WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

# "TINOSPORA CORDIFOLIA: A COMPREHENSIVE REVIEW OF ITS PHYTOCHEMISTRY AND PHARMACOLOGICAL PROPERTIES"

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ABSTRACT

Tinospora cordifolia (Willd.) Miers, popularly called Guduchi or Giloy, is one of the very respected medicinal plants of the traditional systems of medicine including Ayurveda, Unani and Siddha. T. cordifolia has been extensively studied for its diverse therapeutic potential and is a natural source of many phytochemical constituents and pharmacological activities. This review targets to summarize the phyto-pharmacological perspectives of T. cordifolia. One such plant is Danshen, which is rich in bioactive compounds, including alkaloids, diterpenoid lactones, glycosides, and polysaccharides, that produce diverse pharmacological actions. Its validation among the scientific community is owed to several significant pharmacological activities including immunomodulatory, anti-inflammatory, antidiabetic, antioxidant, antimicrobial, hepatoprotective, and anticancer properties. Moreover, T. cordifolia shows a unique safety profile which makes it an attractive drug development resource and integrative medicine. T. cordifolia is used in several therapeutic modalities, and this review summarizes literature from different studies focusing on their mechanism of action, significance of its clinical effects, applicability and roles in disease prevention. The current scope and the challenges in its future research such as the need of standardized extracts, mechanistic studies and clinical trials have also been discussed for taking it forward to the pharmacological frontiers.

**Keywords**: Tinospora cordifolia, Phytochemistry, pharmacological properties, immunomodulation, antioxidants, traditional medicine, herbal therapeutics.

## INTRODUCTION

Tinospora cordifolia, commonly referred to as "Amrita" or "Guduchi," is a significant medicinal herb utilized in Indian Systems of Medicine (ISM) for countless centuries. This plant belongs to the Menispermaceae family [1]. Known as giloe in Hindi [2], this dioecious species occupies a unique spot in Hindu mythology, linked to a divine liquid that provides eternal energy upon celestial beings [3]. The name "Amrita" emphasizes its revitalizing attributes, which are important in Ayurveda. respected pharmacopoeias also acknowledge this extraordinary plant [4]. In India, this well-known bitter remedy is used to treat illnesses such as fevers, diabetes, digestive issues, jaundice, leprosy, skin-related concerns, urinary disorders, and chronic diarrhea and dysentery [5]. For centuries, Tinospora cordifolia has been a basic part of Ayurvedic remedies, honored as a "Rasayana" plant due to its regarded ability to improve mental and physical health [6]. The plant's well-known anti-inflammatory and antioxidant benefits are thought to play a role in its therapeutic properties [7].

**Fig. 1: Tinospora cordifolia**

## BOTANICAL DESCRIPTION

T. cordifolia is known by names and is generally referred to as gud or Amrita (and called by its Tinospora sin (Lour.).). In hindi, it is named gil, while in English, it is called Tinospora orospora gulan [8]. Other names includes: Amrytu, Samrytu (Malyalam), Ambar, Giroli, Gulvel (Marathi), Garjo (Nepali), Gulancha (Ori), Gulbel (Persian), Gilo (Punjabi, Kashmiri), Amrita, Guduchi (Sanskrit), Gurjo (Sikkim), and Amridavalli, Niraidarudian (Tamil), Guruchi, Iruluchi (Telugu), and Guruch (Urdu) [9]. T. cordifolia is classified as an angiosperm in the Ranunculaceae family Menispermaceae, class Magnoliopsida, and order Magnoliophyta [10]. Culus convolvulaceus DC., Menispermum cordifolium wild., M. malabaricum Lm., M. tomentosum (Colebr.) Roxb., T. malabarica (Lam.) Hook, T. sinensis (Lour.) Merr., T. cordifolia (Willd.) Miers, T. & Thomson, T. entosa (Colebr.) Hook, T. cordifolia var. congesta Mujaffar, Yasin Solanki, and T. fosbergii kundu are among its taxonomic synonyms [11]. Guduchi and Amrita, also known as Tinospora cordifolia, is a large dioduous climbing shrub that is distinguished by its numerous coils and wide growth. Its woody stem has thin, smooth bark that is grayish-brown in color. The plant has simple, heart-shaped, alternately arranged leaves that are joined by a longiole and terminate in a point. It has tiny, yellowish-green, unisexual blooms that grows in axillary racemes. The female flower appear singly, while the male flower form clusters. The end product is a crimson berry that looks like a pea and has only one seed [12]. This plant has a wide variety of morphologies, and its traits can vary depending on the environment and geographic location; The leaf size can vary from 5 to 15 cm in length and 3 to 8 cm in breadth, while the stem diameter can range from 1 to 5 cm [13].

## GEOGRAPHICAL DISTRIBUTION

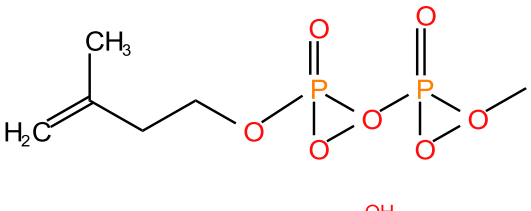
Tinospora cordifolia is a trailing plant that hails from the humid regions of the Indian subcontinent. Its distribution spans India, China, and various parts of Asia, stretching from the Himalayas to the southern regions of India, surround states like Andhra Pradesh, Assam, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and West Bengal. [14]. This species can also be found in southern regions of China such as Yunnan, Sichuan, and Xizang [13], and is present in other Asian locales like Bangladesh, Nepal, and Sri Lanka. [15]. Tinospora cordifolia blooms in temperatures ranging from 20 to 30°C and requires an yearly precipitation of 1000 to 2000 mm. It shows great adaptability to various soil types, containing clay, loam, and sand [16]. This vine develops in numerous habitats, from forests and grasslands to wetlands, frequently rising on trees, rocks, and other structures [14].

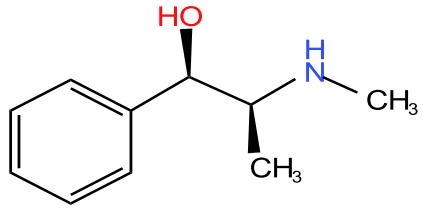
## TRADITIONAL USES AND ETHANOPHARMACOLOGY

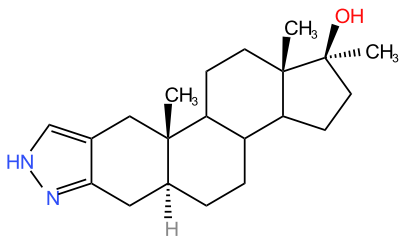
Tinospora cordifolia, commonly referred to as Giloy, has been used in conventional medicine for a range of purposes. It is recognized for its anti-diabetic, antioxidant, cardioprotective, hepatoprotective, anti-microbial, and a variety of other properties [17]. Its applications in ancient medicine encompass: Alleviating fever, rheumatism, and skin conditions, Boosting immune response and warding off infections, Promoting digestive wellness and addressing gastrointestinal issues, Lessening inflammation and discomfort [18]. The traditional pharmacology of Tinospora cordifolia focuses on examining its historical applications and the scientific substantiation of its therapeutic qualities. This plant is rich in diverse active compounds substances, such as alkaloids, glycosides, and terpenoids, which are integral to its medicinal effects [19]. Research has proven its anti-diabetic, antioxidant, and anti-inflammatory properties. Historically, the plant has been used in traditional medications for various ailments, including diabetes, arthritis, and respiratory infections [20]. T. cordifolia in Ayurveda is an adaptogen with potential anticancer properties, promoting vitality and reducing stress. Studies show cytotoxic effects on cancer cells, leading to interest in its neuroprotective and mental health benefits. [21].

## PHYTOCHEMICAL COMPOSITION

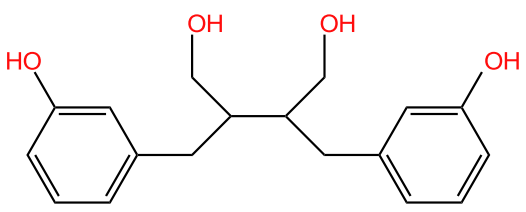
Tinospora cordifolia belong to different classes of constituents such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides etc [22].




**Steroids**




**Lignans**

**Table 1:** Chemical composition of Tinospora cordifolia

| Components | Compounds | References |
|---|---|---|
| Alkaloids | Tinosporine, (S), Magnoflorine, (S), Berberine, (S), Choline, (S), Jatrorrhizine, (S), 1,2-Substituted pyrrolidine(S), Alkaloids, viz. jatrorrhizine, palmatine, beberine, tembeterine, choline. | [23], [24], |
| Terpenoids | Tinosporide, Furanolactone diterpene, Furanolactone clerodane diterpene, furanoid diterpene, Tinosporaside, ecdysterone makisterone | [25], [26], [27] |
| Lignans | 3 (a, 4-dihydroxy-3-methoxybenzyl)-4-(4-hydroxy-3-methoxybenzyl), (S) | [28] |
| Steroids | Giloinsterol, (S), ß-Sitosterol, (S), 20a- Hydroxy ecdysone, (S). | [29], [30] |
| Other | Giloin, Tinosporan acetate, Tinosporal acetate, Tinosporidine, Heptacosanol, Octacosanol, sinapic acid, Tinosponone | [31] , [32] |

## PHARMACOLOGICAL PROPERTIES

Antioxidant activity

Tinospora cordifolia is extensively recognized for its antioxidant capabilities, which alleviate oxidative stress by countering free radicals and minimizing cellular damage. Research has shown that T. cordifolia extracts are rich in phenolic compounds that detoxify reactive oxygen species (ROS), thus shielding cells from oxidative harm [33]. For example, an in vitro study utilizing DPPH assays showed marked antioxidant effectiveness in methanol extracts, underscoring its function as a organic source of antioxidants [34].Total flavonol and phenolic phytochemicals extracted from the T. cordifolia formulation displayed important antioxidant efficacy evaluated through 1-diphenyl-2-picrylhydrazyl (DPPH) [35]. T. cordifolia has been found to enhance GSH levels and the showing about the gamma-glutamylcysteine ligase gene. It also shown robust unbound free radical neutralizing abilities [36].

**Antidiabetic Activity**

In the regions of Asia and Africa, T. cordifolia has been widely used as a treatment for type 2 diabetes (T2D). The alkaloid-rich ingredients derived from the stem, including palmatine, jatrorrhizine, and magnoflorine, have demonstrated effects akin to insulin and the ability to promote insulin secretion in both in-vitro and in-vivo settings [37]. Various modes of action for T. cordifolia extracts have been identified, impacting sites such as the liver, adipose tissue, pancreatic β cells, intestinal mucosa-L cells, and muscles [38]. Its actions beyond the pancreas, which include the stimulation of glycogenesis and the suppression of glycogenolysis in the liver, enhancing glucose absorption and processing, inhibiting gluconeogenesis, reducing intestinal glucose absorption, blocking α-glucosidase and α-amylase, alleviating oxidative stress, and exhibiting antioxidant properties along with safeguarding against tissue injury, appear to significantly influence diabetes management [39].

**Immunomodulatory activities**

The phytochemicals extracted from T. cordifolia, including magnoflorine, tinocordioside, 11-hydroxymuskatone, , N-methyl-2-pyrrolidone, and N-formylannonain, exhibited cytotoxic

and immunomodulatory properties [40]. These extracted compounds improved the phagocytosis ability of macrophages, boosting nitric oxide (NO) generation by inducing splenocytes and the ability to produce reactive oxygen species (ROS) in neutrophil immune cells[41, 42]. *T. cordifolia* treatment suppressed arthritic inflammation and bone and cartilage damage by reducing pro-inflammatory cytokines such as IL-1β, tumor necrosis factor-alpha (TNF-α), IL-6, and IL-17 [43]. The methanolic extract of T. cordifolia demonstrated a considerable reduction in lipo-oxygenase/cyclo-oxygenase (LOX/COX) activity [44].

**Hepatoprotective Effects**

T. cordifolia has a protective role against liver toxicity. Ethanol extracts from all sections of T. cordifolia revealed liver-protecting properties against carbon tetrachloride-triggered hepatic impairment in rats[45]. Evidence indicates that T. cordifolia mitigates CCl4 induced liver damage and restores liver function, as examined and confirmed by biological indicators of liver health (SGPT, SGOT, ALT, AST, and bilirubin), highlighting its anti-hepatotoxic characteristics [46]. T. cordifolia demonstrates hepatoprotective effects against alcohol-induced harm, not just by reducing liver-specific catalysts and lipid amounts but also by reducing fatty acid amides in urine [47].

**Antimicrobial Properties**

Phytochemical compounds derived from T. cordifolia, including berberine, furanolactone, palmatine, tinosporon, jatorrhizin, and columbin, have been noted for their potential efficacy against microbial infections[48]**.** The antibacterial properties of T. cordifolia extracts have demonstrated effectiveness against a range of bacteria such as Bacillus subtilis, Escherichia coli, Enterobacter aerogenes, Klebsiella pneumoniae, Micrococcus luteus, Proteus vulgaris, Pseudomonas aeruginosa, Salmonella typhi, Salmonella paratyphi, Salmonella typhimurium, Shigella flexneri, Serratia marcescens, Staphylococcus aureus, and Staphylococcus epidermidis[49, 50].Different dosages of T. cordifolia's aqueous extract, when taken orally, resulted in enhanced endurance rates and a remarkable decrease in fungal intensity for Aspergillus species [51].

Anti-allergic activity

T. cordifolia has been historically employed in managing asthma, while its juice is also utilized for addressing persistent coughs [52]. The aqueous extract of T. cordifolia alleviates mast cell-mediated hypersensitive responses in rats through anti-histaminic properties [53]. Reports indicate a reduction in signs of allergic rhinitis, such as sneezing, nasal discharge, nasal congestion, and nasal itching [54].

## TOXICOLOGICAL PROFILE

**Safety Data from Animal and Human Studies**

Research on Tinospora Cordifolia (commonly known as Guduchi) suggests that the plant is generally safe when used within prescribed doses. Animal studies have shown that the aqueous and ethanolic extracts are non-toxic at standard therapeutic doses. For example, studies in rats have shown no side effects at doses up to 2000 mg/kg body weight [55]. Similarly, human studies have confirmed the safety of the plant, especially in treating conditions such as diabetes and immune disorders, although some individuals have reported mild side effects such as gastrointestinal discomfort [56].

**Side Effects and Adverse Reactions**

Although T. cordifolia is generally considered safe, side effects such as gastrointestinal discomfort, fatigue, and headaches have been reported in some cases [57]. Rare side effects include liver toxicity, especially when used in high doses or in combination with other hepatotoxic drugs. These reactions highlight the importance of monitoring and consulting a healthcare provider before use [58,59].

**Safe Dosage Ranges and Contraindications**

The recommended dosage of T. cordifolia extracts typically ranges between 300 mg to 1 g per day for adults, depending on the form (e.g., powder, capsules, or decoction) [60]. Contraindications include pregnancy, lactation, and pre-existing liver conditions. Patients on immunosuppressive therapy should avoid T. cordifolia due to its immunostimulatory effects, which could counteract such treatments [61].

## CONCLUSION

Tinospora cordifolia, popularly known as Guduchi, is a medicinal herb with great potential in classical and modern medicine. This herb contains a wide variety of phytochemicals providing it immunomodulatory, anti-inflammatory, antioxidant, and hepatoprotective effects. Plagued by chronic diseases: If Guduchi has shown some benefits in combating infections, metabolic disorders and chronic inflammation. Research suggests that as long as it is taken in appropriate doses, it poses no harm, but those with sensitive systems need to use caution. This is one of the key characteristics of an adjunct that, when combined with other natural therapies, can lead to better outcomes reinforcing its position in the realm of integrative medicine. Even though we are making progress in understanding its pharmacological benefits, further studies should explore its mechanisms, improve formulations, and perform large-scale clinical trials, which will potentially increase its status in evidence-based medicine as an important component of herbal treatments.

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