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Review Article

Screening of *Tinospora cordifolia* Miers for its Anti-Inflammatory Activity

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ABSTRACT

Tinospora cordifolia is a medicinal plant widely found in Tamil Nadu and is known for its therapeutic properties. Preliminary phytochemical screening showed the presence of steroids, terpenoids, phenolic compounds, tannins, and alkaloids, which contribute to its pharmacological effects. The study evaluated the anti-inflammatory activity of chloroform and ethanol extracts of the plant and found that both extracts exhibited significant anti-inflammatory activity, supporting its traditional medicinal use.

INTRODUCTION

Tinospora cordifolia is a widely used medicinal plant known for its therapeutic properties. It contains berberine, a major active constituent, and has been traditionally used to treat diabetes, fever, infections, and venomous bites. Previous studies have reported its antioxidant, antitumor, and immunomodulatory activities, but its anti-inflammatory effect had not been scientifically validated. Therefore, this study was conducted to evaluate the anti-inflammatory activity of *Tinospora cordifolia* extracts using the

carrageenan-induced paw edema model in albino rats.

OVERVIEW OF INFLAMMATION

Inflammation is a vital immune response that protects the body against infections and tissue damage while maintaining normal tissue homeostasis. It is initiated by the recognition of molecular signals associated with pathogens or injured tissues, triggering complex molecular pathways that regulate the production of pro-inflammatory mediators. Although acute inflammation is beneficial for healing and defense,

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prolonged or uncontrolled inflammation can lead to harmful health effects. Persistent inflammatory stimuli and genetic factors contribute to chronic inflammation, increasing the risk of various inflammatory diseases and pathological conditions.

NEED FOR SAFER ANTI-INFLAMMATORY AGENTS

Conventional non-steroidal anti-inflammatory drugs (NSAIDs) remain the cornerstone of therapy for inflammatory disorders such as osteoarthritis, rheumatoid arthritis, ankylosing spondylitis, and acute gout because of their proven efficacy in reducing pain and inflammation. However, prolonged NSAID therapy is frequently associated with serious adverse effects, including gastrointestinal bleeding, renal dysfunction, cardiovascular complications, and hepatotoxicity, limiting their long-term use. In addition, alternative treatments such as opioids, corticosteroids, and colchicine have significant limitations, including dependence, immunosuppression, and other systemic adverse effects. These drawbacks highlight the need to develop safer anti-inflammatory agents that are effective, well tolerated, and suitable for chronic use. Medicinal plants such as *Tinospora cordifolia* have attracted considerable interest because their bioactive constituents exhibit anti-inflammatory, antioxidant, and immunomodulatory activities, making them promising candidates for the development of safer therapeutic alternatives.

IMPORTANCE OF MEDICINAL PLANTS IN INFLAMMATION MANAGEMENT

Medicinal plants are important in the management of inflammation because they contain bioactive phytochemicals such as flavonoids, phenolics, tannins, saponins, and triterpenes, which possess significant anti-inflammatory properties.

Compared with conventional NSAIDs, medicinal plants generally produce fewer adverse effects and are considered safer for long-term use. Their diverse natural compounds provide valuable sources for the development of new anti-inflammatory drugs with improved efficacy and lower toxicity. Plant-derived compounds exert their effects by inhibiting inflammatory mediators such as cytokines, chemokines, nitric oxide, and the arachidonic acid pathway. Thus, medicinal plants represent promising alternatives and complementary therapies for the prevention and treatment of inflammatory diseases.

BOTANICAL PROFILE OF TINOSPORA CORDIFOLIA (MIERS.)

Tinospora cordifolia (Thunb.) Miers, commonly known as Guduchi or Giloy, is a large, deciduous, perennial climbing shrub belonging to the Menispermaceae family. It is indigenous to tropical regions of India, Myanmar, Sri Lanka, China, Thailand, the Philippines, Indonesia, Malaysia, Vietnam, Bangladesh, and parts of Africa. The plant typically grows in deciduous and dry forests at elevations up to 1,000 feet (≈300 m) and thrives in a wide range of soils, from acidic to alkaline, with moderate moisture. The family Menispermaceae comprises approximately 70 genera and 450 species, many of which are rich in biologically active alkaloids and terpenoids. The genus *Tinospora* includes about 32 species distributed across tropical regions of Africa, Asia, Australia, and the Pacific Islands, with *T. cordifolia* being the most widely studied and medicinally important species in India due to its broad therapeutic potential.

ETHNOMEDICINAL USES OF TINOSPORA CORDIFOLIA

Different parts of *Tinospora cordifolia* have been traditionally used to treat a wide range of ailments.



The leaves are used for the treatment of gout and ulcers, while the stem is valued for its bitter, stomachic, diuretic, and blood-purifying properties. Stem preparations are traditionally used to manage jaundice, diabetes, skin disorders, fever, enlarged spleen, intestinal worms, chronic diarrhoea, dysentery, and digestive disorders, as well as for their antipyretic and antimalarial effects. A combination of the stem and root is used as an antidote for snake bites and scorpion stings. The fruits are consumed with ghee or honey as a tonic and for treating jaundice and rheumatism, whereas the bark possesses anti-allergic, antispasmodic, and anti-leprotic properties. Overall, *T. cordifolia* is widely recognized in traditional medicine for treating urinary and skin diseases, bronchitis, syphilis, and for enhancing immunity, promoting longevity, and increasing the body's resistance to diseases.

PATHOPHYSIOLOGY OF INFLAMMATION

Inflammation begins when the immune system recognizes pathogens or tissue injury through pattern recognition receptors (PRRs), such as Toll-like receptors (TLRs). This activates the release of pro-inflammatory mediators, including histamine, prostaglandins, leukotrienes, and cytokines (IL-1, IL-6, and TNF- α), leading to vasodilation, increased vascular permeability, and migration of leukocytes to the affected site. Acute inflammation is primarily mediated by neutrophils, which eliminate pathogens through phagocytosis and the production of reactive oxygen species. In contrast, chronic inflammation develops when the inflammatory stimulus persists or immune regulation fails. It is characterized by the infiltration of macrophages, lymphocytes, and plasma cells, resulting in tissue remodeling and fibrosis. Persistent activation of inflammatory pathways, particularly NF- κ B and pro-

inflammatory cytokines, contributes to chronic inflammatory diseases such as rheumatoid arthritis, inflammatory bowel disease, and systemic lupus erythematosus.

MECHANISM OF ACTION

Tinospora cordifolia (Guduchi) exhibits potent anti-inflammatory activity by modulating multiple inflammatory signaling pathways. It inhibits the activation and nuclear translocation of NF- κ B and suppresses MAPK signaling, thereby reducing the production of pro-inflammatory cytokines such as TNF- α , IL-1 β , IL-6, and IL-17. The plant also downregulates inflammatory enzymes, including inducible nitric oxide synthase (iNOS) and cyclooxygenase-2 (COX-2), resulting in decreased synthesis of nitric oxide (NO) and prostaglandin E₂ (PGE₂). Bioactive constituents such as alkaloids, glycosides, and diterpenoid lactones further contribute to its anti-inflammatory effects by regulating cytokine production. Additionally, *T. cordifolia* demonstrates immunomodulatory and anti-osteoclastic properties, helping to protect joints and cartilage from damage in chronic inflammatory conditions such as rheumatoid arthritis.

SCREENING OF ANTI-INFLAMMATORY ACTIVITY

The anti-inflammatory activity of chloroform and ethanolic extracts of *Tinospora cordifolia* was evaluated using the carrageenan-induced hind paw edema model in albino rats. Animals were divided into four groups: control, diclofenac sodium (standard), chloroform extract, and ethanolic extract. Paw edema was measured at 0, 60, 120, 180, and 240 minutes using a plethysmograph.

The ethanolic extract showed better anti-inflammatory activity than the chloroform extract, with 29.41% inhibition of paw edema at 240



minutes, while the chloroform extract showed 22.03% inhibition. The standard drug diclofenac sodium produced the highest inhibition (57.75%). The study concluded that *Tinospora cordifolia*, particularly its ethanolic extract, possesses significant anti-inflammatory properties.

PHARMACOLOGICAL EFFECTS

Tinospora cordifolia (Guduchi) possesses diverse pharmacological properties supported by experimental and preclinical studies. It exhibits strong antioxidant activity by scavenging free radicals, reducing lipid peroxidation, and enhancing antioxidant enzymes such as superoxide dismutase (SOD), catalase, glutathione peroxidase (GPx), and glutathione (GSH). The plant demonstrates antidiabetic effects by lowering blood glucose levels, improving insulin secretion, reducing oxidative stress, and regulating carbohydrate metabolism. It also shows broad-spectrum antimicrobial activity against several pathogenic bacteria while enhancing phagocytic and immunostimulatory functions.

In addition, *T. cordifolia* has shown anticancer and chemopreventive potential by inhibiting tumor growth, reducing metastasis, protecting against radiation-induced damage, and enhancing detoxifying enzymes. It also exhibits anti-HIV activity by improving immune responses and enhancing the effectiveness of antiretroviral therapy. The plant possesses anti-arthritic and anti-osteoporotic properties, promoting osteoblast differentiation, protecting cartilage, and reducing bone loss. Furthermore, *T. cordifolia* displays antipyretic, immunomodulatory, and anti-toxic activities by regulating cytokine production, activating macrophages and antibody responses, and protecting organs against toxin-induced oxidative damage. These multiple pharmacological actions highlight its potential as a valuable therapeutic agent for managing

inflammatory, metabolic, infectious, and degenerative diseases.

TOXICITY OF TINOSPORA CORDIFOLIA

Tinospora cordifolia is generally considered safe when used in moderation. However, prolonged use, high doses, or unsupervised self-medication may increase the risk of liver injury (hepatotoxicity). Although traditionally regarded as a hepatoprotective herb, recent evidence has reported cases of liver damage ranging from mild elevations in liver enzymes to acute hepatitis. Individuals with pre-existing liver disease, older adults, and genetically susceptible people may be at greater risk. Additionally, the plant can accumulate heavy metals from contaminated soil, making the quality and source of the raw material important for safety. Animal studies indicate that aqueous extracts are generally safe at doses up to 2000 mg/kg/day, but human use should remain moderate and under medical supervision.

FUTURE PERSPECTIVES

Future research on *Tinospora cordifolia* should focus on developing nanophytomedicine to enhance the bioavailability and targeted delivery of its bioactive compounds. A key challenge is the standardization of extracts, as phytochemical composition varies with geographical origin, plant age, and extraction methods. Additionally, although promising results have been demonstrated in laboratory and animal studies, large-scale human clinical trials are needed to establish optimal dosages, confirm long-term safety, and validate therapeutic efficacy.

CONCLUSION

The study concluded that *Tinospora cordifolia* (Guduchi) leaves possess significant anti-inflammatory activity. Both the chloroform and



ethanolic leaf extracts effectively reduced inflammation in the experimental model, supporting the traditional use of the plant as an anti-inflammatory remedy.

The authors suggest that *Tinospora cordifolia* could serve as a safer alternative to conventional painkillers, potentially offering fewer adverse effects such as gastric ulcers, hepatotoxicity, and nephrotoxicity, which are commonly associated with prolonged use of NSAIDs, especially in chronic inflammatory conditions like arthritis.

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