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Pharmacological potential of *Tinospora cordifolia* (Willd.) Miers ex hook. & Thoms. (Giloy): A review

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Abstract

Various kinds of bioactive molecules form the basis of designing of various kind of pharmacologically important drugs. *Tinospora cordifolia* (Willd.) Miers ex Hook. & Thoms. (Giloy) is very important medicinal plant, belonging to the family Menispermaceae, acting as one of the main sources of new pharmaceuticals and health care products. The innumerable medicinal qualities and therapeutic uses of Giloy as well as its phytochemical investigations prove its importance as a valuable medicinal plant. It is reported to possess anti-inflammatory, anti-oxidant, anti-spasmodic, anti-allergic, anti-HIV and anti-cancer properties. Its main part stem is bitter, stomachic, diuretic, stimulates bile secretion and cures jaundice. This present review article put special emphasis on pharmacological potential of *T. cordifolia* along with the phytochemicals responsible for its pharmacological properties.

Keywords: *Tinospora cordifolia*, Giloy, pharmacological potential, phytochemicals.

1. Introduction

In the recent years, interest in usage of medicinal plants in pharmaceutical and cosmetic industries have overgrown due to their easy availability, less side effects, less cost, inadequate supply of drugs to larger portion of population in developing nations, prohibitive cost of treatment, side effects of several allopathic drugs and development of resistance to allopathic drugs used for treatment of diseases. According to WHO estimates, 80 % of people depend on traditional remedies such as medicinal plants for curing or prevention of ailments. Plants produce a diverse range of bioactive molecules, making them a rich source of different types of medicines. Free radicals or reactive oxygen species are formed in our body as a result of biological oxidation. The overproduction of free radicals such as hydroxyl radical, superoxide anion radical, hydrogen peroxide can damage the body and contribute to oxidative stress^[1]. Medicinal plants are naturally very good antioxidant source where antioxidant activity is ascribed due to presence of phenolics, flavonoids, vitamins and secondary metabolites^[2]. Use of antioxidants in our diet protect against free radicals by scavenging them. Hence, there is an increasing interest to study the effects of various extraction factors on the phytochemical substances including phenolics, flavonoids, active ingredients, essential oil, amino acids and carotenoids^[3].

Tinospora cordifolia (Willd.) Miers ex Hook. & Thoms which belongs to Menispermaceae family is a large, deciduous, climbing shrub found throughout India and also in Srilanka, Bangladesh and China. It is known as Giloy (in Hindi), Guduchi (in Sanskrit) and Moonseed plant (in English). It contains flavonoids, glycosides, saponins and some amount of phytosterols. These active constituents alone or in combination are responsible for antioxidant activity. Leaves of Giloy are rich in protein and are fairly rich in Ca and P^[4]. Different chemical constituents such as giloin, columbin, chasmanthin, palmatine, isocolumbin, tembetarine, syringing, ecdysterone, cordioside, tinocordifolin, tinocordifolioside, cordifolioside A, palmarin, tinosporin and tinosporic acid have been isolated from different parts of Giloy^[5]. (Fig. 1). It is known to possess anti-spasmodic, anti-inflammatory, anti-allergic, anti-periodic, anti-arthritis, anti-leprotic, anti-diabetic, antioxidant, hepatoprotective and immunomodulatory^[5].

Phytochemical Profile of Various Parts of *T. cordifolia*

Leaves are rich in protein, calcium, and phosphorus^[5, 6]. Methanol extract of leaves is rich in flavanoids, alkaloids and glycosides^[7]. A post harvest experiment has revealed that mechanical drying of the herb at 40 °C provides the highest alkaloid (tinosporin) content (0.045%). However, the content decreases (0.033%) with drying at 60 °C or in direct sunlight. Further, the dried stem bits packed in polyethylene lined gunny bag retain the highest alkaloid content (0.042%) as compared to storage under ambient conditions.^[8]

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These findings suggest that tinosporin may be either photosensitive and/or thermo labile.

Herbal extracts in various forms like infusion, decoction, strong decoction, tinctures, syrups and maceration etc. are commonly used since ancient time for medicinal effects. Cold infusion of Giloy prepared using stem is given in chronic

conditions of fever. The juice extract from the stem of Giloy is highly effective for treatment of gout as it helps to neutralise the increased uric acid levels in the body. Strong decoction of Giloy with basil leaves offer resistance against swine-flu.

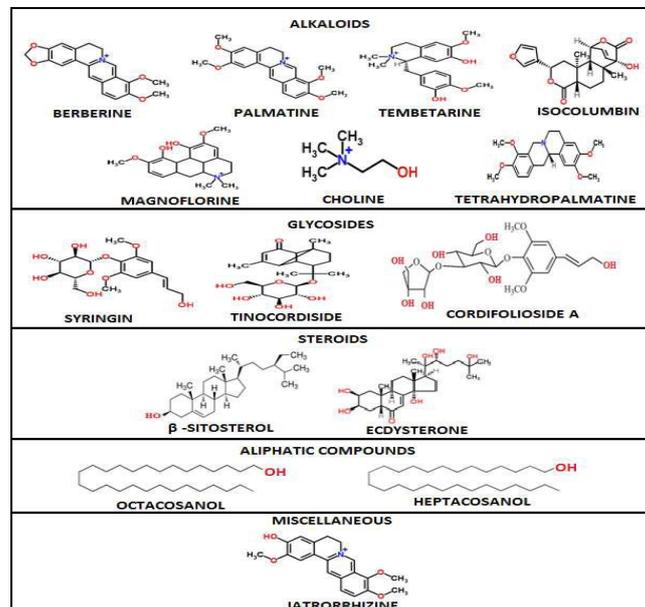


Fig 2: Important phytochemicals from *T. cordifolia*

Main chemicals present in *T. cordifolia* parts and their pharmacological potential

Phytochemicals Class	Compounds isolated	Plant Part	Pharmacological Potential in Human beings	References
Steroids	β -sitosterol, δ -sitosterol, 20 β -hydroxyecdysone, Ecdysterone, Makisterone A, Giloinsterol	Stem	Glucocorticoid induced osteoporosis in early inflammatory arthritis. Induce cell cycle arrest in G2/M phase and apoptosis through c-Myc suppression.	[9]
Alkaloids	Berberin, choline, tembetarine, magnoflorine, tinosporin, palmetin, isocolumbin, aporphine, jatrorrhizine, tetrahydropalmatine	Stem root	Antiviral, anti-cancer, ant diabetic, antiinflammatory, immunomodulatory	[10-13]
Diterpenoid Lactones	Furanolactone, clerodane derivatives, tinosporin, tinosporides, jateorine, columbin	Whole Plant	Vasorelaxant: relaxes norepinephrine induced contractions, inhibits calcium ion influx, anti-inflammatory, antimicrobial, antiviral.	[14-16]
Sesquiterpenoid	tinocordifolin	Stem	Antiseptic	[17]
Glycosides	Tinocordiside, tinocordifolioside, cordioside, syringin, syringin-apiosylglycoside, pregnane glycoside palmatosides	Stem	Treats dementia, motor and cognitive deficits and neuron loss in spine and hypothalamus. immunomodulator	[18, 19]
Others	Jatrorrhizine, cordifol, giloin, tinosporic acid	Roots, whole plant	Protease inhibitors for HIV	[20]

Anti-diabetic potential of *T. cordifolia* parts

Various phytoconstituents isolated from different parts of *T. cordifolia* are responsible for cure of diabetes mellitus. These phytochemicals include alkaloids, tannins, cardiac glycosides, flavonoids, saponins and steroids [21, 11]. It has the magical potential of lowering the blood sugar level in human beings. The isoquinoline alkaloid rich fraction from stem, includes palmatine, jatrorrhizine and magnoflorine which show insulin mimicking and insulin releasing effect both *in vitro* (using rat pancreatic β -cell line, RINm5F) and *in vivo* [22]. Another isoquinoline alkaloid 'berberin' is reported to be highly effective for curing human diabetes. It lowers elevated glucose level as effectively as metformin. It also improves hepatic metabolism during insulin resistance and metabolic syndrome by inhibiting FOXO1 which integrates mitochondrial function with insulin signaling. By adenosine

monophosphate-activated protein kinase activation, it decreases the blood sugar and cholesterol level and maintains the blood pressure [23, 24, 25, 26]. Besides, tinosporin, isocolumbin, palmatine, tinocordiside, cordioside and β -sitosterol compounds present in stem and root are also reported to possess ant diabetic, antihyperlipidemic and antioxidant properties as shown in Fig. 2 [27]. Due to presence of major and minor essential minerals such as Zn, Mn, Cl, K, Ca, Fe, Co, Ni and Cu and proteins and fibres in *T. cordifolia* parts, it helps in health restoration and in alleviation of degenerative processes in diabetes [28, 29]. Crude values for food content in *Tinospora cordifolia* include high fibre (15.19%), sufficient protein (4.5%-11.2%), sufficient carbohydrate (61.66%), and low fat (3.1%). Nutritive value is 292.54 calories per 100 g. It has high potassium (0.845%) (regulatory function of nerve impulses), high chromium

(0.006%) (regulation of carbohydrate utilization pathophysiological alterations in diabetes), sufficient iron (0.28%) (to improve haematopoietic functions especially in diabetic nephropathy where erythropoietin release from kidney is compromised), and sufficient calcium (0.131%) (regulatory functions in nervous, cardiovascular, and musculoskeletal systems) [30]

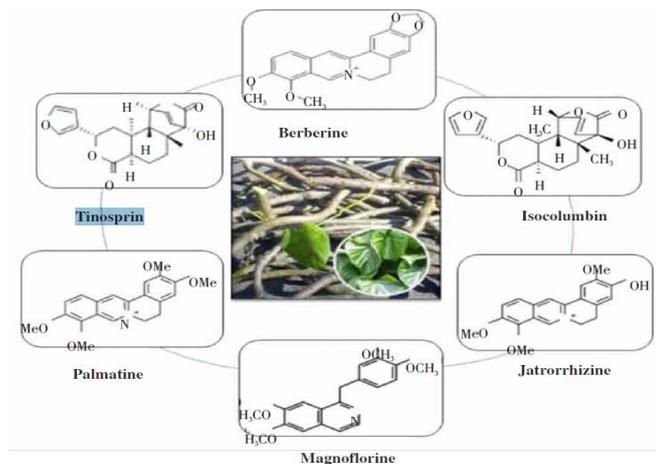


Fig 2: Phytochemical antidiabetic virtues of *T. cordifolia*.
Antioxidant potential of *T. cordifolia* parts

Premanath and Lakshmidēvi (2010) determined the antioxidant activity of *T. cordifolia* leaves in different solvent extracts (ethanol, methanol, chloroform, hexane, aqueous) using standard methods and reported that ethanol extract had the highest total phenols & flavonoids contents i.e. 5.1 and 0.52 mg/g, respectively and also exhibited highest DPPH radical scavenging activity (EC₅₀ value: 0.5 mg/mL) [31]. Rajurkar and Hande (2011) reported that *T. cordifolia* have 0.23 mg GAE/g dw total phenolic content and 1.50 mg CE/g dw total flavonoids content They also reported that *T. Cordifolia* have 0.20 mg TEAC/g dw total antioxidant activity as measured by DPPH method [32]. These reports showed that *T. cordifolia* show significant antioxidant activity. It denotes its ability to scavenge the reactive oxygen species and free radical generates in our body. Radical scavenging activity in it is due to presence of phenols and flavonoids. Due to presence of alkaloids it shows protection against aflatoxin-induced nephrotoxicity [33]. Aqueous extracts of *T. cordifolia* possesses significant radio-protective activity, enhancing the survival of mice against a sub-lethal dose of γ -radiations [34]. Owing to good antioxidant properties of *T. cordifolia* it is given with L-DOPA during Parkinson's disease. L-DOPA produces free radicals during the formation of dopamine. Thus, *T. cordifolia* neutralizes the side effects of drug [35].

Anti-HIV potential of *T. cordifolia* parts

Root extracts of Giloy have shown significant effect in modulating the immune system positively in HIV positive patients. This immunomodulatory response of extracts of Giloy stem are due to its ability to reduce eosinophil count, stimulation of B lymphocytes, macrophages, level of haemoglobin and polymorphonuclear leucocytes [36, 37].

Anti-toxic potential of *T. cordifolia* parts

Free radicals generated during aflatoxicosis can be scavenged by the antioxidants present in aqueous extracts of Giloy [12]. Lead nitrate induced liver damage was prohibited by the Giloy extracts [38]. *T. cordifolia* shows anti-toxic potential due to its ability of lowering the concentration of thiobarbituric acid reactive substances (TBARS) and enhancing the level of

glutathione, ascorbic acid and proteins. It also enhances the activities of antioxidant enzymes such as superoxide dismutase, catalase, glutathione peroxidase, glutathione S-transferase and glutathione reductase in kidneys. Moreover the presence of alkaloids such as isocolumbin, palmetin, tetrahydropalmatine and magnoflorine in *T. cordifolia* protects against aflatoxin induced nephrotoxicity [12].

Antimicrobial potential of *T. cordifolia* parts

The anti-bacterial activity of *Tinospora cordifolia* extracts has been assayed against *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Salmonella typhi*, *Shigella flexneri*, *Salmonella paratyphi*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Enterobacter aerogene*, and *Serratia marcescens* (Gram-positive bacteria) [39]. Aqueous, ethanol and acetone extracts of leaves and stem of *Tinospora cordifolia* Hook. F. Thoms showed maximum inhibitory activity against on clinical isolates of urinary pathogens *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* [40]. Silver nanoparticles synthesized from stem of *Tinospora cordifolia* possess very good antibacterial activity against multidrugresistant strains of *Pseudomonas aeruginosa* isolated from burn patients [41]. The active compound [(5R, 10R)-4R, 8R-Dihydroxy-2S, 3R:15, 16-diepoxycleroda-13(16), 17, 12S, 18, 1S-dilactone] was isolated from ethanol extract of *Tinospora cordifolia* stem showed activity against bacteria and fungi.

Conclusion

T. cordifolia is very important medicinal plant which holds a special position in Ayurvedic system of medicines for prevention and treatments of various human ailments. Because of presence of various kinds of phytochemicals in Giloy, it has found applications in pharmaceutical chemistry due to its antiosteoporetic, hepatoprotective, immunomodulatory, antihyperglycemic, anti-tumor, anti-HIV properties.

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