CHEMISTRY AND MEDICINAL PROPERTIES OF TINOSPORA CORDIFOLIA (GUDUCHI)


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ABSTRACT

Tinospora cordifolia (Guduchi) is a widely used shrub in folk and ayurvedic systems of medicine. This review presents a detailed survey of the literature on chemistry and medicinal properties of Tinospora cordifolia. The chemical constituents reported from this shrub belong to different classes such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides. The notable medicinal properties reported are anti-diabetic, anti-periodic, anti-spasmodic, anti-inflammatory, anti-arthritis, anti-oxidant, anti-allergic, anti-stress, anti-leprotic, anti-malarial, hepatoprotective, immunomodulatory and anti-neoplastic activities.

KEY WORDS

Anti-diabetic anti-oxidant alternative medicine phytochemistry

Introduction

Guduchi [Tinospora cordifolia (Willd.) Miers ex Hook. F. & Thoms] is a large, glabrous, deciduous climbing shrub belonging to the family Menispermaceae. It is distributed throughout tropical Indian subcontinent and China, ascending to an altitude of 300 m. In Hindi, the plant is commonly known as Giloya, which is a Hindu mythological term that refers to the heavenly elixir that have saved celestial beings from old age and kept them eternally young. The stem of Tinospora cordifolia are rather succulent with long filiform fleshy aerial roots from the branches. The bark is creamy white to grey, deeply left spirally, the space in between being spotted with large rosette like lenticels. The leaves are membranous and cordate. The flowers are small and yellow or greenish yellow. In auxiliary and terminal racemes or racemose panicles, the male flowers are clustered and female are usually solitary. The drupes are ovoid, glossy, succulent, red and peaseized. The seeds are curved. Fruits are fleshy and single seeded. Flowers grow during the summer and fruits during the winter.

Guduchi is widely used in veterinary folk medicine/ ayurvedic system of medicine for its general tonic, anti-periodic, anti-spasmodic, anti-inflammatory, anti-arthritis, anti-allergic and anti-diabetic properties. The plant is used in ayurvedic, “Rasayananas” to improve the immune system and the body resistance against infections. The root of this plant is known for its anti-stress, anti-leprotic and anti-malarial activities. Authors investigated earlier one of the plants of the family Menispermaceae and found that the constituents and activities were similar to other reports.

Chemistry

A variety of constituents have been isolated from Tinospora cordifolia plant and their structures were elucidated. They belong to different classes such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides.

Leaves of this plant are rich in protein (11.2%) and are fairly rich in calcium and phosphorus. Studies
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<thead>
<tr>
<th>Type of Chemical</th>
<th>Active principle with references</th>
<th>Part in which present</th>
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<tbody>
<tr>
<td>Alkaloids</td>
<td>Berberine (I) (^{14-18}), Palmatine (II) (^{14-18}), Tembentaine (III) (0.012%) (^{14-18}), Magnoflorine (IV) (0.075%) (^{14-18}), Choline (V) (^{18}), Tinosporin (^{18}), Isocolumbin (^{19}), Palmatine (^{19}), Tetrahydropalmatine (VI) (^{19}), Magnoflorine (^{19})</td>
<td>Stem</td>
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<td></td>
<td>18-norclerodane glucoside (VII) (^{20})</td>
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<td>Furanoid diterpene glucoside (^{21,22}) (VIII and IX)</td>
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<td>Tinocordiside (X) (^{23,24}), Tinocordifolioside (XI) (^{25-26})</td>
<td>Stem</td>
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<td></td>
<td>Cordioside (^{25,26}), Cordifolioside A (^{27,28}), Cordifolioside B (^{27,28})</td>
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<td>Syringin (XII) (^{29,30}), Syringin-apiosylglycoside (^{29,30})</td>
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<td>Palmatosides (^{31}), Palmatosides (^{31})</td>
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<td>Cordifoliside A (XIII) (^{28,32}), Cordifoliside B (^{28,32})</td>
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<td>Cordifoliside C (^{28,32}), Cordifoliside D (^{28,32}), Cordifoliside E (^{28,32})</td>
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<tr>
<td>Glycosides</td>
<td>18-norclerodane glucoside (VII) (^{20})</td>
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<td>Furanoid diterpene glucoside (^{21,22}) (VIII and IX)</td>
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</table>
**TINOSPORA CORDIFOLIA: CHEMISTRY AND MEDICINAL PROPERTIES**

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<thead>
<tr>
<th>Type of Chemical</th>
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<th>Part in which present</th>
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<tbody>
<tr>
<td>Diterpenoid</td>
<td>Furanolactone XIV(^3^3), Clerodane derivatives XV, XV(^4^4,4^5) and XVI(^3^3), (5R,10R)-4R-8R-dihydroxy-2S-3R:15,16-diepoxy-cleroda-13 (16), 14-dieno-17,12S:18,1S-dilactone(^3^6) and Tinosporon(^3^7), Tinosporides XVIII(^1,2,2^2,4^3-4^3) and XIX(^1,2^2,2^2,4^3-4^3), Jateorine (XX)(^1,2^8-4^2), Columbin (XXI)(^1,2^2,2^3-4^3)</td>
<td>Whole plant</td>
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**Steroids**

- β-sitosterol (XXII)\(^4^4-4^7\), δ-sitosterol\(^4^4-4^7\), 20β-hydroxy ecdysone (XXIII)\(^4^4-4^7\).
- Ecdysterone (XXIV)\(^4^8-5^0\), Makisterone A (XXV)\(^4^8-5^0\), Giloinsterol\(^4^8-5^0\).

**Aerial part**

- β-sitosterol (XXII)\(^4^4-4^7\), δ-sitosterol\(^4^4-4^7\), 20β-hydroxy ecdysone (XXIII)\(^4^4-4^7\).
- Ecdysterone (XXIV)\(^4^8-5^0\), Makisterone A (XXV)\(^4^8-5^0\), Giloinsterol\(^4^8-5^0\).

**Stem**

- β-sitosterol (XXII)\(^4^4-4^7\), δ-sitosterol\(^4^4-4^7\), 20β-hydroxy ecdysone (XXIII)\(^4^4-4^7\).
- Ecdysterone (XXIV)\(^4^8-5^0\), Makisterone A (XXV)\(^4^8-5^0\), Giloinsterol\(^4^8-5^0\).
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<tbody>
<tr>
<td>Sesquiterpenoid</td>
<td>Tinocordifolin$^{51}$, Octacosanol (XXVI)$^{45-47}$, Heptacosanol (XXVIII)$^{45-47}$, Nonacosan-15-one (XXVIII)$^{45-47}$</td>
<td>Stem</td>
</tr>
<tr>
<td>Aliphatic compound</td>
<td></td>
<td>Whole plant</td>
</tr>
<tr>
<td>Miscellaneous compounds</td>
<td>3$(\alpha, 4$-dihydroxy-3-methoxy-benzyl)-4-$\alpha$-hydroxy-3-methoxy-benzyl)-tetrahydrofuran$^{45-47}$, Jatrorhizine (XXIX)$^{52}$, Tinosporidine$^{17,47,53}$, Cordifol$^{17,47,53}$, Cordifelone$^{17,47,53}$, N-trans-feruloyl tyramine as diacetate$^{54}$, Giloin$^{48,55}$, Giloinin$^{48,55}$, Tinosporic acid$^{48,55}$</td>
<td>Whole plant, Root, Whole plant</td>
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</table>

on the physical characteristic and chemical composition of the starch obtained from Guduchi Satwa (extract) were carried out and the polysaccharide was found to consist chiefly of $\alpha\rightarrow4$ linked glucan with occasionally branched points$^{11,12}$. Its similarities and differences from amylose were elucidated. An arabinogalactan had been isolated from the dried stems of *T. cordifolia*$^{13}$.

**Medicinal properties**

The stem of *Tinospora cordifolia* is one of the constituents of several ayurvedic preparations used in general debility, dyspepsia, fever and urinary diseases. The stem is bitter, stomachic, diuretic$^{56}$, stimulates bile secretion, causes constipation, allays thirst, burning sensation, vomiting, enriches the blood and cures jaundice. The extract of its stem is useful in skin diseases$^{57,58}$. The root and stem of *T. cordifolia* are prescribed in combination with other drugs as an anti-dote to snake bite and scorpion sting$^{22,36}$. Dry barks of *T. cordifolia* has anti-spasmodic, anti-pyretic$^{59}$, anti-allergic$^{60}$, anti-inflammatory$^{61,62}$ and anti-leprotic$^{63}$ properties.

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. Intravenous exposure to aqueous extract of *T. cordifolia* in doses of 5.0, 10.0 and 15.0 mg/kg body
weight produces a temporary but marked fall in blood pressure and bradycardia in anaes-thetized dogs.4

*T. cordifolia* is widely used in Indian ayurvedic medicine for treating diabetes mellitus64-66. Oral administration of an aqueous *T. cordifolia* root extract to alloxan diabetic rats caused a significant reduction in blood glucose and brain lipids. Though the aqueous extract at a dose of 400 mg/kg could elicit significant anti-hyperglycemic effect in different animal models, its effect was equivalent to only one unit/kg of insulin67.

It is reported that the daily administration of either alcoholic or aqueous extract of *T. cordifolia* decreases the blood glucose level and increases glucose tolerance in rodents68,69. Aqueous extract also caused a reduction in blood sugar in alloxan-induced hyperglycemia in rats and rabbits in the dose of 400 mg/kg. However, histological examination of pancreas has not revealed any evidence of regeneration of ß-cells of islets of Langerhans and the possible mode of action of the plant is through glucose metabolism70. The aqueous extract has also exhibited some inhibitory effect on adrenaline-induced hyperglycemia. Ethyl acetate extract of its roots has afforded a pyrrolidine derivative with hypoglycemic activity in rabbits71-73. Another study has also revealed significant hypoglycemic effect of extract of leaves in normal and alloxan diabetic rabbits. However, the extract had no significant effect on total lipid levels in normal or treated rabbits74-75.

*T. cordifolia* is reported to benefit the immune system in a variety of ways70,76-77. The alcoholic and aqueous extracts of *T. cordifolia* have been tested successfully for immuno-modulatory activity78-84. Pre-treatment with *T. cordifolia* was to impart protection against mortality induced by intra-abdominal sepsis following coecal ligation in rats. It has also significantly reduced the mortality from *E. coli* induced peritonitis in mice. In a clinical study, it has afforded protection in cholestatic patients against *E. coli* infection. These activities are not due to its anti-bacterial activity as shown by the negative in-vitro anti-bacterial activity of the plant extract76,85. It is reported that the treatment in rats had resulted in significant leucocytosis and predominant neutrophilia. It has been also observed that it stimulates the macrophages as evidenced by an increase in the number and % phagocytosis of *S. aureus* by peritoneal macrophages in rats86. Other workers have also supported these observations. The phagocytic and Intra-cellular killing capacity of polymorphs in rats, tested at 3.5 h after *E. coli* infection were significant87,88.

The anti-stress and tonic property of the plant was clinically tested and it was found that it brought about good response in children with moderate degree of behaviour disorders and mental deficit. It has also significantly improved the I.Q. levels.

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 h89. The aqueous extract of *T. cordifolia* exerted a significant anti-inflammatory effect on cotton pellet granuloma and formalin induced arthritis models. Its 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 subacute models of inflammation. *T. cordifolia* was found to be more effective than acetylsalicylic acid in acute inflammation. But in subacute inflammation, the drug was inferior to phenylbutazone90. In a clinical evaluation, a compound preparation ‘Rumalaya’ containing *T. cordifolia* was reported to significantly reduce the pain in patients suffering from rheumatoid arthritis1.

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 (2.5, 50 mg/kg body weight) for 6 weeks resulted in a significant reduction of serum and tissue cholesterol, phospholipids and free fatty acids in alloxan diabetic rats91.

Jagetia *et al.*, have found that guduchi killed the HeLa cells very effectively *in vitro* and thus it indicates that guduchi needs attention as an anti-neoplastic agent92. In this study exposure of HeLa cells to 0, 5, 10, 25, 50 and 100 μg/ml of guduchi extract (methanol, aqueous and methylene chloride) resulted in a dose dependent but significant increase in cell killing when compared to non drug treated controls.
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 dilution. 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) was found to elicit good clinical response in children suffering from upper respiratory tract infection and chronic otitis media.

The Ayurveda literature reports that it can cause constipation, if taken regularly in high doses; it has no side effect and toxicity. Yet the safety and the potential indications in human beings have to be established using modern methods.

**REFERENCES**


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