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Pharmacological effects of *Tinospora cordifolia*: (Giloy) in human body

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Abstract

Bioactive compounds of diverse types are used to design a variety of pharmacologically important medications. *Tinospora cordifolia* (Giloy) is a prominent medicinal plant in the Menispermaceae family that serves as a major source of novel pharmaceuticals and health care goods. Giloy's numerous medical characteristics and therapeutic uses, as well as phytochemical research, demonstrate its value as a remarkable medicinal plant. Anti-inflammatory, anti-oxidant, anti-spasmodic, anti-allergic, anti-HIV and anti-cancer properties have been documented. The primary stem of the plant is bitter, stomachic, diuretic, increases bile secretion, and heals jaundice. The pharmacological potential of *T. cordifolia*, as well as the phytochemicals responsible for its pharmacological activities, were highlighted in this review paper.

Keywords: *Tinospora cordifolia*, anti-inflammatory, anti-allergic, anti-oxidant, ayurvedic

Introduction

World Health Organization (WHO) estimate that 81% of people mainly depend on traditional remedies such as for curing or preventing ailments. Plants generate a different range of bioactive molecules making them rich sources of different types of medicines. *Tinospora cordifolia* is a deciduous climbing, large shrub which belongs to the family Menispermaceae (Rana *et al.*, 2012) [17]. This plant is widely distributed in India, Burma, China, Myanmar and Sri Lanka, and is known by the common names Giloy and Heart-leaved moonseed. Other synonymous and common names are Guduchi, Amrita, Guduchika, Chinnobhava, Vatsadani, Kundalini, Gulancha (Bengali), Gurcha (Hindi), Gala (Gujarat), Amrutavalli (Kannada), Gilo (Punjab), Seendal, Seendil Kodi (Tamil) and Amarlata (Assamese) (Narayana, 2008) [13]. Recently, the *Tinospora cordifolia* is of great interest to researchers across the globe because of its reported medicinal properties like anti-periodic, anti-inflammatory, anti-arthritis, anti-oxidant, anti-allergic, hepatoprotective, immunomodulatory and anti-neoplastic activities (Soham and Shyamasree, 2012) [24]. A variety of active compounds derived from plants like alkaloids, steroids, diterpenoid lactones, and glycosides have been isolated from different parts of the plant body which include the stem, root and whole plant (Upadhyay *et al.*, 2010) [27].

Pharmacology

A huge number of chemicals have been isolated from *Tinospora cordifolia*, which belongs to different classes such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoids, and polysaccharides. The structure of these compounds was established on the basis of spectroscopic studies. (Maurya *et al.*, 2004) [11]. This has been used in Ayurvedic preparation for the treatment of various diseases. It is also used as a *Rasayana* to improve the immune system and body resistance.

Anti-allergic properties

Tinospora cordifolia is mainly used for the treatment of asthma and the juice is also employed for the treatment of chronic coughs (Spelman, 2001) [25]. Sneezing was reported to be completely relieved in 83 per cent of patients treated with *T. cordifolia* in a clinical study. Similarly, 69 per cent experienced alleviation from nasal discharge, 61 per cent from nasal blockages, and 71 per cent from nasal pruritus. Only 21% of patients in the placebo group reported alleviation from sneezing, 16.2 per cent from nasal discharge, 17 per cent from nasal blockage, and 12 per cent from nasal pruritus. As a result, *T. cordifolia* significantly reduced all allergic rhinitis symptoms while also being well-tolerated. The anti-allergic and bronchodilator properties of an aqueous extract of the stem were tested on histamine-induced

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bronchospasm in guinea pigs, capillary permeability in mice, and mast cell disruption in rats, and it was found to significantly reduce bronchospasm, capillary permeability, and the number of disrupted mast cells (Badar *et al.*, 2005) [2].

Antioxidant activity

In diabetic rats, there was a considerable increase in the concentration of thiobarbituric acid-reactive compounds (TBARS) in the brain, as well as a decrease in the heart. Treatment with *Tinospora cordifolia* reduced glutathione reductase (GSH) concentrations and activity of superoxide dismutase (SOD), catalase, and glutathione peroxidase (GPx) in diabetic rats' tissues. *T. cordifolia* root alcoholic extract (TCREt) given orally to diabetic rats at a dose of 100 mg/kg for 6 weeks restored the antioxidant state of the heart and brain. Although insulin (6 units/kg) returned all parameters to normal status, *T. cordifolia* root extract had a better effect than glibenclamide (600/kg) (Prince *et al.*, 2004) [16]. The Fenton (FeSO₄) reaction and radiation-mediated 2-deoxyribose degradation were both inhibited by aqueous extract of *T. cordifolia* in a dose-dependent manner, with an IC₅₀ value of 700/mL for both Fenton and radiation-mediated 2-DR degradation. Similarly, at 500/mL and higher, it displayed a moderate but dose-dependent suppression of chemically produced superoxide anion, with an IC₅₀ value of 2000/mL (Goel *et al.*, 2002) [5]. *T. cordifolia* has also been shown to increase GSH levels, gamma-glutamylcysteine ligase expression, and Cu-Zn SOD gene expression. Electron paramagnetic resonance spectroscopy revealed that the herb had high free radical-scavenging properties against reactive oxygen and nitrogen species (Rawal *et al.*, 2004) [19]. *Tinospora cordifolia* also contains components that reduce HIV recurrent resistance to antiretroviral therapy (ART) and increase the medication's outcome. [93] In the liver of Swiss albino mice, the effect of a hydroalcoholic (80 per cent ethanol: 20 per cent distilled water) extract of *Tinospora cordifolia* aerial roots on carcinogen/drug metabolising phase-I and phase-II enzymes, anti-oxidant enzymes, GSH content, LDH, and lipid peroxidation was demonstrated. *Tinospora cordifolia*'s chemopreventive activity is suggested by increased GSH levels and enzyme activities involved in xenobiotic metabolism and cell anti-oxidant status (Singh *et al.*, 2006) [22].

Anti-diabetic Activity

Tinospora cordifolia stems are commonly used in traditional Indian folk medicine to treat diabetes by controlling blood glucose levels. It has been suggested that it possesses anti-diabetic properties via reducing oxidative stress (OS), increasing insulin secretion, and decreasing gluconeogenesis and glycogenolysis, all of which help to regulate blood glucose levels. *Tinospora cordifolia*'s principal phytoconstituents, including alkaloids, tannins, cardiac glycosides, flavonoids, saponins, and steroids, have been shown to have anti-diabetic properties (Sangeetha *et al.*, 2011) [20]. Both *in vitro* and *in vivo*, the isoquinoline alkaloid-rich fraction from the stem, comprising palmatine, jatrorrhizine, and magnoflorine, has been shown to exhibit insulin-mimicking and insulin-releasing effects. [10] Root extracts have been shown to lower blood glucose levels, increase insulin production, and inhibit OS indicators when taken orally. *In vitro* studies have shown the initiation and restoration of cellular defence anti-oxidant markers such as superoxide dismutase (SOD), glutathione peroxidase (GPx),

and glutathione (GSH), as well as the inhibition of glucose 6-phosphatase and fructose 1, 6-diphosphatase and the restoration of glycogen content in the liver (Patel and Mishra, 2011) [15]. In diabetic rats, the root extract was found to reduce glycosylated haemoglobin, plasma thiobarbituric acid reactive compounds, hydroperoxides, ceruloplasmin, and vitamin E levels. Oral administration of *Tinospora cordifolia* extract in the "Ilogen-Excel" formulation (Ayurvedic herbal formulation) containing eight medicinal plants, including *Curcuma longa*, *Strychnos potatorum*, *Salacia oblonga*, *Tinospora cordifolia*, *Vetivelia zizanioides*, *Coscinium fenestratum*, *Andrographis paniculata*, and *Mimosa pudica*, has been shown to reduce GSH and The heart and brain of diabetic rats have lower levels of GSH, GPx, and SOD, as well as lower catalase activity (Umamaheswari and Prince, 2007) [26].

Anti-microbial Activity

Tinospora cordifolia methanol extracts are effective against microbiological infections. *Tinospora cordifolia* extracts were tested for antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumonia*, *Proteus vulgaris*, *Salmonella typhi*, *Shigella flexneri*, *Salmonella paratyphi*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Enterobacter aerogene*, and *Serratia marcescens* (Gram-positive bacteria) (Narayanan *et al.*, 2011) [14]. TCE has been shown to aid bacterial clearance and boost neutrophil phagocytic and intracellular bactericidal capacities in mice models. On macrophages, TCE has been shown to have immunostimulant effects. In bovine preclinical mastitis, intramammary infusion of hydro-methanolic extracts of *Tinospora cordifolia* therapy increased polymorphonuclear cell phagocytic activity (Sengupta *et al.*, 2011) [21].

Anti-cancer Activity

Tinospora cordifolia's anti-cancer properties are largely researched in animal models. In male Swiss albino mice, TCE has been demonstrated to have a radio protective effect by increasing body weight, tissue weight, testes-body weight ratio, and tubular diameter, as well as inhibiting the damaging effects of sub-lethal gamma radiation on testes. TCE had a substantial effect on the radiation-induced elevation in lipid peroxidation in pre-irradiated animals, resulting in a decrease in GSH concentration in the testes. TCE pretreatment of HeLa cells was found to reduce cell viability, increase LDH, and decrease GSH S-transferase activity. TCE containing dihydrotestosterone (DHT) has been shown to promote the development and proliferation of human LNCaP cells (which are androgen-sensitive human prostate adenocarcinoma cells) (Kapur *et al.*, 2009) [9]. Increased levels of pro-inflammatory cytokines, such as IL-1, IL-6, TNF-, granulocyte monocyte-colony stimulating factor (GM-CSF), and the vascular endothelial cell growth factor (VEGF), as well as increased production of anti-angiogenic agents IL-2 and tissue inhibitor of metalloprotease-1 (TIMP-1), were detected in the B16-F10 extract-treated animals, indicating TCE's anti-angi *Tinospora cordifolia* polysaccharide fractions were found to be particularly effective at reducing the metastatic potential of B16-F10 melanoma cells. When compared to the untreated control mice, markers of neoplastic growth were dramatically reduced in the treated animals (Leyton and Kuttan, 2004) [10]. *Tinospora cordifolia* increased acid-soluble sulfhydryl (-SH), cytochrome P (450) contents, and enzyme activities of cytochrome P (450) reductase, cytochrome b5 reductase,

GST, DT-diaphorase (DTD), SOD, catalase, GPX, and GR activity in the liver of Swiss albino mice, highlighting the chemo preventive role (Singh *et al.*, 2006)^[22].

Anti-HIV effect

TCE has been proven to reduce the HIV's recurrent resistance, hence increasing therapeutic success. TCE's anti-HIV actions were demonstrated by a decrease in eosinophil count, activation of B lymphocytes, macrophages, and polymorphonuclear leucocytes, and a decrease in haemoglobin percentage, indicating that it has a promising function in disease management (Kalikata *et al.*, 2008).

Anti-Arthritic Activity

Traditional medicine has utilised single or synergistic formulations of *Tinospora cordifolia* and *Zingiber officinale* to treat rheumatoid arthritis. *Tinospora cordifolia* has been shown to inhibit the proliferation, differentiation, and mineralization of bone-like matrix in osteoblast model systems *in vitro*, suggesting that it could be used as an anti-osteoporotic agent. *Tinospora cordifolia* alcoholic extract has been demonstrated to increase the proliferation of osteoblasts, as well as the differentiation of cells into the osteoblastic lineage and the mineralization of bone-like matrix (Abhiramasundari *et al.*, 2012). In mammals, ecdysteroids extracted from the plant have been shown to have protein anabolic and anti-osteoporotic properties. The compound beta-ecdysone (ECD) derived from *Tinospora cordifolia* extracts has been shown to improve joint cartilage thickness, stimulate osteogenic differentiation in mouse mesenchymal stem cells, and alleviate osteoporosis in osteoporotic animal models. The anti-osteoporotic properties of 20-OH-Ecd isolated from *Tinospora cordifolia* have also been documented, underlining *Tinospora cordifolia*'s involvement in the treatment of osteoporosis and osteoarthritis (Kapur *et al.*, 2010)^[9].

Antipyretic activity:

T. cordifolia is traditionally recognised for its jwarahara action (antipyretic activity). Antipyretic efficacy was found in the water-soluble fraction of a 95 per cent ethanolic extract of *T. cordifolia*. The hexane- and chloroform-soluble parts of *T. cordifolia* stems were found to exhibit antipyretic properties in another experiment. *T. cordifolia* has anti-infective and antipyretic effects, according to several research. In rats, pre-treatment with *T. cordifolia* protected them against mortality caused by intra-abdominal sepsis after coecal ligation, and dramatically reduced mortality caused by *E. coli*-induced peritonitis in mice (Jayachandran *et al.*, 2003).

Immunomodulatory Activity:

Tinospora cordifolia is thought to have rasayana (rejuvenating), balsa (tonic), vayah-sthapana (anti-ageing), aayushyaprada (extension of life), vrishya (aphrodisiac), and chakshusya (helpful in eye problems) characteristics in Ayurveda. The alcoholic and aqueous extracts of *T. cordifolia* have been successfully investigated for their immunomodulatory activities and have been reported to have favourable effects on the immune system. During photosensitization, concomitant treatment with G1-4A/PPI (partially purified immunomodulator) from *T. cordifolia* substantially reduced protein degradation as measured by Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) (Dikshitar *et al.*, 2000; Desai *et al.*, 2002).

TLR6 signalling, NFkappaB translocation, and cytokine production are all activated by the new (1,4)-alpha-D-glucan produced from the plant, which engages the immune system by activating macrophages via TLR6 signalling, NFkappaB translocation, and cytokine generation. The enhanced production of antiangiogenic agents IL-2 and tissue inhibitor of metalloprotease-1 (TIMP-1) in the B16F10-injected, extract-treated rats shows that *Tinospora cordifolia* regulates cytokine rise differently. *T. cordifolia*'s antiangiogenic effect is linked to the modulation of cytokines and growth factors in the blood. *In vitro*, the aqueous extract of *T. cordifolia* was reported to improve phagocytosis. *In vivo*, both the aqueous and ethanolic extracts increased antibody production. (Nair *et al.*, 2006; Ranjith *et al.*, 2008)^[18, 12].

Anti-toxic potential of *Tinospora cordifolia*

The antioxidants found in the Giloy aqueous extracts can scavenging free radicals produced during aflatoxicosis. The Giloy extract prevented lead nitrate-induced liver damage. *Tinospora cordifolia* has anti-toxic properties due to its capacity to reduce thiobarbituric acid reactive substance (TBARS) levels while increasing glutathione, ascorbic acid, and protein levels. In the kidneys, it also boost the activity of antioxidant enzymes such superoxide dismutase, catalase, glutathione peroxidase, glutathione S-transferase, and glutathione reductase. Furthermore, alkaloids found in *Tinospora cordifolia*, such as isocolumbin, palmitic, tetrahydropalmatine, and magnoflorine, protect against aflatoxin-induced nephrotoxicity. The above study show the anti-toxic properties of giloy or guduchi.

Constituents of *Tinospora cordifolia* (Singh *et al.*, 2003)^[23]:

Types of Chemicals	Principles	Parts
Alkaloids	Barberine, Palmatine, Tembetarine	Stem and Root
Steroids	Hydroxy ecdysone	Stem
Sesquiterpenoid	Tinocordifilin	Stem
Glycosides	Tinocordiside, Cordioside, Syringing, cordifiside.	Stem
Diterpenoid Lactones	Furanolactone	Whole plant
Aliphatic compounds	Octacosanol, Heptacosanol	Whole plant
Miscellaneous	Nonanosan-15-one	Whole plant



Health benefits of Giloy

- Control blood sugar level
- Boost immunity
- Improve digestion
- Reduces stress
- Improve eye-sight
- Improved respiratory health
- Reduces anxiety
- Treats arthritis and gout
- Giloy for hay fever

Conclusion

The pharmacological action shows that *Tinospora cordifolia* in Ayurvedic has a remarkable body of modern evidence suggesting that this drug has potential in modern pharmacotherapeutics. All the compounds present in this show the immunomodulatory and physiological role of different types which is because of various kinds of phytochemicals in giloy, it has found applications in pharmaceutical, antihyperglycemic, anti tumour and HIV properties. The future scope of review focus on utilising the signalling pathways and biochemical of *T. cordifolia* active components to enable effective disease targeting. *Tinospora* is a great source in the scientific realm of medicine because it has so much to provide.

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