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Review Article

Herbal Medicines as Anti-Inflammatory Agents: A Comprehensive Review

Neha Devi*, Ritunja Singh, Dr. Arpita Singh

Seth Vishambhar Nath Institute of Pharmacy, Dewa Road, Barabanki

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ABSTRACT

Inflammation is a fundamental biological response triggered by harmful stimuli, including pathogens, damaged tissues, or irritants. Although acute inflammation is a protective process necessary for tissue repair and immune defense, persistent or chronic inflammation is associated with a wide range of diseases such as rheumatoid arthritis, cardiovascular disorders, neurodegenerative diseases, and cancer. Conventional anti-inflammatory therapies, including corticosteroids and non-steroidal anti-inflammatory drugs (NSAIDs), are commonly used but are often limited by adverse effects and long-term toxicity. As a result, increasing attention has been directed toward herbal medicines as potential alternatives or complementary agents for managing inflammation. Herbal remedies have been traditionally employed in various medicinal systems like Ayurvedic, Traditional Chinese Medicine, and Unani. These natural therapies contain bioactive Phytoconstituents such as flavonoids, alkaloids, terpenoids, and polyphenols that exert anti-inflammatory effects through multiple mechanisms. These include inhibition of pro-inflammatory enzymes (e.g., COX, LOX), modulation of cytokine production, and suppression of inflammatory signaling pathways like NF- κ B and MAPKs. This review explores several prominent medicinal plants—including Curcuma longa, Zingiber officinale, Boswellia serrata, and Withania somnifera—focusing on their phytochemical profiles, mechanisms of action, and therapeutic potential.

INTRODUCTION

Definition and causes: Inflammation is defined as the local response of living mammalian tissues to injury due to any agent. It is a body defense

reaction in order to eliminate or limit the spread of injurious agent, followed by removal of the necrosed cells and tissues.

The agents causing inflammation may be as under:

*Corresponding Author: Neha Devi

Address: Seth Vishambhar Nath Institute of Pharmacy, Dewa Road, Barabanki.

Email ✉: nd158737@gmail.com

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1. Infective agents like bacteria, viruses and their toxins, fungi, parasites.
2. Immunological agents like cell-mediated and antigen antibody reactions.
3. Physical agents like heat, cold, radiation, mechanical trauma.
4. Chemical agents like organic and inorganic poisons.
5. Inert materials such as foreign bodies.

Thus, inflammation is distinct from infection—while inflammation is a protective response by the body to variety of etiologic agents (infectious or non-infectious), while infection is invasion into the body by harmful microbes and their resultant ill effects by toxins. Inflammation involves 2 basic processes with some overlapping, viz. early inflammatory response and later followed by healing. Though both these processes generally have protective role against injurious agents, inflammation and healing may cause considerable harm to the body as well e.g. anaphylaxis to bites by insects or reptiles, drugs, toxins, atherosclerosis, chronic rheumatoid arthritis, fibrous bands and adhesions in intestinal obstruction (Harshmohan, 2010).

Signs of inflammation

The Roman writer Celsus in named the famous 4 cardinal signs of inflammation as:

- Rubor (redness)
- Tumor (swelling)
- Calor (heat)
- Dolor (pain).

To these, fifth sign *functio laesa* (loss of function) was later added by Virchow. The word inflammation means burning. This nomenclature had its origin in old times but now we know that burning is only one of the signs of inflammation.

Types of inflammation (Harshmohan, 2010)

Depending upon the defense capacity of the host and duration of response, inflammation can be classified as acute and chronic.

A. Acute inflammation: Is of short duration (lasting less than 2 weeks) and represents the early body reaction, resolves quickly and is usually followed by healing. The main features of acute inflammation are:

1. Accumulation of fluid and plasma at the affected site;
2. Intravascular activation of platelets; and
3. Polymorph nuclear neutrophils as inflammatory cells.

Sometimes, the acute inflammatory response may be quite severe and is termed as fulminant acute inflammation

Table1 Mediators of acute inflammation (Harshmohan, 2010):

Mediators	Vasodilation	Vascular permeability	Chemotaxis	Pain
Histamine	++	+++	-	-
Serotonin	+	+	-	-
Bradykinin	+++	+	-	+++
Prostaglandin	+++	+	+++	+
Leukotrienes	-	+++	+++	-

(+++ severe, ++ moderate, + mild, - absent)

B. Chronic inflammation: Is of longer duration and occurs either after the causative agent of acute inflammation persists for a long time, or the stimulus is such that it induces chronic inflammation from the beginning. A variant, chronic active inflammation is the type of chronic

inflammation in which during the course of disease there are acute exacerbations of activity.

The characteristic feature of chronic inflammation is presence of chronic inflammatory cells such as lymphocytes, plasma cells and macrophages, granulation tissue formation, and in specific situations as granulomatous inflammation. In

some instances, the term subacute inflammation is used for the state of inflammation between acute and chronic.

Table2. Mediators of chronic inflammation (Harshmohan, 2010)

Mediators	Sources	Primary effects
IL-1, IL-2, IL-3	Macrophages, T-lymphocytes	Lymphocyte activation, prostaglandin production
GM-CSF	T-lymphocytes, endothelial cells, fibroblast	Macrophages and granulocyte activation
TNF- α	Macrophages	Prostaglandin
Interferons	Macrophages, endothelial cells, Tlymphocytes	Many
PDGF	Macrophages, endothelial cells, fibroblast, platelets	Fibroblast chemotaxis, proliferation

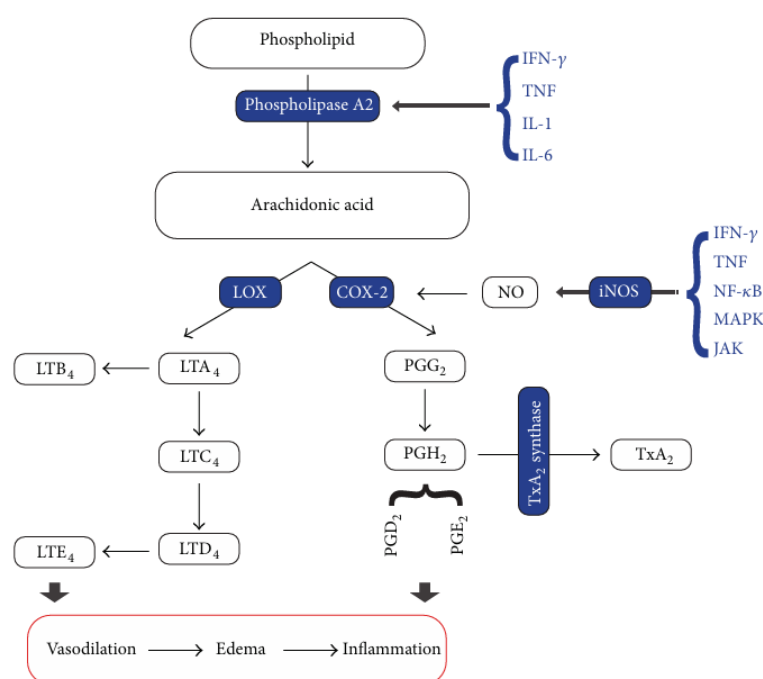


Figure 1: Inflammation Pathway

ROLE OF HERBAL MEDICINES IN INFLAMMATION

Inflammation is a complex biological response to harmful stimuli, such as pathogens, damaged cells, or irritants. While acute inflammation is a protective mechanism, chronic inflammation is implicated in various diseases, including arthritis, cardiovascular disorders, and neurodegenerative conditions. Conventional anti-inflammatory drugs, like non-steroidal anti-inflammatory drugs

(NSAIDs) and corticosteroids, are effective but often associated with adverse effects, prompting the exploration of alternative therapies.

Herbal medicines have been utilized for centuries across different cultures to manage inflammatory conditions. These natural remedies contain a plethora of bioactive compounds, such as flavonoids, alkaloids, terpenoids, and phenolic acids, which exhibit anti-inflammatory properties. The mechanisms by which these phytochemicals exert their effects include the inhibition of pro-

inflammatory enzymes (e.g., cyclooxygenase and lipoxygenase), suppression of cytokine production, and modulation of signaling pathways like nuclear factor-kappa B (NF- κ B) and mitogen-activated protein kinases (MAPKs). For instance, curcumin from *Curcuma longa* (turmeric) has been shown to inhibit NF- κ B activation, thereby reducing the expression of inflammatory cytokines. Similarly, boswellic acids from *Boswellia serrata* inhibit 5-lipoxygenase, leading to decreased leukotriene synthesis. These examples underscore the potential of herbal medicines as effective anti-inflammatory agents. Moreover, the integration of herbal medicines into modern therapeutic regimens offers a complementary approach, potentially enhancing efficacy and reducing the dosage requirements of conventional drugs, thereby minimizing side effects. However, it is imperative to conduct rigorous clinical trials to validate the safety and efficacy of these herbal remedies. Standardization of herbal extracts, understanding herb-drug interactions, and elucidating precise mechanisms of action are crucial steps toward their acceptance in mainstream medicine.

MAJOR HERBAL PLANTS WITH ANTI-INFLAMMATORY ACTIVITY

Herbal medicines have been integral to traditional healing systems worldwide, offering a plethora of bioactive compounds that exhibit anti-inflammatory properties. The following section highlights several medicinal plants renowned for their anti-inflammatory effects, detailing their active constituents and mechanisms of action.

1. *Curcuma longa* (Turmeric)

Turmeric, a staple in Ayurvedic medicine, contains curcumin as its principal active compound. Curcumin has been extensively studied for its ability to inhibit key inflammatory

mediators, including nuclear factor-kappa B (NF- κ B), cyclooxygenase-2 (COX-2), and various cytokines. These actions contribute to its efficacy in managing conditions like arthritis and inflammatory bowel disease.

2 *Zingiber officinale* (Ginger)

Ginger is rich in bioactive compounds such as gingerols and shogaols, which have demonstrated significant anti-inflammatory effects. These constituents modulate inflammatory pathways by suppressing prostaglandin synthesis and inhibiting the activation of NF- κ B, thereby reducing inflammation and associated pain.

3 *Boswellia serrata* (Indian Frankincense)

The resin of *Boswellia serrata* contains boswellic acids, which are known to inhibit 5-lipoxygenase (5-LOX), an enzyme involved in leukotriene synthesis. By blocking this pathway, boswellic acids help in alleviating inflammatory conditions such as osteoarthritis and rheumatoid arthritis.

4 *Withania somnifera* (Ashwagandha)

Ashwagandha, a prominent adaptogen in traditional medicine, exhibits anti-inflammatory properties through its withanolide content. These compounds suppress pro-inflammatory cytokines and modulate immune responses, contributing to reduced inflammation and enhanced resilience to stress.

5 *Glycyrrhiza glabra* (Licorice)

Licorice root contains glycyrrhizin, a saponin glycoside that exerts anti-inflammatory effects by inhibiting the release of reactive oxygen species and suppressing the expression of pro-inflammatory genes. Its application spans various inflammatory disorders, including respiratory and gastrointestinal conditions.



6 *Centella asiatica* (Gotu Kola)

Centella asiatica is rich in triterpenoids like asiaticoside and madecassoside, which have been shown to possess anti-inflammatory and wound-healing properties. These compounds modulate collagen synthesis and reduce inflammatory responses, making the plant valuable in dermatological applications.

7 *Eucalyptus globulus* (Eucalyptus)

Eucalyptus leaves contain eucalyptol (1,8-cineole), a Monoterpenoid with notable anti-inflammatory and analgesic properties. Eucalyptol acts by inhibiting cytokine production and reducing oxidative stress, thereby alleviating symptoms in conditions like bronchitis and sinusitis.

Phytoconstituents Involved in Anti-Inflammatory Activity

Medicinal plants are rich in diverse Phytoconstituents that exhibit significant anti-inflammatory properties. Key classes of these bioactive compounds include:

- **Flavonoids:** These polyphenolic compounds, such as quercetin and kaempferol, are known to inhibit pro-inflammatory enzymes and cytokines, thereby modulating inflammatory responses.
- **Alkaloids:** Compounds like berberine have demonstrated the ability to suppress inflammatory mediators, contributing to their anti-inflammatory effects.
- **Terpenoids:** This class includes monoterpenes and sesquiterpenes, which can interfere with inflammatory signaling pathways, reducing inflammation.
- **Polyphenols:** These compounds, including resveratrol, possess antioxidant properties that help in mitigating oxidative stress-induced inflammation.

These Phytoconstituents act through various mechanisms, such as inhibition of cyclooxygenase (COX) and lipoxygenase (LOX) enzymes, suppression of nuclear factor-kappa B (NF- κ B) activation, and modulation of cytokine production.

MECHANISMS OF ACTION

Herbal anti-inflammatory agents exert their effects through multiple biochemical pathways:

1. **Enzyme Inhibition:** Many phytochemicals inhibit COX and LOX enzymes, leading to reduced synthesis of pro-inflammatory mediators like prostaglandins and leukotrienes.
2. **Cytokine Modulation:** Herbal compounds can down regulate the production of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF- α) and interleukins (e.g., IL-1 β , IL-6), thereby attenuating inflammatory responses.
3. **Signal Transduction Pathways:** Phytoconstituents often interfere with signaling pathways like NF- κ B and mitogen-activated protein kinases (MAPKs), which play crucial roles in the expression of inflammatory genes.
4. **Antioxidant Activity:** By scavenging reactive oxygen species (ROS), these compounds reduce oxidative stress, which is a key contributor to chronic inflammation.

ADVANTAGES AND LIMITATIONS OF HERBAL ANTI-INFLAMMATORIES

Advantages:

1. **Multifaceted Action:** Herbal medicines often contain a combination of active compounds that work synergistically to modulate various aspects of the inflammatory process.
2. **Reduced Side Effects:** Compared to synthetic drugs, herbal remedies are generally



associated with fewer adverse effects, making them suitable for long-term use.

3. **Accessibility:** In many regions, medicinal plants are readily available and affordable, providing an accessible option for managing inflammation.

Limitations:

- **Variability in Composition:** The concentration of active constituents in herbal preparations can vary due to factors like plant species, growing conditions, and processing methods, leading to inconsistent therapeutic effects.
- **Lack of Standardization:** There is often a lack of standardized dosing and quality control in herbal products, which can affect their safety and efficacy.
- **Limited Clinical Evidence:** While many herbal compounds show promise in preclinical studies, there is a need for more rigorous clinical trials to substantiate their therapeutic benefits and safety profiles.

CONCLUSION

Herbal medicines offer a promising alternative for managing inflammation due to their rich phytochemical content and multifaceted mechanisms of action. Compounds such as flavonoids, terpenoids, alkaloids, and polyphenols exhibit significant anti-inflammatory effects by modulating cytokines, inhibiting pro-inflammatory enzymes, and suppressing oxidative stress. While traditional use and preclinical studies support their therapeutic potential, clinical evidence and standardization remain critical challenges. Further scientific validation through controlled trials is essential to establish their safety, efficacy, and integration into modern healthcare. Overall, botanical therapeutics represent a valuable and largely untapped resource in the treatment of inflammation-related disorder.

REFERENCES

1. Harshmohan. (2010) "Textbook of Pathology" 6th edition, Jaypee Brothers Medical Publishers (P) Ltd.
2. Ghasemian M, Owlia S, Owlia MB. Review of anti - inflammatory herbal medicines. *Advances in Pharmacological and Pharmaceutical Sciences*. 2016;2016(1):9130979.
3. Hewlings SJ, Kalman DS. Curcumin: A review of its effects on human health. *Foods*. 2017 Oct;6(10):92.
4. Daily JW, Zhang X, Kim DS, Park S. Efficacy of ginger for alleviating the symptoms of primary dysmenorrhea: a systematic review and meta-analysis of randomized clinical trials. *Pain Medicine*. 2015 Dec 1;16(12):2243-55.
5. Ammon HP. Boswellic acids and their role in chronic inflammatory diseases. *Anti-inflammatory Nutraceuticals and Chronic Diseases*. 2016:291-327.
6. Dar NJ, Hamid A, Ahmad M. Pharmacologic overview of *Withania somnifera*, the Indian Ginseng. *Cellular and molecular life sciences*. 2015 Dec;72:4445-60.
7. Pastorino, G., Cornara, L., Soares, S., Rodrigues, F., & Oliveira, M. B. P. P. (2018). Liquorice (*Glycyrrhiza glabra*): A phytochemical and pharmacological review. *Phytotherapy Research*, 32(12), 2323–2339.
8. James JT, Dubery IA. Pentacyclic triterpenoids from the medicinal herb, *Centella asiatica* (L.) Urban. *Molecules*. 2009 Oct 9;14(10):3922-41.
9. Juergens UR. Anti-inflammatory properties of the monoterpene 1,8-cineole: current evidence for co-medication in inflammatory airway diseases. *Drug research*. 2014 Dec;64(12):638-46.



10. Nunes CD, Barreto Arantes M, Menezes de Faria Pereira S, Leandro da Cruz L, de Souza Passos M, Pereira de Moraes L, Vieira IJ, Barros de Oliveira D. Plants as sources of anti-inflammatory agents. *Molecules*. 2020 Aug 15;25(16):3726.
11. Wu Z, Zhang T, Ma X, Guo S, Zhou Q, Zahoor A, Deng G. Recent advances in anti-inflammatory active components and action mechanisms of natural medicines. *Inflammopharmacology*. 2023 Dec;31(6):2901-37.
12. Ansari P, Reberio AD, Ansari NJ, Kumar S, Khan JT, Chowdhury S, Abd El-Mordy FM, Hannan JM, Flatt PR, Abdel-Wahab YH, Seidel V. Therapeutic Potential of Medicinal Plants and Their Phytoconstituents in Diabetes, Cancer, Infections, Cardiovascular Diseases, Inflammation and Gastrointestinal Disorders. *Biomedicines*. 2025 Feb 12;13(2):454.
13. Gonfa YH, Tessema FB, Bachheti A, Rai N, Tadesse MG, Singab AN, Chaubey KK, Bachheti RK. Anti-inflammatory activity of phytochemicals from medicinal plants and their nanoparticles: A review. *Current Research in Biotechnology*. 2023 Jan 1;6:100152

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