A review on chemical and biological properties of *Tinospora cordifolia*

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**Abstract:** *Tinospora cordifolia* (Guduchi) is an important herb in folk and ayurvedic systems of medicine. This paper presents a critical review on chemical and biological properties of *Tinospora cordifolia*. *Tinospora cordifolia* contain various chemical constituents belonging to different classes such as alkaloids, diterpenoid lactones, glycosides and sterols. The most important biological properties reported are antioxidant, anti-diabetic, anti-inflammatory, anti-arthritis, anti-stress, hepatoprotective, immunomodulatory and anti-neoplastic activities.

**Keywords:** Alkaloids; Immunomodulatory; *Tinospora cordifolia*.

**Introduction**

*Tinospora cordifolia* is a climbing shrub, which belongs to family menispermaceae. *Tinospora cordifolia* is a glabrous and succulent shrub, which is native to and widely distributed in India. Besides India, it is also widely distributed in Burma, Ceylon and China. It is called Guduchi in Sanskrit and Amrita or Giloya in Hindi. The term 'Amrita' is attributed to this drug in recognition of its ability to impart youthfulness, vitality and longevity to its patron. Different local names of *Tinospora cordifolia* are famous in different regions of India like Shindilkodi (Tamil), Gala (Gujarati) and Citamerdu (Malayalam). In the today’s world of modern medicine, it is also called as magical herb due to its property of curing a lot of diseases (Srivastava 2011).

**Botany**

*Tinospora cordifolia* is a deciduous plant that grows to 1.0 meters (3.3 feet) high by 0.5 meters (1.65 feet) wide and prefers many types of soil ranging from acid to alkaline and partial to full sun with moderate moisture. Stems of *Tinospora cordifolia* are succulent and having long filliform fleshy aerial roots, which arise from the branches. Bark is thin, greyish or creamy white in colour, when peeled fleshy stem is exposed. It often attains a great height and mostly climbs up the trunks of large neem trees. Leaves of *Tinospora cordifolia* are heart shaped, membranous, juicy and cordate. Wood of this plant is porous soft and white in color. *Tinospora cordifolia* has greenish flowers, which are unisexual and bloom in summer. Male flowers are small, yellow or green coloured occur in clusters whereas female flower occur singly. Fruits are Pea shaped, fleshy, shiny turn red when boiled and occur in winter. Seeds of *Tinospora cordifolia* are curved and pea sized.

**Chemical constituents**

A variety of constituents have been isolated from *T. cordifolia* belonging to different classes such as alkaloids, glycosides, diterpenoid lactones, sesquiterpenoids and steroids (Table 1). *T. cordifolia* contains about 11.2 percent protein and rich in Ca and phosphorus (Zhao et al. 1991; Khosa et al. 1971).

**Biological properties of Tinospsora cordifolia**

**Antioxidant action**

It has been reported that extract of *Tinospsora cordifolia* has free radical scaveng-
ing and antioxidant effect. Alcoholic root extract has antioxidant defence mechanism in alloxan induced diabetic rats and it is reported that there is significant increase in the concentration of thiobarbituric acid reactive substances (TBARS) in liver and kidney of diabetic rats. Decreased concentration of glutathione (GSH) and decreased activities of superoxide dismutase (SOD) and catalase in liver and kidney of diabetic rats were also noted. Alcoholic Tinospora cordifolia root extract (TCREt) administered at a dose of 100 mg/kg body weight to diabetic rats orally for six weeks normalized the antioxidant status of liver and kidney. He also reported that effect of Tinospora cordifolia root extract was more potent than glibenclamide (Prince et al. 2004).

Table 1: Active principle isolated from different parts of T. cordifolia plant

<table>
<thead>
<tr>
<th>Plant part</th>
<th>Active principle</th>
<th>References</th>
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<tr>
<td>Stem</td>
<td>Alkaloids</td>
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<tr>
<td></td>
<td>Berberine</td>
<td>Kumar et al. (2000)</td>
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<td></td>
<td>Palmitine</td>
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<td>Choline</td>
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<td>Tinosporine</td>
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<td></td>
<td>Glycosides</td>
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<td></td>
<td>18-norclerodane glycoside</td>
<td>Khan et al. (1989)</td>
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<td></td>
<td>Furanoidditerpene</td>
<td>Bhatt et al. (1989)</td>
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<td></td>
<td>Glucoseide</td>
<td>Ghosal et al. (1997)</td>
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<td></td>
<td>Tinocordiside</td>
<td>Sipahimalani et al. (1994)</td>
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<td></td>
<td>Syringin</td>
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<td></td>
<td>Steroid</td>
<td>Pradhan et al. (1997),</td>
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<td></td>
<td>Ecdyosterone</td>
<td>Gangan et al. (1997),</td>
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<td>A and Giloisterol</td>
<td>Maurya et al. (1998)</td>
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<tr>
<td>Roots</td>
<td>Alkaloids</td>
<td>Sarma et al. (1998)</td>
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<td>Whole plant</td>
<td>Diterpenoid lactones.</td>
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<td></td>
<td>Furanolactone</td>
<td>Hanuman et al. (1986)</td>
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<td></td>
<td>Tinosporon</td>
<td>Qudrat-i-Khuda et al. (1966)</td>
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<td>Columbin</td>
<td>Ahmad et al. (1978)</td>
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<tr>
<td>Aerial plant stem</td>
<td>Steroids</td>
<td>Pathak et al. (1995),</td>
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<td></td>
<td>b – Sitosterol</td>
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<td>and g – Sitosterol</td>
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Oral administration of 2.5 g and 5.0 g/kg body weight of the aqueous extract of the roots for 6 weeks resulted in a significant reduction in thiobarbituric acid reactive substances (TBARS) and an increase in reduced glutathione (GSH), catalase (CAT) and superoxide dismutase (SOD) in alloxan diabetic rats. The effect of Tinospora cordifolia root extract (TCREt) was most prominently seen in the case of rats given 5.0 g/kg body weight (Stanely and Menon 2001).

Aqueous extract of T. cordifolia inhibited Fenton (FeSO4) reaction and radiations mediated 2-deoxyribose degradation in a dose dependent fashion with an IC50 (Inhibitory concentration) value of 700 microg/ml for both Fenton and radiation mediated 2-DR degradation. Similarly, it showed a moderate but dose dependent inhibition of chemically generated superoxide anion at 500 microg/ml concentration and above with an IC50 value of 2000 microg/ml. Aqueous extract inhibited the formation of Fe2+-bipiridyl complex and formation of comet tail by chelating Fe2+ ions in a dose dependent manner with an IC50 value of 150 microg/ml for Fe2+-bipiridyl formation and maximally 200 microg/ml for comet tail formation, respectively. The extract inhibited ferrous sulphate mediated lipid peroxidation in a dose-dependent manner with an IC50 value of 1300 microg/ml and maximally (70%) at 2000 microg/ml. The results reveal that the direct and indirect antioxidant actions of T. cordifolia probably act in corroboration to manifest the overall radioprotective effects (Goel et al. 2002).

Hypoglycemic effect

In Indian Ayurvedic medicine, Tinospora cordifolia is widely used for treating the diabetes mellitus. Oral administration of an aqueous T. cordifolia root extract (TCREt) to alloxan diabetic rats caused a significant reduction in blood glucose and brain lipids. The extract caused an increase in body weight, total haemoglobin and hepatic hexokinase. The root extract also lowers hepatic glucose-6-phosphatase and serum acid phosphatase, alkaline phosphatase, and lactate dehydrogenase in diabetic rats. Thus TCREt has hypoglycaemic and hypolipidaemic effect (Stanely et al. 2000).

Oral administration of the extract of Tinospora cordifolia (TCREt) roots for 6 weeks resulted in a significant reduction in blood and urine glucose in alloxan diabetic rats. The extract also prevented a decrease in body weight (Stanely and Menon 2001).
Immuno-modulatory activity

The plant is used in ayurvedic medicine to improve the immune system and the body resistance against infections. It is reported that T. cordifolia benefits the immune system in a variety of ways. Both alcoholic and aqueous extracts of T. cordifolia have been tested successfully for immuno-modulatory activity. Pretreatment with Tinospora cordifolia reduced mortality in mice injected with 1 x 10^8 E. coli intraperitoneally from 100% in controls to 17.8%. This was associated with significantly improved bacterial clearance as well as improved phagocytic and intracellular bactericidal capacities of neutrophils in the Tinospora cordifolia treated group. Tinospora cordifolia did not possess in vitro bactericidal activity (Thatte et al. 1994). Dry stem crude extract (DSCE) of Tinospora cordifolia contained a polyclonal B cell mitogen, G1-4A. DSCE as well as G1-4A also enhance immune response in mice (Desai et al. 2002).

Treatment with T. cordifolia extract also deleted the immunosuppressive effect of CCl4 and there is significant increment in the functional capacities of rat peritoneal macrophages (PMφ) following T. cordifolia treatment. Treatment by T. cordifolia extract may be the critical remedy for the adverse effect of CCl4 in liver function as well as immune functions (Bishayi et al. 2002). It also has significantly reduced the mortality from E. coli induced peritonitis in mice. In clinical study, it has afforded protection in cholestatic patients against E.coli infection (Dhuby 1997). It is believed that hyper-reactive malarious splenomegaly (HMS) is result of immunological dysfunction due to recurrent episodes of malaria. Addition of T. cordifolia aqueous extract to the treatment of HMS for initial six weeks accelerated the well-being with subsidence of haemolytic state besides marked reduction in spleen size and serum IgM as well as rise in Hb (Singh et al. 2005).

Hepatoprotective activity

Effect of Tinospora cordifolia extract on modulation of hepatic functions is also reported. Treatment with T. cordifolia extract (100 mg/kg body weight for 15 days) in CCl4 intoxicated rats was found to protect the liver, as indicated by enzyme level in serum. A significant reduction in serum levels of SGOT, SGPT, ALP, bilirubins were observed following T. cordifolia treatment during CCl4 intoxication (Bishayi et al. 2002).

The hepatoprotective action of T. cordifolia was reported in one of the experiment in which goats treated with T. cordifolia have shown significant clinical and hemato-biochemical improvement in CCl4 induced hepatopathy. Extract of T. cordifolia has also exhibited in vitro inactivating property against Hepatitis B and E surface antigen in 48-72 hrs (Mehrotra et al. 2000).

Other properties

It has been reported that guduchi killed the HeLa cells very effectively in vitro and thus it indicates that guduchi needs attention as an anti neoplastic agent (Jagetia et al. 1998). Anti-inflammatory potency of water extract of T. cordifolia has been proved by the study on induced oedema arthritis and on human arthritis. The effect was comparable with indomethacin and its mode of action appeared to resemble that of a non-steroidal anti-inflammatory agent. The dried stem of T. cordifolia produced significant anti-inflammatory effect in both acute and sub-acute models of inflammation. T. cordifolia was found to be more effective than acetylsalicylic acid in acute inflammation (Jana et al. 1999). It also has antipyretic action. The aqueous extract of the stem antagonizes the effect of agonists such as 5-hydroxytryptamine, histamine, bradykinin and prostaglandins E1, and E2 on the rabbit smooth muscle, relaxes the intestinal, uterine smooth muscle and inhibits the constrictor response of histamine and acetylcholine on smooth muscle. I/V exposure to aqueous extract of T. cordifolia in doses of 5, 10 and 15.0 mg/kg body weight produces a temporary but marked fall in blood pressure and bradycardia in anaesthetized dogs (CSIR 1976).

Ethanol extract of root of T. cordifolia induced a marked protection against restraint stress induced ulcerization. This activity was comparable to that of diazepam (Sarma et al. 1995). Antiamoebic effect of crude drug formulation containing T. cordifolia against Entamoeba...
histolytica was also observed (Sohni et al. 1995). A herbal preparation BR-16A containing *T. cordifolia* was tested in short term memory paradigm in mice and result suggest for possibly nootropic action of BR-16A involving cholinergic ad GABAergic modulation (Kulkarni and Verma 1993).

**Conclusion**

*T. cordifolia* is widely used in ayurvedic medicine for the treatment of various ailments. It is reported that extract of *Tinospora cordifolia* has good immunomodulating effect. It also has the ability to scavenge free radicals and to block free radicals and to inhibit radical induced membrane damage. It also has the hypoglycemic activity and hypolipidemic activity. It also has ability to protect the liver from various diseases. It is found that it is non-toxic in acute toxicity studies. Various types of studies, which have been done on *T. cordifolia*, reveal that it is an excellent drug, which could be a good remedy for various ailments of animals as well as human beings yet the safety and the potential indications in human beings and animals have to be established using modern techniques.

**References**


