



TINOSPORA CORDIFOLIA: THE INCOMPARABLE ONE: A REVIEW

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ABSTRACT

Plants have been one of the important sources of medicines since the beginning of human civilization. There is a growing demand for plant-based medicines, health products, pharmaceuticals, food supplements, cosmetics etc. A review of chemical constituents' presents in various parts of *Tinospora cordifolia* and their pharmacological actions is given in the present article. *Tinospora cordifolia* commonly named as "Guduchi" is known for its immense application in the treatment of various diseases in the traditional Ayurvedic literature. It is a popular medicinal plant spread across the tropics and is being used in Diet by various tribal people of India and it also forms a part of traditional Indian cuisine. Recently the discovery of active components from the plant and their biological function in disease control has led to active interest in the plant across the globe. The compounds isolated from *Tinospora* so as to enable new and effective formulation in disease eradication. This review can be used for further research as well as clinical purpose.

KEYWORDS: Anti-allergic, Ayurvedic medicine, Health products, *Tinospora cordifolia*, Immune modulator.

INTRODUCTION

Tinospora cordifolia (wild) is a deciduous climbing shrub which belongs to the family *Menispermaceae*. The plant family *Menispermaceae* consists of about 70 genus & 450 species that are found in tropical regions. It is found throughout the India & also in parts of Sri Lanka, Bangladesh and China. (Raghu *et al.*, 2006) The plant is designated as Rasayana in Ayurveda and is very well known for building up the immune system and body's defence against definite infecting Micro-organisms. (Tirtha *et al* 2007, Khare *et al.*, 2007).

Taxonomy

Kingdom: Plantae-Plant

Subkingdom: Tracheobionta-Vascular plant

Super division: Spermatophyta-Seed bearing plant

Division: Magnoliophyta – Flowering

Class: Magnoliopsida – Dicotyledons

Sub-class: Polypetalae – Petals are free

Series: Thalamiflorae – Many stamens and flower hypogynous

Order: Ranales

Family: Menispermaceae – The Moonseed family

Tribe: Tinosporeae

Genus: *Tinospora*

Species: *T. cordifolia*

As a science of life and the world's oldest medical system, Ayurveda has a holistic approach to health and disease that focuses on preserving and promoting good health and preventing disease through healthy lifestyle practices. These practices include consumption of fresh, minimally processed foods, the use of Rasayanas (formulas) that eradicate ageing and disease, sophisticated detoxification practices and regular consumption of adaptogen herbs that enhance the body's capacity to maintain balance in the midst of a variety of stressors.

Ayurveda use of medicinal and culinary herbs draws upon India's incredible biodiversity with a variety that is unsurpassed by any medical system; yet, of all the herbs used, none has a status comparable to Guduchi (*Tinospora cordifolia*). The World Health Organization (WHO) estimated that up to 80% of people still rely mainly on traditional remedies such as medicinal plants for their medicines. Since the beginning of human civilization, plants have been used as natural medicines. Recently, scientists are showing a great interest in the development of new drugs from traditional medicinal plants.

India with its vast bio-diversity and huge knowledge of ancient traditional systems of medicine such as Ayurveda, Siddha and Unani provide a strong base for

the utilization of a large number of plants in general healthcare and common ailments of the people (Pandey *et al.*, 2008).

Distribution and Morphology

Tinospora cordifolia plant is distributed throughout the tropical and subtropical regions of India. It is indigenous to areas of India, Sri Lanka, China, Myanmar, Thailand, Philippines, Indonesia Malaysia, Vietnam, Bangladesh and South Africa. (Sinha 2004, Sharma *et al.*, 2010). *Tinospora corifolia* is a large, deciduous, extensively spreading and climbing shrub with several elongated twining branches. Different parts of exhibits different types of morphology.

Root: Roots are aerial, thread like, long filiform, threadlike, squairsh, which arise from the mature branches or cut bits of stems grow downward and by continuously lengthening sometimes reach the ground. (Spandana *et al.*, 2013) The dried aerial roots are light grey –brown or creamy white in colour, odourless and bitter taste. Starch is present throughout the parenchyma of the aerial root.

Stem: Stem of this plant is rather succulent with long, filiform, fleshy and climbing in nature. Aerial roots arise from the branches. Dried stem is cylindrical, slender, slightly twisted in shape. Outer bark is thin and papery which is brown to greyish in colour. The stem is used in dyspepsia, fever and urinary diseases. (Bishayi *et al.*, 2002) The starch obtained from the stem known as “Guduchi-satva” is highly nutritive and digestive and used for many diseases.

Leaves: Leaves are seen in bulk intensely green in colour but over mature leaves are yellowish green to yellow colour. Leaves are bitter and have an indistinct odour. Lamina is ovate cordate, 10-20 cm long, 8-15cm broad (Nasreen *et al.*, 2010). Leaves are rich in protein, calcium and phosphorus.

Flowers: Flowers are small and unisexual which are greenish yellow in colour. Male flowers are clustered and female flowers exist in solitary. Sepals are six in two series of three each. Outer ones are smaller than the inner sepals. Petals are also six, smaller than sepals, free and membranous. Flowering is seen during summer (March to June). (Kirtikar 2005, Nasreen *et al.*, 2010).

Fruit: Fruits are fleshy and single seeded which are aggregates of one to three. These are drupelets on thick stalk with a sub terminal style scar. The shape of the fruit is ovoid with smooth texture and Scarlet or orange red in colour. These appear during winter (Kirtikar 2005, Nasreen *et al.*, 2010).

Seed: Seeds are white, bean shaped and curved. Embryo also turned in to curve shape automatically.

Chemical composition

A variety of constituents have been isolated from different parts of *Tinospora cordifolia*. They belong to different classes such as alkaloids, diterpenoid lactones, steroids, glycosides aliphatic compounds, polysaccharides. Some constituents have been isolated from plant mainly they are tinosporone, tinosporic acid, cordifolisides A to E, syringen, berberine, giloin, gilenin, crude giloininand, arabinogalactan polysaccharide, picrotene, bergenin, gilosterol, tinosporol, tinosporidine, sitosterol, cordifol, heptacosanol, octacosonal, tinosporide, columbin, chasmanthin, palmarin, palmatosides C and F, amritosides, cordioside, tinosponone, ecdysterone, makisterone A, hydroxyecdysone, magnoflorine, tembetarine, syringine, glucan polysaccharide, syringine apiosylglycoside, isocolumbin, palmatine, tetrahydropalmitine, jatrorrhizine respectively (Singh *et al.*, 2003).

Medicinal property: The plant possesses anti-oxidant, anti-hyperglycemic, anti-neoplastic, anti-stress, anti-dote, anti-spasmodic, anti-pyretic, antiallergic, anti-leprotic, anti-inflammatory, anti-hyperlypidaemia, Immunomodulatory properties. Various parts of the plant contain immense medicinal property.

Some of the important formulations are Guduchyadi churna, Guduchi taila, Sanjavani vati, Kanta-Kari avaleha, Chyavnaprasha, Guduchi satva, Guduchu ghrita, Amrita guggulu, Brihat guduchi taila, amritashtaka churna etc.

Folk and Tribal Medicine

The tribals Baiga, living in the interior areas of Naugarh and Chakia Block of Varanasi district, Uttar Pradesh make the paste of stem of the Guduchi (*T. cordifolia*) and the roots of Bhatkatiaya (*Solanum surattense*). The pills are prepared and used in the treatment of fever for three days (Singh *et al.*, 1983).

The tribals of Mumbai and its neighbouring areas and the fishermen along the sea coast use *cordifolia*as drug in the treatment of fever, jaundice, chronic diarrhoea and dysentery. (Shah *et al.*, 1984).

In Dahanu forest division of Maharashtra, tribal races, viz. Agaris, Bhils, Dhodias, Dublas, Khakarais, Rimoshis, Thakurs, Vardaris, Vagharis and Varlis use the stem decoction with cold or hot water (about 3-4 gm) in morning in an empty stomach as a tonic in general debility. (Shah *et al.*, 1983).

Powder of *Terminalia chebula* (Haritaki), *Tinospora cordifolia* (Amrita) and *Trachyspermum ammi* (Ajwain) in equal quantity is administered orally, once daily early morning with salt for the treatment of Kasa (cough). Decoction of these drugs is also to be taken in dose of 50 ml for the treatment of Kasa (cough) by the people of Dhurala (Haryana), (Anonymous *et al.*, 1999).

Ameliorative activity: Root or ethanol extract is used for the estimation of activity. *T. cordifolia* was found to show protective effect by lowering down the content of thiobarbituric acid reactive substances and enhancing the reduced GSH, ascorbic acid, protein, and the activities of antioxidant enzymes such as superoxide dismutase, CAT, GSH peroxidase, GST, and glutathione reductase in kidney (Gupta *et al.*, 2011).

Analgesic: Whole plant or ethanol extract is used for analgesic activity. It was assessed by hot plate and abdominal writhing method in albino rats (Hussain *et al.*, 2015).

Anti-allergic activity: *T. cordifolia* is used for the treatment of kafa (cough) and swasa (asthma), which is described in various texts of Ayurveda. *T. cordifolia* is traditionally used for the treatment of asthma, and the juice is also employed for the treatment of chronic coughs, (Spelman *et al.*, 2001). Thus, *T. cordifolia* significantly decreased all symptoms of allergic rhinitis and was well tolerated, (Badar *et al.*, 2005).

Anti-angiogenic Activity: *Tinospora cordifolia* has showed the antiangiogenic activity in in-vivo and in-vitro models. The plant extract being administered at a concentration of 20 mg/kg b w significantly inhibited the tumour directed capillary formation induced by melanoma cells.

Anti-cancer activity: *T. cordifolia* shows anti-cancer activity, this activity is mostly shown in animal models. Dichloromethane extracts of *T. cordifolia* shows cytotoxic effects owing to lipid peroxidation and release of LDH and decline in GST. In pre-irradiating mice, root extract has widely affected radiation, induced rise in lipid peroxidation and resulted in the decline of GSH in testes, (Upadhyay *et al.*, 2011).

Anti-cholinesterase Activity: The Alkaloids isolated from *T. crispa* should be evaluated for their Ach E inhibitory activity. The Ach E inhibition has therapeutic potential for treatment of parkinson's and alzheimer's diseases, senile dementia, ataxia, and myasthenia gravis. Nevertheless, the results presented in above-mentioned study are not sufficient to draw a meaningful conclusion. Hence, more cutting-edge and mechanistic studies are needed to better understand the anticholinesterase activity.

Anti-clastogenicity activity: Anticlastogenic potential of the ethanolic extract of *T. cordifolia* stem against arsenic-induced genotoxicity. plant stem extract may have antimutagenic or anticlastogenic property so it is noteworthy in the preventive aspects of chemical carcinogenesis and several types of disorders caused by genetic damages due to arsenic toxicity and *T. cordifolia* may be used as a preventive herbal drug against chemical or arsenic toxicity (Raghunathan *et al.*, 1969).

Anti-depressant: Depression is characterized by decreased brain levels of monoamines like norepinephrine, serotonin, and dopamine. Established antidepressants act by inhibiting reuptake or breakdown of these amines and increasing their levels at postsynaptic receptors. Inhibition of metabolism of monoamines, particularly serotonin and noradrenaline also demonstrated (Dhingra *et al.*, 2008).

Anti-diabetic activity: *Tinospora cordifolia* helps in curing diabetes patients. In diabetic rats, the treatment of oral administration of methanolic stem extract of Giloy predominantly helped in treating diabetes and brings back to near normal level when it was compared to the diabetic rats. (Agrawal *et al.*, 2012).

Antidiarrheal activity: Whole plant and ethanol or aqueous extracts are used for the estimation of antidiarrheal activity. The in vivo activity of extracts was assessed using castor oil (induces diarrhoea by inducing nitric oxide, stimulating prostaglandin synthesis, and increasing peristalsis) and magnesium sulfate (prevents reabsorption of water and promotes cholecystokinin release from duodenal mucosa) induced diarrhoea by means of evaluating onset of diarrhoea, frequency of wet and total stools, weight of wet stool, and total weight of stools. (Kaur *et al.*, 2014).

Anti-feedant activity: Whole plant or chloroform extract of *Tinospora* is used for the estimation of antifeedant activity. *Tinospora* is a potent source of natural antifeedant and activities against selected important agricultural lepidopteran field pest *Spodopteralitura*, *Helicoverpa armigera*, *Earias vittella*, and *Plutella xylostella* (Stanely *et al.*, 2003).

Anti-fertility activity: Oral administration of 70% methanolic extract of *T. cordifolia* stem to male rats at a dose level of 100 mg/d for 60 days did not cause body weight loss but decreased the weight of testes, epididymis, seminal vesicle and ventral prostate in a significant manner. (Gupta *et al.*, 2003).

Anti-filarial Activities: The aqueous extract of dried stems of *T. crispa*, investigated for *in vitro* anti-filarial effects, showed moderate activity against the adult worms of sub periodic *Brugia malayi* whereby the value of relative movability values was used as a measure of the anti-filarial activity (Zaridah *et al.*, 2001).

Anti-HIV effects: Anti-HIV effects of TCE was revealed by reduction in eosinophil count, stimulation of B lymphocytes, macrophages and polymorphonuclear leucocytes and haemoglobin percentage thus, revealing its promising role of application in management of the disease. (Akhtar *et al.*, 2010).

Anti-hyperglycaemic activity: *T. cordifolia* is widely used in Ayurveda for treating diabetes mellitus, (Prince *et al* 2004, Mathew *et al* 1997, Stanley *et al* 2001).

Inhibitory effect on adrenaline-induced hyperglycaemia by pyrrolidine derivative, (Grover *et al.*, 2001, Stanely *et al.*, 2000) and significant hypoglycaemic effect in normal and alloxan diabetic rabbits. (Wadood *et al.*, 1992) following administration of *T. Cordifolia*.

Anti-inflammatory: Stem or aqueous extract is used for anti-inflammatory activity. It was exhibited significantly in the carrageenan-induced inflammation test (paw oedema model in rats).

Anti-leprotic activity: *T. cordifolia* is used for its *kushtahara* (anti-leprotic) properties, along with wide use in *kandu* and *visarpa* (types of skin disorders) and has been shown to exert anti-leprotic activity in a combination formulation. (Asthana *et al.*, 2001).

Anti-microbial activity: The methanol extracts of *Tinospora cordifolia* have been reported to have potential against microbial infections. (Narayanan *et al.*, 2011). 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). (Narayanan *et al.*, 2009).

Anti-malaria (HMS) Activity: Hyper-reactive malarious splenomegaly (HMS) is thought to be the result of immunological dysfunction due to recurrent episodes of malaria. 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. Likewise decrease in IgM and increase in Hb as well as well-being were observed. Their findings required large scale trial to confirm the beneficial effect of *T. cordifolia* extract in combination with chloroquine. (Singh *et al.*, 2005).

Anti-osteoporotic effects: Alcoholic extract of *T. cordifolia* has been shown to stimulate the growth of osteoblasts, increasing the differentiation of cells into the osteoblastic lineage and also increasing the mineralization of bone-like matrix. (Abiramasundari *et al.*, 2012). Further 20-OH- β -E cd isolated from *T. cordifolia* has been reported for its anti-osteoporotic effects, thus highlighting the role of *Tinospora cordifolia* in the treatment of osteoporosis and osteoarthritis. (Kapur *et al.*, 2010).

Anti-oxidant activity: *Tinospora cordifolia* shows an effective anti-oxidant potential by reducing the generation of free radicals in the body due to various types of conditions. (Stanely *et al.*, 2001)

Antiparasitic Activity: The methanol extract from the whole plant of *T. crispera* exhibited 100% inhibition of *Plasmodium falciparum* growth after 72 h at a dose of 2.5 mg/mL (Najib Nik a Rahman *et al.*, 1999). It was discovered that the crude extract of *T. crispera* exhibited inhibitory effect on the growth of plasmodium in a dose-dependent way.

Antipsychotic activity: *Tinospora* is an active central nervous system stimulant and helps in various neurological activities. Berberine, choline, tembetarine, magnoflorine, tinosporin, palmetine, isocolumbin, aporphine alkaloids, jatrorrhizine, and tetrahydropalmatine are the alkaloids responsible for the activity (Josh *et al.*, 2016).

Antipyretic activity: Studies have shown insignificant antipyretic effects in the hexane and chloroform soluble fractions of the stem of *Gilo*. (Ikram *et al.*, 1987)

Anti-scabies: The 50% *Gilo* lotion showed a significant decrease in all the parameters. *Gilo* lotion exhibited a comparable anti-scabies activity with Permethrin having the same cure rate [*Gilo*: 70%, 53.60 to 86.94%; Permethrin: 50%, 32.11 to 67.89%; P = 0.187] and clearance time of 23rd days, 20.47 to 25.53 days. Since the *Gilo* lotion is inexpensive compared to the commercially available drugs, it can be used as an alternative treatment to scabies infestation, (Castillo *et al.*, 2013).

Anti-stress activity: The plant extract gives a moderate degree of behaviour disorders and mental deficit response. The clinical research showed the improved I. Q level of patients. In Ayurveda, it acts as Medhya Rasayana or brain tonic by increasing mind power like memory and recollection. (Baghel *et al.*, 2017).

Antitoxic activity: *Tinospora* scavenges the free radicals produced during aflatoxicosis. Some of the toxins present in *Tinospora* showed aflatoxin-induced nephrotoxicity. Oral administration of plant extracts (stem and leaf) prevented the occurrence of lead nitrate-induced liver damage, this antitoxic activity reported by the (Saha *et al.*, 2012).

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, (Vedavathy *et al.*, 1991).

Anti-ulcer activity: Anti-ulcer activity of *Tinospora* was estimated in albino rats using pylorus ligation-induced ulcer. *T. cordifolia* extract has shown significant

($p < 0.01$) reduction in gastric volume, total acidity, and ulcer index as compared to control and also significant ($p < 0.01$) reduction in ulcer index seen among *T. cordifolia* extract treated rats of aspirin and ethanol-induced models, (Kaur *et al.*, 2014).

Atherosclerosis Inhibitory Activity: (Amom *et al.*, 2011) discovered that the aqueous extract from *T. crispata* stem administered to hypercholesterolemic rabbits delayed the development of atherosclerosis by suppressing the levels of total cholesterol, triglycerides and low-density lipoproteins.

Bronchial asthma: Gulvel stem aqueous extract decreased bronchospasm in guinea pigs, capillary permeability in mice, and reduced number of disrupted mast cells in rats (Nayampalli *et al.* 1986, Nayampalli *et al.* 1982). Immune-modulation is also likely to be a responsible mechanism in allergies and bronchial asthma.

Cardioprotective activity: Whole plant or alcoholic extract of the herb is used here. *cordifolia* is used for the treatment of atrial and ventricular fibrillation, flutter, and ventricular tachyarrhythmias. (Sharma *et al.*, 2011) Chemical constituents are furanolactone, tinosporin, tinosporide, jateorine, columbin, and clerodane derivatives.

Diuretic activity: *T. cordifolia* has been described as useful in *mutrakriccha* (urinary trouble) separately and in the form of various formulations in Ayurveda. In a scientific study on rats and human volunteers, *T. cordifolia* was found to have diuretic effects. (Nayampalli *et al.*, 1988) It was also found effective in modulation of morphology and some gluconeogenic enzymes activity in diabetic rat kidney. (Nagaraja *et al.*, 2007).

Digestive activity: The anti-amoebic Effect of a crude drug formulation containing *T. cordifolia* against *Entamoeba histolytica* was studied. There were varying degrees of inhibition of the enzymes, viz, DNase, RNase, aldolase, alkaline phosphatase, acid phosphatase, α -amylase and protease activities of crude extracts of axenically cultured amoebae, (Sohni *et al.*, 1995).

Effects on central nervous system: Petroleum ether and ethanol extracts of leaf, stem, and Guduchi roots decreased the locomotor activity of mice after 2 hours of oral administration. Both aqueous and ethanol extracts of Guduchi reduced spontaneous locomotor activity in rats. (Aiyer *et al.* 1963).

Gastroprotective activity: Whole plant is used to estimate this activity. Epoxy clerodane diterpene isolated from *T. cordifolia* Miers (Guduchi) on indomethacin has induced gastric ulcer in rats as extracellular domain exerts its antiulcer activity by reinforcement of defensive elements and diminishing the offensive elements.

Epoxyclerodane diterpene is the chemical constituent responsible (Antonisamy *et al.*, 2014).

Hepatic disorder: Protective Effects of *Tinospora cordifolia* water extract (TCE) on Hepatic and Gastrointestinal Toxicity was reported by Sharma *et al.*, 2016; a significant increase in the levels of gamma-glutamyl transferase, aspartate transaminase, alanine transaminase, Triglyceride, Cholesterol, HDL and LDL ($P < 0.05$) in alcoholic sample whereas their level get downregulated after TCE intervention, patients showed the normalized liver function of *T. cordifolia* stand to relieve the symptoms. (Sharma *et al.*, 2016)

Hepatoprotective activity: Ethanol extract of all the parts of *Tinospora* showed hepatoprotective effect by reduction in serum enzymes alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, and total bilirubin accompanied by pet ether and aqueous extracts. Some of the alkaloids and terpenoids such as magnoflorin, tinosporin, isocolumbin, palmatine, and tetrahydropalmatine present in the herb are responsible for hepatoprotective activity (Kavitha *et al.*, 2011).

Immunomodulatory activity: Guduchi possesses immunomodulatory activity. (Tripathi *et al.* 1997) Various active compound or substances present in Guduchi are responsible for its excellent immunomodulatory activity. (Sharma *et al.*, 2011). Variety of compounds present in this plant enhanced phagocytic activity of macrophages (Upadhyaya *et al.*, 2011) and increased production of reactive oxygen species (ROS) in human neutrophil cells. (More *et al.*, 2012).

Immunostimulatory activity: Few *Tinospora* species have effects on humeral immunity, cellular immunity, and nonspecific immunity. Polysaccharide, a natural macromolecule, acquired all over the place occurrence in biological bodies and has abundant set of biological activities, which perform a special role in regulating immune system. (Ferreira *et al.*, 2014).

Liver Disorder: *T. cordifolia*, it was proved to be effective in preventing fibrous changes and promoting regeneration by parenchymal tissue. (Reddy *et al.*, 1993) An Ayurvedic preparation in HPN-12 containing *T. cordifolia* was investigated for the hepatoprotective effect on CCl₄ induced hepatic dysfunction in male albino rats Sprague Dawley strain. It was found that HPN- 12 is an effective drug against CCl₄ induced liver damage. (Latha *et al.*, 1999).

Memory enhancing activity: Studies have shown that Giloy helps in cognitive enhancement by immune-stimulation and synthesis of acetylcholine. Thus, contributing in increased choline level which shows that it has memory enhancing property for learning and memory in normal and memorydeficits animals. (Lannert *et al.*, 1998).

Mental disorder: A psychotropic preparation BR-16A containing *T. cordifolia* was investigated in short term memory paradigms in mice. The result suggests for possibly nootropic action of BR-16 A involving cholinergic and GABAergic modulation 80 (Kulkarni *et al.*, 1993).

Natural binder: Mucilage was extracted from the fresh stems of *T. cordifolia* which was characterized for physicochemical parameters. Using 2%, 4%, 6%, 8%, and 10% concentration of mucilage of *T. cordifolia* as natural binder, diclofenac sodium tablets (f1-f6) were prepared by dry granulation method (Madaan *et al.*, 2018).

Neuroprotective activity: The experiment conducted shows that *T. cordifolia* ethanolic extract on 6-hydroxy dopamine-induced Parkinson's disease by protecting dopaminergic neurons and reducing iron accumulation. Aerial parts or ethanolic extracts are used to estimate this activity. (Kosaraju *et al.*, 2014).

Post-Menopausal Syndrome: Clinical evaluation of non – hormonal drug minofil containing *T. cordifolia* along with other plant drugs was done in women of post-menopausal syndrome. Breast discomfort, nausea and fluid retention was observed in 22% (7 Cases) with estrial and almost no side effect was observed with minofil.

Skin disorders and leprosy: Traditional use of Gulvel has been mentioned in skin diseases. In Ayurveda, it has been mentioned as Kushtahara means, useful in leprosy, and useful in skin disorders like Kandu and Visarpa. Gulvel has been shown to have beneficial antileprotic activity in a combination formulation, (Asthana *et al.*, 2001).

Snake bite and scorpion bite: Use has been mentioned in snake bite and scorpion bite due to its ability to remove exogenous and endogenous toxins. (Ninivaggi *et al.*, 2001, Zhao *et al.*, 1991) The most likely mechanism relates to immune-modulation and antioxidant properties.

Wound healing: The extract of *T. cordifolia* may be attributed to the promotion of collagen synthesis. The extract of *T. cordifolia* did not reverse dexamethasone suppressed wound healing. (Shanbhag *et al.* 2005).

Uraemia: The water extract produced marked but transient fall in B.P. along with bradycardia and increased force of ventricular contraction in dogs and diuresis. It significantly decreases blood urea levels in uremic dogs and patients, (Singh *et al.*, 1975).

CONCLUSION

The scientific research on *Tinospora cordifolia* suggests a huge biological potential of this plant. It is strongly believed that detailed information as presented in this review on the phytochemical and various biological

properties of the extracts might provide detailed evidence for the use of this plant in different medicines. The phytochemical variations and efficacy of the medicinal values of *Tinospora cordifolia* is dependent on geographical locations and seasons at the same time, the organic and aqueous extract of *Tinospora cordifolia* could be further exploited in the future as a source of useful phytochemical compounds for the pharmaceutical industry. *Tinospora cordifolia* can be a potential dietary component which can help in prevention of different diseases. The utility of Guduchi leaves in diet is advisable and is highly beneficial.

The presented review summarizes the information concerning the botany, Ethnopharmacology, phytochemistry and biological activity of the *Tinospora cordifolia* plant. Future directions will entail studies on its pharmacology using animal models and isolated bioactive compounds. Further studies on this plant must be carried out to explore some other important, necessary and unknown benefits.

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