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Tinospora cordifolia – Phytochemical and Pharmacological evaluation

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Abstract
Plants of medicinal importance are attaining a great demand in this era. Synthetic medicines have numerous side effects, so the demand of herbals medicines are increasing day by day. *Tinospora cordifolia* is one of these plants which has a great potential in the treatment of many diseases. It must be considered for future research to eliminate the use of harmful medicines.

Keywords: medicinal, herbals, *Tinospora cordifolia*, potential

1. Introduction
Tinospora cordifolia which is also known as Giloe, belongs to the family *Menispermaceae*. It is an important medicinal plant used in ayurvedic system of medicine. The stem of the plant is greyish brown-black in colour and bitter in taste. The stems of *Tinospora cordifolia* are rather succulent with long filiform fleshy aerial roots from the branches. The stem is soft wooded, dry, cylindrical and 5mm to 25mm in diameter.
Traditionally, it has been used as an anti-spasmodic, anti-inflammatory, jaundice, diabetes, seminal weakness, urinary tract infections, fever, general debility, skin diseases, expectorant, carminative, digestive, anti-stress and aphrodisiac. Piles problem can be controlled by eating this plant mixed with milk or water and thus, preventing the bleeding and constipation (Kirtikar *et al*., 1987) [8].

2. Chemical constituents of *Tinospora cordifolia*
A variety of chemical constituents have been isolated from this plant and their structures have been established. The active ingredients include alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides. Table 1. Gives the detailed account on chemical constituents of *Tinospora cordifolia*.

Table 1: Chemical constituents of *Tinospora cordifolia*

Part of plant	Category of constituent	Active constituent
Stem	Alkaloids	Berberine, Palmatine, Tembetarine, Magnoflorine (Singh SS *et al*., 2003; Sinha K *et al*., 2004) [20, 21]
	glycosides	18-norclerodane glucoside, Furanoidditerpeneglucoside**,** Tinocordiside, Tinocordifolioside, Cordioside**,** Cordifolioside, Cordifolioside Syringin, Syringin-apiosylglycoside**,** Palmatosides, Palmatosides, Cordifoliside A, Cordiofoliside B**,** Cordifoliside C**,** Cordifoliside D**,** Cordifoliside E (Singh SS *et al*., 2003; Gagan VD *et al*., 1994; Wazir V *et al*., 1995 ; Gagan VD *et al*., 1996; Maurya R *et al*.,1997; Ghosal S *et al*.,1997) [20, 4, 13, 3, 11, 5]
	steroids	Ecdysterone,Makisterone A, Giloinsterol (Singh SS *et al*., 2003) [20]
	Sesquiterpenoid	Tinocordifolin (Maurya R *et al*.,1998) [12]
Root	Alkaloids	Choline, Tinosporin**,** Isocolumbin**,** Palmatine, Tetrahydropalmatine, Magnoflorine (Singh SS *et al*., 2003) [20]
	Miscellaneous compounds	Tinosporidine, cordifol, cordifelone, N-trans-feruloyl tyramine as diacetate, giloin, gilonin, tinosporic acid, 3,(a,4-di ydroxyl-3-methoxy-benzyl)-4-(4- Whole plant Compounds,ydroxyl-3-methoxy-benzyl)-tetrahydrofuran**,** Jatrorrhizine (Singh SS *et al*., 2003; Hanuman JB *et al*., 1986) [20, 6]
Whole plant	Diterpenoid lactones	Furanolactone,Clerodane derivatives, [(5R,10R)-4R-8R-dihydroxy-2S-3R:15,16-diepoxy-cleroda-13 (16), 14-dieno-17,12S:18,1S-dilactone], Tinosporon, Tinosporides, Jateorine, Columbin (Singh SS *et al*., 2003; Maurya R *et al*., 1997; Maurya R *et al*., 1989; Swaminathan K *et al*., 1989) [20, 11, 25]
	Aliphatic compound	Octacosanol, heptacosanol, nonacosan-15-one s (Singh SS *et al*., 2003; Thippeswamy G *et al*., 2008) [20, 26]
Aerial parts	steroids	b-sitosterol, d-sitosterol, g- sitosterol, b-hydroxygenase, ecdysterone, makisterone, giloinsteroljateorine, columbin (Singh SS *et al*., 2003) [20]

3. Pharmacological activities
3.1 Anti-Diabetic Activity
Pharmacological studies have proven in vivo antidiabetic potential of various extracts of T. cordifolia. It has been reported to mediate its antidiabetic potential through myriad of biologically active phytoconstituents isolated from different parts of plant, including alkaloids, tannins, cardiac glycosides, flavanoids, saponins and steroids (Sharma *et al*., 2015).

3.2 Aphrodisiac activity
Tinospora cordifolia extracts are being exerted on both the mechanisms of sexual arousal and performance on rats of either sex. It was found that an increased copulatory sexual behavior

and mounting were observed in animals treated with plant extracts. Among the two extracts, as clearly indicated, hydroalcoholic and aqueous extracts of *Tinospora cordifolia* possess potent aphrodisiac activity as evidenced by an increase in number of mounts, ano-genital sniffing attitude, penile erection index, ejaculatory behavior and mating performance (Wani *et al*., 2011) [27]

3.3 Anticonvulsant activity

The anticonvulsant activity was accessed by determining and comparing the test group with that of the standard drug treated group. The petroleum ether extract having the % inhibition of extension phase is 35.3% and the ethanolic extract having % inhibition phase of 61.1%. The ethanolic extract treated animals was found to be significantly good activity compared to standard drug treated cases (Murthy *et al*., 2012).

3.4 Anti-oxidant activity

Tinospora cordifolia stem extract has shown to produce immunological activity because of the presence of arabinogalactan. Probably all thesesecondary metabolites from the three plants contribute to provide a synergistic effect and greater inhibition for the microbes under investigation. It was further noticed that those extract combinations with T. cordifolia showed better inhibition and susceptibility to various pathogens. This study supports the traditional use of T. cordifolia and indicated that it contains some major bioactive compounds inhibiting the growth of microorganisms there by proving very effective source of derived drugs (Debnath *et al*., 2014) [2].

3.5 Immunomodulatory activity

T. cordifolia extract in human immuno-deficiency virus positive patients. For this, they assessed the efficacy of T. cordifolia extract (TCE) in HIV positive patients in randomized double blind placebo controlled trial. After clinical examination TLC, DLC, ESR, platelet count, hemoglobin and CD4 count were done and the results showed significant reduction in eosinophil due to that TCE treatment (Mathew *et al*., 1999) [10].

3.6 Immunostimulatory activity

The immunostimulatory effect of leaf extract of T. cordifolia on (a) specific immunity (antibody response), (b) non-specific immunity (neutrophil activity) and (c) disease resistance against *Aeromonas hydrophila* in *O. mossambicus* using ethanol and petroleum ether extracts of the leaves. They observed that the fish injected with both the extract at a dose of 8 mg/kg were protected against experimental infection with virulent *A. hydrophila* and concluded that the potentiality of *T. cordifolia* leaf extracts for use as an immunoprophylactic to prevent diseases in finfish aquaculture (Sudhakaran *et al*., 2006) [24].

3.7 Anti-cancer/Anti-tumor Activity

T. cordifolia extracts (TCE) in vitro inhibited cell proliferation and induced cell death in a dose-dependent (25-75µg/ml) and time dependent (24-120 hours) manner in oral squamous cell carcinoma cell line along with a significant cytostatic effect. Hence; it may have therapeutic potential in cancer. Differentiation and antitumor functions of tumor-associated macrophages (TAM) derived dendritic cells (DC) obtained from tumor-bearing host administered with alcoholic extract of T. cordifolia (ALTC). Their study indicates that the T. cordifolia can influence the myeloid differentiation of bone marrow progenitor cells and the recruitment of macrophages in response to tumor growth in situ (Mishra, 2015) [14].

3.8 Cognition (Learning and Memory) Activity

T. cordifolia extract effects on learning and memory in normal and cyclosporine induced memory deficit rats. Alcoholic and aqueous extracts of the wholeplant of T. cordifolia was administered orally for 15 days in two groups of rats. Both alcoholic and aqueous extracts of TC produced a decrease in learning scores in Hebb William maze and retention memory indicating enhancement of learning and memory.

3.9 Anti-inflammatory and Wound Healing Activity.

The dried stem of T. cordifolia produced significant anti-inflammatory effect in both acute and sub acute models of inflammation. T. cordifolia has been found to be more effective than acetylsalicylic acid in acute inflammation but insub acute inflammation, the drug is inferior to phenylbutazone (Patgiri *et al*., 2014) [18].

3.10 Anti-tuberculosis Activity

Ether extract of the stem distillate of aerial part of T. cordifolia has inhibited the in vitro growth of Mycobacterium tuberculosis at 1:50,000 dilutions. Its ethanolic extract has exhibited significant antipyretic activity in experimental rats. 'Septilin' syrup, a compound preparation containing T. cordifolia (7.82% in 5 ml of syrup) has been found to elicit good clinical response in children suffering from upper respiratory tract infection and chronic otitis media.

3.11 Hepatoprotective and Anti-oxidant Activity

The aqueous extract of roots of T. cordifolia has shown the anti-oxidant action in alloxan diabetes rats. The administration of the extract of T. cordifolia roots (25, 50 mg/kg body weight) for 6 weeks resulted in a significant reduction of serum and tissue cholesterol, phospholipids and free fatty acids inalloxan diabetic rats. Extract of T. cordifolia has also exhibited in vitro inactivating property against Hepatitis B and E surface antigen in 48-72 hrs. T. cordifolia is very well documented for hepatoprotective and antioxidant activity (Stance *et al*., 2011) [23].

3.12 Anti-osteoporotic Activity

T. cordifolia ethanolic stem extract in ovariectomized rat model of osteoporosis has been investigated. Ovx rats treated with TC (10 mg/kg b.wt) showed anosteoprotective effect. They found serum osteocalcin and cross-laps levels have been significantly reduced as well as alkaline phosphatase activity significantly higher in TC treatment groups. Total cholesterol and LDL levels remained unaltered but HDL (Kapoor *et al*., 2008) [7].

3.13 Anti-malaria (HMS) Activity

The effect of aqueous extract of *T. cordifolia* along with chloroquine in the treatment of three cases of hyper-reactive malarious splenomegaly (HMS) was studied. Aqueous extract of *T.cordifolia* (500mg) added to CQ base (300mg) weekly and CQ prophylaxis including spleen enlargement, Hb, serum IgM and well-being have been observed up to six months. The

results showed regression of spleen by 37-50% after six weeks and 45- 69% after six months (Baskar *et al*., 2009) [1].

3.14 Cardio-protective

Ethanolic extract of *T. cordifolia* at various dose levels showed dose dependent reduction in infarct size and in lipid peroxide levels of serum and heart tissue80. The cardioprotective activity of an herbal formulation "Caps HT2", which contains methanol extract of *T. cordifolia*, has antioxidant, anticoagulant, platelet antiaggregatory, lipoprotein lipase releasing, anti inflammatory and hypolipidaemic activity in rat (Mukeshwar *et al*., 2012) [17].

3.15 Anti-bacterial activity

The methanolic extracts of in vitro grown plants and callus showed a broad spectrum of activity against all the bacterial strains at the tested concentration of 10 – 20µg/disc for Staphylococcus aureus, S. typhi (8mm) (Madhu *et al*., 2012).

3.16 Antimicrobial Activity

T.cordifolia as therapeutic agents for treating infections in traditional medicine. cordifolia stem extract creping on Azadirachta indica has potential antimicrobial activity similar to that of neem tree when compared to Tinospora cordifolia creping on fencing. This can explain that the host plant will gain some of the activities when they survive on medicinal plants. It is essential that research should continue to isolate and purify the active components of this natural herb and use in experimental animals (Nagaprashanth *et al*., 2012) [16].

3.17 Free radical scavenging activity

To elevate the antiradical activity of methanolic Tinospora cordifolia stem exhibited DPPH radical scavenging activity in concentration dependant manner. This method is based on the reduction of methanolic DPPH solution in the presence of hydrogen donating antioxidant (AH) due to the formation of non- radical form DPPH.

The sensitivity of the method is determined by the strong absorption of DPPH (Sivakumar *et al*., 2010) [22].

4. Conclusion

The pharmacological and clinical studies reported in the present review confirm the therapeutic value of *Tinospora cordifolia*. Chemical compounds indicates that the plant could serve as "lead" for development of novel agents for disorders in the coming years. In this regard, further studies need to be carried out to explore *Tinospora cordifolia* for its potential in preventing and treating diseases.

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