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THERAPEUTIC POTENTIAL OF ANTI-INFLAMMATORY MEDICINAL PLANTS: EVIDENCE FROM PHYTOCHEMISTRY AND EXPERIMENTAL STUDIES

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ABSTRACT

Inflammation is a protective biological response that maintains tissue integrity following injury, infection or exposure to harmful stimuli. However, dysregulated or persistent inflammation contributes to the development of chronic diseases such as arthritis, diabetes, cardiovascular disorders and neurodegenerative conditions. Synthetic drugs including NSAIDs, COX-2 inhibitors, corticosteroids, DMARDs and biologics remain the primary therapeutic options, but their long-term use is often limited by gastrointestinal injury, renal toxicity, immunosuppression and cardiovascular complications. This has encouraged a growing interest in medicinal plants as safer, multi-targeted alternatives for managing inflammatory disorders. This review systematically highlights a wide range of medicinal plants traditionally used in inflammation, along with their extraction types, phytochemical profiles and mechanisms of action. Many of these plants contain flavonoids, alkaloids, terpenoids, saponins, phenols and essential oils that exert anti-inflammatory effects by inhibiting COX/LOX enzymes, suppressing NF-κB activation, modulating cytokines such as TNF-α, IL-1β and IL-6, and reducing oxidative stress. Experimental evidence from various in-vivo models—including carrageenan-induced paw edema, FCA-induced arthritis, LPS-stimulated macrophages and granuloma assays—supports their pharmacological potential. Overall, medicinal plants represent promising therapeutic resources with significant anti-

inflammatory activities. Further research on standardization, toxicity profiling and clinical validation is required to facilitate their safe integration into modern medicine.

INTRODUCTION

Inflammation is a complex biological response of the immune system and serves as an essential defence mechanism that evolved to protect living organisms and maintain tissue homeostasis[1]. This protective reaction is activated when normal physiological balance is disrupted by injury, infection, toxins or other harmful stimuli[2]. The classic clinical signs of acute inflammation redness, heat, swelling and pain have been recognized since the first century A.D. and reflect the vascular and cellular changes that occur at the site of tissue damage[3].

Inflammation is broadly classified into acute and chronic types. Acute inflammation represents the immediate and innate response aimed at the removal of harmful agents and restoration of normal function[4]. However, when this response becomes uncontrolled or persists over time, it transitions into chronic inflammation, a prolonged pathological state characterized by continuous tissue destruction, dysregulated immune activity and impaired healing[5]. Chronic inflammation is now well established as a major contributing factor to a wide range of non-communicable diseases, including cancer, diabetes, cardiovascular disorders, arthritis and neurodegenerative diseases[6]. Globally, chronic inflammatory disorders account for nearly 60% of total deaths, highlighting their immense public health burden[7].

At the molecular level, inflammation is orchestrated by a complex network of mediators, including prostaglandins, leukotrienes, cytokines, chemokines and transcription factors[8]. The arachidonic acid cascade plays a central role, regulated by enzymes such as cyclooxygenase (COX) and lipoxygenases (LOX), which generate key inflammatory mediators[9]. The inducible isoform COX-2 is particularly associated with pain, fever and inflammatory tissue damage. Similarly, activation of transcription factors such as nuclear factor-κB (NF-κB) and pattern-recognition receptors like Toll-like receptors (TLRs) further amplifies inflammatory gene expression and propagates the inflammatory response[10].

To manage inflammatory conditions, nonsteroidal anti-inflammatory drugs (NSAIDs) remain among the most widely used therapeutic agents[11]. However, prolonged NSAID use is associated with significant adverse effects, including gastrointestinal injury, renal impairment and cardiovascular risks, creating a need for safer and more effective alternatives[12]. In this

context, medicinal plants have gained considerable attention as potential therapeutic candidates. Many plant species contain bioactive phytochemicals with proven anti-inflammatory, antioxidant and immunomodulatory properties, often with fewer side effects compared to synthetic drugs[13].

Given the global disease burden of inflammation and the limitations of current pharmacotherapy, exploring medicinal plants as natural anti-inflammatory agents is both scientifically valuable and clinically relevant. This review provides a comprehensive overview of medicinal plants traditionally used for inflammatory conditions, their phytochemical constituents and the molecular mechanisms through which they exert anti-inflammatory effects.

SYNTHETIC DRUGS

1. Nonsteroidal Anti-Inflammatory Drugs (NSAIDs).[14,15]

Nonsteroidal anti-inflammatory drugs are the most commonly used synthetic agents for managing inflammation, pain and fever. They act primarily by inhibiting cyclooxygenase enzymes (COX-1 and COX-2), which are responsible for converting arachidonic acid into prostaglandins—key mediators of inflammation. Drugs such as ibuprofen, diclofenac, naproxen and aspirin reduce swelling, redness and pain by decreasing prostaglandin levels at the site of injury. NSAIDs are effective in acute conditions like sprains, headaches and minor injuries, as well as chronic inflammatory disorders such as arthritis. However, long-term use is limited by side effects including gastric irritation, peptic ulceration, kidney damage and increased cardiovascular risk. Despite their limitations, NSAIDs remain the cornerstone of anti-inflammatory therapy due to their strong efficacy and easily accessible dosage forms.

2. Selective COX-2 Inhibitors (Coxibs).[16,17]

Selective COX-2 inhibitors were developed to address the gastric toxicity associated with traditional NSAIDs. Drugs such as celecoxib and etoricoxib selectively inhibit the inducible COX-2 enzyme which is elevated during inflammation while sparing COX-1 which protects the stomach lining. This selective action provides powerful anti-inflammatory and analgesic effects with fewer gastrointestinal side effects. Coxibs are particularly useful in chronic inflammatory conditions such as osteoarthritis and rheumatoid arthritis. However, their prolonged use may increase the risk of cardiovascular complications such as hypertension, stroke and myocardial infarction. Therefore, despite their therapeutic benefits, selective

COX-2 inhibitors must be prescribed with caution, especially in patients with underlying heart disease.

3. Corticosteroids.[18,19]

Corticosteroids are among the most potent synthetic anti-inflammatory agents and are used when rapid suppression of inflammation is required. Drugs such as prednisolone, dexamethasone, hydrocortisone and betamethasone mimic the natural glucocorticoids produced by the adrenal cortex. They inhibit phospholipase A2, thus blocking the entire arachidonic acid cascade and suppressing the formation of prostaglandins and leukotrienes. Additionally, corticosteroids downregulate multiple inflammatory cytokines such as TNF-α, IL-1 and IL-6, leading to strong immunosuppressive effects. While they are extremely effective for severe inflammation, autoimmune diseases and allergic reactions, long-term use can cause serious side effects including weight gain, immunosuppression, diabetes, osteoporosis, mood disturbances and adrenal suppression. Therefore, corticosteroids are generally used for short-term or controlled therapy.

4. Disease-Modifying Anti-Rheumatic Drugs (DMARDs).[20,21]

DMARDs are a class of synthetic drugs specifically designed to prevent disease progression in chronic inflammatory conditions such as rheumatoid arthritis, psoriatic arthritis and autoimmune disorders. Common DMARDs include methotrexate, leflunomide, sulfasalazine and hydroxychloroquine. Unlike NSAIDs, which only provide symptomatic relief, DMARDs act on the underlying immune processes by inhibiting lymphocyte proliferation, reducing cytokine production and modulating immune signaling pathways. Methotrexate, the most widely used DMARD, reduces joint damage by decreasing T-cell activation and pro-inflammatory cytokines. Although highly effective, DMARDs require regular monitoring because of potential adverse effects such as liver toxicity, bone marrow suppression and gastrointestinal disturbances. They are often used in combination with NSAIDs or corticosteroids to enhance therapeutic outcomes.

5. Biologic Anti-Inflammatory Agents.[22,23,24]

Biologic agents represent the most advanced category of anti-inflammatory therapies. These drugs are genetically engineered to specifically target key molecules involved in inflammation. Examples include anti-TNF-α antibodies (infliximab, adalimumab), IL-6 receptor blockers (tocilizumab) and IL-1 receptor antagonists (anakinra). By neutralizing specific cytokines that drive inflammation, biologics offer a level of precision that traditional

drugs cannot achieve. They are particularly effective in severe, refractory autoimmune conditions where conventional therapies have failed. However, biologics are expensive and require injection or infusion. They may also increase the risk of serious infections, including tuberculosis, due to their powerful immunosuppressive actions. Despite these limitations, biologics have revolutionized the management of chronic inflammatory diseases.

Although synthetic anti-inflammatory drugs are highly effective, their long-term use is often limited by adverse effects. This has increased the global interest in plant-based anti-inflammatory agents**,** which are believed to act through multi-target mechanisms with potentially fewer side effects. Comparing synthetic drugs with natural alternatives helps highlight the therapeutic gap and supports the scientific need to investigate medicinal plants as safer and holistic options for managing inflammation.

List of Medicinal Plants With Reported Anti-Inflammatory Activity.

Sl no	**Plant Name (Scientific Name)**	**Common Name**	**Extraction Used**	**Phytoconstituents Responsible for Activity**	**Method Used for Induction / Assay**	**Reference**
1	*Achillea millefolium*	Yarrow	Oil extracts, Ethanolic extract	Sesquiterpenes, Flavonoids, Alkaloids, Salicylic acid	Tested on artificially irritated skin (human volunteers), Inhibition of polymorphonuclear leukocytes/oxidative stress	25
	Adhatoda vasica	Adosa or Malabar nut tree, Vasaka	Pyrroloquinazoline alkaloids (from roots), Methanolic leaf extract	Vasicine and Vasicinone (quinazoline alkaloids)	Carrageenan and Freund's Complete Adjuvant (FCA)-induced paw edema in rats, Collagen-induced arthritis (CIA) model	26
	Aegle marmelos	Bilwa	Aqueous extract (root bark)	- (Anti-inflammatory effect reported generally)	Carrageenan induced paw oedema model, Cotton pellet induced granuloma model	27

	Agrimonia eupatoria	Common Agrimony	Infusion, Polyphenol-enriched fraction	Polyphenols (isoquercetin, tiliroside, kaempferol O-acetyl-hexosyl-O-rhamnoside)	Carrageenan-induced paw oedema, Inhibition of inflammatory cytokines (IL-1, IL-4, IL-6)	28
	Agropyrum repens	Couch Grass, Pirevina	Ethanol extract (rhizomes), Dry couch grass extract (in cream)	Carbohydrates, mucilages, saponins, essential oils	Carrageenan foot oedema (rat hind-paw), Tested for allergic contact dermatitis in rats	29
	Albizia lebbeck	Shirisha or Siris	Bark extract (petroleum ether/ethyl acetate/methanol mixture)	- (Anti-inflammatory reported generally)	Carrageenan induced rat paw edema model	30
	Allium cepa	Onion	Aqueous extract/Poultices (traditional use)	Quercetin, Thiosulfinates, Cepaenes, Flavonoids	Inhibition of chemotaxis of human polymorphonuclear leukocytes, Inhibition of COX and LOX enzymes	31
	Allium sativum	Garlic	Garlic oil, Garlic extracts	Allicin, Thiacremonone (sulfur compound)	Inhibition of cytoskeleton formation/disassembly,	32
	Aloe ferox	aloe	Extract (gel/resin)	Malic acid acylated polysaccharid	Anti-swelling (general mechanism)	33

				es, Aloe resin, Enzymes (carboxypepti dase, brady kinase)		
	Alstonia scholaris	Devils Tree or Dita Bark Tree	Alkaloids fraction of ethanolic leaf extract, Ethanolic extract (EEAS) leaves	Alkaloids, Flavonoids	Xylene-induced ear edema, Carrageenan-induced air pouch formation, FCA-induced arthritis in rats	34
	Althaea officinilas	Marshmallow, Beli Slez	Root extracts	Mucilage, Flavonoids, Caffeic acid, p-coumaric acid	induced cytotoxicity/ROS in macrophages, LPS-induced release of TNF-alpha and IL6	35
	Anacardium occidentale	Cashew or Kaju	Leaf extract	Oleamide	(Anti-inflammatory property determined but specific induction method is not detailed in the excerpt)	36
	Asparagus racemosus	Shatavari or Satavar	Ethanolic leaf extract, Hydroalco holic roots extract	Steroidal saponins (Shatavarin I-X), Flavonoids (quercetin, rutin)	Carrageenan-induced paw edema in rats, FCA-induced arthritis in rats	37
	Betula pendula	Common Birch, Bela Breza	Aqueous extract, Dense	Flavonoids, Tannins, Resins,	In vitro study on human peripheral blood mononuclear cells (PBMC), Carrageenin-	38

			extract (tablets)	Essential oils	induced inflammation in rats	
	Bryophyllum pinnatum	Parnabeeja	Aqueous extract (plant leaf)	Flavonoids, Polyphenols	Fresh egg albumin-induced pedal (paw) oedema model	39
	Calendula officinalis	Calendula, Neven	Calendula oil (flower extract), Methanolic extract of flowers	Triterpenoids, Flavonoids	LPS-stimulated macrophages (NO inhibition), Carrageenan-induced paw oedema (implied in anti-oedematous effect)	40
	Camelia sinensis	Tea (Green/Black tea)	Aqueous green tea extract (GTE), Aqueous black tea extract (BTE)	Polyphenols (Catechins, Flavonoids), EGCG	Rat adjuvant-induced arthritis (AIA) model, FCA-induced arthritis rat model	41
	Cassia fistula	Golden shower tree	Bark extracts	Flavonoids and Bioflavonoids	Acute and chronic anti inflammatory models of inflammation in rats	42
	Cassia occidentalis	Coffee senna	Ethanolic extract (whole plant)	(Anti-inflammatory activity reported generally)	Carrageenan-induced paw oedema model	43
	Cedrus deodara	Himalayan Cedar or Deodar	Wood oil, Aqueous stem bark extract	Essential oils, Flavonoids, Sesquiterpenes (himachalenes)	Carrageenan-induced paw edema, FCA-induced arthritis, Croton oil-induced granuloma pouch	44

	Cissampelos sympodialis	-	Alkaloids total fraction and ethanolic extract (aerial parts)	Alkaloids (implied)	Reduced tumor necrosis factor and interlukin-1 (IL-1) levels	45
	Citrus limetta	Mosambi / Mousambi	Essential oils (EOs)	Limonene (monoterpene hydrocarbon)	Lipopolysaccharide-induced Inflammation (macrophages), 12-O-tetradecanoylphorbol-13acetate-induced ear inflammation (in vivo)	46
	Citrus limon	Nimbu and Lemon	Essential oils (EOs)	(Anti-inflammatory activity reported generally)	Reduced the sum of writhes and paw licking	47
	Cuminum cyminum	Cumin	Volatile oil, Essential oils (EOs)	(Anti-inflammatory activity reported generally)	Carrageenan-induced Rat-paw oedema, LPS-stimulated RAW 264.7 cells (inhibited COX-2, IL-1, IL-6)	48
	Curcuma longa	Turmeric or Haldi	Oil-free aqueous extract (COFAE) of rhizome, Polar extract (PCL) of rhizome	Curcuminoids (curcumin, demethoxycurcumin), Volatile oils	Xylene induced ear edema/Cotton pellet granuloma, Monosodium Iodoacetate induced osteoarthritis in rats	49
	Cynodon	Bermuda grass	Aqueous	(Anti-	Carrageenan, serotonin,	50

	dactylon		extract	inflammatory activity reported generally)	histamine, dextran induced rat paw edema, cotton pellet method	
	Cyperus rotundus	Nutgrass	Essential oils (EOs)	(Anti-inflammatory activity reported generally)	Carrageenan injection (reduced paw edoema)	51
	Dendropanax morbifera	Korean Dendropanax Gold-Leaf Tree	Methanolic extracts	Phenolic compounds (quercetin, rutin, resveratrol, chlorogenic acid)	Inhibited LPS induced pro inflammatory cytokines/mediators	52
	Emblica officinalis	Amla / Indian gooseberry	Water fraction of methanol extract (leaves)	(Anti-inflammatory reported generally)	Tested on the synthesis of leukotriene B_4, PAF, and thromboxane	53
	Glycyrrhiza glabra	Liquorice, Radix dulcis	Hydroalcoholic extract, Methanol extract	Glycyrrhizin, Glycyrrhizic acid.	Carrageenan-induced paw oedema, COX-2 inhibitory screening assay, Reduced antigen induced arthritis symptoms in mice	54
	Hibiscus rosa-sinensis L. / H. rosa-sinensis var alba	Red Hibiscus / White Hibiscus	Ethanol extracts (flower and leaf)	Flavonoids, Saponins, Steroids	Carrageenan-induced Paw Edema, PNL Infiltration study, Formalin-induced Paw Licking Test	55
	Hypericum	St. John's Wort,	Lipophilic	Hyperforin,	Antiedematogenic/antinocicept	56

	perforatum	Kantarion	extract, Hypericum oil extracts	Hypericin, Flavonoids, Tannins	ive properties in rats	
	Ipomoea pescaprae	Goat Foot Vine and Beach Morning Glory	Leaf extracts	- (Compounds inhibiting prostaglandin synthesis, implied)	Oedema caused by ethyl phenyl propiolate in animals, Treating dermatitis caused by jellyfish stings	57
	Juglansregia	Walnut, Orah	Ethanolic extracts (leaves), Walnut septum extract	Tannins, Naphthoquinone derivatives, Flavonoids	Carrageenan-induced hind paw edema model in mice, Citric acid-induced cough model in rats	58
	Leonotis ocymifolia	Granthiparni	80 percent methanolic leaf extract	- (Anti-inflammatory activity reported generally)	Reduced paw oedema by carrageenan induction, Slowed granuloma synthesis	59
	Matricaria chamomilla	Chamomile, Kamilica	Volatile essential oil, Aqueous extract	Essential oils, Sesquiterpene lactones, Coumarins	Carrageenan-induced pedal swelling in rats, Xylol-induced ear swelling in mice	60
	Mentha piperita	Peppermint, Nana	Essential oil and extract	Essential oils, Phenolics, Flavonoids	Croton oil-induced mouse ear oedema model, Inhibitory effect on NO and PGE_2 production	61
	Moringa oliefera	shigru	Aqueous and ethanolic extract (stem bark)	- (Anti-inflammatory activity reported generally)	Carrageenan induced rat paw edema	62

	Nicotiana tobacum	Dhumrapatra or Tamraparna	Leaf extract	Alkaloids (nicotine, anabasine), Quercitrin, Scopoletin	Used as an anti-inflammatory (general mention)	63
	Olea europaea	Olive tree	Extra virgin olive oil	- (Anti-inflammatory activity reported generally)	Carrageenan-induced paw edoema in rats	64
	Oroxylum indicum	Sonapatha or Shyonaka	Ethanol extract (stem bark), Petroleum ether root bark extract	Flavonoids (baicalein, chrysin), Phenolic compounds	Xylene-induced ear edema, Formalin-induced paw edema in mice, Adjuvant-induced arthritis in rat model	65
	Persicaria chinensis	Chinese knotweed	Methanolic extract	- (Anti-inflammatory activity reported generally)	LPS-induced nitric oxide and PGE_2 in RAW264.7 macrophages	66
	Phyllanthus acidus	StarGooseberry and Harpharauri	Methanolic extract (aerial parts)	Flavonoids (kaempferol and quercetin)	Inhibited PGE_2 and NO production in LPS-treated RAW 264.7 cells	67
	Piper nigrum	Piper or Black Pepper	Hexane/ethanolic fruit extracts	Piperine (alkaloid)	Carrageenan-induced paw inflammation in rats, Carrageenan-induced acute paw pain and arthritis in rats	68
	Salix alba	White Willow, Bela Vrba	Methanolic and	Salicylic acid, Phenolic	Xylene-induced ear oedema, Carrageenan-induced paw	69

			aqueous extracts (barks)	glycosides, Flavonoids	oedema	
	Salvia officinalis	Sage, Žalfija	Chloroform extracts	Flavonoids, Triterpenes (ursolic acid, carnosol)	Croton oil-induced ear oedema in mice, Formalin-induced inflammatory phase	70
	Sida cordifolia	Malva-branca	Aqueous extract	- (Anti-inflammatory activity reported generally)	Anti-inflammatory and analgesic activity evaluation (general test methods)	71
	Solanum melongena	Eggplant	Aqueous extract (leaves)	Ascorbic acid, Alanine, Arginine, Caffeic acid	Anti inflammatory activity (general assessment)	72
	Swertia chirayita	Chiretta or Chiratitka	Ethanolic extract (root), Aqueous stem extract	Xanthones, Terpenoids, Flavonoids, Glycosides	Carrageenan-induced paw edema in the rat model, Adjuvant-induced arthritis in mice	73
	Syzygium caryophyllatum	South Indian Plum and Dwarf Black Plum	Aqueous root extract	- (Anti-inflammatory activity reported generally)	Heat-induced egg albumin denaturation bio assay technique (in-vitro)	74
	Tephrosia purpurea	Wild Indigo	50 percent alcoholic extract (root)	- (Anti-inflammatory activity reported generally)	Carrageenan and produced paw oedema method	75
	Vitex	Chaste Tree or	Aqueous	Lignans,	Carrageenan-induced paw	76

	negundo	Nirgundi	leaves extract, Ethanolic seeds extract (total lignans)	Flavonoids, Essential oils	edema in rats, Collagen-induced arthritis in rats	
	Withania somnifera	Ashwagandha or Indian Ginseng	Methanolic leaves extract, Aqueous roots extract (WSAq)	Steroidal withanolides, Alkaloids, Polyphenols	Stainless steel-induced inflammation in adult zebra fish, Collagen-induced arthritis in rats	77
	Zingiber officinale	Ginger, Red ginger	40% ethanolic extract (dried red ginger), Aqueous rhizome extract	Essential oil, Polyphenolic compounds, Gingerol	Acute and chronic inflammation models, Carrageenan-induced paw edema in rats, Collagen-induced arthritis in mice	78

CONCLUSION

This review demonstrates that medicinal plants possess significant anti-inflammatory potential supported by strong phytochemical composition and mechanistic evidence. Their bioactive constituents—such as flavonoids, terpenoids, alkaloids, and phenolic compounds—act through multiple pathways, including inhibition of COX/LOX enzymes, suppression of NF-κB signaling, modulation of pro-inflammatory cytokines and enhancement of antioxidant defenses. While synthetic anti-inflammatory drugs remain effective, their long-term adverse effects highlight the need for safer, natural alternatives. The findings of this review clearly indicate that medicinal plants offer multi-targeted, accessible and biologically safe therapeutic options for managing both acute and chronic inflammation. However, despite the promising preclinical evidence, further research involving standardization, bioavailability

studies, toxicity assessments and well-designed clinical trials is essential to ensure their effective translation into clinical practice.

REFERENCE

1. Medzhitov R. Inflammation 2010: new adventures of an old flame. Cell. 2010 Mar 19;140(6):771-6.
2. Chen L, Deng H, Cui H, Fang J, Zuo Z, Deng J, Li Y, Wang X, Zhao L. Inflammatory responses and inflammation-associated diseases in organs. Oncotarget. 2017 Dec 14;9(6):7204.
3. Kiss AL. Inflammation in focus: the beginning and the end. Pathology and Oncology Research. 2022 Jan 4;27:1610136.
4. Nathan C, Ding A. Non resolving inflammation. Cell. 2010 Mar 19;140(6):871-82.
5. Medzhitov R. Origin and physiological roles of inflammation. Nature. 2008 Jul 24;454(7203):428-35.
6. Lopez-Castejon G, Brough D. Understanding the mechanism of IL-1β secretion. Cytokine & growth factor reviews. 2011 Aug 1;22(4):189-95.
7. Furman D, Campisi J, Verdin E, Carrera-Bastos P, Targ S, Franceschi C, Ferrucci L, Gilroy DW, Fasano A, Miller GW, Miller AH. Chronic inflammation in the etiology of disease across the life span. Nature medicine. 2019 Dec;25(12):1822-32.
8. Wautier JL, Wautier MP. Pro-and anti-inflammatory prostaglandins and cytokines in humans: a mini review. International journal of molecular sciences. 2023 Jun 1;24(11):9647.
9. Samuelsson B. From studies of biochemical mechanism to novel biological mediators: Prostaglandin endoperoxides, thromboxanes, and leukotriences: Nobel Lecture, 8 December 1982. Bioscience reports. 1983 Sep;3(9):791-813.
10. Takeda K, Kaisho T, Akira S. Toll-like receptors. Annual review of immunology. 2003 Apr;21(1):335-76.
11. Lawrence T. The nuclear factor NF-κB pathway in inflammation. Cold Spring Harbor perspectives in biology. 2009 Dec 1;1(6):a001651.
12. Rainsford KD. Ibuprofen: pharmacology, therapeutics and side effects. Springer Science & Business Media; 2013 Feb 1.
13. Watanabe T, Fujiwara Y, Chan FK. Current knowledge on non-steroidal anti-inflammatory drug-induced small-bowel damage: a comprehensive review. Journal of gastroenterology. 2020 May;55(5):481-95.

14. Vane JR, Botting RM. Mechanism of action of nonsteroidal anti-inflammatory drugs. The American journal of medicine. 1998 Mar 30;104(3S1):2S-8S.
15. Rao P, Knaus EE. Evolution of nonsteroidal anti-inflammatory drugs (NSAIDs): cyclooxygenase (COX) inhibition and beyond. Journal of pharmacy & pharmaceutical sciences. 2008 Sep 20;11(2):81s-110s.
16. Shi S, Klotz U. Clinical use and pharmacological properties of selective COX-2 inhibitors. European journal of clinical pharmacology. 2008 Mar;64(3):233-52.
17. FitzGerald GA, Patrono C. The coxibs, selective inhibitors of cyclooxygenase-2. New England Journal of Medicine. 2001 Aug 9;345(6):433-42.
18. Sibilia J. Corticosteroids and inflammation. La Revue du praticien. 2003 Mar 1;53(5):495-501.
19. Belvisi MG. Regulation of inflammatory cell function by corticosteroids. Proceedings of the American Thoracic Society. 2004 Nov;1(3):207-14.
20. Benjamin O, Goyal A, Lappin SL. Disease modifying anti-rheumatic drugs (DMARD).
21. Bermas BL. Non-steroidal anti inflammatory drugs, glucocorticoids and disease modifying anti-rheumatic drugs for the management of rheumatoid arthritis before and during pregnancy. Current opinion in rheumatology. 2014 May 1;26(3):334-40.
22. Rider P, Carmi Y, Cohen I. Biologics for targeting inflammatory cytokines, clinical uses, and limitations. International journal of cell biology. 2016;2016(1):9259646.
23. Nishimoto N, Kishimoto T. Humanized antihuman IL-6 receptor antibody, tocilizumab. Therapeutic antibodies. 2008 Jan 1:151-60.
24. Bartelds GM, Wijbrandts CA, Nurmohamed MT, Stapel S, Lems WF, Aarden L, Dijkmans BA, Tak PP, Wolbink GJ. Anti-infliximab and anti-adalimumab antibodies in relation to response to adalimumab in infliximab switchers and anti-tumour necrosis factor naive patients: a cohort study. Annals of the rheumatic diseases. 2010 May 1;69(5):817-21.
25. Bussmann RW. Achillea millefolium L. ASTERACEAE. Ethnobotany of the Mountain Regions of Eastern Europe: Carpathians. 2025 Apr 23:55.
26. Singh B, Sharma RA. Anti-inflammatory and antimicrobial properties of pyrroloquinazoline alkaloids from Adhatoda vasica Nees. Phytomedicine. 2013 Mar 15;20(5):441-5.
27. Benni JM, Jayanthi MK, Suresha RN. Evaluation of the anti-inflammatory activity of Aegle marmelos (Bilwa) root. Indian journal of pharmacology. 2011 Jul 1;43(4):393-7.

28. Santos TN, Costa G, Ferreira JP, Liberal J, Francisco V, Paranhos A, Cruz MT, Castelo-Branco M, Figueiredo IV, Batista MT. Antioxidant, Anti-Inflammatory, and Analgesic Activities of Agrimonia eupatoria L. Infusion. Evidence-Based Complementary and Alternative Medicine. 2017;2017(1):8309894.
29. Al-Snafi AE. Chemical constituents and pharmacological importance of Agropyron repens–A review. Research Journal of Pharmacology and Toxicology. 2015;1(2):37-41.
30. Babu NP, Pandikumar P, Ignacimuthu S. Anti-inflammatory activity of Albizia lebbeck Benth., an ethnomedicinal plant, in acute and chronic animal models of inflammation. Journal of ethnopharmacology. 2009 Sep 7;125(2):356-60.
31. Lee HS, Kwon YJ, Seo EB, Kim SK, Lee H, Lee JT, Chang PS, Choi YJ, Lee SH, Ye SK. Anti-inflammatory effects of Allium cepa L. peel extracts via inhibition of JAK-STAT pathway in LPS-stimulated RAW264. 7 cells. Journal of Ethnopharmacology. 2023 Dec 5;317:116851.
32. Recinella L, Gorica E, Chiavaroli A, Fraschetti C, Filippi A, Cesa S, Cairone F, Martelli A, Calderone V, Veschi S, Lanuti P. Anti-inflammatory and antioxidant effects induced by Allium sativum L. extracts on an ex vivo experimental model of ulcerative colitis. Foods. 2022 Nov 9;11(22):3559.
33. Mwale M, Masika PJ. Analgesic and anti-inflammatory activities of Aloe ferox Mill. aqueous extract. Afr J Pharm Pharmacol. 2010 Jun 1;4(6):291-7.
34. Shang JH, Cai XH, Feng T, Zhao YL, Wang JK, Zhang LY, Yan M, Luo XD. Pharmacological evaluation of Alstonia scholaris: anti-inflammatory and analgesic effects. Journal of ethnopharmacology. 2010 May 27;129(2):174-81.
35. Bonaterra GA, Bronischewski K, Kinscherf R et al . Anti-inflammatory and Anti-oxidative Effects of Phytohustil® and Root Extract of Althaea officinalis L. on Macrophages in vitro. Frontiers in pharmacology. 2020 Mar 17;11:290.
36. da Silveira Vasconcelos M, Gomes-Rochette NF, de Oliveira ML, Nunes-Pinheiro DC, Tome AR, Maia de Sousa FY, Pinheiro FG, Moura CF, Miranda MR, Mota EF, de Melo DF. Anti-inflammatory and wound healing potential of cashew apple juice (Anacardium occidentale L.) in mice. Experimental Biology and Medicine. 2015 Dec;240(12):1648-55.
37. Plangsombat N, Rungsardthong K, Kongkaneramit L, Waranuch N, Sarisuta N. Anti-inflammatory activity of liposomes of Asparagus racemosus root extracts prepared by various methods. Experimental and therapeutic medicine. 2016 Oct 1;12(4):2790-6.

38. Chumak O, Bezrukavyi Y, Maloshtan L, Maloshtan A. Studies of the anti-inflammatory and diuretic properties of tablets with dense extract of Betula pendula leaves. Dan. Sci. J. 2019;1:46-8.
39. Chibli LA, Rodrigues KC, Sousa OV et al. Anti-inflammatory effects of Bryophyllum pinnatum (Lam.) Oken ethanol extract in acute and chronic cutaneous inflammation. Journal of ethnopharmacology. 2014 Jun 11;154(2):330-8.
40. Silva D, Cruz MT, Almeida IF. et al Anti-inflammatory activity of Calendula officinalis L. flower extract. Cosmetics. 2021 Apr 25;8(2):31.
41. Chattopadhyay P, Besra SE, Vedasiromoni JR. et al Anti-inflammatory activity of tea (Camellia sinensis) root extract. Life sciences. 2004 Feb 27;74(15):1839-49.
42. Ilavarasan R, Malika M, Venkataraman S. Anti-inflammatory and antioxidant activities of Cassia fistula Linn bark extracts. African journal of traditional, complementary and alternative medicines. 2005;2(1):70-85.
43. Sreejith G, Latha PG, Shine VJ, Anuja GI, Suja SR, Sini S, Shyamal S, Pradeep S, Shikha P, Rajasekharan S. Anti-allergic, anti-inflammatory and anti-lipidperoxidant effects of Cassia occidentalis Linn. Indian journal of experimental biology. 2010 May 1;48(5):494.
44. Shinde UA, Phadke AS, Nair AM, Mungantiwar AA, Dikshit VJ, Saraf MN. Studies on the anti-inflammatory and analgesic activity of Cedrus deodara (Roxb.) Loud. wood oil. Journal of Ethnopharmacology. 1999 Apr 1;65(1):21-7.
45. THOMAS G, PIUVEZAM MR. Anti-inflammatory activity of Cissampelos sympodialis Eichl.(Menispermaceae) leaf extract. Acta Farm. Bonaerense. 2001;20(4):275-9.
46. Maurya AK, Mohanty S, Pal A, Chanotiya CS, Bawankule DU. The essential oil from Citrus limetta Risso peels alleviates skin inflammation: In-vitro and in-vivo study. Journal of ethnopharmacology. 2018 Feb 15;212:86-94.
47. El Aboubi M, Hdech DB, Bikri S, Benayad A, El Magri A, Aboussaleh Y, Aouane EM. Chemical composition of essential oils of Citrus limon peel from three Moroccan regions and their antioxidant, anti-inflammatory, antidiabetic and dermatoprotective properties. Journal of Herbmed Pharmacology. 2022 Dec 31;12(1):118-27.
48. Asaad GF, Redai AQ, Hakami AO, Ghazwani FY, Nomier YO, Alshahrani SA. Potential analgesic and anti-inflammatory effect of Cuminum cyminum and Borago officinalis in rats and mice. Asian J Pharm Clin Res. 2020;13(1):216-8.
49. Chainani-Wu N. Safety and anti-inflammatory activity of curcumin: a component of tumeric (Curcuma longa). The Journal of Alternative & Complementary Medicine. 2003 Feb 1;9(1):161-8.

50. Garg VK, Paliwal SK. Anti-inflammatory activity of aqueous extract of Cynodon dactylon
51. Ibrahim SR, Mohamed GA, Khayat MT, Zayed MF, El-Kholy AA. Anti-inflammatory terpenoids from Cyperus rotundus rhizomes. Pakistan journal of pharmaceutical sciences. 2018 Jul 2;31.
52. Hyun TK, Ko YJ, Kim EH, Chung IM, Kim JS. Anti-inflammatory activity and phenolic composition of Dendropanax morbifera leaf extracts. Industrial Crops and Products. 2015 Nov 15;74:263-70
53. Asmawi MZ, Kankaanranta H, Moilanen E, Vapaatalo H. Anti-inflammatory activities of Emblica officinalis Gaertn leaf extracts. Journal of Pharmacy and Pharmacology. 1993 Jun;45(6):581-4.
54. Leite CD, Bonafé GA, Carvalho Santos J, Martinez CA, Ortega MM, Ribeiro ML. The anti-inflammatory properties of licorice (Glycyrrhiza glabra)-derived compounds in intestinal disorders. International journal of molecular sciences. 2022 Apr 8;23(8):4121.
55. Raduan SZ, Abdul Aziz MW, Roslida AH, Zakaria ZA, Zuraini A, Hakim MN. Anti-inflammatory effects of Hibiscus rosa-sinensis L. and Hibiscus rosa-sinensis var. alba ethanol extracts. International journal of pharmacy and pharmaceutical sciences. 2013 May;5(4):754-62.
56. Sosa S, Pace R, Bornanciny A, Morazzoni P, Riva A, Tubaro A, Loggia RD. Topical anti-inflammatory activity of extracts and compounds from Hypericum perforatum L. Journal of Pharmacy and Pharmacology. 2007 May;59(5):703-9.
57. Pongprayoon U, Bohlin L, Soonthornsaratune P, Wasuwat S. Antiinflammatory activity of Ipomoea pes-caprae (L.) R. Br. Phytotherapy research. 1991 Apr;5(2):63-6.
58. Fizeșan I, Rusu ME, Georgiu C, Pop A, Ștefan MG, Muntean DM, Mirel S, Vostinaru O, Kiss B, Popa DS. Antitussive, antioxidant, and anti-inflammatory effects of a walnut (Juglans regia L.) septum extract rich in bioactive compounds. Antioxidants. 2021 Jan 15;10(1):119.
59. Alemu A, Tamiru W, Nedi T, Shibeshi W. Analgesic and Anti-Inflammatory Effects of 80% Methanol Extract of Leonotis ocymifolia (Burm. f.) Iwarsson Leaves in Rodent Models. Evidence-Based Complementary and Alternative Medicine. 2018;2018(1):1614793.
60. Wu YN, Xu Y, Yao L. Anti-inflammatory and anti-allergic effects of German chamomile (Matricaria chamomilla L.). Journal of Essential Oil Bearing Plants. 2012 Jan 1;15(1):75-83.

61. Kehili S, Boukhatem MN, Belkadi A, Ferhat MA, Setzer WN. Peppermint (Mentha piperita L.) essential oil as a potent anti-inflammatory, wound healing and anti-nociceptive drug. European Journal of Biological Research. 2020 Apr 1;10(2).
62. Ezeamuzie IC, Ambakederemo AW, Shode FO, Ekwebelem SC. Antiinflammatory effects of Moringa oleifera root extract. International Journal of Pharmacognosy. 1996 Jan 1;34(3):207-12.
63. Zhang W, Pan X, Fu J, Cheng W, Lin H, Zhang W, Huang Z. Phytochemicals derived from Nicotiana tabacum L. plant contribute to pharmaceutical development. Frontiers in pharmacology. 2024 Apr 12;15:1372456.
64. Süntar İP, Akkol EK, Baykal T. Assessment of anti-inflammatory and antinociceptive activities of Olea europaea L. Journal of medicinal food. 2010 Apr 1;13(2):352-6.
65. Ali RM, Houghton PJ, Raman A, Hoult JR. Antimicrobial and antiinflammatory activities of extracts and constituents of Oroxylum indicum (L.) Vent. Phytomedicine. 1998 Oct 1;5(5):375-81.
66. Hossen MJ, Baek KS, Kim E, Yang WS, Jeong D, Kim JH, Kweon DH, Yoon DH, Kim TW, Kim JH, Cho JY. In vivo and in vitro anti-inflammatory activities of Persicaria chinensis methanolic extract targeting Src/Syk/NF-κB. Journal of Ethnopharmacology. 2015 Jan 15;159:9-16.
67. Ihantola-Vormisto A, Summanen J, Kankaanranta H, Vuorela H, Asmawi ZM, Moilanen E. Anti-inflammatory activity of extracts from leaves of Phyllanthus emblica. Planta medica. 1997 Dec;63(06):518-24.
68. Tasleem F, Azhar I, Ali SN, Perveen S, Mahmood ZA. Analgesic and anti-inflammatory activities of Piper nigrum L. Asian Pacific journal of tropical medicine. 2014 Sep 1;7:S461-8.
69. Shara M, Stohs SJ. Efficacy and safety of white willow bark (Salix alba) extracts. Phytotherapy Research. 2015 Aug;29(8):1112-6.
70. Baricevic D, Sosa S, Della Loggia R, Tubaro A, Simonovska B, Krasna A, Zupancic A. Topical anti-inflammatory activity of Salvia officinalis L. leaves: the relevance of ursolic acid. Journal of ethnopharmacology. 2001 May 1;75(2-3):125-32.
71. Martins CA, Campos ML, Irioda AC, Stremel DP, Trindade AC, Pontarolo R. Anti-inflammatory effect of Malva sylvestris, Sida cordifolia, and Pelargonium graveolens is related to inhibition of prostanoid production. Molecules. 2017 Nov 3;22(11):1883.

72. Sun J, Gu YF, Su XQ, Li MM, Huo HX, Zhang J, Zeng KW, Zhang Q, Zhao YF, Li J, Tu PF. Anti-inflammatory lignanamides from the roots of Solanum melongena L. Fitoterapia. 2014 Oct 1;98:110-6.
73. Hu TY, Ju JM, Mo LH, Ma L, Hu WH, You RR, Chen XQ, Chen YY, Liu ZQ, Qiu SQ, Fan JT. Anti-inflammation action of xanthones from Swertia chirayita by regulating COX-2/NF-κB/MAPKs/Akt signaling pathways in RAW 264.7 macrophage cells. Phytomedicine. 2019 Mar 1;55:214-21.
74. Chandran R, Abrahamse H, Parimelazhagan T. Cytotoxic, analgesic and anti-inflammatory properties of Syzygium calophyllifolium bark. Biomedicine & Pharmacotherapy. 2018 Jul 1;103:1079-85.
75. Shenoy S, Shwetha K, Prabhu K, Maradi R, Bairy KL, Shanbhag T. Evaluation of antiinflammatory activity of Tephrosia purpurea in rats. Asian Pacific journal of tropical medicine. 2010 Mar 1;3(3):193-5.
76. Kulkarni RR, Virkar AD, D'mello P. Antioxidant and antiinflammatory activity of Vitex negundo. Indian journal of pharmaceutical sciences. 2008 Nov;70(6):838.
77. Gupta A, Singh S. Evaluation of anti-inflammatory effect of Withania somnifera root on collagen-induced arthritis in rats. Pharmaceutical biology. 2014 Mar 1;52(3):308-20.
78. Karunakaran R, Sadanandan SP. Zingiber officinale: Antiinflammatory actions and potential usage for arthritic conditions. InBioactive food as dietary interventions for arthritis and related inflammatory diseases 2019 Jan 1 (pp. 233-244). Academic Press.