



**Knowledgeable Research**

**ISSN 2583-6633**

**Vol.02, No.12, July, 2024**

<http://knowledgeableresearch.com/>

## ***Tinospora cordifolia*: Bridging Ayurveda and Modern Pharmacology with Multifaceted Therapeutic Potential**

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**Abstract:** *Tinospora cordifolia*, commonly known as Guduchi or Giloy, is a widely used as medicinal plant in Ayurved. It is widely praised for its immunomodulatory, anti-inflammatory, and anti-diabetic properties. Despite its extensive use, certain limitations are there, such as variability in bioactive compounds due to environmental factors, potential liver toxicity when consumed in excess, and insufficient large-scale clinical trials confirming its efficacy and safety. Additionally, standardization of dosage and formulation remains a challenge. Future research should focus on rigorous clinical trials, molecular mechanisms of action, and biotechnological advancements to enhance its medicinal potential while ensuring safety and consistency. Integrating modern pharmacological approaches with traditional knowledge could further establish *Tinospora cordifolia* as a reliable therapeutic agent. The present review is an attempt to focus on the various benefits of the *Tinospora cordifolia*.

**Keywords:** *Giloy, Ayurveda, Medicinal plant, Curved embryo.*

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### **Introduction**

*Tinospora cordifolia* (Willd.) Miers ex Hook. F. & Thoms, commonly known as Guduchi, Giloy, or Amrita; it is a deciduous climbing shrub belonging to the family Menispermaceae. The common names are Gilo (Arabic); Amarlata (Assamese); Gadancha, Guluncha, Giloe (Bengali); K'uan chu Hsing (Chinese); Culancha (French); *Tinospora* (English); Gado, Galo, Gulo (Gujarati); Giloe, Gulbel, Gurcha (Hindi); Amrytu, Sittamrytu (Malayalam); Ambarvel, Giroli, Gulvel (Marathi), Garjo (Nepali); Gulancha (Oriya); Gulbel (Persian); Gilo (Punjabi, Kashmiri), Amrita, Guduchi, (Sanskrit); Gurjo (Sikkikim); Amridavalli, Niraidarudian (Tamil); Guduchi, Iruluchi (Telugu) and Guruch (Urdu). Highly used in Ayurvedic medicine for centuries, this plant is indigenous to tropical regions of India

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Received Date: 10.07.2024

Publication Date: 31.07.2024

such as Uttar Pradesh, Madhya Pradesh, Maharashtra, Kerala, Karnataka, Kashmir etc, extending to parts of China, Myanmar, Bangladesh, Sri Lanka, and Africa [1,2,3,4]. Its widespread use in traditional systems stems from its reputation as a "rejuvenating" herb, believed to protect the body against various ailments [1,2].

Guduchi, a Sanskrit term meaning "the plant that protects from diseases," is mentioned in ancient Ayurvedic texts such as the Sushrut Samhita and Charak Samhita. *Tinospora cordifolia* is Ayurvedic medicine, is used to treat various conditions, including allergies, anaemia, heart disorders, diabetes, inflammation, jaundice, skin diseases, leprosy, rheumatism, urinary issue and many other diseases [1,5]. Its leaf and fruit decoction help with jaundice, while a stem extract mixed with honey serves as a tonic. Its stems, leaves, and roots are commonly used in medicine. In Ayurveda, *Tinospora cordifolia* is classified as a "rasayana," a term referring to the circulation of "rasa" or vital nutrients. The renowned Indian physician Charaka described rasayana as having anti-aging properties, enhancing lifespan, boosting intelligence, improving memory, and promoting immunity. Additionally, it is recognized for its antispasmodic and antidiarrheal properties. Modern scientific research has increasingly validated these claims, uncovering a broad spectrum of pharmacological activities attributed to its rich phytochemical profile. This review synthesizes the botanical, chemical, and therapeutic aspects of *T. cordifolia*, highlighting its potential as a cornerstone in both traditional and contemporary medicine [1,2,3].

### Botanical Description

*Tinospora cordifolia* is a perennial, woody climber with succulent, heart-shaped leaves and slender, aerial roots that aid in its climbing habit. The plant thrives in tropical and subtropical climates, often found twining around trees or shrubs in forests and along riverbanks. Its stems are cylindrical and fibrous, turning woody with age, while the bark is thin and papery. The flowers are small, unisexual, and yellowish-green, appearing in racemes, and the fruits are drupes that turn red when ripe. All parts of the plant—stem, leaves, roots, and even aerial roots—are utilized in traditional medicine, with the stem being the most commonly employed [1,6]. The description of the plant is as follows:

**Stem:** Succulent, long, filiform, fleshy, and climbing in nature. It has creamy white to grey bark with deep spiral grooves. Aerial roots grow from the branches.

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**Aerial Roots:** Characterized by a tetra- to penta-arch primary structure, with a cortex divided into an outer thick-walled layer and an inner parenchymatous zone.

**Leaves:** Simple, alternate, exstipulate, and long-petiole (about 15 cm).

**Flowers:** Unisexual and greenish-yellow, appearing when the plant is leafless. Male flowers grow in clusters, while female flowers are solitary. Flowers have six sepals (arranged in two series of three, with outer sepals smaller than the inner ones) and six free, membranous petals that are smaller than the sepals. Flowering occurs between March and June.

**Fruits:** Fleshy, orange-red, aggregate of 1-3 ovoid drupelets, smooth, with a thick stalk and subterminal style scars. Fruits develop in winter.

**Seeds:** Curved in shape, leading to a similarly curved embryo. The plant belongs to the "moonseed family" due to this characteristic. The endocarp is ornamented and holds taxonomic significance.

### **Phytochemical Composition**

The therapeutic efficacy of *T. cordifolia* is underpinned by its diverse array of bioactive compounds. Phytochemical analyses have identified several classes of constituents, in *Tinospora cordifolia* such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoids, phenolics, aliphatic compounds, and polysaccharides [7,8,9].

**Alkaloids:** Berberine, palmatine D, choline D, tinosporine, Magnoflorine, isocolumbin, tetrahydropalmatine, 18-norclerodane glycoside known for their antimicrobial and anti-inflammatory properties.

**Terpenoids:** Tinosporaside, tinocordiside, and clerodane diterpenoids, which contribute to its immunomodulatory and antiviral effects.

**Glycosides:** Tinocordifolioside, cordioside, cordifolioside A, cordifolioside B, palmatoside C31, palmatoside F31, cordiofoliside B2, cordifolioside D2, cordifolioside Furanoid diterpene glycoside, Cordifoliosides A and B, linked to antioxidant and hepatoprotective activities.

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**Steroids:** b-sitosterol, d-sitosterol, g-sitosterol b-hydroxyecdysone, makisterone, giloinsterol jateorine, columbin and ecdysterone, with potential anti-inflammatory and adaptogenic roles.

**Polysaccharides:** Arabinogalactans, associated with immune stimulation.



**Fig. 1.** *Tinispora cordifolia* growing under pot condition and in wild.

**Phenolics and Flavonoids:** Contributing to its potent antioxidant capacity.

**Sesquiterpenoid:** Tinocordifolin.

**Diterpenoid lactones:** Furanolactone, tinosporon , columbin

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**Miscellaneous compound:** Nonacosan-15-one 3, (a,4-dihydroxy-3-methoxy-benzyl)-4-(4-hydroxy-3-methoxybenzyl)-tetrahydrofuran, Tinosponidine, 6 cordifol, 6 Cordifelone, 6 Jatrorrhizine.

These compounds vary in concentration across plant parts, with the stem being particularly rich in alkaloids and terpenoids, making it a focal point for pharmacological studies.

### Pharmacological Properties

*T. cordifolia* exhibits a wide range of pharmacological activities, supported by both traditional use and modern research:

1. **Immunomodulatory Activity:** The polysaccharides and alkaloids in *T. cordifolia* enhance immune responses by stimulating macrophage activity and increasing cytokine production. Studies have shown its efficacy in boosting immunity against infections, including its potential role during the COVID-19 pandemic as an immunomodulator. Seven immunomodulatory compounds from different classes have been isolated and identified from *T. cordifolia*, suggesting that the immunomodulatory effects of *Tinospora cordifolia* result from the combined action of multiple compounds working synergistically [10,11]. The immunomodulatory properties of *Tinospora cordifolia* (Guduchi), which are due to a combination of active compounds rather than a single constituent. This aligns with the concept that herbal medicines often exert their effects through a synergistic interaction of multiple bioactive compounds [10,12,13,14].

2. **Antioxidant Effects:** *T. cordifolia* stem contains several beneficial compounds such as flavonoids, phenols and tannins, along with high crude fiber content. *T. cordifolia* shows strong antioxidant activity, reducing power and DPPH radical scavenging activity, even the crude extract of *T. cordifolia* stem can be used as a potential source of antioxidants [15]. Jain et al., [16] through their experiments showed that *T. cordifolia* and *T. sinensis* have antioxidant properties.

The presence of flavonoids and phenolics enables *T. cordifolia* to scavenge free radicals, reducing oxidative stress. This property is critical in managing chronic diseases like diabetes and neurodegenerative disorders [14].

3. **Anti-inflammatory Action:** Compounds like berberine and tinosporaside inhibit pro-inflammatory mediators (e.g., COX enzymes and nitric oxide), making it effective against conditions such as

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arthritis and inflammatory bowel disease. *Tinospora cordifolia* is known to inhibit NF- $\kappa$ B signalling, a critical pathway in chronic inflammation [14].

4. **Antiviral Potential:** Recent research has highlighted its activity against SARS-CoV-2, with constituents like cordifoliosides showing promise in inhibiting viral spike protein binding to human ACE2 receptors [14,17].

5. **Hepatoprotective Effects:** Ethanolic and aqueous extracts of the stem have demonstrated the ability to reduce liver enzyme levels (ALT, AST) in models of carbon tetrachloride-induced liver damage, underscoring its role in liver health [14]. *Tinospora cordifolia* supports liver health by reducing oxidative stress and lipid peroxidation. It has potential uses in treating liver disorders, as a food supplement, and in developing new liver disease treatments [5,18].

6. **Antidiabetic Properties:** *T. cordifolia* lowers blood glucose levels by enhancing insulin sensitivity and reducing oxidative stress in diabetic models, as evidenced by studies on streptozotocin-induced rats. This plant exhibits antidiabetic properties, with its stem commonly used to regulate blood glucose levels and effectively normalize blood sugar. Its antidiabetic effects are linked to reducing oxidative stress, enhancing insulin secretion, and inhibiting gluconeogenesis and glycogenolysis [19,20]. The stem contains isoquinoline alkaloids like palmatine, jatrorrhizine, and magnoflorine, which have been shown to mimic insulin and stimulate its release in both in vitro and in vivo studies. These bioactive compounds contribute to the plant's potential in diabetes management [13, 20,21].

7. **Neuroprotective Benefits:** Its antioxidant and anti-inflammatory effects extend to neuroprotection, with potential applications in Alzheimer's and Parkinson's diseases by mitigating neuronal oxidative stress [14,20].

8. **Anticancer Property:** *Tinospora cordifolia* herbal supplements have gained attention for their immune-boosting and anticancer properties. One of its key bioactive compounds, berberine (BBR), has shown significant potential in fighting tumors. Other phytochemicals from *Tinospora cordifolia*, such as palmatine, new clerodane furanoditerene glycoside, arabinogalactan, phenolic compounds, and epoxy clerodane diterpene, also exhibit anti-carcinogenic effects. While cancer treatments have advanced, natural plant-derived compounds like those from *Tinospora cordifolia* offer a promising,

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non-toxic approach to cancer management. These extracts target multiple molecular mechanisms in malignant cells and could be developed into safe and effective cancer therapies [22].

### Therapeutic Applications

In Ayurveda, *T. cordifolia* is classified as a "Rasayana" (rejuvenating) herb, used to treat fever, jaundice, diabetes, skin disorders, and respiratory infections. Traditionally, it is consumed as a decoction, powder, or juice, often combined with other herbs like *Terminalia chebula* or *Phyllanthus emblica*. Modern applications include its incorporation into dietary supplements, herbal wines, and functional foods aimed at enhancing immunity and overall wellness. Its crude extracts are widely used in rural India for managing dengue fever and chronic infections, while clinical studies are exploring its adjunctive role in cancer therapy and antimicrobial resistance.

### Safety and Toxicological Profile

Acute toxicity studies indicate that *T. cordifolia* is generally safe at therapeutic doses. A 28-day repeated-dose study in rats using aqueous stem extracts showed no significant adverse effects, aligning with its long history of safe use in Ayurveda. However, excessive consumption may lead to mild gastrointestinal discomfort, and further clinical trials are needed to establish precise dosage guidelines.

### Future Research Directions

Despite its well-documented benefits, several gaps remain. The bitter taste of crude *T. cordifolia* limits its palatability, necessitating research into taste-masking techniques and stabilized formulations for food and pharmaceutical applications. The precise mechanisms of its bioactive compounds, particularly in complex diseases like cancer and neurodegeneration, require deeper exploration through in vivo and clinical studies. Additionally, its potential synergy with other medicinal plants and its role in combating emerging viral threats warrant further investigation. Developing standardized extracts and authenticating commercial products using high-resolution mass spectrometry could enhance its global acceptance.

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## Conclusions

*Tinospora cordifolia* stands as a testament to the convergence of traditional wisdom and modern science. Its multifaceted pharmacological properties, rooted in a rich phytochemical profile, position it as a promising candidate for addressing contemporary health challenges. As research progresses, *T. cordifolia* may emerge as a key player in integrative medicine, bridging the gap between ancient remedies and cutting-edge therapeutics.

## Acknowledgement

The author Dr Raghvendra Pratap Narayan, Associate Professor, is thankful to Higher Education Council, Department of Higher Education, Government of Uttar Pradesh for providing financial assistance.

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Publication Date: 31.07.2024