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A Review on Anti-Inflammatory Activity of *Tinospora cordifolia* (Giloy)

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ABSTRACT

Tinospora cordifolia (Willd.) Hook. f. & Thomson, commonly known as Giloy or Guduchi, is an important medicinal plant widely used in traditional Ayurvedic medicine for its immunomodulatory and anti-inflammatory properties. The present review summarizes the available preclinical pharmacological studies investigating the anti-inflammatory potential of *T. cordifolia.* Several in vivo experimental models, including carrageenan-induced paw edema, collagen-induced arthritis, and neuroinflammation models, have demonstrated significant reduction of both acute and chronic inflammatory responses following administration of various extracts of the plant [1–3]. In addition, in vitro studies using macrophage and immune cell lines have confirmed the suppression of important pro-inflammatory mediators such as tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), interleukin-6 (IL-6), nitric oxide (NO), prostaglandin E_2 (PGE_2), and cyclooxygenase-2 (COX-2) [4,5]. Mechanistic studies further suggest modulation of key inflammatory signaling pathways including nuclear factor-kappa B (NF-κB), mitogen-activated protein kinase (MAPK), and Janus kinase/signal transducer and activator of transcription (JAK/STAT) [5,6].The anti-inflammatory activity of *T. cordifolia* is primarily attributed to the presence of several bioactive phytoconstituents such as alkaloids, diterpenoid lactones, glycosides, steroids, and polysaccharides [2,7]. Toxicological investigations indicate a favorable safety profile in experimental models; however, long-term clinical studies and standardized formulations are still limited [4].Overall, the available evidence highlights the potential of *T. cordifolia* as a promising multi-targeted anti-inflammatory agent and supports the need for further translational and clinical research.

Keywords: *Tinospora cordifolia,* Anti-inflammatory, Phytoconstituents, Pharmacological activities

INTRODUCTION

Inflammation is a highly coordinated biological response initiated by the immune system to eliminate harmful stimuli, including pathogens, toxins, allergens, and tissue injury. It is an essential defense mechanism aimed at restoring tissue homeostasis. However, when excessive, prolonged, or dysregulated, inflammation becomes a critical driver of tissue damage and chronic disease progression [8].

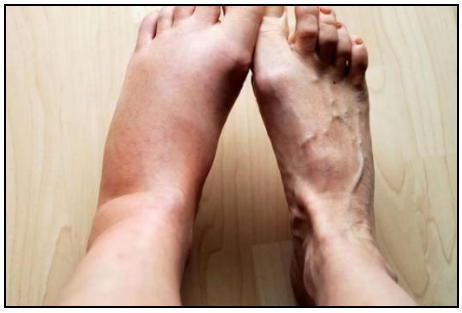

Figure 1: Inflammation

The classical signs of inflammation include redness (rubor), heat (calor), swelling (tumor), pain (dolor), and loss of function (functio laesa). These responses are mediated by several inflammatory mediators including cytokines, prostaglandins, histamine, and nitric oxide [9].

Although inflammation is a protective process, excessive or uncontrolled inflammatory responses can contribute to the development of various chronic diseases such as rheumatoid arthritis, cardiovascular diseases, diabetes, inflammatory bowel disease, and cancer [8,9]. Therefore, controlling inflammation is a major therapeutic target in modern medicine.

CLASSIFICATION OF INFLAMMATION:

Inflammation is broadly classified into two major types: **acute inflammation** and **chronic inflammation** [13,14].

1. Acute Inflammation: This is your immune system's response to a sudden injury or illness. Inflammatory cells travel to the site of injury (like a cut on your finger) or infection and start the healing process. Infections in different parts of your body can cause sudden, and usually short-lived, inflammation. For example, bacterial infections like strep throat and viral infections like the flu can cause throat inflammation. Other bacterial and viral infections can cause inflammation of your small intestine (enteritis). Acute inflammation may last for a few hours to a few days, depending on your condition [13,15].

2. Chronic Inflammation: This is when your body continues sending inflammatory cells even when there's no danger. For example, in rheumatoid arthritis, inflammatory cells and substances attack joint tissues. This leads to inflammation that comes and goes and can cause severe damage to your joints. With chronic inflammation, processes that normally protect your body end up hurting it. Chronic inflammation can last for months or years. You may have periods where it improves and other times when it gets worse. Researchers have linked chronic inflammation to a wide range of conditions (inflammatory diseases) [14,16].

EPIDEMIOLOGY OF INFLAMMATION

Inflammation is a fundamental biological response to injury, infection, or harmful stimuli. Epidemiologically, it plays a central role in many acute and chronic diseases worldwide [24,25].

1. Global Burden of Inflammatory Diseases

Inflammation underlies a large proportion of the world's leading causes of death and disability, including:

- Cardiovascular diseases (e.g., atherosclerosis)
- Cancer
- Chronic respiratory diseases
- Autoimmune disorders
- Metabolic diseases (e.g., type 2 diabetes) [25,26].

According to the World Health Organization, non-communicable diseases (NCDs) account for over 70% of global deaths, and chronic low-grade inflammation is a common underlying mechanism [27].

2. Epidemiology by Major Disease Categories

A. Cardiovascular Disease [26,28]

- Atherosclerosis is now recognized as a chronic inflammatory condition
- Elevated inflammatory markers (e.g., CRP, IL-6) predict cardiovascular events.
- Leading cause of mortality worldwide

B. Autoimmune Diseases [29]

Examples:

- Rheumatoid arthritis

- Systemic lupus erythematosus
- Inflammatory bowel disease

Epidemiological patterns:

- More common in females
- Increasing incidence in industrialized countries
- Higher prevalence in populations with genetic susceptibility

C. Chronic Respiratory Diseases [30]

- Asthma and COPD have inflammatory pathophysiology
- Higher prevalence in urban and polluted regions

D. Metabolic Disorders [31]

- Obesity-related inflammation (adipose tissue cytokine production)
- Insulin resistance linked to chronic low-grade inflammation
- Global obesity epidemic driving inflammatory disease burden

3. Geographic and Demographic Patterns [25,29,31]

- **High-income countries**: Higher prevalence of autoimmune and metabolic inflammatory diseases.
- **Low-income countries**: Higher rates of acute inflammatory diseases due to infections.
- **Age**: Chronic inflammation increases with age.
- **Sex**: Autoimmune inflammatory diseases are more common in women.
- **Socioeconomic status**: Lower SES is associated with higher inflammatory biomarkers due to stress, poor diet, and environmental exposures.

4. Risk Factors for Chronic Inflammation [25,31]

- Obesity
- Smoking
- Physical inactivity
- Chronic psychological stress
- Poor diet (high refined sugars, trans fats)
- Air pollution
- Persistent infections

5. Emerging Trends [25,32]

- Increasing prevalence of inflammatory diseases globally
- Growing interest in anti-inflammatory therapies (biologics, cytokine inhibitors)
- Precision medicine approaches targeting inflammatory pathways
- Research into microbiome–inflammation interactions

1 MOLECULAR MECHANISMS OF INFLAMMATION

The inflammatory response is regulated by a complex network of molecular signaling pathways and mediators. When tissue damage or infection occurs, immune cells such as macrophages and neutrophils are activated and release various pro-inflammatory mediators [17].

Key inflammatory mediators include cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-1 beta (IL-1β), and interleukin-6 (IL-6), which promote the recruitment of immune cells to the site of injury. Enzymes such as cyclooxygenase-2 (COX-2) and inducible nitric oxide synthase (iNOS) are also activated, leading to the production of prostaglandins and nitric oxide that contribute to inflammation and pain [20].

Several intracellular signaling pathways play crucial roles in regulating inflammatory responses. These include the nuclear factor kappa B (NF-κB) pathway, mitogen-activated protein kinase (MAPK) pathway, and Janus kinase/signal transducer and activator of transcription (JAK/STAT) pathway. Activation of these pathways leads to increased expression of inflammatory genes and mediators [21].

LIMITATIONS OF CONVENTIONAL ANTI-INFLAMMATORY DRUGS

Conventional anti-inflammatory drugs such as non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and immunosuppressive agents are widely used for the treatment of inflammatory disorders. Although these drugs are effective in reducing inflammation and pain, their long-term use is often associated with various adverse effects [18].

NSAIDs may cause gastrointestinal irritation, ulcers, and bleeding due to inhibition of protective prostaglandins in the stomach. Corticosteroids can lead to immunosuppression, osteoporosis, weight gain, and metabolic disturbances when used for prolonged periods. Similarly, some immunosuppressive drugs may increase the risk of infections and organ toxicity [22].

These limitations highlight the need for safer and more effective anti-inflammatory agents, particularly those derived from natural sources [19].

ROLE OF MEDICINAL PLANTS IN INFLAMMATORY DISORDERS

Medicinal plants have been used for centuries in traditional systems of medicine such as Ayurveda, Unani, and Traditional Chinese Medicine for the treatment of various diseases including inflammatory conditions [10]. Many plant-derived compounds possess significant anti-inflammatory, antioxidant, and immunomodulatory properties.

Natural products are considered valuable sources of new therapeutic agents due to their structural diversity and relatively lower toxicity. Several modern drugs have been developed from plant sources, highlighting the importance of medicinal plants in drug discovery [10].

Among these medicinal plants, *Tinospora cordifolia* has attracted significant attention due to its wide range of pharmacological activities including anti-inflammatory, antioxidant, antipyretic, immunomodulatory, and antimicrobial properties [1,5].

RATIONALE OF THE STUDY

Tinospora cordifolia, commonly known as Guduchi or Giloy, is an important medicinal plant widely used in Ayurvedic medicine. It has been traditionally used for the treatment of fever, arthritis, diabetes, and various inflammatory conditions [7,3].

Recent pharmacological studies have demonstrated that extracts and bioactive constituents of *Tinospora cordifolia* exhibit significant anti-inflammatory effects in both experimental and clinical models. These effects are attributed to the presence of various phytochemicals such as alkaloids, diterpenoid lactones, glycosides, steroids, and polysaccharides [1,2].

Despite numerous experimental studies, a comprehensive compilation and analysis of the available evidence on the anti-inflammatory activity of *Tinospora cordifolia* is necessary to better understand its therapeutic potential. Therefore, this review aims to summarize and critically analyze the existing preclinical research related to the anti-inflammatory properties of this plant.

OBJECTIVES OF THE REVIEW

The main objectives of this review are:

1. To provide an overview of inflammation and its underlying mechanisms [17].
2. To discuss the limitations of conventional anti-inflammatory drugs [18].
3. To highlight the importance of medicinal plants in the management of inflammatory disorders [19].
4. To review the phytochemical constituents of *Tinospora cordifolia* [7].
5. To summarize the experimental evidence supporting the anti-inflammatory activity of *Tinospora cordifolia* [3].
6. To analyze the potential mechanisms responsible for its anti-inflammatory effects[1].

OVERVIEW OF *TINOSPORA CORDIFOLIA*

Tinospora cordifolia (Willd.) Miers, commonly known as Giloy or Guduchi, is a highly valued medicinal plant belonging to the family Menispermaceae. It has long been revered in Indian traditional systems of medicine such as Ayurveda, Siddha, and Unani for its wide spectrum of therapeutic applications [1]. Classified as a "Rasayana" in Ayurveda, T. cordifolia is known to promote longevity, enhance vitality, and act as an adaptogen by improving the body's resistance to stress and infections. Native to tropical and subtropical regions of India, the plant grows as a climbing shrub and is extensively distributed across the Indian subcontinent. The stems, roots, and leaves of T. cordifolia have been used in ethnomedicine for centuries [2]. Recent pharmacological studies have confirmed its diverse biological activities, including antioxidant, anti-inflammatory, immunomodulatory, hepatoprotective, antipyretic, anti-diabetic, and anti-cancer effects [3,4]. During the COVID-19 pandemic, the use of Giloy gained popularity due to its immune-boosting capabilities, drawing the attention of researchers globally. The therapeutic potential of this herb is attributed to its rich composition of bioactive phytoconstituents such as alkaloids, glycosides, terpenoids, and polysaccharides, which act on various physiological pathways and immune mechanisms [5].

Figure 2: *Tinospora Cordifolia*

In ayurvedic medicine, *T-Cordifolia* (Willd.) Miers ex Hook.F. & Thomas is known as "Guduchi" and is considered to be one of the most divine herbs. It is distributed throughout tropical Indian subcontinent and China, Ascending of 300 m. in Hindi, the plant is commonly known as Giloy, which is a Hindu mythological term that refers to the heavenly elixir that have saved celestial beings from old age and kept them externally young [3,7].

Guduchi is widely used in veterinary folk medicine/ayurvedic system of medicine for its general tonic, antiperiodic, anti-spasmodic, anti-inflammatory, antiarthritic, anti-allergic and anti-diabetic properties. The plant is used in ayurvedic, "Rasayanas" to improve the system and the body resristance against infections hence the plant is a natural immune booster. The root of this plant is known for its antistress, anti-leprotic and anti-malarial activities [2,3].

Tinospora is supposed to be the nectar of God Indra, that's why, it is considered as Amrita (pious liquid or nectar). It is used in the treatment and cure of many diseases and known as panacea for all the diseases and disorders. Giloy is useful in the promotion and restoration of health and make you ready for holistic well-being. It is helpful is stress and anxiety and having immunomodulatry

effects. Besides, it has many unknown health benefits and uses; it is also very useful in Dengue because it helps to increase the count of platelets [1,2].

India is home to diverse range of medicinal plants which have been the mainstay of traditional health care practices across all societies for centuries. Medicinal plants form the major resource base of our indigenous health care tradition or systems across the globe [23].

India also has very strong traditional health care practices that are represented by the Indian system of medicine like Ayurveda, Siddha, Unani and Homoeopathy. A very significant population is having the medicinal plants in primary health care as well as source of medicine, so it can be mentioned that the medicinal plants are an integral part of people's life. Also, the plant species which generally used as health promoters are categorized as 'Health Plants' [23].

BOTANICAL DESCRIPTION

Tinospora cordifolia is a large, deciduous climbing vine in the family *Menispermaceae* [3].

Stem: The stem of T. cordifolia is rather succulent with long filiform. Fleshy aerial roots from the brancheswith a thick, soft, warted bark [7].

Leaf: The leaves are membranous and cordate at the base. Leaves alternate, on long flexnose petioles, spreading 2-4inches long, roundish oval, entire, acute at the apex, quite smooth and thin. The leaves have bitter taste and anindistinct odour, when the leaves seen in bulk, they look intensely green. Mature leaves show yellowish to green colour [3].

Figure 3: Stem, Leaf, Flower, Fruits

Flower: The flowers are small and yellow or greenish in colour. In auxiliary and terminal racemes or racemose panicles, the male flowers are clustered and female are usually solitary [2].

Fruits: 3 or less usually less by abortion shortly, stalked, subglobose drupes. The drupes are ovoid, glossy, succulent, red and pea sized. Flowers grow during the summer and Fruits during the winter and fruits are fleshy [2].

TAXONOMY AND NOMENCLATURE

Kingdom: Plantae

Order: Ranunculales

Family: *Menispermaceae*

Genus: *Tinospora*

Species: *Tinospora cordifolia*

Authority: (Thunb.) Miers

Common names include Guduchi, Giloy, Amrita, Heart-leaved Moonseed, and various regional names across South and Southeast Asia. In Ayurveda, "Amrita" reflects its traditional status as a life-enhancing herb [3,7].

DISTRIBUTION

It is found throughout India especially tropical area, mainly in state of India such as Arunachal Pradesh, Assam, Bihar, Delhi, Gujarat, Goa, Karnataka, Kerala, Maharashtra, Odisha, Sikkim, Tamil Nadu, Uttar Pradesh, and West Bengal [1,3].

It grows throughout **tropical and subtropical forests and gardens** and is commonly found throughout India, often climbing on tree hosts like neem.

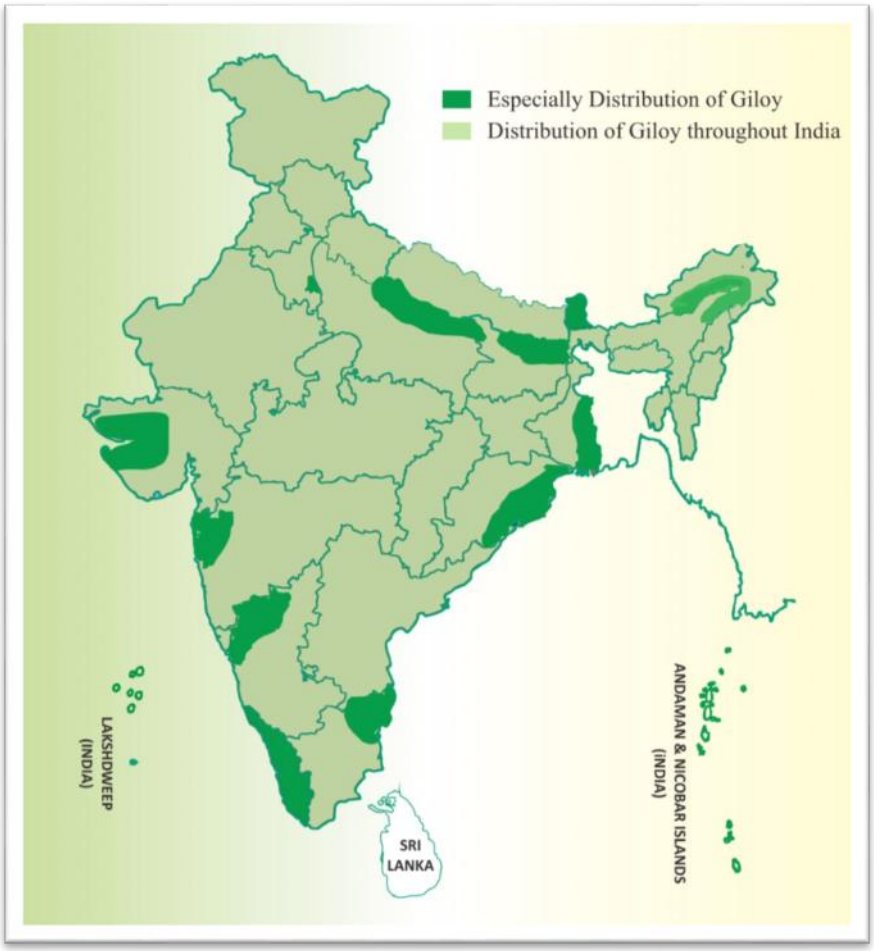

Figure 4: Especially Distribution of Giloy

ACTIONS/ PROPERTIES

Actions:

The stem is bitter, astringent,sweet, thermogenic, anodyne, anthelmintic, alterant, antiperiodic,antispasmodic, antiinflammatory, antipyretic, antiemetic, digestive, carminative, appetiser, stomachic, constipating, cardiotonic, depurative, haematinic, expectorant, aphrodisiac, rejuvenating, galacto-purifier and tonic [2].

Uses:

It is useful in burning sensation, hyperdipsia, helminthiasis, dyspepsia, vomiting, flatulence, acid gastritis, jaundice, haemorrhoids, meno-metrorrhagia, intermittent fevers, viral fevers, inflammations, gout, cardiac debility, skin diseases, leprosy, erysipelas, anaemia, cough, asthma, general debility, seminal weakness, urinary disorders, splenomegaly, rheumatoid arthritis, filaria, eye diseases. The whole plant, well ground, is applied on fractures and skin disorders [1,2].

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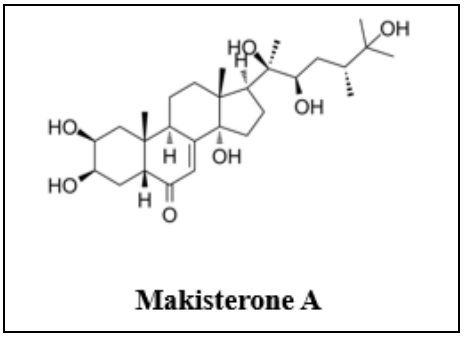
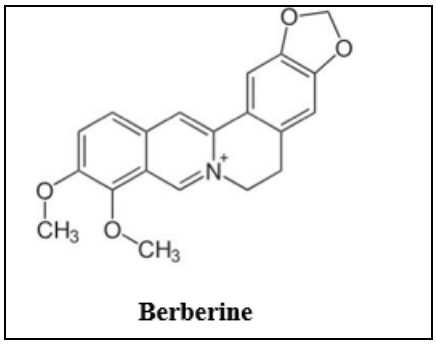
PHYTOCHEMICAL CONSTITUENTS

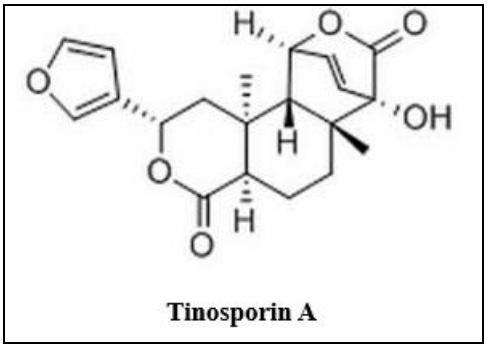
Tinosporine, tinosporon, tinosporic acid, tinosporol, tinosporide, tinosporidine, columbin, chasmanthin, palmarin, berberine, giloin, giloinisin, 1,2- substituted pyrrolidine, a diterpenoid furanoactone, 18-norclerodancediterpene-O-glucoside, aryltetrahydrofuranolignan, octacosanol, nonacosan-15-one and -sitosterol. Cordifolide, unosporin, heptacosanol, cordifol, cordifolon, meganoflorine, tembertarine, cardiofoliosides A and B, phenolic lignan-3- (4-dihydroxy-3-methoxybenzyl)-4-(4-hydroxy-3-methoxybenzyl)-tetrahydrofuran, arabinogalac-tan (Various parts) [1,3,5].



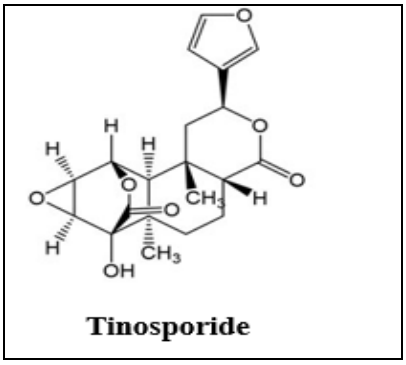
Makisterone A



Berberine



Tinosporin A



Tinosporide

Tinospora cordifolia is pharmacologically active due to a diverse range of phytoconstituents. Alkaloids like berberine and magnoflorine exhibit antimicrobial, antioxidant, and neuroprotective effects. Diterpenoid lactones such as tinosporide and columbin are responsible for anti-inflammatory, antipyretic, and anticancer activities [2,10]. Glycosides like cordifolioside A contribute to immunomodulation and hepatoprotection, while β-sitosterol, a phytosterol, displays anti-inflammatory and antioxidant potential. Additionally, arabinogalactans and glucans—its polysaccharide components—are known for enhancing immune responses. These constituents act through diverse mechanisms including cytokine modulation, enzyme inhibition, and free radical scavenging, making T. cordifolia a potent therapeutic candidate in traditional and modern medicine [2,10].

Table 1: Major Phytoconstituents and Their Pharmacological Roles

S.No.	Phytoconstituent	Chemical Class	Associated Activity
1	Tinosporide	Diterpenoid lactone	Anti-inflammatory, anti-cancer [10]
2	Cordifolioside A	Glycoside	Immunomodulatory, hepatoprotective [2]
3	Magnoflorine	Alkaloid	Antioxidant, neuroprotective [3]
4	Berberine	Alkaloid	Antimicrobial, anti-diabetic [1]
5	β-sitosterol	Phytosterol	Anti-inflammatory, antioxidant [5]
6	Polysaccharides	Glucans,arabinogalactans	Immunostimulant [10]
7	Columbin	Diterpenoid	Antioxidant, antipyretic [3]

PHARMACOLOGICAL ACTIVITIES

Many research works have been carried out on T. cordifolia with different activities i.e. adaptogenic, antineoplastic, antidiabetic, anti-bacterial, miscellaneous. But here some research works have been mentioned which are related to this study.

Tinospora cordifolia exhibits a wide range of pharmacological activities supported by numerous in vitro, in vivo, and clinical studies. Its therapeutic effects are largely attributed to bioactive phytochemicals such as alkaloids, glycosides, diterpenoids,

steroids, and polysaccharides [6]. It shows significant immunomodulatory effects by enhancing macrophage function and cytokine release. Antioxidant and anti-inflammatory actions are mediated through free radical scavenging and inhibition of COX/LOX enzymes. It also improves glycemic control in diabetic models, protects against liver damage, reduces fever, and exhibits anticancer, antimicrobial, neuroprotective, and anti- HIV properties through various cellular pathways [7-11].

Table 2: Pharmacological Activities of *Tinospora cordifolia*

S.No.	Pharmacological Activity	Study Type	Mechanism
1	Immunomodulatory [1]	In vivo, Clinical	Enhances macrophage activity, cytokine production (TNF-α, IL-6)
2	Antioxidant [5]	In vitro, In vivo	Scavenges free radicals; increases SOD and catalase
3	Anti-inflammatory [6]	In vivo	Inhibits COX and LOX pathways
4	Antidiabetic [7]	Invivo, Clinical	Modulates insulin secretion,improves glucose tolerance
5	Hepatoprotective [8]	In vivo	Prevents CCl4 and paracetamol-induced hepatotoxicity
6	Antipyretic [9]	In vivo	Reduces yeast-induced fever
7	Anti-cancer [8,10,11]	In vitro	Induces apoptosis, inhibits cell proliferation
8	Antimicrobial [12]	In vitro	Effective against gram-positive and gram-negative bacteria
9	Neuroprotective [11]	In vivo	Enhances memory, protects neurons against oxidative stress
10	Anti-HIV [813]	In vitro	Inhibits reverse transcriptase enzyme

ANTI-INFLAMMATORY ACTIVITY

Several experimental studies have demonstrated the anti-inflammatory effects of *Tinospora cordifolia*.

In Vivo Studies

Animal models such as:

- Carrageenan-induced paw edema
- Collagen-induced arthritis
- Formalin-induced inflammation

have shown significant reduction in edema and inflammatory markers after treatment with *T. cordifolia* extracts [3,6].

In Vitro Studies

Cell culture studies have reported inhibition of:

- TNF-α
- IL-1β
- IL-6
- Nitric oxide
- Prostaglandins

These findings confirm the plant's ability to suppress inflammatory signaling pathways [4,5].

CONCLUSION

Tinospora cordifolia is a well-recognized medicinal plant with significant anti-inflammatory potential supported by various preclinical studies. The presence of diverse bioactive phytoconstituents such as alkaloids, diterpenoids, glycosides, and polysaccharides contributes to its pharmacological effects.

Experimental studies have demonstrated that *T. cordifolia* effectively modulates inflammatory mediators and signaling pathways, thereby reducing both acute and chronic inflammation [3,5]. Although the available evidence highlights its therapeutic potential, further **well-designed clinical trials and standardization of extracts** are required to validate its efficacy and safety in humans.

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Conflict of Interest Statement:
The authors have no conflicts of interest to declare.