ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Phyto-therapeutic Agents in the Treatment of Pain and Inflammation: A Systematic Review.

Deepa N, Nirmala S*, Mohamed Aasif A, Namphrang Bareh, Naveen K, Naveen KS, Nivetha R, and Swathi R.

Faculty of Pharmacy, Sree Balaji Medical College And Hospital, Bharath Institute of Higher education and Research, Chromepet, Chennai-44, Tamil Nadu, India.

ABSTRACT

Pain and inflammation are natural physiological responses to injury, infection, or disease, designed to protect and heal the body. However, when these responses persist or become chronic, they can significantly impair daily functioning and reduce an individual's quality of life. Conventional pharmaceutical treatments such as nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids are widely used to manage these conditions. While effective, these medications often carry a risk of adverse effects, including gastrointestinal discomfort, kidney dysfunction, and in the case of opioids, potential for addiction and dependency.This growing concern has led to increased interest in herbal medicine as a safer and more sustainable alternative or complementary therapy. This review explores a range of medicinal herbs traditionally used for their analgesic and anti-inflammatory properties. Notable examples include Turmeric, Ginger, Cinnamon, Echinacea, Rosemary, Garlic, Clove, Tulsi (Holy Basil), Liquorice, and Basil. These herbs, used for centuries in traditional healing systems like Ayurveda and Traditional Chinese Medicine, are now gaining scientific support. Their active phytoconstituents work by modulating key inflammatory pathways—targeting enzymes such as cyclooxygenase (COX), reducing the activity of nuclear factor kappa B (NF-κB), and offering antioxidant protection to tissues.Despite promising evidence, the clinical application of herbal treatments still faces several challenges. These include variations in formulation, poor bioavailability, and the absence of standardized dosing protocols. Therefore, further clinical trials and pharmacokinetic studies are essential to validate their efficacy and safety.Nonetheless, herbal remedies hold great promise as accessible and well-tolerated options for managing pain and inflammation, especially for mild conditions manageable at home. With appropriate scientific validation and regulatory frameworks, these natural compounds could help reduce dependency on conventional drugs and enhance overall patient well-being.

Keywords: Herbs, food supplements, Nutraceuticals, turmeric, ginger, pepper

https://doi.org/10.33887/rjpbcs/2025.16.4.11

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Food supplements, or dietary or nutritional supplements, are substances formulated to offer essential nutrients that could be insufficient in an individual's diet. These supplements might comprise vitamins, minerals, amino acids, fatty acids, fiber, and plant extracts. Supplements are offered in several forms like tablets, capsules, powders, liquids, and gummies, depending on different dietary needs and preferences. The chief function of food supplements is to maintain overall health, promote the functions of the body, and prevent deficiency of nutrients. They may be especially useful for those who have certain dietary limitations, medical issues, or higher nutritional needs based on considerations such as pregnancy, old age, or extreme physical exertion. Whereas food supplements can help improve one's health, they must never substitute a well-balanced diet. Rather, they must serve as a supplement to a healthy eating regimen. High-quality supplements from credible manufacturers must be chosen, and advice from a medical practitioner must be sought before introducing them into one's regimen, particularly for individuals with pre-existing health conditions or on medication.

With a growing worldwide demand for food supplements, continuous research aims to determine their efficacy and potential uses. By regulating the manufacture and labelling of these products, government bodies in different countries work to protect consumers by maintaining safety standards and qualities, enabling consumers to make well-informed decisions regarding their nutritional requirements. Herbal food supplements are plant-based natural products intended to enhance general well-being and health. They have healthful substances like vitamins, minerals, and antioxidants in their composition that may improve the functions of the body. These supplements are usually taken as an addition to a healthy diet. Unlike allopathic drugs herbal medicines can be easily prepared and can used as an remedy for some conditions like cold, cough, runny nose, fever, etc. They are available in different forms, i.e., capsules, powders, and teas. Although they may have potential to improve health, they must be used responsibly and a healthcare worker consulted prior to adding them into a regimen.(1)

Role And Applications Of Herbal's

Antiviral Effect

Conventional antibiotics and many pharmaceutical agents exhibit limited efficacy against viral pathogens. In contrast, numerous herbal medicines and their extracts demonstrate potent antiviral activities while posing minimal adverse effects on aquatic organisms. These herbal remedies primarily act by inhibiting viral entry and replication through bioactive immunomodulatory compounds. Notable examples include Astragalus membranaceus, Lonicera, and Euphorbia humifusa. (2)

Antibacterial Effect

Bacterial infections are a major cause of mortality in aquaculture species. Several herbal medicines have shown targeted antibacterial activity against pathogenic bacteria. Examples include Astragalusmembranaceus, Scutellariabaicalensis, Andrographispaniculata, Allium sativum, Eucommiaulmoides, Zingiberofficinale, and Menthapiperita. The growing interest in these botanicals stems from their efficacy and lower risk of contributing to antimicrobial resistance (3).

Antiparasitic Effect

Parasitic infections significantly impact the aquaculture industry by causing large-scale mortality and economic losses. Commonly used chemical treatments, such as furazolidone, dipterex, and the antibiotic avermectin, have contributed to the emergence of drug-resistant parasites. In contrast, herbal medicines offer an eco-friendly alternative, posing minimal environmental risk and toxicity to humans, thereby supporting food safety. Although limited, existing studies suggest promising antiparasitic potential in certain herbal extract. (4)

Immunostimulator

Herbal immunostimulants such as Ganodermalucidum and Echinacea purpurea play a significant role in boosting both innate and adaptive immune mechanisms in aquatic organisms, thereby enhancing their overall disease resistance. (5)

Anti-Inflammatory Effect

Plants like Curcuma longa (turmeric) and Glycyrrhizaglabra possess potent anti-inflammatory constituents that help mitigate inflammatory responses associated with infections. (6)

Antioxidant Effect

Herbs such as Ocimum sanctum and Camellia sinensis exhibit strong antioxidant properties that combat oxidative stress and support cellular protection, contributing to improved health and resilience in aquatic species. (7)

Growth Promotion

Botanical agents like Zingiberofficinale and Phyllanthusemblica are known to enhance growth by promoting efficient digestion and nutrient utilization in aquatic animals. (8)

Stress Reduction

Adaptogenic herbs including Withaniasomnifera (ashwagandha) and Ocimum sanctum aid in reducing physiological stress, enabling aquatic species to better adapt to environmental and handling challenges. (9)

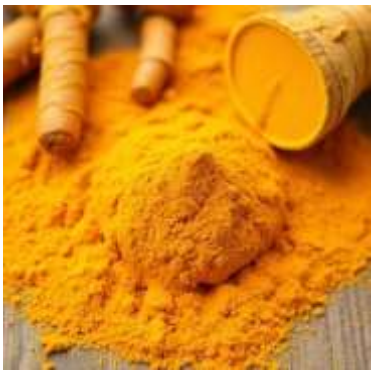
Antifungal Property

Herbal extracts from Laws oniainterims and Azadirachtaindica have demonstrated effective antifungal activity against pathogens like Saprolegnia, contributing to the management of fungal infections in aquaculture system. (3)

Available Herbal Food Supplements

Turmeric

Curcuma longa, or turmeric, is a plant native to India, with curcumin as its primary active compound. Curcumin is widely recognized for its anti-inflammatory effects, supported by numerous clinical trials. It has been shown to reduce symptoms of rheumatoid arthritis, such as joint swelling and stiffness, and is comparable in effectiveness to phenylbutazone. In cases of anterior uveitis, curcumin led to complete remission within two weeks. Clinical studies also report benefits in treating dyspepsia, gastric ulcers, and irritable bowel syndrome (IBS). Additionally, curcumin helps prevent delayed graft rejection post-kidney transplant, manages inflammatory bowel disease (IBD), and supports remission in ulcerative colitis and psoriasis by selectively inhibiting phosphorylase kinase. (11)



Chemical Constituents

Curcuma longa, commonly known as turmeric, contains more than 235 identified phytochemicals, with polyphenols and terpenoids being the most abundant classes. The primary bioactive components include:

Curcuminoids: These are the most extensively researched compounds, mainly made up of curcumin (about 80%), demethoxycurcumin (around 12%), and bisdemethoxycurcumin (approximately 6%).

Volatile oils: Notable constituents of the essential oil fraction are turmerone (40%), α-turmerone (10%), and curlone (23%).

Additional compounds: Other significant phytochemicals include quercetin, caffeic acid, curdione, and traces of bisdemethoxycurcumin.(12)

Therapeutic Uses

Anti-inflammatory and Antioxidant Properties

Curcumin, the main active compound in turmeric, has strong anti-inflammatory and antioxidant effects. It works by regulating inflammatory processes and neutralizing harmful free radicals.(13)

Antimicrobial Potential

Turmeric exhibits significant antimicrobial activity, including antibacterial, antifungal, and antiviral effects, which may help in managing various infectious diseases.(14)

Neuroprotective Benefits

Curcumin has shown promise in protecting nerve cells by minimizing oxidative damage and inflammation, suggesting potential in the treatment of neurological disorders.(15)

Heart-Protective Effects

Curcuma longa may support cardiovascular health by enhancing fat metabolism and reducing the development of atherosclerosis (plaque buildup in arteries).(16)

Cinnamon

The type of cinnamon may be the reason why it has the specific health benefits. Ceylon "true" cinnamon (Cinnamomumverum) is usually associatedtrusted Source with health benefits because it is rich in antioxidants. However, this type is not so common in the United States.It is not in all grocery stores; you will have to go to a specialty grocery store or order it online.Cassian cinnamon (Cinnamomumaromaticum) is the type of cinnamon sold as "cinnamon" in the United States and is cheaper than the Cassia cinnamon (Cinnamomum cassia).A 2022 review trusted Source looking at whether cinnamon might help with diabetes cites cinnamon's polyphenolic compounds as potentially lowering several markers of an inflammatory disease, including:Interleukin 1 and 6 (IL-1 and 6), C-reactive protein (CRP), Tumor necrosis factor (TNF)-alpha level In general, the higher the levels of these, the more inflammation is in the body.A 2023 in vitro study trusted Source indicates Ceylon cinnamon's antioxidant and anti-inflammatory compounds may survive digestion as opposed to some other compounds found in food.(17)

Chemical Constituents Of Cinnamon

Cinnamon is derived from the inner bark of various Cinnamomum species, with the most commonly used types being:

1. Cinnamomumverum (commonly known as True or Ceylon cinnamon)
2. Cinnamomum cassia (also referred to as Chinese cinnamon)

Primary Chemical Components

Volatile (Essential) Oils (0.5–4%)

1. Cinnamaldehyde (making up 65–80% of the oil) – the key bioactive compound responsible for cinnamon's antimicrobial, antioxidant, and anti-inflammatory effects
2. Eugenol – found in higher concentrations in C. verum
3. Linalool
4. Caryophyllene
5. Cinnamyl acetate
6. Coumarin – prevalent in C. cassia; potentially toxic to the liver in large amounts

Polyphenolic Compounds and Tannins

Includes proanthocyanidins, catechins, and flavonoids, which contribute to cinnamon's antioxidant capacity

Other Components: Mucilage, Resin, and Natural Sugars

These elements provide cinnamon with its characteristic texture and gentle soothing (demulcent) effects on mucous membranes.(18)

Therapeutic Uses Of Cinnamon

Anti-diabetic activity:

1. Enhances insulin receptor activity and glucose uptake.
2. Reduces fasting blood glucose and HbA1c in some studies.(19)

Anti-oxidant and Anti-inflammatory

1. Polyphenolic compounds scavenge free radicals and upregulate antioxidant enzymes.
2. Cinnamaldehyde inhibits nitric oxide (NO) production and downregulates NF-κB activation.(20)(21)

Antimicrobial activity

Effective against Escherichia coli, Staphylococcus aureus, Candida albicans, and various fungi and viruses.(22)

Gastrointestinal and Antispasmodic Effects

Traditionally used to relieve nausea, indigestion, flatulence, and diarrhea.(23)

Ginger

Zingiberofficinale, commonly referred to as "Ginger," belongs to the Zingiberaceae family and is a highly regarded medicinal plant. It has been widely utilized in traditional systems of medicine such as Ayurveda, Tibb-Unani. The rhizome of Z. officinale is abundant in various bioactive compounds, including polyphenols (such as gingerol, paradol, shogaol, zingerone, and quercetin), essential oils (like zingiberene, zingiberol, linalool, geranial, limonene, cineole, neral, α-farnesene, α-curcumene, β-bisabolene, and β-sesquiphellandrene), proteins (including alanine, cysteine, arginine, glutamate, and proline), sugars (polysaccharides, cellulose, and soluble sugars), vitamins, minerals, resins, flavonoids, alkaloids, saponins, tannins, and inorganic elements.These bioactive constituents contribute to a wide range of pharmacological effects, such as anti-inflammatory, anti-arthritic, anticancer, antioxidant, antifungal, antibacterial, antiemetic, antidiabetic, antihypertensive, antiallergic, antitussive, antiulcer, neuroprotective, gastroprotective, hepatoprotective, cytotoxic, and hypoglycemic activities. The anti-inflammatory and anti-arthritic properties of Z. officinale are likely attributed to the presence of these . compounds.(24)

Chemical Constituents

Volatile Oils (1–3%):

These give ginger its characteristic aroma and therapeutic potential:

1. Zingiberene (30–40% of essential oil) – major sesquiterpene
2. β-Bisabolene

3. α-Farnesene
4. α- and β-Sesquiphellandrene
5. Camphene
6. Citral
7. Linalool

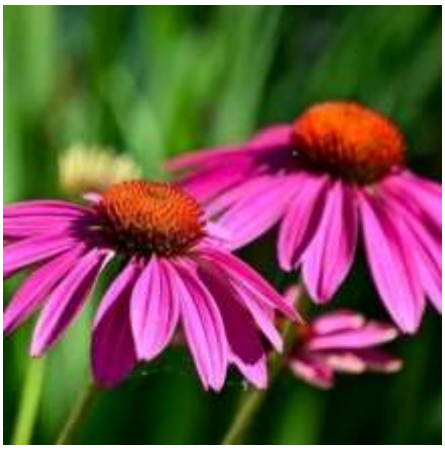
Non-Volatile Pungent Compounds

These are responsible for ginger's spiciness and many of its health benefits:

1. Gingerols (especially [6]-gingerol) – major active constituent in fresh ginger
2. Shogaols – formed from gingerols when ginger is dried or cooked
3. Paradols – present in processed ginger
4. Zingerone – produced during heating

Other Constituents

1. Phenolic acids
2. Flavonoids
3. Polysaccharides
4. Proteins and carbohydrates(25)



Therapeutic Uses

Anti-inflammatory and Antioxidant:

1. Gingerols and shogaols inhibit pro-inflammatory cytokines and suppress COX and LOX pathways.
2. Reduces oxidative stress by neutralizing free radicals.(26)

Antiemetic (Anti-nausea):

Effective in reducing nausea and vomiting related to motion sickness, pregnancy, chemotherapy, and post-operative conditions.(27)

Anticancer

1. Inhibits proliferation and induces apoptosis in various cancer cells, including colorectal, breast, and ovarian cancer.
2. Modulates multiple pathways including NF-κB, STAT3, and Akt.(28)

Cardioprotective and Antidiabetic:

1. Lowers blood glucose and lipid levels.
2. Improves circulation and protects against cardiovascular diseases.(29)

Echinacea

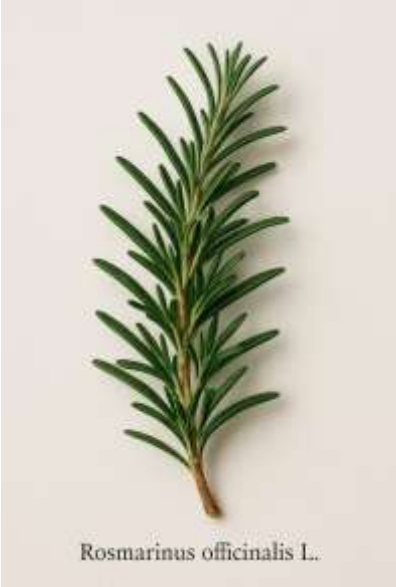
The common echinacea (Echinacea purpurea), a close relative of Echinacea laevigata, is a rhizomatous perennial herb. The common species' cordate (heart-shaped) leaves serve as a distinguishing feature between the two. E. laevigata has a smooth, leafless, largely bare stem that can reach a height of approximately 1.5 meters (5 feet). Any leaves have a lance-like form. A flower head with thin pink or purplish ray florets up to 8 centimeters (3.2 inches) long sits atop the stalk. The florets sag away from the head's center. Dark purple are the tiny, tubular disc florets in the middle. Blooming takes place from May to July.(30)

Chemical Constituents

Echinacea purpurea is one of the most commonly used Echinacea species in traditional medicine, valued for its role in treating infections, enhancing wound healing, and boosting the immune system. Echinacea contains potent anti-inflammatory components such as alkamides and caffeic acid derivatives.(31) Research has shown that polysaccharides extracted from the roots of E. angustifolia exhibit anti-inflammatory effects in live models, including the carrageenan-induced rat paw edema test and the croton oil-induced mouse ear inflammation test, when administered topically and intravenously. Traditionally, topical applications of Echinacea extracts have been used to accelerate wound healing. This is thought to occur through a mechanism involving a combination of hyaluronic acid and polysaccharides (like echinacin B), which indirectly inhibit hyaluronidase and promote fibroblast activity.(32) Echinacea has also been found to inhibit enzymes involved in producing inflammation-promoting chemicals. A 1994 in vitro study showed that E. angustifolia root extracts suppressed cyclooxygenase and 5-lipoxygenase enzymes, which are responsible for forming inflammatory compounds like prostaglandin E2 and leukotriene B4. Alkamides, especially isobutylamides from the roots of E. purpurea and E. angustifolia, are believed to contribute to this enzyme inhibition and thus to Echinacea's anti-inflammatory effects. Additionally, compounds like cichoric acid and cynarine from E. angustifolia have shown anti-hyaluronidase activity, potentially reducing tissue inflammation. Some studies also suggest that Echinacea might help protect the skin from sun-related damage by preventing collagen breakdown caused by free radical.

Therapeutic Uses

Various lab and animal studies indicate that echinacea contains compounds that enhance immune response, ease pain, lower inflammation, and exhibit hormonal, antiviral, and antioxidant properties.(33)


Rosmarinus officinalis L.

Rosmary

Introduction

Rosmarinus officinalis L. (rosemary) is a widely recognized medicinal plant known for its analgesic, anti-inflammatory, and neuroprotective effects. Traditionally, it has been used in folk medicine to relieve conditions such as rheumatic pain, abdominal discomfort, and menstrual cramps. Its therapeutic benefits are largely attributed to active compounds like rosmarinic acid. This study aimed to evaluate the anti-inflammatory potential of R. officinalis and rosmarinic acid in a rat model of sciatic nerve chronic constriction injury (CCI)-induced neuropathic pain, in order to support its traditional medicinal applications.

Chemical Constituents

Rosmarinus officinalis L., commonly known as rosemary, is a widely used herb in both traditional medicine and culinary practices, renowned for its rich composition of bioactive compounds that contribute to various therapeutic effects. It is particularly recognized for its essential oils and polyphenolic compounds, which demonstrate significant antioxidant, anti-inflammatory, antimicrobial, and neuroprotective activities. Rosemary essential oil comprises numerous monoterpenes and sesquiterpenes, with key constituents such as 1,8-cineole, camphor, α-pinene, and borneol. These elements are largely responsible for the plant's characteristic fragrance and contribute to its antimicrobial and respiratory-supporting functions (Pérez-Fons et al., 2010). Among its polyphenols, rosmarinic acid is one of the most extensively researched for its potent antioxidant and anti-inflammatory effects. Additional phenolic compounds like caffeic acid, carnosic acid, and carnosol also play crucial roles in combating oxidative stress and supporting neurological health. Carnosic acid and carnosol, classified as diterpenes, are particularly important for their neuroprotective potential, helping to defend neural cells from oxidative damage and offering therapeutic promise in neurodegenerative conditions. Furthermore, rosemary contains flavonoids such as luteolin and apigenin, which enhance its anti-inflammatory and antioxidant capabilities. The combined activity of these chemical constituents gives R. officinalis a wide range of beneficial biological

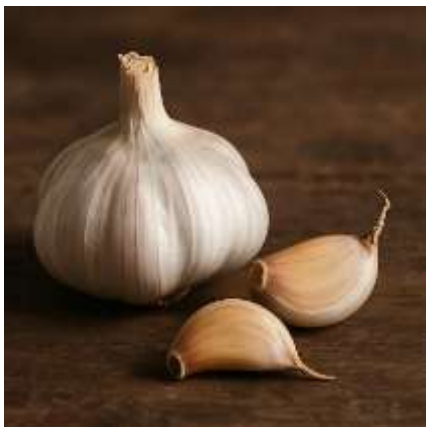
effects, validating its historical medicinal use and its continued relevance in contemporary fields such as pharmaceuticals, cosmetics, and food industry applications.

Therapeutic Benefits

Rosmarinus officinalis L. (rosemary) is a medicinal herb known for its wide range of health benefits, largely attributed to its abundance of active compounds like rosmarinic acid, carnosic acid, and essential oils. It possesses notable antioxidant, anti-inflammatory, antimicrobial, and neuroprotective effects. Traditionally, rosemary has been used to ease pain, aid digestion, and address respiratory issues. Its neuroprotective properties may contribute to the management of neurodegenerative disorders, while its antimicrobial nature promotes wound healing and helps prevent infections. Furthermore, rosemary supports cognitive health, alleviates stress, and benefits heart function, underscoring its value in both traditional remedies and modern healthcare.(34)

Garlic

Garlic (Allium sativum), a member of the Allium family, has been recognized for its medicinal properties for centuries. Commonly used as a culinary ingredient, garlic has shown notable pharmacological activities, particularly in the domains of pain relief (analgesic) and inflammation reduction (anti-inflammatory). In traditional medicine, garlic has been employed to treat a variety of ailments ranging from cardiovascular disorders to microbial infections. Scientific investigations into the bioactive compounds present in garlic have revealed its potent pharmacological effects, including analgesic and anti-inflammatory properties. These activities have made garlic a subject of interest in modern pharmacology and herbal medicine.



Chemical Constituents

The therapeutic effects of garlic can be attributed to its rich and diverse array of bioactive compounds. Some of the most significant compounds include:

1. **Allicin** is the most studied and biologically active sulfur compound in garlic. It is formed when garlic is crushed or chopped, and it possesses antimicrobial, anti-inflammatory, and analgesic properties.
2. **Diallyl Disulfide (DADS):** This sulfur compound contributes to garlic's anti-inflammatory properties and has been shown to inhibit the production of pro-inflammatory mediators such as cyclooxygenase (COX) and prostaglandins.
3. **S-allyl cysteine (SAC):** SAC is another sulfur compound that has been identified as having potent antioxidant and anti-inflammatory effects, contributing to the reduction of oxidative stress and inflammation.
4. **Fructans and Polysaccharides**: These compounds have been noted to support immune function and potentially alleviate inflammation.(35)

Therapeutic Benefits

Analgesic Activity

The analgesic effects of garlic have been investigated in both experimental models and clinical settings. Several studies have suggested that garlic can help alleviate pain through different mechanisms, including:

1. **Inhibition of Pro-inflammatory Cytokines:**Garlic has been shown to reduce the production of inflammatory mediators like prostaglandins and cytokines (TNF-α, IL-1β), which play key roles in the sensation of pain.(36)
2. **Activation of the Opioid Pathway**: Some animal studies indicate that garlic may activate the opioid receptors in the central nervous system, providing relief from chronic pain.

3. **Reduction in Oxidative Stress**: Garlic's antioxidant properties can also help mitigate oxidative stress, which is often associated with chronic pain conditions such as arthritis and neuropathic pain.

Anti-Inflammatory Activity

Garlic's anti-inflammatory effects are primarily attributed to its ability to regulate various molecular pathways involved in the inflammatory response. These include:

1. **Inhibition of COX and LOX Pathways**: Garlic compounds, particularly DADS, can suppress the activity of cyclooxygenase (COX) and lipoxygenase (LOX), enzymes responsible for the production of pro-inflammatory mediators such as prostaglandins and leukotrienes.
2. **Reduction of NF-κB Activation**: Garlic inhibits the activation of nuclear factor-kappa B (NF-κB), a transcription factor that controls the expression of genes involved in inflammation.
3. **Antioxidant Mechanisms**: Garlic also exerts its anti-inflammatory effects through its antioxidant properties, which reduce oxidative stress, a common initiator of inflammation.
4. **Impact on Inflammatory Mediators:** Garlic reduces the levels of key inflammatory cytokines such as TNF-α, IL-6, and IL-1β, S209394)further promoting its anti-inflammatory activity.(35)

Clove

Introduction

Clove (Syzygiumaromaticum) is a highly aromatic spice obtained from the dried flower buds of the clove tree, native to the Maluku Islands of Indonesia. Traditionally used in Ayurveda, Unani, and Chinese medicine, clove is recognized not only for its culinary value but also for its potent medicinal properties. Among these, its **analgesic (pain-relieving)** and **anti-inflammatory** activities are the most notable and well-researched. Clove has long been used in treating dental pain, headaches, muscle aches, and inflammatory conditions like arthritis. These effects are primarily attributed to its essential oil, particularly the compound **eugenol,** which exhibits both anesthetic and anti-inflammatory action.

Chemical Constituents

The pharmacological activity of clove is largely due to its essential oil composition, which includes:

1. Eugenol (70–85%): A phenolic compound with strong analgesic, anti-inflammatory, and antiseptic properties. Eugenol modulates pain receptors and reduces prostaglandin synthesis.
2. Beta-caryophyllene (7–12%): A sesquiterpene known to act as a CB2 receptor agonist, contributing to anti-inflammatory effects.
3. Eugenyl acetate and acetyleugenol: These compounds enhance the action of eugenol and exhibit soothing and numbing effects.
4. Flavonoids, tannins, and triterpenoids: These natural antioxidants support anti-inflammatory actions by reducing oxidative stress.
5. The synergistic interaction of these compounds provides a wide spectrum of biological activity.(37)

Therapeutic Benefits

Analgesic Activity

1. Clove is commonly used in dental preparations for its topical analgesic action. Eugenol acts by blocking sodium channels in neurons, thereby reducing the transmission of pain signals. Studies have shown that clove oil is effective in alleviating dental and muscular pain when applied topically.
2. In an in vivo study, clove extract significantly increased the pain threshold in mice using **hot plate and tail flick tests**, indicating central and peripheral analgesic actions. A clinical trial also revealed that clove gel was as effective as benzocaine in managing oral mucosal pain, further supporting its topical anesthetic role.

Anti-Inflammatory Activity

1. Clove exhibits significant anti-inflammatory action by inhibiting pro-inflammatory mediators such as prostaglandins, TNF-α, and nitric oxide. Eugenol also suppresses COX-2 enzyme activity and inhibits the NF-κB pathway, which are key contributors to inflammation.
2. In rodent models of inflammation, such as carrageenan-induced paw edema, clove oil reduced swelling and inflammatory markers, comparable to standard anti-inflammatory drugs like diclofenac. Its antioxidant constituents also help in neutralizing free radicals that aggravate inflammation.(38)(37)

Tulsi

Introduction

Tulsi, scientifically known as Ocimum sanctum, and commonly referred to as "Holy Basil," is one of the most revered plants in traditional Ayurvedic medicine. It has been used for centuries due to its powerful therapeutic properties, including its significant anti-inflammatory effects. Known as the "queen of herbs," Tulsi has earned its place in the wellness world not just for its spiritual significance but also for its potent medicinal qualities. In recent years, scientific studies have started to validate its traditional uses, particularly in the management of inflammation-related conditions. Inflammation is a natural immune response to injury or infection, but chronic inflammation is associated with various diseases, such as arthritis, cardiovascular disease, diabetes,

Chemical Constituents Of Tulsi

Tulsi contains a wide array of bioactive compounds responsible for its therapeutic effects. These constituents include:

1. **EUGENOL**: Eugenol is one of the primary bioactive compounds found in Tulsi. It possesses significant anti-inflammatory and analgesic properties, making it particularly useful in treating conditions like arthritis and muscle pain. Eugenol also has antioxidant properties that protect the body against oxidative stress, a key contributor to chronic inflammation.

2. **UROSOLICACID**: Urosolic acid, a triterpenoid compound, is found in Tulsi leaves and has shown promise in reducing inflammatory markers. It has also been linked to anti-cancer and anti-viral activities.

3. **RomanticAcid:**Known for its anti-inflammatory and antioxidant properties, rosmarinic acid can inhibit pro-inflammatory enzymes like cyclooxygenase-2 (COX-2), thereby reducing inflammation.

4. **Flavonoids and Phenolic Compounds:**These compounds contribute to Tulsi's antioxidant capacity and work synergistically to reduce inflammation. They also help modulate the immune system by inhibiting the release of inflammatory cytokines.
5. **Tannins and Saponins:**Tannins are astringent compounds that have demonstrated anti-inflammatory effects by modulating immune cell activity. Saponins are known to possess immunomodulatory and anti-inflammatory effects, enhancing the overall therapeutic benefits of Tulsi.(39)

Therapeutic Benefits

Tulsi's anti-inflammatory properties are multifaceted and extend to a range of health conditions:

Arthritis and Joint Pain

Studies have demonstrated that Tulsi extracts can reduce pain and swelling in individuals with rheumatoid arthritis and osteoarthritis. The eugenol content in Tulsi is believed to play a key role in inhibiting the production of pro-inflammatory mediators, leading to a reduction in pain and stiffness.

Respiratory Health

Tulsi is well-known for its ability to treat respiratory conditions, including asthma, bronchitis, and coughs. By reducing inflammation in the airways, it helps improve breathing and reduce symptoms such as wheezing and shortness of breath. Tulsi's ability to act as a bronchodilator further supports its use in respiratory distress.

Cardiovascular Health

Chronic inflammation is a significant risk factor for cardiovascular diseases, including heart attacks and strokes. Tulsi's anti-inflammatory properties can help protect the heart and blood vessels by reducing the inflammatory markers that contribute to the narrowing of blood vessels, thus improving circulation and heart health.(40)

Skin Inflammation

Topical application of Tulsi extracts has shown promise in treating skin conditions like acne, eczema, and psoriasis. The anti-inflammatory properties help calm irritation, reduce redness, and promote faster healing of the skin.

Neurological Protection

Recent research suggests that Tulsi has neuroprotective properties, helping to reduce inflammation in the brain. This can potentially aid in the management of neurodegenerative diseases such as Alzheimer's and Parkinson's disease by lowering inflammation-induced neurodegeneration.(41)

Liquorice

Introduction

Glycyrrhizaglabra, commonly referred to as liquorice, is a perennial plant belonging to the legume family, naturally found in Southern Europe and various parts of Asia. Its roots have a long history of use in traditional medicinal systems, valued for their broad therapeutic benefits. Modern scientific investigations have affirmed many of these historical uses, particularly its potential in alleviating pain and controlling inflammation.

Chemical Constituents

Liquorice root contains an array of bioactive compounds responsible for its pharmacological actions. Key components include:

1. **Glycyrrhizin**: A triterpenoid saponin that plays a central role in the plant's medicinal effects.
2. **Glabridin**: A potent antioxidant flavonoid.
3. **Isoliquiritigenin**: A chalcone known for its dual action as an anti-inflammatory and antioxidant agent.
4. **Liquiritigenin**: A flavonoid with emerging anti-inflammatory potential.
5. **Licochalcones**: A group of phenolic substances that exhibit strong antioxidant and inflammation-reducing activities.
6. **Glycyrrhetinic acid**: A metabolite derived from glycyrrhizin, known for its significant anti-inflammatory effects. (42)

Therapeutic Benefits

Analgesic Effects

Liquorice has shown the ability to reduce pain through multiple physiological mechanisms:

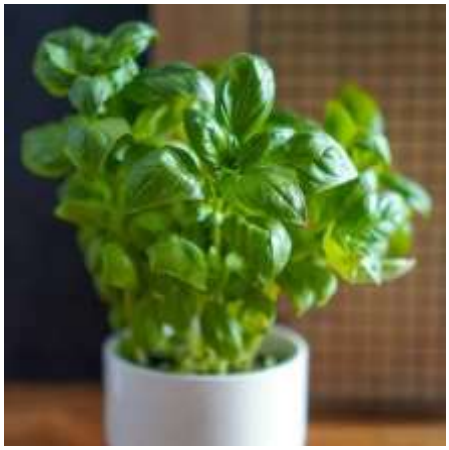
1. **Inhibition of COX-2**: Glycyrrhizin suppresses cyclooxygenase-2, an enzyme that facilitates the synthesis of pro-inflammatory compounds that contribute to pain.
2. **iNOS Activity Reduction**: It lowers inducible nitric oxide synthase (iNOS) expression, thereby reducing nitric oxide levels associated with pain signaling.
3. **Cytokine Regulation**: Bioactive constituents in liquorice help downregulate pro-inflammatory cytokines, leading to reduced pain perception. (43)

Anti-Inflammatory Effects

Liquorice's anti-inflammatory effects are well recognized in pharmacological literature:

1. **NF-κB Suppression**: Active compounds inhibit the nuclear factor kappa-light-chain-enhancer of activated B cells (NF-κB) pathway, a key regulator of inflammation.
2. **MAPK Pathway Modulation**: It interferes with mitogen-activated protein kinases, crucial enzymes in the inflammatory cascade. (44)
3. **Cytokine Suppression**: Liquorice helps lower levels of inflammatory mediators like TNF-α and IL-6.
4. **Antioxidant Action**: Many of its constituents neutralize oxidative stress, which plays a major role in chronic inflammation. (45)

Basil



Introduction

Sweet basil (*Ocimumbasilicum*), an aromatic herb from the Lamiaceae family, originates from tropical areas in Central Africa and Southeast Asia. Widely cultivated for both culinary and therapeutic applications, basil has earned scientific validation for its traditional use in managing pain and inflammation.

Chemical Constituents

Basil's therapeutic potential is attributed to its diverse array of phytochemicals, including:

1. **Eugenol**: A phenolic compound noted for its pain-relieving and anti-inflammatory activities.
2. **Methyl chavicol (estragole)**: Provides antimicrobial and mild anti-inflammatory effects.
3. **Linalool**: A terpene with calming, analgesic, and inflammation-reducing properties.
4. **β-Caryophyllene**: This sesquiterpene modulates inflammation via cannabinoid receptor pathways.
5. **1,8-Cineole (eucalyptol)**: Offers mucolytic and anti-inflammatory effects.
6. **Methyl eugenol**: Shares structural similarity with eugenol and supports anti-inflammatory responses. (46)

Therapeutic Benefits

Analgesic Effects

Basil contributes to pain reduction through several mechanisms:

1. **COX Enzyme Inhibition**: Eugenol and other compounds inhibit cyclooxygenase enzymes, limiting prostaglandin synthesis that contributes to pain.
2. **TRPV1 Receptor Interaction**: Certain components engage with TRPV1 receptors, integral to pain signal transmission.

3. **Neurochemical Modulation**: Basil's compounds influence neurotransmitters that mediate the perception of pain. (47)

Anti-Inflammatory Effects

Basil's anti-inflammatory effects stem from its action on multiple biological targets:

1. **NF-κB Inhibition**: Its phytochemicals prevent the activation of the NF-κB pathway, thereby reducing the production of inflammatory proteins. (48)
2. **Reduction of Cytokines**: Basil lowers circulating levels of TNF-α, IL-6, and other inflammatory cytokines.
3. **Antioxidant Effects**: Antioxidants present in basil mitigate oxidative stress, a key driver of inflammation-related disorders. (49)

CONCLUSION

The management of pain and inflammation has long relied on pharmaceutical interventions, but growing concerns over side effects, drug resistance, and long-term safety have led both patients and researchers to explore alternative approaches. Herbal medicine, with its rich history rooted in traditional healing systems, has emerged as a promising complementary or integrative strategy in pain and inflammation management. A wide range of herbal ingredients—such as turmeric (Curcuma longa), ginger (Zingiber officinale), boswellia (Boswellia serrata), willow bark (Salix alba), and devil's claw (Harpagophytum procumbens)—have demonstrated potent anti-inflammatory and analgesic properties in both preclinical and clinical studies.. These botanicals often act through multiple pathways, including the inhibition of pro-inflammatory cytokines, downregulation of cyclooxygenase (COX) enzymes, and modulation of oxidative stress. Unlike many synthetic drugs that target single pathways, herbal remedies may offer a broader, synergistic mode of action, which can potentially lead to more holistic and sustained relief. Importantly, herbal treatments are often perceived as more natural and gentler alternatives. When used responsibly and under proper guidance, they may offer fewer adverse effects, especially for individuals requiring long-term management of chronic pain or inflammation. However, the notion that "natural" equals "safe" must be approached with caution. Nevertheless, the resurgence of interest in plant-based therapies, backed by growing scientific evidence, underscores the need for more robust clinical trials, regulatory oversight, and interdisciplinary collaboration. Integrating modern pharmacological tools with traditional wisdom can help unlock the full therapeutic potential of herbal ingredients.In summary, herbal remedies offer a valuable adjunct or alternative for managing pain and inflammation, especially when conventional treatments are insufficient or not well tolerated. While they are not without limitations, their multifaceted effects and growing evidence base make them worthy of deeper exploration and integration into personalized healthcare strategies. With continued research, education, and responsible use, herbal ingredients can play a meaningful role in promoting relief and enhancing quality of life for individuals dealing with acute or chronic inflammatory conditions.

Images Sourced From- https://chatgpt.com/g/g-3bxChvw71-link
https://in.pinterest.com/pin/478718635413369300/

REFERENCES

[1] Unauthorized Natural Substances in Herbal Food Supplements on EU Market. Končić, Marijana Zovko. New York : Thieme, 2017.
[2] Efficacy of Laws onia interims in fungal control. Journal of Applied Aquaculture. P, Bhatnagar. A & Devi. Chennai : s.n., 2010, Vol. 1. isbn.
[3] Antifungal properties of neem in aquaculture. In Aquaculture and Fish Health. El-Sayed, A. F. M. 2020.
[4] Adaptogenic properties of six rasayana herbs used in Ayurvedic medicine. N N Rege, U M Thatte, S A Dahanukar. Delhi : Pubmed, 1999.
[5] Echinacea purpurea and Allium sativum as immunostimulants in fish culture using Nile tilapia (Oreochromis niloticus). S M Aly, M F Mohamed. Punjab : Pubmed, 2010.
[6] Pharmacology of Curcuma longa. A, Ammon. H. P & hl. M. Ohio : Planta medica, 1999.
[7] Antioxidant activity of Ocimum sanctum. Bhattacharya. S.K, Bhattacharya. A, Sairam. K,Ghosal. S. Chennai : Indian Journal Of Experimental Biology, 2001.

[8] Use of Phyllanthus emblica in growth promotion of fish. Pandey, A., Singh, A., & Das. P. Chennai : Fish Physiology and Biochemistry, 2012.
[9] Stress tolerance induced by herbal supplements. Dey. A, De. J.N, Datta. A. Punjab : Journal of Ayurveda and Integrative Medicine, 2016.
[10] The efficacy of aloe vera used for burn wound healing: a systematic review. Ratree Maenthaisong, Nathorn Chaiyakunapruk, Surachet Niruntraporn, Chuenjid Kongkaew. Delhi : Pubmed, 2007 sep.
[11] Review of Anti-Inflamatory Herbal Medicines. Ghasemian, Mona. s.l. : National Library Of Medicine, 2016. 27247570.
[12] Curcumin, a component of golden spice: From bedside to bench and back. Sahdeo Prasad, Subash C. Gupta, Amit K. Tyagi. 6, Texas : science direct, 30 April 2014, Vol. 32.
[13] Potential therapeutic effects of curcumin, the anti-inflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases. Bharat B. Aggarwal, Kuzhuvelil B. Harikumar. 1, Texas : Science Direct, 2009, Vol. 41.
[14] Synergistic antibacterial effect of curcumin against methicillin-resistant Staphylococcus aureus. Su-Hyun Mun, Dae-Ki Joung, Yong-Sik Kim, Ok-Hwa Kang, Yun-Soo Seo, Dong-Yeul Kwon. 8-9, korea : Science direct, 2013, Vol. 20.
[15] Neuroprotective Effects Of Curcumin. Greg M. Cole, Bruce Teter & Sally A. Frautschy. Punjab : Signature link, 2010.
[16] Cytotoxic and cytoprotective activities of curcumin: studies on curcumin and curcuminoids in isolated rat hepatocytes and in rat liver microsomes and hepatocytes. Donatus, I. A., Sardjoko, & Vermeulen, N. P. chicago : Biochemical Phrmacology, 1990.
[17] Ellis, Mary Ellen. Health Line. healthline.com. [Online] october 01, 2024. https://www.healthline.com/health/osteoarthritis/turmeric-and-anti-inflammatory-herbs.
[18] Medicinal properties of 'true' cinnamon (Cinnamomum zeylanicum): a systematic review. Priyanga Ranasinghe, Shehani Pigera, GA Sirimal Premakumara, Priyadarshani Galappaththy, Godwin R Constantine & Prasad Katulanda. Chennai : BMC complementary and alternative medicine, 2013.
[19] Cinnamon Improves Glucose and Lipids of People With Type 2 Diabetes. Alam Khan, MS, PHD, et al., et al. 12, Beltsville : American diabetes applicaion, 2003, Vol. 26.
[20] Antioxidant activity of cinnamon (Cinnamomum zeylanicum, Breyne) extracts. Mancini-Filho, J., Van-Koiij, A., Mancini, D. A., Cozzolino, F. F., & Torres, R. P. Darjelling : Bollettino Chimico Farmaceutico, 1998.
[21] Anti-inflammatory activities of the methanol extract of Cinnamomum cassia and its active components. Tung, Y. C., Chou, Y. C., Wu, J. H., Chen, C. C., & Kuo, Y. H. Kolakata : Journal of Agricultural and Food Chemistry, 2008.
[22] Antimicrobial activities of cinnamon oil and cinnamaldehyde from the Chinese medicinal herb Cinnamomum cassia Blume. Ooi, L. S. M., Li, Y., Kam, S. L., Wang, H., Wong, E. Y. L., & Ooi, V. E. C. Ahmedabad : American Journal of Chinese Medicine, 2006.
[23] Cinnamon and health. Gruenwald, J., Freder, J., & Armbruester, N. Udaipur : Critical Reviews in Food Science and Nutrition, 2010.
[24] Medicinal Plant With Potent Anti-inflammatory and Anti-arthritic properties found in Eastern Parts of Himalaya:An Ethnomedical Review. Bapan Banik, Sanjoy Das. 28, Assam : s.n., 2020, Vol. 14.
[25] Some phytochemical, pharmacological and toxicological properties of ginger (Zingiber officinale Roscoe): A review of recent research. Badreldin H. Ali, Gerald Blunden, Musbah O. Tanira, Abderrahim Nemmar. 2, Oman : Science direct, 2008, Vol. 46.
[26] Ginger—An Herbal Medicinal Product with Broad Anti-Inflammatory Actions. Reinhard Grzanna, Lars Lindmark, and Carmelita G. Frondoza. 2, Qatar : Journal of medicinal food, 2005, Vol. 8.
[27] Efficacy of ginger for nausea and vomiting: a systematic review of randomized clinical trials. Ernst, E., & Pittler, M. H. Yemen : British Journal of Anaesthesia, 2000.
[28] Cancer preventive properties of ginger: A brief review. Yogeshwer Shukla, Madhulika Singh. 5, Uttar Pradesh : Science direct, 2007, Vol. 45.
[29] Protective effects of Zingiber officinale (Zingiberaceae) against carbon tetrachloride and acetaminophen-induced hepatotoxicity in rats. Omoniyi K. Yemitan, Matthew C. Izegbu. Jharkandh : Phytotherapy Research, 2006.
[30] Pharmaceutical and herbal products that may contribute to dry eyes. Ufuk Askeroglu, Brendan Alleyne, Bahman Guyuron. Punjab : Pubmed, 2013 Jan.
[31] Echinacea for treating the common cold: a randomized trial. Bruce Barrett, Roger Brown, Dave Rakel, Marlon Mundt, Kerry Bone, Shari Barlow, Tola Ewers. Punjab : Pubmed, 2010 Dec.

[32] Use of a standardized extract from Echinacea angustifolia (Polinacea) for the prevention of respiratory tract infections. Francesco Di Pierro, Giuliana Rapacioli, Tarcisio Ferrara, Stefano Togni. Delhi : Pubmed, 2012 Mar.
[33] The potential use of Echinacea in acne: control of Propionibacterium acnes growth and inflammation. M Sharma, R Schoop, A Suter, J B Hudson. Delhi : Pubmed, 2011 Apr.
[34] Relationship between the antioxidant capacity and effect of rosemary (Rosmarinus officinalis L.) polyphenols on membrane phospholipid order. Pérez-Fons, L., Garzón, M. T., & Micol, V. Sharja : Journal of Agricultural and Food Chemistry, 2010.
[35] Garlic And Its Bioactive Compounds In The Prevention Of Inflammation And Pain Related Diseases. Zhao, B., Li, J., & Wang, W. 2019, Vol. 12.
[36] Analgesic And Anti Inflammatory Properties Of Garlic In Experimental Models. Roh E, Lee J. S.L. : Frontiers In Pharmacology, 2021, Vol. 12.
[37] Anti-Inflammatory And Anti-Nocieptive Activities Of Eugenolessential Oilin Experimental Animal Models. Daniel .A.N, Sartoretto .Sm, Schmidt .G, Caparroz-Assef Sm,. S.L. : Rev Bras Commun, 2009.
[38] A Natural Compound With Versatile Pharmacological Actions. Pramod K, Ansari Sh, Ali J. S.L. : Nat Prod Commum, 2015.
[39] Therapeutic potential of Tulsi (Ocimum sanctum) in the management of inflammation. Pandey, A., & Verma, S. s.l. : Journal of Herbal Medicine., 2021, Vol. 28(3).
[40] Pharmacological properties of Tulsi (Ocimum sanctum) and its role in inflammatory diseases. Sharma, M., & Bansal, S. s.l. : Phytotherapy Research., 2019, Vol. 33(5).
[41] Antioxidant and anti-inflammatory activities of Tulsi (Ocimum sanctum) in clinical trials. Mishra, S., & Bhattacharyya, D. s.l. : Indian Journal of Pharmaceutical Sciences, 2020, Vol. 82(4).
[42] Anti-inflammatory activity of glycyrrhizin and glycyrrhetinic acid: Molecular mechanisms and therapeutic potential. Arystarkhova, A. et al. s.l. : International Journal of Molecular Sciences, 2021, Vol. 22(5).
[43] Flavonoids from Glycyrrhiza uralensis and their anti-inflammatory activities. Wang, Z. et al. 2013, Vol. 27(2).
[44] Licorice: A possible anti-inflammatory and anti-viral agent. Fiore, C. et al. s.l. : Medical Research Reviews, 2008, Vol. 28(1).
[45] Anti-inflammatory effects of glycyrrhizin in experimental models. Yamamoto, Y. et al. s.l. : Life Sciences, 1999.
[46] Antioxidant and cyclooxygenase inhibitory compounds from Ocimum sanctum. Kelm, M. A. et al. s.l. : Phytomedicine, 2000.
[47] Evaluation of anti-inflammatory and analgesic activity of Ocimum sanctum Linn (Tulsi). Gupta, S. K. et al. s.l. : Journal of Ethnopharmacology, 2005.
[48] Anti-inflammatory effect of Ocimum basilicum L. essential oil complexed in β-cyclodextrin. Vasconcelos, da Silveira. s.l. : BMC Complementary Medicine and Therapies, 2023, Vol. ARTICLE 195.
[49] 49. A review on the pharmacological effects of Ocimum basilicum L. (Sweet Basil). Kooti, W. et al. s.l. : Biomedicine & Pharmacotherapy, 2022.