



ISSN (E): 2277-7695  
 ISSN (P): 2349-8242  
 NAAS Rating: 5.23  
 TPI 2022; 11(6): 1987-1991  
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[www.thepharmajournal.com](http://www.thepharmajournal.com)

Received: 08-04-2022  
 Accepted: 18-05-2022

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## A systematic review on the bioactive compounds and health benefits of *Tinospora cordifolia*

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**Abstract**

Herbal plants produce a miscellaneous range of bioactive molecules, making them a rich source of different types of medicines. Thus, there is a need for proper scientific evidence or assessment has become the criteria for acceptance of herbal health claims. In the present scenario, effect of the traditional Ayurvedic formulation Giloy Satva (*Tinospora cordifolia* known as Guduchi) is examined especially the antioxidant properties. Some species of giloy are endemic to India. It is an alternative, anthelmintic, anti-pyretic, aphrodisiac, bitter tonic, and blood purifier, cardiac, carminative digestive, diuretic and expectorant. Some parts are having special features like starch from the roots and stem is used in chronic diarrhoea and dysentery, juice of fresh plant is diuretic and used in gonorrhoea. The studies shows that plant is distributed throughout the tropical region of India up to 1,200m above sea level from Kumaon to Assam, in north extending through West Bengal, Bihar, Deccan, Kankan, Karnataka and Kerala. The medicinal properties of *Tinospora cordifolia* are because of the presence of several phytochemical compounds in its different parts such as root, stem, and leaves. Antioxidant rich giloy acts as immune booster, controls blood sugar level, fights against urinary tract infection, boosts immunity as well as aids in detoxification of blood, thereby improving liver health.

**Keywords:** *Tinospora cordifolia*, health supplements, steroids, immunity, medicinal

**1. Introduction**

Traditional medicinal plants and the usage of herbal medicines in the prevention and in the treatment of various nutrition related non communicable diseases has been widely accepted in a country like India. One among such plants is *T. cordifolia* which belongs to family of climbing shrubs known as Menispermaceae (Joshi *et al.*, 2021) [26]. It is also known as Giloy or Amrita and is a large, deciduous climbing shrub having a flashy stem and coiled branches which produces greenish- yellow flowers throughout the summer and winters, often found at higher altitudes. It is having succulent stems with long filiform fleshy aerial roots forming the branches. The bark of the plant is gray brown and watery (Onkar and Bangar, 2012) [35]. This plant is widely distributed in the Asian countries like India, China, particularly native to India. The plant is found throughout the tropical region in India from Kumaon to Assam, in north extending through West Bengal, Bihar, Deccan, Kankan, Karnataka and Kerala. (Arshad *et al.*, 2018) [11]. A wide range of chemical constituents are present in Giloy namely- Tinosporine, (S), Magnoflorine, Giloinsterol, (S),  $\beta$ -Sitosterol, cordifolioside A, B and C, cordifoliside D and E, Tinocordioside, cordioside, palmatosides C and F which belongs to the different classes of bioactive compounds such as alkaloids, diterpenoid lactones, steroids, lignans, terpenoids, glycosides, aliphatic compounds, polysaccharides etc. (Upadhyay *et al.*, 2010) [34]. Leaves are particularly rich in protein, calcium, and phosphorus. The starch obtained from the stem which is known as "Guduchi- satva" is highly nutritious (Kadir and Hossan. 2009) [36]. Giloy helps in improving digestion and getting relief from the problems like abdominal pain, excessive thirst, and vomiting, and even liver disorders like hepatitis. Giloy is loaded with phytoconstituents such as steroids, alkaloids, cardiac glycosides that are known to regulate the blood glucose and possess anti- diabetic potential by promotion of insulin secretion and gluconeogenesis inhibition thus regulating the blood glucose (Rawal *et al.*, 2004) [38]. Giloy plant is also very effective in reducing dark spots, pimples fine lines and wrinkles, skin disease because it is having anti- aging properties and is rich in antioxidants (Arunachalam *et al.*, 2022) [37]. One of the few risks that is associated with the consumption of Giloy, is that the person who is diabetic should be cautious while consuming the Giloy specially if an individual is taking medicines to lower down the blood glucose (Srivastava *et al.*, 2021) [12].

Further, Giloy is having stimulating effects on the immune system so may possess some complications to the person suffering from auto-immune diseases such as Rheumatoid arthritis, Crohn's disease etc. due to the overstimulation of the immune system (Mittal *et al.*, 2014)<sup>[3]</sup>. The popular products which are available in the Indian markets are Giloyyadi churna, Amrita guggulu, Sudarshan churna, Giloyyadi churna, Rasnapanchak kwath, sanjivni vati etc (Sharma *et al.*, 2021)<sup>[39]</sup>.

The present study highlights the nutritional composition of this miraculous herb & the diverse role it plays in the maintenance of our overall health by boosting our immunity levels, maintaining the cardiovascular health, memory enhancement and by the prevention of other lifestyle related disorders. Further, the traditional utilization of *T. cordifolia* and its market presence are also uncovered.

## 2. Geographical distribution and habitat

*T. cordifolia* is a climbing shrub, distributed throughout the tropical region of India up to 1,200m above water position from Kumaon to Assam, in north extending through West Bengal, Bihar, Deccan, Kankan, Karnataka and Kerala. It is generally grown in evanescent and dry timbers at elevations up to 1000 feet. (Jain *et al.*, 2010). It prefers wide range of soil, acid to alkaline and it needs moderate position of soil humidity (Premila *et al.*, 2006). *T. cordifolia* prefers medium black or red soil for its cultivation. Giloy can also be successfully grown in large variety of soils, ranging from flaxen to complexion gault. Still, the soil should be well drained with sufficient humidity and rich with organic matter for its growth (Chaudhari and Shaikh, 2013)<sup>[33]</sup>.

The factory is very veritably and it can be grown in nearly all climates but prefers warm climate. Planting is generally done during stormy season (July to August). As it is rambler so it requires support for its growth. Fast growing species similar as Neem (*Azadirachta indica*), Jatropha (*Jatropha curcas*) and Moringa (*Moringa oleifera*) have been planted to give support for its growth. *T. cordifolia* growing with Neem (*Azadirachta indica*) is called as neem giloy has chemical composition as analogous as neem as well as giloy and show better remedial parcels (Choudhary *et al.*, 2013)<sup>[33]</sup>.

## 3. Growth Constraints

The constraints on husbandry are in part technological and in large part institutional; while in the case of exports the ramification of a significantly further outward-acquainted growth may involve changes in numerous abecedarian tenets, including political, of current development policy.

*T. cordifolia* can be propagated by seeds and vegetative slices. Still, both the ways are not suitable for large scale product and having problems in traditional styles of propagation. Viability of seeds is veritably less, poor seed set and germination of seeds are the main problems associated with its clonal propagation (Padma and Upadhyay, 2013)<sup>[21]</sup>. Stem slices are the best planting material for raising marketable crop (Sharma and Prajapati, 2013)<sup>[29]</sup>. The slices can be attained from mother's shops in June–July. The factory can also be raised using seeds. Seeds take nearly further than double the time to

develop and yield the same volume of medicine. Vegetative slices are also not suitable due to lower productivity and also dependent upon rainfall conditions for its farther growth. Considering the musts of development, factory tissue culture methodology might be a sensible system to make a tremendous reach in a more modest reality. Plant tissue culture- Murashige and Skoog medium was fortified with 3% sucrose and 0.3% Clerigar. After the addition of phytohormones the pH was acclimated to 5.8 after that MS medium was sterilized in an autoclave under 15 PSI pressures and 121°C temperature for 20 twinkles. Castrated medium was castrated into laminar air inflow for inoculation. After inoculation culture vessels were transferred into culture room contains 25± 2°C temperatures for 3- 4 weeks with 16 hours of photoperiod and 70% relative moisture (Sinha *et al.*, 2017)<sup>[7]</sup> and the ways may be suitable styles for its large-scale product in a lower time and space, nursing fashion, (Daniel *et al.*, 2006; Jindal and Khan, 2019).

## 4. Nutritional composition of *T. cordifolia*

The whole plant of *T. cordifolia* such as, stem, leaves, roots and fruits, is rich energy (288.8-292.54 cal/100g) macronutrients like carbohydrates (61.66-71.4 g/100g), protein (2.13-11.2 g/100g), fats (1.92-3.1 g/100g) and fibre (5.72-15.9 g/100g) (Kavya *et al.* 2015; Pandey *et al.* 2020)<sup>[22, 28]</sup> and micronutrients like vitamin C (17.01 mg/100g), vitamin E, iron (9.7 mg/100g), calcium (70 mg/100g), zinc (143 mg/100g), copper (32 mg/100g), phosphorus (54-193 mg/100g), manganese (0.29 mg/100g) and magnesium (6.34 mg/100g) (Sharma *et al.* 2019; Pandey *et al.* 2020)<sup>[9, 28]</sup>. Phytochemicals like phenolics, flavonoids, carotenoids, terpenes, steroids, aliphatic compounds, terpenoids, diterpenoids lactones, steroids, and alkaloids are distributed in various parts of the giloy plant (Upadhyay *et al.* 2010; Saeed *et al.* 2019; Pandey *et al.* 2020)<sup>[34, 28]</sup>. It also contains antinutritional factors like saponins, glycosides, lignans, and tannins (Chaudhary *et al.* 2014; Sharma *et al.* 2019)<sup>[9]</sup>.

## 5. Pharmacological profile and health benefits of *Tinospora cordifolia*

*T. cordifolia* or Giloy has been documented as a traditional medicinal plant owing to its high pharmacological profile and it possess numerous health benefits (Joshi *et al.*, 2021)<sup>[26]</sup>. Several research studies have been conducted by the researchers so that the pharmacological profile of *T. cordifolia* can be explored. Every part of the plant including its roots, stem, leaves, flowers, fruits etc. has its benefits in curing various types of diseases (Promila *et al.*, 2017)<sup>[7]</sup>. *T. cordifolia* has been reported to have numerous biological activities. The plant is also having various useful features wiz. it is having an anti-microbial effect, having stress relieving properties, used to cure various metabolic disorders including diabetes & kidney diseases, & also used to prevent skin disorder (Mittal *et al.*, 2014; Promila *et al.*, 2017; Sharma *et al.*, 2019)<sup>[3, 7, 9]</sup>. These different types of bioactive properties are due to the presence of various classes of bioactive components (Mittal *et al.*, 2014)<sup>[3]</sup>. A complete detail of the same along with all the key findings has been presented in Table 1.

**Table 1:** Health benefits of *T. cordifolia* along with the key findings

S. No.	Health benefits	Key findings	References
1.	Cancer prevention	<ul style="list-style-type: none"> <li>Chemically provokes breast cancer can be prevented with the help of component like Epoxy clerodane diterpene present in <i>T. cordifolia</i>.</li> <li><i>T. cordifolia</i> can be used as a safer drug to cure cancer as it does not have adverse health effects as compared to synthetic chemotherapeutic agents.</li> </ul>	Alam <i>et al.</i> (2021) <sup>[40]</sup>
2.	Removal of toxins	<ul style="list-style-type: none"> <li>Antioxidants present in aqueous extracts of Giloy are having scavenging activity against the free radicals generated during aflatoxicosis</li> <li><i>T. cordifolia</i> possess anti- toxic activity due to its ability of reducing thiobarbituric acid reactive substances (TBARS) concentration S-transferase (GST) and</li> </ul>	Arshad <i>et al.</i> (2018) <sup>[11]</sup>
3.	Prevents Diabetes	<ul style="list-style-type: none"> <li>Phytochemicals like alkaloids, tannins, cardiac glycosides, flavonoids, saponins and steroids that are isolated from different parts of <i>T. cordifolia</i> are responsible for curing the diabetes</li> <li>Stem extract of <i>T. cordifolia</i> enhances the efficiency of insulin secretion from <math>\beta</math>- cell of the pancreas and enhances glycogenesis and inhibiting the glucose formation thus have a strong antidiabetic potential.</li> </ul>	Promila <i>et al.</i> (2017) <sup>[7]</sup>
4.	Boosts Immunity	<ul style="list-style-type: none"> <li>Giloy's stem strengthen the immune system by altering the levels of enzyme catalase thus stimulating the lymphocytes</li> <li><i>T. cordifolia</i> contains polysaccharide (G1-4A) enhances the production and differentiation of B-cells and T-cells thus boosting the immunity</li> <li>Variety of compounds like cordifolioside A, magnoflorine, tinocordioside and syringin are responsible for immunomodulatory and cytotoxic effect of <i>T. cordifolia</i></li> </ul>	Arshad <i>et al.</i> (2018) <sup>[11]</sup> Mittal <i>et al.</i> (2014) <sup>[3]</sup>
5.	Anti- pyretic	<ul style="list-style-type: none"> <li>Flavonoids and Alkaloids are having ability of reducing the body temperature by inhibition in the release of prostaglandins (PGs)</li> <li>Many Ayurvedic practitioners says that <i>T. cordifolia</i> has an antipyretic effect while used alone, or in conjunction with paracetamol and/or other antibiotics</li> <li>Synergetic action of flavonoids and alkaloids present in <i>T. cordifolia</i> extracts is responsible for its anti- pyretic effect</li> </ul>	Alam <i>et al.</i> (2021) <sup>[40]</sup> Arunachalam <i>et al.</i> (2022) <sup>[37]</sup>
6.	Improves cardiovascular health	<ul style="list-style-type: none"> <li>An aqueous root extract of <i>T. cordifolia</i> has a hypolipidemic action</li> <li><i>T. cordifolia</i> has been reported to show a significant reduction in phospholipids, free fatty acids (FFA), and cholesterol levels.</li> <li><i>T. cordifolia</i> is having antioxidant activity</li> </ul>	Arshad <i>et al.</i> (2018) <sup>[11]</sup> Arunachalam <i>et al.</i> (2022) <sup>[37]</sup>
7.	Prevent ulcers	<ul style="list-style-type: none"> <li>Active compounds like tannins, Alkaloids that are present in <i>T. cordifolia</i> prevents oxidative damage</li> <li><i>T. cordifolia</i> suppresses the prostaglandin secretion &amp; counteracts the liberating action of ROS.</li> <li>It prevents the damage to gastric mucosa and speed up the healing of gastric ulcers.</li> </ul>	Arunachalam <i>et al.</i> (2022) <sup>[37]</sup>
8.	Memory enhancement	<ul style="list-style-type: none"> <li>It enhances the stimulation of immune system and synthesis of acetylcholine</li> <li>It is having a beneficial effect against anxiety</li> <li>It helps in relieving stress</li> </ul>	Arshad <i>et al.</i> (2008) <sup>[11]</sup> Joshi <i>et al.</i> (2021) <sup>[26]</sup> Sharma <i>et al.</i> (2019) <sup>[9]</sup>

## 6. Traditional usages of Giloy (*T. cordifolia*)

*Tinospora cordifolia* or Guduchi is an ayurvedic drug which is mentioned in classical texts of Ayurvedic System of Medicine, viz. Charak, Sushrut and Ashtang Hridaya and other treatises like Bhava Prakash and Dhanvantari Nighantu under other various names, viz. Amara, Amritvalli, Chinnarruha, Chinnodebha etc. (Sharma *et al.*, 2001) <sup>[23]</sup>. *T. cordifolia* is mentioned in Ayurvedic literature as a constituent of several compound formulations used in general debility, dyspepsia, high fever and urinary diseases. Some of the important formulations which are: Guduchyadi churna, Guduchi taila, Dashmoolarishtha, Sanjivani vati, Kanta- kari avaleha,

Chyavanaprasha, Guduchi sattva, Brihat guduchi taila, Stanyashod- hana Kashaya, churana, Punchedha churana, Guduchi ghrita, Amritaguggulu, Amritashtaka churna, etc (Sharma *et al.*, 2001) <sup>[23]</sup>.

The plant possesses a wide range of active compounds like berberine, photoberberine, palmatine, magnoflorine etc. Berberine is an isoquinoline alkaloid mainly found in the stem and in minor quantities in roots. It is used to cure diabetes, controlling blood sugar levels, high fever, jaundice, neurological disorders and several other ailments (Sharma *et al.*, 2015) <sup>[20]</sup>.

**Table 2:** Uses of Giloy in different classical texts of Ayurvedic System of Medicine

S. No.	Different classical texts of Ayurvedic System of Medicine	Key findings	References
1	<i>Sushrut Samhita</i>	Giloy claimed to be useful in treating Kustha (leprosy), Maha-jvara (a kind of fever), Svasa (asthma) and Aruchi (anorexia).	Sharma <i>et al.</i> , (2001) <sup>[41]</sup>
2	<i>Charak Samhita</i>	Giloy had been indicated in diseases like Kamala (jaundice), Jvara (fever) and Vat rakta (gout)	Tripathi <i>et al.</i> , (2003) <sup>[43]</sup>
3	<i>Bhava Prakash</i>	Giloy was considered as a bitter tonic, astringent, diuretic and curative against skin infection, jaundice, diabetes and Dysentery diseases.	Chunekar KC <i>et al.</i> , (2006) <sup>[43]</sup>
4	<i>Ark Prakash</i>	Giloy's medicinal properties were mentioned for cure of Kasa, Jawara.	Tripathi <i>et al.</i> , (2006) <sup>[44]</sup>
5	<i>Amrita</i>	Giloy was referred to the property of providing longevity and youthfulness	Choudhary <i>et al.</i> , (2013) <sup>[33]</sup>
6	<i>Dhanvantari Nighantu</i>	Giloy was used to cure Jantu, Chardi, Jawara	Kamat SD <i>et al.</i> , (2002) <sup>[45]</sup>

## 7. Utilisation of *Tinospora cordifolia* (Giloy) in value-added products:

Giloy (*Tinospora cordifolia*) is a potent antioxidant found in ayurveda. It is one of the constituents of several ayurvedic preparations used in general debility, dyspepsia, fever and urinary diseases. It is an important ingredient of many medicinal and non medicinal preparations and is considered to have aphrodisiac, immunostimulant, hepatoprotective, and antioxidant, anticancer and antidiabetic activities (Kumar *et al.*, 2019) <sup>[9]</sup>. Besides its therapeutic properties, the plant also provides multiple essential minerals (Sharma *et al.*, 2020) <sup>[8]</sup>. It is also good for younger and anemic people as it contains sufficient protein, carbohydrate with low fat and high fiber (Bharati *et al.*, 2021) <sup>[19]</sup>. Results of studies has also suggested that giloy possesses significant antimicrobial potential which justifies the folklore antimicrobial usage of drug, thus it can be used as potent antimicrobial compound and can be used in or as a health supplement to flus and other microbial infections (Srivastava *et al.*, 2021) <sup>[12]</sup>.

Having so many benefits giloy is now being extensively used in several value added products like RTS (Ready to serve drinks), cookies, squash, syrups etc. and is also being incorporated in cooking. Studies reported that products incorporated with giloy has great nutritional value and can be organoleptically acceptable to the consumers. It contains high medicinal value can also be used for preparation of ready to eat and healthy products (Sharma *et al.*, 2013) <sup>[29]</sup>. Nutritional and medicinal properties of cookies can be improved by incorporation of sun dried giloy leaf powder.

Nutritional value of cookies is increased 0 to 7.5% by increase in iron, calcium, dietary fiber, protein, anti-oxidant activity and  $\beta$ -carotene by addition of giloy dry leaves powder (Sharma *et al.*, 2013) <sup>[29]</sup>. Dried powder sample from leaf (sun dried) and stem of giloy has high solubility. It not only contains various benefits and medicinal properties but can also be used in powder form for formulation of various health benefit food products like supplements.

## 8. Conclusion

Giloy or *Tinospora cordifolia* is a climbing scrub with numerous health benefits but is generally unacceptable due to its bitter taste. It is native to India and known by different names in different regions. In ancient times, tribal people of India used it for the treatment of various diseases. Now it is being used as a medicinal plant because of its pharmacological benefits. Giloy is abundant in macro and micro nutrients, besides that it contains bioactive compounds which gives it the property of health benefits.

Giloy can be consumed in different forms. It can be incorporated into various value added food products like RTS, squash, bakery, beverages etc. It is also used extensively in other non food products like wound healing creams and health supplements. The present study has thoroughly described the miracle herb known as "Giloy" with its various benefits as a basis for reference to any further research conducted on Giloy or other herbs.

## 9. Acknowledgement

The authors are highly grateful to Lovely Professional University for providing the necessary facilities, which were necessary for the preparation of manuscript.

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