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## *Tinospora cordifolia*: Nutritional value, pharmacological profile and health benefits

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#### Abstract

This review provides an overview of *Tinospora cordifolia*'s morphology, pharmacological profile, and health benefits, along with its ethnobotanical usage, value-added products, and market product availability. The plant is extensively used in traditional Ayurvedic medicine for treating jaundice, rheumatism, urinary disorders, skin illnesses, diabetes, anaemia, inflammation, allergic conditions, anti-periodic, radioprotective qualities, and so on. It exhibits various therapeutic properties in treating metabolic problems as well as its potential as an immune booster, which has given it a considerable amount of scientific attention. It is worth using because it is quite efficient against a range of infections and is very economical.

**Keywords:** *Tinospora cordifolia*, Giloy, immunity, nutritional composition, therapeutic effects

#### 1. Introduction

*Tinospora cordifolia*, commonly known as 'Guduchi' or 'Giloy', is a genetically diverse, large climbing shrub with greenish-yellowish flowers usually found at higher altitudes. It is a Menispermaceae family herbaceous vine native to the Indian Subcontinent's tropical regions. It has been used as traditional and ayurvedic medicine to treat many diseases for centuries (Modi *et al.*, 2021) [34]. As stated by (Tiware *et al.*, 2018) [58], this herbaceous deciduous plant grows to about 3–4 feet in height and is about 1 foot in width. The stems are succulent and the branches are formed by long, filiform, fleshy aerial roots. The bark is grey-brown and watery. The leaves are membranous and cordate. The flowers are small and greenish yellow. This herb can be found all over tropical Asia, reaching a height of 300 meters. It can be found in a wide range of soils, from acidic to alkaline, and only requires a small amount of moisture. The giloy plant is scattered in tropical India and reaches an altitude of 1000 feet in South Asia, Indonesia, the Philippines, Thailand, Myanmar, China, and Sri Lanka worldwide (Modi *et al.*, 2021) [34].

*Tinospora cordifolia* comprises numerous diverse bioactive compounds that can affect the body in many ways. Some of these chemicals have antioxidant properties that stimulate the immune system of the body and help fight pathogens. It also seems to have medicinal properties like anti-leprotic, anti-malarial, anti-inflammatory, anti-arthritis, antispasmodic, anti-oxidant, anti-allergic, anti-stress, anti-diabetic, hepatoprotective, immune-modulatory, and antineoplastic activities, which have made this plant more important for research purposes. The various active constituents of this plant can be obtained from the different parts of the plant, like leaves, stems, and roots, etc. (Saxena *et al.*, 2019) [46]. Giloy root is used as an emetic and to treat bowel blockage. This plant's starch is a useful home cure for chronic fever, as it calms burning sensations and boosts energy and appetite. Giloy is used to treat heart disease, leprosy, and rheumatoid arthritis, as well as to boost the immune system and the body's resistance to infections. It also helps to maintain the structure, function, and numbers of white blood cells. It can also help with hyperacidity, colitis, worm infestations, lack of appetite, gastrointestinal pain, excessive thirst, and vomiting, as well as liver disorders such as hepatitis.

#### 2. Chemical composition of *Tinospora cordifolia*

*Tinospora cordifolia* contains a wide range of chemical components, including alkaloids, diterpenoid lactones, steroids, glycosides, aliphatic chemicals, and polysaccharides (Kumar *et al.*, 2017) [28]. According to (Khan *et al.*, 2016) [27], alkaloids, glycosides, steroids, phenolics,

aliphatic compounds, polysaccharides, and polysaccharides are among the chemical elements of *Tinospora cordifolia*. The leaves are high in protein (11.2 percent), calcium, and phosphorus. Alkaloids are active elements in the stem and root of *Tinospora cordifolia*.

Furanolactone, lactones, diterpenoid, clerodane derivative [(5R, 10R)-4R-8R-dihydroxy-cleroda-13,14-dieno-17, 12S:18,1 Sdilactone], columbin, tinosporaside, jateorine, tinosporin are also found in the complete plant of *Tinospora*

*cordifolia* (Gupta *et al.*, 2011) [21]. Diterpenoid furano lactone, cordifolide, cordifol, heptacosanol, tinosporide, Beta-sitosterol, tinosporine, clerodane furano diterpine, tinosporaside, and columbin are the main phytoconstituents of *Tinospora cordifolia*. The stem section of *Tinospora cordifolia* has been shown to include alkaloids such as magnoflorine, berberine, palmatine, non-glycoside gilonin, gilosterol, tembertarine, choline, and tinosporin.

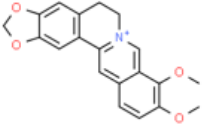
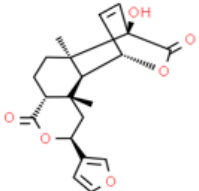
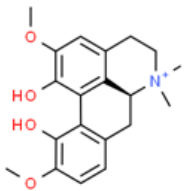
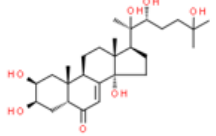
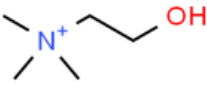
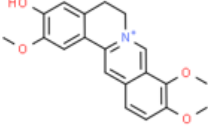
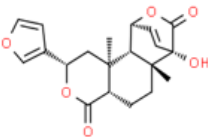
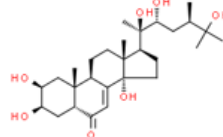
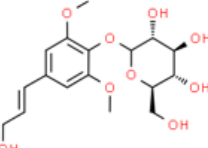



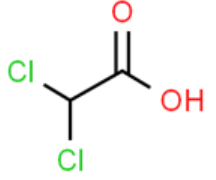

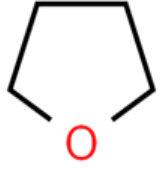
 Berberine (C <sub>20</sub> H <sub>18</sub> NO <sub>4</sub> )	 Tinosporin (C <sub>20</sub> H <sub>22</sub> O <sub>6</sub> )	 Magnoflorine (C <sub>20</sub> H <sub>24</sub> NO <sub>4</sub> )
 Ecdysterone (C <sub>27</sub> H <sub>44</sub> O <sub>7</sub> )	 Choline (C <sub>5</sub> H <sub>14</sub> NO)	 Jatrorrhizine (C <sub>20</sub> H <sub>20</sub> NO <sub>4</sub> ) n
 Isocolumbin (C <sub>20</sub> H <sub>22</sub> O <sub>6</sub> )	 Makisterone A (C <sub>28</sub> H <sub>46</sub> O <sub>7</sub> )	 Syringin (C <sub>17</sub> H <sub>24</sub> O <sub>9</sub> )
 Heptacosanol (C <sub>27</sub> H <sub>56</sub> O)	 Octacosanol (C <sub>28</sub> H <sub>58</sub> O)	 Hexadecanoic acid (C <sub>16</sub> H <sub>32</sub> O <sub>2</sub> )
 Dichloroacetic acid (C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub> O <sub>2</sub> )	 Octadecadenoic acid (C <sub>18</sub> H <sub>32</sub> O <sub>2</sub> )	 Tetrahydrofuran (C <sub>4</sub> H <sub>8</sub> O)

Fig 1: Chemical composition of *Tinospora cordifolia*

### 3. Nutritive value of *Tinospora cordifolia*

*Tinospora cordifolia* is considered to possess a valuable amount of various nutrients, which makes it a useful herb. Different minerals and vitamins are present along with all the other macronutrients. According to (Modi *et al.*, 2021) [34]. *Tinospora cordifolia* stem typically comprises ample protein (4.5–11.2%), adequate carbohydrates (20.78%), low fat (6.68%), and a fair amount of fibre (39.26%). Its nutritional value stands at 156.44 kcal per 100 grams. Some of them are enlisted below:

**Table 1:** Nutritive composition of *Tinospora cordifolia*

Nutrients	Amount	References
<b>Proximate analysis</b>		
Ash content (%)	6.86	Modi <i>et al.</i> (2021) [34]
Moisture content (%)	23.11	
Energy (kCal/ 100gms)	156.44	
Carbohydrates (%)	20.78	
Proteins (%)	4.5- 11.2%	
Fats (%)	6.68	
Fiber (%)	39.26	
<b>Vitamins</b>		
β-carotene (%)	0.11	Khan <i>et al.</i> (2011) [30]
Niacin (mg/100gms)	0.7	
Ascorbic acid (μg/gm)	0.24	
Tocopherol (mg/100gms)	0.7	
<b>Minerals</b>		
Potassium (%)	0.845	Nile and Khobragade, 2009, Khan <i>et al.</i> (2011) [62, 30]
Chromium (%)	0.006	
Iron (%)	0.28	
Calcium (%)	0.131	
Zinc (mg/100gms)	3.3	
Copper (mg/100gms)	0.81	
Sodium (mg/100gms)	39.32	
Magnesium (mg/100gms)	67.57	
Iodine (mg/100gms)	72.4	
<b>Others</b>		
Saturated Fatty Acids (%)	37	Khan <i>et al.</i> (2011) [30]
Unsaturated Fatty Acids (%)	57	
Lipids (%)	5.9	Khan <i>et al.</i> (2011) [30]
Lycopene (mg/100gms)	58.1	
Total Soluble Solids (°Brix)	10.4	(Khan <i>et al.</i> , 2011) [30]

### 4. Pharmacological profile

Since ancient times, *Tinospora cordifolia* has been recognised as the most widely used plant in traditional medicine for its spasmolytic, allergen-free, and anti-diabetic properties. The plant has a considerable impact on the immune system and has a lot of beneficial characteristics. The root is utilised for stress relief and antimalarial effects, while the stem is used as a bitter stomachic and diuretic. It promotes biliary secretion, blood enrichment, and the treatment of jaundice (Tiwari *et al.*, 2018) [58]. Guduchi is a medication that has been extensively studied for its therapeutic potential. It has demonstrated favourable activity across a variety of systems, involving the entire body. It's a rasayana, according to Ayurveda, and it has an all-encompassing effect (Kavya *et al.*, 2015) [26].

#### 4.1 Anti-oxidant effect

*Tinospora cordifolia* extracts were found to have high antioxidant activity in methanol, ethanol, and water extracts. The high antioxidant activities of the extracts indicate that the stem has the potential to be a source of natural antioxidants or nutraceuticals that can help to minimise oxidative stress and

provide health benefits (Srivastava and Singh, 2021) [56]. There has been evidence of antioxidant activity and a reduction in cyclophosphamide-induced toxicity. It has an antiaflatoxicosis effect in ducks (Sinha *et al.*, 2004) [55]. The total flavanol and total phenolic content were calculated. Antioxidant activity is mainly affected through different mechanisms, which include superoxide anion scavenging assay, hydroxyl radical scavenging assay, DPPH radical scavenging, and the ABTS radical scavenging method (Bharath *et al.*, 2021). The antioxidant potential of methanolic stem extract against Cd-induced renal impairment due to oxidative stress was investigated (Padma *et al.*, 2016) [38]. The methanolic stem extract reduces protein carbonyl concentration, inhibits lipid peroxidation, modulates the cellular antioxidant system, and improves membrane ATPase function, according to the findings.

#### 4.2 Immunomodulatory activity

The immunomodulatory effects of *Tinospora cordifolia* are widely known and this property has been well documented by scientists. 11-hydroxy muskatone, Magnoflorine, Cordifolioside A, Tinocordioside, and syringin are only a few of the compounds that have immunomodulatory and cytotoxic properties (Mittal *et al.*, 2014) [33]. A few months ago, a deadly pandemic hit human life and spread like a wildfire. People were told that the only way to stay safe and healthy was to develop strong immunity and avoid contracting the virus. A healthy immune system is essential for preventing coronavirus infection and disease development. Because it is termed the "ultimate immune booster" and is full of antioxidants that assist in detoxifying the body and stimulating immunity, Giloy is an entirely natural medication with no side effects in healthy people. (Srivastava and Singh, 2021) [56]. The stem of *Tinospora cordifolia* modifies the level of enzymes like catalase and activates lymphocyte cells to maintain immunological vigor, indicating the shrub's immuno-protective significance. When macrophage cells are exposed to *Tinospora cordifolia* extract, they produce more enzymes, including myeloperoxidase, which boosts antimicrobial activity and protects immunity. On the other hand, it also boosts macrophage phagocytic activity. When alkaloids, steroids, aliphatic compounds, and other guduchi substances were examined preclinically in a rat model, they showed substantial immuno-protective action (Tiwari *et al.*, 2018) [58].

#### 4.3 Anti-diabetic activity

Tannins, cardiac glycosides, flavonoids, saponins, alkaloids like magnoflorine, palmetine, jatrorrhizine, and other compounds are responsible for their anti-diabetic properties. When rats were given an aqueous extract without *Tinospora cordifolia* extract, glucose levels increased by 21.3 percent, insulin levels increased by 51.5 percent, triglycerides increased by 54.12 percent, and the glucose insulin index increased by 59.8 percent (Sharma *et al.*, 2019). Giloy is a hypoglycaemic agent that aids in the treatment of diabetes, particularly Type 2 diabetes. It also assists in lowering blood sugar levels. It has been suggested that it has anti-diabetic properties by reducing oxidative stress (OS), facilitating insulin secretion, and inhibiting gluconeogenesis and glycogenolysis, all of which help to regulate blood glucose levels. *Tinospora cordifolia* contains alkaloids, tannins, cardiac glycosides, flavonoids, saponins, and steroids, which

have been shown to have antidiabetic properties (Saxena *et al.*, 2019)<sup>[46]</sup>. GSH levels and other reactive species can rise as a result of gestational diabetes, posing a risk to both the mother and the fetus. *Tinospora cordifolia* was added into the daily diet of a diabetic pregnant rat (streptozotocin-induced diabetes) and exhibited a protective effect by reducing the oxidative load, consequently preventing the relative occurrence of illnesses and any birth abnormality (Patel *et al.*, 2011)<sup>[39]</sup>.

#### 4.4 Anti- HIV activity

This plant's root extract has been shown to regularly reduce HIV resistance on a regular basis. The reduction in eosinophil count, stimulation of B lymphocytes, macrophages, haemoglobin level, and polymorphonuclear leukocytes revealed this anti-HIV impact (Mittal *et al.*, 2014)<sup>[33]</sup>. (Sarangi *et al.*, 2013)<sup>[45]</sup> stated that people with HIV and other autoimmune disorders profit from Giloy. The conventional use of Giloy as an immune stimulant prompted researchers to investigate its effects on HIV patients. As per research published in the "Indian Journal of Pharmacology", 60 percent of HIV patients who got giloy medication had fewer disease-related symptoms than those who received placebo treatment. *Tinospora cordifolia*'s anti-HIV activity reveals its use in HIV management by raising CD4 T-cell count and reducing eosinophil (a kind of WBC) levels in HIV positive patients. The phagocytic and intracellular bactericidal activities of *Tinospora cordifolia* extract were dramatically increased. Peritoneal macrophages were similarly activated by *Tinospora cordifolia*. *Tinospora cordifolia* also improves phagocytosis and intracellular killing ability. B-lymphocytes, polymorphonuclear leukocytes, and macrophages are all considerably stimulated by *Tinospora cordifolia* (Patel *et al.*, 2013)<sup>[39]</sup>.

#### 4.5 Anti-cancer activities

As documented by (Mittal *et al.*, 2014)<sup>[33]</sup>, *Tinospora cordifolia* has anti-cancer properties, which are often demonstrated in animal models. *Tinospora* root extract has been shown to have a radioprotective effect due to a significant increase in body weight, tissue weight, and tubular diameter. In living organisms, the majority of synthetic chemotherapeutic agents have toxic side effects. Giloy has been reported to have a stronger effect than doxorubicin. According to (Sinha *et al.*, 2004)<sup>[55]</sup>, consenting breast cancer patients who were undergoing adjuvant therapy (CMF regimen) were recruited and randomised to the medication and placebo groups in a prospective, randomized, double-blind, placebo-regulated clinical trial. According to the findings, *Tinospora cordifolia* provided some defence against cancer chemotherapy-induced leukopenia. The anticancer activity of secondary metabolites isolated from guduchi (such as magnoflorine, palmatine, jatrorrhizine, yangambin, and others) was tested in various types of tumour cells, and a few were reported to treat KB cells and tinocordiside for colon cancer cells and oral cancer cells (KB) respectively (Bala *et al.*, 2015)<sup>[14]</sup>.

#### 4.6 Anti-microbial activity

According to a study, silver nanoparticles made from the stem of *Tinospora cordifolia* had good antibacterial action against the bacteria *Pseudomonas aeruginosa*, prevalent in burn injury

patients. Various bacterial strains, including *S. typhi*, *K. pneumoniae*, *E. coli*, *Aeruginosa*, and others, were tested against *Tinospora cordifolia* extracts and demonstrated potential anti-bacterial activity by either inhibiting their growth or minimising their very presence (Singh *et al.*, 2014). Methanolic extract of *Tinospora cordifolia* has been shown to be antimicrobial. The antibacterial activity of *Tinospora cordifolia* was observed using a solvent extract from various sections of the herb. Guduchi has antibacterial activity against infections of the urinary system, with varying degrees of inhibition against different microbes (Shanthi *et al.*, 2013)<sup>[47]</sup>.

#### 4.7 Hepatoprotective activity

*Tinospora cordifolia* has been shown to have hepatoprotective properties in several sections. *Tinospora cordifolia*'s hepatoprotective qualities could be attributable to a variety of causes, including its ability to stimulate liver regeneration and antioxidant or free scavenging activities (Tiwari *et al.*, 2018)<sup>[58]</sup>. *Tinospora cordifolia* has been shown to have hepatoprotective properties in several sections. *Tinospora cordifolia*'s hepatoprotective qualities could be attributable to a variety of causes, including its ability to stimulate liver regeneration and antioxidant or free scavenging activities (Baghel *et al.*, 2017)<sup>[37]</sup>.

#### 4.8 Anti-toxin activity

According to (Promila *et al.*, 2017)<sup>[43]</sup>, Guduchi has the capability to scavenge free radicals and has a protective effect on the body by modifying hormone and mineral levels. *Tinospora cordifolia* has been shown to reverse aflatoxin toxicity in the kidneys of Swiss albino mice, where it significantly increases hormone levels (such as glutathione) and enzyme activity (such as catalase and glutathione reductase) while lowering reactive oxygen species (ROS). The alkaloids in this plant are principally responsible for this anti-toxin activity. *Tinospora cordifolia* has been found to be useful in overcoming cyclophosphamide-induced toxicity by significantly increasing the level of declined glutathione content, cytokines, and progressively reducing inflammatory cytokines (Tumor necrosis factor) in urinary-bladder and hepatic cells, thereby preventing damage, confirming its anti-toxin activity (Hamsa *et al.*, 2012)<sup>[22]</sup>. Furthermore, *Tinospora cordifolia* protects the kidneys by lowering thiobarbituric acid reactive substance (TBARS) levels and increasing glutathione (GSH), ascorbic acid, protein, and antioxidant enzyme activities (Tiwari *et al.*, 2018)<sup>[58]</sup>.

#### 5. Health benefits of *Tinospora cordifolia*

*Tinospora cordifolia* has a wide range of pharmacological applications, according to data from Ayurveda and ethnobotanical investigations. Aqueous, alcohol, methanol, chloroform, ethanol, acetone, and other extracts of *Tinospora cordifolia* are commonly employed in pharmaceutical, pre-clinical, and clinical investigations (Choudhary *et al.*, 2013)<sup>[17]</sup>. *Tinospora cordifolia* stem is used effectively against cancer, high blood pressure, cardiovascular diseases, and other health related issues. This magical herb shows properties like anti-cancer, hepatoprotective, cardioprotective, analgesic etc. and some of them are enlisted below along with effective plant parts and extract for the particular health benefit.

**Table 2:** Health benefits of *Tinospora cordifolia*

Health benefits	Plant part/ extract	Key findings	References
Prevents cancer	Stem/ Aqueous alcohol extract	<ul style="list-style-type: none"> <li><i>Tinospora cordifolia</i> ethanolic extract can reduce the number of drug-resistant cancer cells.</li> <li>Epoxy clerodane diterpene is a component of <i>Tinospora cordifolia</i> that protects against chemically induced human breast cancer and hepatocellular carcinoma.</li> <li>The phenolic concentration of ethanolic bark extracts is higher, resulting in the highest amount of free radical scavenging (71.49%). <i>Tinospora cordifolia</i> could be considered as a potential therapeutic vector for degenerative disorders induced by free radicals, according to the findings.</li> </ul>	Maliyakal N <i>et al.</i> (2015) Roy <i>et al.</i> (2017) Modi <i>et al.</i> (2021) [31, 44, 34]
Protects against oxidative damage	Whole plant/ ethanol extract	<ul style="list-style-type: none"> <li>The presence of phytochemicals such as polyphenols and tannins contribute to this property.</li> <li><i>Tinospora cordifolia</i> aqueous extract possesses radioprotective properties, allowing mice to survive a sub-lethal dosage of gamma radiation.</li> <li>Leaf and stem extract also offer considerable protection against plasmid DNA damage and protein oxidation caused by free radicals.</li> </ul>	Sharma <i>et al.</i> (2010) Cicero <i>et al.</i> (2016) Bharath Raj <i>et al.</i> (2020) [53, 18, 15]
Prevents Diabetes	Stem/ Aqueous extract	<ul style="list-style-type: none"> <li>The stem of this plant has been reported to work as an anti-diabetic medication through inducing oxidative stress, boosting insulin production by reducing gluconeogenesis and glycogenolysis.</li> <li>The presence of Alkaloids (Magnoflorine, Palmetime, Jatrorrhizine), tannins, cardiac glycosides, flavonoids, saponins, and steroids is thought to be responsible for anti-diabetic benefits.</li> </ul>	Patel <i>et al.</i> (2011) Modi <i>et al.</i> (2021) [40, 34]
Improves Immunity	Whole plant/ Aqueous extract	<ul style="list-style-type: none"> <li>11-hydroxymuskatone, N-methylpyrrolidone, N-formylannonain, cordifolioside A, magnoflorine, tinocordioside, and syringin are some of the chemicals that have immunomodulatory and cytotoxic properties.</li> <li>These natural substances have been shown to improve macrophage phagocytic function.</li> <li><i>Tinospora cordifolia</i> and its component <math>\alpha</math>-D-glucan induce the synthesis of many immune-stimulatory cytokines by stimulating NK cells, B cells, and T cells.</li> </ul>	Upadhyay <i>et al.</i> (2011) Sharma <i>et al.</i> (2012) Srivastava and Singh (2021) [60, 52, 56]
Treats liver infection	Whole plant/ Aqueous extract	<ul style="list-style-type: none"> <li>A decrease in eosinophil count, stimulation of B lymphocytes, macrophages, and polymorphonuclear leukocytes, and a decrease in hemoglobin percentage indicate that it plays a role in illness control.</li> </ul>	Akhtar <i>et al.</i> (2010) [11]
Strengthens heart and improves heart health	Whole plant/ Alcohol extract	<ul style="list-style-type: none"> <li>To induce arrhythmia in rats, calcium chloride was infused intravenously.</li> <li><i>Tinospora cordifolia</i> contains an alkaloid (berberine) that has cardiovascular protective properties. Berberine improves health by lowering endothelium infection.</li> </ul>	Gupta <i>et al.</i> (2012) Cicero <i>et al.</i> (2016) [18]
Anti-inflammatory effect	Stem/ Aqueous extract	<ul style="list-style-type: none"> <li>Carrageenan and histamine-induced rat edoema can be treated with an aqueous extract of guduchi stem.</li> <li>The presence of alkaloids and flavanoids in <i>Tinospora cordifolia</i> methanolic extract inhibited COX and LOX enzymes, resulting in anti-inflammatory action.</li> </ul>	Jacob <i>et al.</i> (2013) Bharath <i>et al.</i> (2020) [23, 15]
Anti-bacterial activity	Stem/ Aqueous and Ethanolic extract	<ul style="list-style-type: none"> <li>Guduchi leaf ethanolic extract has the best antibacterial efficacy against <i>Klebsiella pneumoniae</i> and <i>Pseudomonas aeruginosa</i>.</li> <li>Methanolic extract of <i>Tinospora cordifolia</i> has been shown to be antimicrobial.</li> <li><i>T. cordifolia</i> extract also inhibited bacterial growth and increased neutrophil phagocytic and intracellular bacterial capabilities in mice.</li> </ul>	Shanthi <i>et al.</i> (2013) Mittal <i>et al.</i> (2014) [47, 33]
Pain relieving effect	Whole plant/ Ethanol extract	<ul style="list-style-type: none"> <li>Analgesic action is caused by the presence of phytochemical elements such as alkaloids, glycosides, flavonoid, steroids, and terpenoids in the aqueous extract of the aerial section.</li> <li><i>Tinospora cordifolia</i> is a healthier alternative to NSAIDs, which cause gastrointestinal discomfort, while guduchi has gastroprotective properties.</li> </ul>	Goel <i>et al.</i> (2014) Sumanlata <i>et al.</i> (2019) [20, 57]
Prevents allergies	Aqueous extract	<ul style="list-style-type: none"> <li>Sneezing, nasal discharge, nasal blockage, and nasal pruritus were all significantly relieved by <i>Tinospora cordifolia</i>.</li> </ul>	Badar <i>et al.</i> (2015) [12]

## 6. Traditional uses of *Tinospora cordifolia*

*Tinospora cordifolia* is one of the most commonly used herbs in Ayurvedic medicine, and it has long been utilized by people and tribes as a healing herb for a variety of ailments. It has several therapeutic benefits in Ayurveda, including revitalizing, immune-boosting, antirheumatic, and cleansing effects. *Tinospora cordifolia*'s medicinal characteristics are now used in modern medicine to treat cold and flu prevention, skin problems, liver disorders, immunological support, gout, arthritis, and, more recently, to counteract the side effects of chemotherapy (Sharma *et al.*, 2020) [48].

Whole plant, powdered root and stem bark, decoction of roots and stem, juice of the root, juice or paste of the leaves and stem of *Tinospora cordifolia* are used to treat various ailments

such as chronic fever, jaundice, dysentery, cough, asthma, leucorrhoea, skin diseases, fractures, eye problems, bites of poisonous insects, venomous snake bites (Devprakash *et al.*, 2011) [19]. *Tinospora cordifolia* stem extract is used to treat jaundice, intestinal worms, and vermifuge. Dried fruit, together with ghee or honey, is used to treat rheumatism and jaundice (Bharath *et al.*, 2020) [15].

Many uses of Guduchi were collected by the National Ayurveda Dietetics Research Institute (Bangalore), which performs local health traditional survey trips in different regions of Karnataka, India. Some folk healers in the Davanagere district of Karnataka claim to employ Guduchi decoction orally in situations of hyperacidity, indigestion, and also to relieve leucorrhoea (Kavya *et al.*, 2015) [26].

**Table 3:** Traditional uses of *Tinospora cordifolia*

Plant part	Traditional Uses	References
Leaf	<ul style="list-style-type: none"> <li>Leaves were used to treat ear pain and burning sensations.</li> <li>They were also effective in the treatment of gout and ulcer.</li> </ul>	Choudhary <i>et al.</i> (2013) Bharath <i>et al.</i> (2020) <sup>[17, 15]</sup>
Stem	<ul style="list-style-type: none"> <li>Stems were effective in treating skin diseases, jaundice, chronic diarrhea, chronic dysentery, intestinal problems, low fevers.</li> <li>Stems were useful to treat diabetes,</li> <li>Acted as diuretic and enriches blood,</li> <li>Stems are also helpful with vaginal and urethral discharges</li> <li>They were also believed to stimulate bile secretion.</li> </ul>	Choudhary <i>et al.</i> (2013) Ali <i>et al.</i> (2015) Bharath <i>et al.</i> (2020) <sup>[17, 15]</sup>
Fruit	<ul style="list-style-type: none"> <li>Fruits were helpful in treating jaundice and rheumatism.</li> <li>It was also used as a tonic.</li> </ul>	Choudhary <i>et al.</i> (2013) <sup>[17]</sup>
Stem + Root	<ul style="list-style-type: none"> <li>The combination of stem and root with other drugs worked as an antidote to snake bite and scorpion sting.</li> <li>It was also helpful in treating cancer when taken along with milk.</li> </ul>	Bharath <i>et al.</i> (2020) Choudhary <i>et al.</i> (2013) <sup>[15, 17]</sup>
Bark	<ul style="list-style-type: none"> <li>The bark acted as an antiallergic, antispasmodic and antileprotic.</li> </ul>	Bharath <i>et al.</i> (2020) <sup>[15]</sup>
Root	<ul style="list-style-type: none"> <li>Roots were helpful in treating leprosy, fevers and dysentery</li> </ul>	Ali <i>et al.</i> (2015) Bharath <i>et al.</i> (2020) <sup>[15]</sup>

### 7. Market products based on *Tinospora cordifolia*

Many market products based on *Tinospora cordifolia* are available, which have their own role in maintaining health and promoting a disease-free lifestyle. Giloy products are available in different forms like syrup, powder, capsules, juice, and many others. These products appear to treat

numerous diseases and are effective in boosting immunity. Famous brands such as Dabur and Patanjali have their own Giloy products, which are commonly used by people to treat digestive issues, respiratory and skin problems, as well as viral fever and the common cold. Some of these products are enlisted below:

**Table 4:** Market products of *Tinospora cordifolia*

Product names	Brands	Their roles
Giloy juice	Kapiva	Effective in fever, gout, jaundice, anemia, Works as good detoxifier by flushing out toxins, Improves skin health and controls respiratory problems as well.
Giloy capsules	Zandu	Helps in maintaining healthy liver, Balances blood sugar level, Strengthens digestive system
Giloy Ghanvati	Dabur	Helps in building immunity and protects against various infections, Improves digestion
Guduchi ghrita	Guduchi	Treats gout and skin disorders
Giloy ghan vati	Patanjali	Helps in gastroenteritis, Provides immunity against infectious diseases, chronic fever, cough and cold
Brave heart capsule	Brave Heart	Regulates heart function, Strengthens heart, Lowers blood pressure, lipid levels especially cholesterol and LDL cholesterol
Immuniveda Chyawanprash	Saffola	Acts as a bio-availability enhancer, Improves respiratory health and immunity, Provides strength, energy and stamina
Cirrholid-ds syrup	Paul Medicos	Used as an hepatoprotector and immunomodulator. Treats liver related diseases.
Guduchi sattva	DAV Pharmacy	Soothes burning sensation, Effective in liver diseases, Fever, cough, diabetes
Guduchi churna	Baidyanath	Contains antioxidants that fight free radicals, Treats dengue, swine flu, malaria, Acts as a hypoglycemic agent and helps in treating diabetes, Has anti- ageing properties that helps in improving skin health.
Madhumehari	Baidyanath	Reduces blood and urine sugar levels, helps in beating fatigue
Panchanimbadi churna	Prakruti Remedies	Leukoderma, eczema, dermatitis, skin disorders, diabetes, poison, ascites, arthritis.

Source: (Mittal *et al.*, 2014) <sup>[33]</sup>

### 8. Value added products of *Tinospora cordifolia*

*Tinospora cordifolia* is a medicinal plant that is revered as a natural treasure as it benefits humans in a variety of ways. Since it has been well known for ages in the fields of health

and medicine, multiple studies have been done on the utilisation of *Tinospora* in various food products. Some of the research along with its aim and results is discussed below.

**Table 5:** Value added products of *Tinospora cordifolia*

Food products	Significant findings	References
Goat meat nuggets	<ul style="list-style-type: none"> <li>This study was performed to evaluate the functional efficiency of plant extracts as a source of pancreatic lipase inhibitor and antioxidant in goat meat nuggets in order to address the red meat fat paradox.</li> <li>Plant extracts demonstrated substantial porcine pancreatic lipase inhibition action and had potential antioxidant activity. Among the natural substitutes, <i>Tinospora cordifolia</i> seemed to have the least effect, but these natural plant-based antioxidants can ensure the healthiness of red meat products.</li> </ul>	Chauhan <i>et al.</i> (2021) <sup>[16]</sup>
Chevon sausages	<ul style="list-style-type: none"> <li>The objective of this study was to assess if <i>Tinospora cordifolia</i> could be used as a new natural preservative in muscular meals.</li> <li>The results revealed that the addition of <i>Tinospora cordifolia</i> (0.25, 0.50, and 0.75 percent) to the meat products offered them antibacterial and antioxidant capabilities, which improved lipid oxidative stability and storage quality.</li> </ul>	Kalem <i>et al.</i> (2018) <sup>[24]</sup>

Giloy- goat milk	<ul style="list-style-type: none"> <li>▪ The purpose of this research was to create and define a functional pasteurized goat milk beverage containing debittered <i>Tinospora cordifolia</i> (giloy) juice.</li> <li>▪ The results showed that adding giloy juice to goat milk improved the beverage's bio-functional qualities and made it sensorially palatable for up to 5 days at refrigeration temperature.</li> </ul>	Sharma <i>et al.</i> (2021) <sup>[50]</sup>
Functional cookies	<ul style="list-style-type: none"> <li>▪ The aim of the study was to incorporate the <i>Tinospora cordifolia</i> stem powder into the cookies at the level of 2%, 4%, 8%, 10%, and 12%.</li> <li>▪ Cookies containing 8% TC were found to be acceptable based on sensory evaluation. The addition of TC increased the cookie's trace element content, such as iron and zinc, dietary fibers, proteins, and antioxidants, phenolics, and flavonoids.</li> </ul>	Tyagi <i>et al.</i> (2021) <sup>[59]</sup>
Herbal tea	<ul style="list-style-type: none"> <li>▪ The goal of the study was to assess the nutritional, phytochemical, antioxidant, and antibacterial activity of <i>Withania somnifera</i> stems, cinnamon bark, <i>Tinospora cordifolia</i> stems, <i>Terminalia arjuna</i> bark, green tea, and a formulation mixture of these herbs in order to see if they could be used to make new herbal teas.</li> <li>▪ <i>Withania somnifera</i> stem, cinnamon bark, <i>Tinospora cordifolia</i> stems, <i>Terminalia arjuna</i> bark, green tea, and the formulation mixture of these herbs showed that they can be proven to be excellent sources of nutraceuticals and flavouring agents based on nutritional, phytochemical, antioxidant, and antibacterial activity.</li> <li>▪ It enhances not just its appeal but also its palatability, making it a wonder product in terms of human health.</li> </ul>	Namdev <i>et al.</i> (2015) <sup>[35]</sup>

## 9. Conclusion

*Tinospora cordifolia* is a traditional medicinal herb in South Asia that has a wide range of biological properties and is mostly utilised as a therapeutic medication. Fever, jaundice, diarrhoea, dysentery, general debility, and other diseases have traditionally been treated with the whole plant, stem, powdered root and stem bark, decoction of aerial root and stem, juice of the root, and juice or paste of the leaves of this vital medication. Its pharmacological activities in Ayurvedic texts contain evidence suggesting that this substance has enormous potential in modern pharmacotherapy. Overall, this study provides information on *Tinospora cordifolia*'s antitoxin, antidiabetic, anticancer, immunomodulatory, antioxidant, and antibacterial activities, which can be exploited for further research and development of various drugs.

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