action
Suppresses pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6
Inhibits NF-κB signaling pathway Exhibits antioxidant activity by scavenging reactive oxygen species (ROS)
Inhibits cyclooxygenase (COX) and lipoxygenase (LOX) enzymes
Modulates immune cell functions, including macrophages and lymphocytes

- **Aloevera**

Active Constituents Anthraquinones: Aloin, emodin Polysaccharides: Acemannan Flavonoids: Luteolin, quercetin Saponin
Sterols: Lophenol, cycloartanol

Mechanism of Action
Suppresses pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6
Inhibits NF-κB signaling pathway
Exhibits antioxidant activity by scavenging reactive oxygen species (ROS)
Inhibits cyclooxygenase (COX) and lipoxygenase (LOX) enzymes
Modulates immune cell functions, particularly macrophages

- **Neem**

Active Constituents
Limonoids: Azadirachtin, nimbin, nimbidin
Flavonoids: Quercetin, catechin Tannins
Polysaccharides and sterols

Mechanism of Action
Suppresses pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6
Inhibits NF-κB signaling pathway
Exhibits antioxidant activity by scavenging reactive oxygen species (ROS)
Inhibits cyclooxygenase (COX) and lipoxygenase (LOX) enzymes
Modulates immune cell functions, including macrophages and lymphocytes

- **Moringa oleifera**

Active Constituents
Isothiocyanates
Flavonoids: Quercetin, kaempferol Phenolic acids: Chlorogenic acid Alkaloids: Niazimicin
Sterols and saponin.

Mechanism of Action
Suppresses pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6
Inhibits NF-κB signaling pathway
Exhibits antioxidant activity by scavenging reactive oxygen species (ROS)
Inhibits cyclooxygenase (COX) and lipoxygenase (LOX) enzymes
Modulates immune cell functions, including macrophages and lymphocytes.

REFERENCES

1. Journal of Chemical Health Risks Hemalatha S., Nirmalkumar G., Priya S., Mahalakshmi K., Kabilan D., Logeshwari N. — Herbal Medicinal Plants with Anti- inflammatory Properties: A Comprehensive Review, 2024; 14(4).
2. Journal of Pharmacognosy & Phytochemistry — Shingala Z., Chauhan B., Baraiya J. — A review on medicinal plants as a source of anti-inflammatory agents, 2021; 10(6): 364-371.
3. Pharmacognosy Reviews — Banik B., Das S., Das M.K. — Medicinal Plants with Potent Anti-inflammatory and Anti-arthritic Properties found in Eastern Parts of the Himalaya: An Ethnomedicinal Review, 2021; 14(28): 121-137.
4. Open Access Journal of Pharmaceutical Research — Reddy I.K., Yerragopu A.K., ChamarthiS.K. — A Review on Plants having Anti-Inflammatory Activity, 2020; 4(4).
5. Mediterranean Journal of Pharmacy & Pharmaceutical Sciences — Akhlaq M., Alum M.K., Alam M.M. Anti-inflammatory potential of medicinal plants, 2022; 2(1): 13-21, (approx.).
6. Journal of Pharmaceutical Research International — Alam F., Amin R., Dey B.K. — A Comprehensive Review on Natural Products and Anti-Inflammatory Activity, 2021; 33(7): 57-77.
7. Journal of Ayurveda and Integrated Medical Sciences — Gupta P., Tiwari S. — A Summarize Review of Few Plants: Its Anti- Inflammatory Properties due to Their Phytochemical Components.
8. Emerging Trends in Metabolites — Wasiullah M., Yadav P., Ahsan A. A Review Article on Spice Up The Solution of Inflammation Through Phytomedicines, (2024).
9. Iranian Journal of Basic Medical Sciences — Ghasemian M., Owlia S., Owlia M.B. — Review of Anti- Inflammatory Herbal Medicine.
10. Journal of Pharmacognosy & Phytochemistry — Virshette S.J., Patil M.K., Somkuwar A.P. — A review on medicinal plants used as anti-inflammatory agents, 8(4).
11. Molecules (MDPI) — Jin Y. X., et al. — "A review on daphnane-type diterpenoids and their biological activities (anti- inflammatory/anticancer)." 2019;

24(9): 1842.
12. Pharmacognosy Reviews — Kuruvalli G., et al. — "Phytochemistry and anti- inflammatory activities of Bacopa monnieri." Pharmacogn Rev., 2023; 17(34).
13. MDPI / Cosmetics — Baby A. R., et al. — "Azadirachta indica (Neem) as a potential natural active for cosmetics — pharmacology & anti-inflammatory effects," 2022; 9(3): 58.
14. Biochemical Pharmacology — Singh B. N., Shankar S., Srivastava R. K. — "Green tea catechin, epigallocatechin-3-gallate (EGCG): mechanisms, perspectives and clinical applications.", 2011; 82(12): 1807–1821.
15. Antioxidants / MDPI — Mokra D.et al. — "EGCG: anti-inflammatory and therapeutic potentials in respiratory and inflammatory diseases." 11(8): 1566 (2022). Plants (MDPI) — Chiş A., et al. — "Bioactive compounds in Moringa oleifera: mechanisms of anti- inflammatory action," 2023; 13(1): 20.
16. International Journal of Pharmaceutical Compounds / review — Pareek A., et al. — "Moringa oleifera: an updated comprehensive review of its pharmacology including anti-inflammatory effects," 2023; PMC. 18.