



## *Tinospora cordifolia* (GILOY): A MAGICAL SHRUB

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### ABSTRACT

Medicinal plants have been used as natural medicines, since prehistoric times because of the presence of natural chemical constituents. Among them *Tinospora cordifolia* has a wide array of bioactive principles as well as it has been proven medicinally important plant, have not received considerable scientific attention. The plant is commonly used as traditional ayurvedic medicine and has several therapeutic properties such as jaundice, rheumatism, urinary disorder, skin diseases, diabetes, anemia, inflammation, allergic condition, anti-periodic, radio protective properties, etc. A special focus has been made on its health benefits in treating endocrine and metabolic disorders and its potential as an immune booster. The stem of this plant is generally used to cure diabetes by regulating level of blood glucose. *T. cordifolia* is well known for its immunomodulatory response. This property has been well documented by scientists. A large variety of compounds which are responsible for immunomodulatory and cytotoxic effects are 11-hydroxymuskatone, N-methyle-2-pyrrolidone, Nformylannonain, cordifolioside A, magnoflorine, tinocordioside and syringin. Root extract of this plant has been shown a decrease in the regular resistance against HIV. The active principles from *T. cordifolia* enhance host immune system by increasing immunoglobulin and blood leukocyte levels and by the stimulation of stem cell proliferation. *Tinospora cordifolia* has been used in indigenous systems of medicine, as indicated in various classical texts of Ayurvedic System of Medicine, viz. Charak, Sushrut and Ashtang Hridaya and other ancient treaties.

**Keywords:** *Tinospora*; alkaloids; antihyperglycemic; antimutagenic; stimulant; adaptogen.

### 1. INTRODUCTION

Medicinal plants have been used as intrinsic medicines, since prehistoric times because of the presence of natural chemical ingredient such as berberine, morphine, psilocin, and vincristine and also used as natural compounds for the synthesis of drugs such as tubocurarine, colchicine, nicotine, quinine etc. for therapeutic purpose by folk people [1]. India is assigned to enormous biodiversity of medicinal plants. Among them *Tinospora cordifolia* has a wide

range of bioactive principles as well as it has been manifest medicinally important plant, have not received considerable scientific attention [2]. Sofowora et al. [3] reported that a large number of plants are being used in medicine for remedial or prophylactic purposes. Tungmunnithum et al. [4] reported that the therapeutic properties of medicinal plants are assign to the presence of active substances such as alkaloids, flavonoids, glycosides, vitamins, tannins and coumarins. These natural compounds anatomically affect the body of human beings, interact

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with the pathogens and punctuate their growth at different stages of development and make the body disease free [5]. Herbal formulations are medicinal preparation of one or more herbs present in designate quantities to give the benefits meant for cosmetic, diagnose and to mitigate diseases of human beings or animals [6]. Yuan et al. [7] described in his article that the earlier in the twentieth century, herbal medicine was the prime medication system as antibiotics or analgesics were not available and increasing use of an allopathic system of medicine due to its fast therapeutic action and herbal medicine gradually lost their popularity among the people. He also reported that Herbal medicine has gained impulse and is more effective as compared to artificial drugs. *T. cordifolia* is also known as Guduchi/Amrita and its names in Latin: *Tinospora cordifolia*, Hindi: Giloya. It belongs to the family of Menispermaceae and is found in Myanmar, Sri Lanka, and China [8]. The plant is commonly used as conventional ayurvedic medicine and has several therapeutic assets such as jaundice, rheumatism, urinary disorder, skin diseases, diabetes, anemia, inflammation, allergic condition, anti-periodic, radioprotective properties, etc.. Tripathi et al. [9] reported that the root of Giloya (*T. cordifolia*) is used as potent laxative and for bowel barrier. The starch of this plant serves a favourable household remedy for chronic fever, relieves burning sensation, increases energy and appetite. Giloya is useful in the treatment of helminthiasis, heart diseases, leprosy, rheumatoid arthritis, support the immune system, the body's resistance to infections, supports standard white blood cell structure, function, and levels. It also helps in digestive malady such as hyperacidity, colitis, worm infestations, loss of appetite, abdominal pain, excessive thirst, and vomiting, and even liver disorders like hepatitis [10]. Tiwari et al. [11] reported that this pharmacological activities of the plant is due to its chemical constituents like diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds, essential oils, a mixture of fatty acids, and polysaccharides and is present in a different part of the plant body, including root, stem, and whole part. *Tinospora cordifolia* is known for its enormous application in the treatment of various diseases in the traditional ayurvedic literature. Newly the discovery of active ingredient from the plant and their biological function in disease control has led to active interest in the plant across the globe [12]. Dhama et al. [13] described in his review that *T. cordifolia* controlling various disorders and usages as anti-oxidant, antihyperglycemic, antihyperlipidemic, hepatoprotective, cardiovascular protective, neuroprotective, osteoprotective, radioprotective, anti-anxiety, adaptogenic agent, analgesic, anti-inflammatory, antipyretic, a thrombolytic agent, anti-diarrheal, anti-ulcer, antimicrobial and anti-cancer

agent and the plant is also a source of micronutrients viz. copper, calcium, phosphorus, iron, zinc and manganese. Gupta et al. [14] described a particular attention on its health benefits in treating endocrine and metabolic disorders and its potential as an immune booster. Several patents have been filed and granted to inventions encompassing *T. cordifolia* as a major component of therapeutics for enhancing metabolic, endocrinal and several other ailments, aiding in the betterment of human life expectancy. *Tinospora cordifolia* has an importance in traditional ayurvedic medicine used for ages in the treatment of fever, jaundice, chronic diarrhea, cancer, dysentery, bone fracture, pain, asthma, skin disease, poisonous insect, snake bite, eye disorders [11]. The current review is aimed to provide an updated literature review on recent research advancement of pharmacognosy, chemistry and pharmacological activities of *Tinospora cordifolia*.

**Distribution:** The plant is disseminating 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 [15].

#### **Taxonomic Position:**

Kingdom: Plante  
 Division: Magnoliopsida  
 Class: Manoliopsida  
 Order: Ranunculales  
 Family: Menispermaceae  
 Genus: *Tinospora*  
 Species: *cordifolia*

## **2. CHEMICAL COMPOSITION**

A variety of chemical constituents such as alkaloids, diterpenoid lactones, steroids, glycosides aliphatic compounds, polysaccharides have been reported from different parts of *Tinospora cordifolia* [2]. Khan et al. [10] reported that the chemical constituents of *T. cordifolia* belong to different classes such as alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharides, leaves are rich in protein (11.2%), calcium and phosphorus. He also reported that the stem accommodate clerodane furono diterpene glucoside (amritoside A, B, C and D) and the structure has been traditionally by different spectroscopic studies.

## **3. ANTI-DIABETIC ACTIVITIES**

Joladarashi et al. [16] reported that the extract of *T. cordifolia* stem ameliorates the disarray in lipid metabolism caused by diabetes mellitus in streptozotocin induced diabetic rats. Salehi et al. [17]

reported that endowment of various extracts (hexane, ethyl acetate and methanol) of *T. cordifolia* stem was found to have potent antidiabetic property by reducing blood sugar level in streptozotocin induced diabetic rats at a dose of 250 mg/kg. Srivastava et al. [18] reported that polyherbal articulation, Dihar containing eight different herbs viz., *Syzygium cumini*, *Momordica charantia*, *Embllica officinalis*, *Gymnema sylvestre*, *Enicostemma littorale*, *Azadirachta indica*, *T. cordifolia* and *Curcuma longa* remarkably reduces level of lipid peroxidation and increases activity of antioxidant enzymes in streptozotocin induced diabetic rats. Chougale et al. [19] reported that the ethyl acetate, dichloromethane, chloroform and hexane extracts of *T. cordifolia* stem were estimated for alpha glucosidase inhibition activity and resulted that the dichloromethane extract was the most powerful i.e. 100% inhibition of the alpha glycosidase than others. Sharma et al. [20] updated that saponarin isolated from leaf extract of *T. cordifolia* showed hypoglycemic activity at doses of 20-80 mg/kg. Krishna et al. [21] reported that the hydro alcoholic and chloroform extracts of *T. cordifolia* stem denoted significant antidiabetic property at 250 and 500 mg/kg dose dependently in alloxan induced diabetic rats. He also noted that the stem of this plant is basically used to cure diabetes by regulating level of blood glucose. Mittal et al. [1] updated that it has anti-diabetic drug through descriptive oxidative stress, stimulate insulin secretion by retarding gluconeogenesis and glycogenolysis and the anti-diabetic properties indicated by this plant species are attributed due to the presence of alkaloids (Magnoflorine, Palmetine, Jatrorrhizine), tannins, cardiac glycosides, flavonoids, saponins, steroids etc. He also noted that the crude extract of stem in ethyl acetate, dichloromethane, chloroform and hexane inhibits the enzymes like salivary, amylase and glucosidase resulting increase in post-prandial glucose level and shows inherent activities against Diabetes mellitus disease. Manaharan et al. [22] reported that the root extract of this plant has also been reported to have anti-diabetic properties which decrease the level of glycosylated haemoglobin, hydroperoxidase and vitamin E. He also noted that the crude extract of the stem in ethyl acetate, dichloromethane (CDM), chloroform and hexane was studied for inhibition of the alpha-glucosidase enzyme. Reddy et al. [23] reported that the aqueous extract was studied in the rats, without the insertion of *Tinospora cordifolia* extract increase in glucose by 21.3%, insulin by 51.5%, triglycerides by 54.12%, and glucose-insulin index by 59.8 when plant containing extract was given and concluded that the fructose-induced abnormalities in the liver involving lipid peroxidation, protein carbonyl groups, GSH levels, and enzymatic antioxidants decreased. Khedekar et al. [24] tested the different doses of

ethanolic extract of *T. cordifolia* leaves were apply orally for ten days and 30 days in streptozotocin-diabetic albino rats. *T. cordifolia* showed the antidiabetic activity in diabetic animals an efficacy a 50%–70% compared to insulin. Sharma et al. [20] also reported that in a diabetic rat model, *T. cordifolia* root extracts of Guduchi attenuated the brain mediated lipid level and down-regulated the blood glucose and urinary glucose level emphasizing its anti-diabetic and lipid-lowering activity. He also reported that the root extract of guduchi showed an antihyperglycemic effect in the alloxan-induced diabetic model by decreasing its excess glucose level in urine as well as in normal. Tiwari et al. [11] reported in his paper that certain herbal preparation, including Guduchi like Ilogen-Excel, Hyponidd, and Dihar have been tested in diabetic rat models, the anti-diabetic activity of *T. cordifolia* was observed. The effects by Ilogen excel down the level of excess glucose in the blood and enhance the insulin efficiency by increasing its amount in the systemic circulation. Hyponidd maintained the oxidative load by decreasing reactive species and reduced the glucose-mediated hemoglobin count. When the tested of ‘Dihar’ for one and a half month in streptozotocin-induced diabetic model decreased the urea as well as creatinine amount in the blood with an increase in enzyme activities.

#### 4. IMMUNOMODULATORY ACTIVITIES

*T. cordifolia* is well known for its immunomodulatory feedback [25]. Anusha and Sailaja [26] reported that a large variety of compounds which are supervise for immunomodulatory and cytotoxic effects are 11-hydroxymuskatone, N-methyle-2-pyrrolidone, Nformylannonain, cordifolioside A, magnoflorine, tinocordioside and syringin. Rawat et al. [27] reported that these natural compounds have been reported to upgrade the phagocytic activity of macrophages, amplification in nitric acid production by stimulation of splenocyte and creation of reactive oxygen species (ROS) in human neutrophil cells. Alsuhailbani and Khan [28] reported that *T. cordifolia* and its constituent  $\alpha$ -D-glucan stimulate NK cells, B cells, and T cells with simultaneous production of various immune-stimulatory cytokines. Gupta et al. [29] reported that a polysaccharide from *T. cordifolia*, G1-4A, has been shown to inhibit the intracellular growth of *Mycobacterium tuberculosis* through toll-like receptor 4- (TLR4-) dependent signaling and they also noted that macrophages are an relevant part of the innate immunity and play a crucial role in defending the host against the microbial appropriation. Before few months ago with the novel corona virus infection (COVID-19) spreading around the world like wildfire, and no specific cure or vaccine available for it as yet, people have been told that a strong immunity and

prevention from contracting the virus are the only ways they can stay safe and healthy. According to a protocol document issued by the Health Ministry, Union of India, it has been pointed out that the current understanding indicates a good immune system is vital for the prevention of corona virus infection and to safe guard from disease progression. Giloy is an absolutely natural remedy and does not have any side effects in healthy people because it called the “ultimate immunity booster” and is full of antioxidants which help to detox the body, and improve immunity.

## 5. ANTI-TOXIC ACTIVITIES

Reddy and Reddy [30] reported that the aqueous extract of this plant has previously reported to show scavenge activity due to the presence of antioxidant against free radicals generated during aflatoxicosis and alkaloids such as choline, tinosporine, isocolumbin, palmetine, tetrahydropalmatine and magnoflorine from *T. cordifolia* showed protection against aflatoxin induced nephrotoxicity. Gupta and Sharma [31] reported that *T. cordifolia* shows defensive effect by lowering the concentration of thiobarbituric acid reactive substance (TBARS) and enhancing the glutathione (GSH), ascorbic acid, protein and the activities of antioxidant enzymes viz., superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase, glutathione S-transferase (GST) and glutathione reductase (GR) in kidney. Sharma and Pandey [32] reported that leaf and stem extract of *T. cordifolia* show hepatoprotective effect in male albino mice against lead nitrate induced toxicity and similarly, oral dose of plant extract prohibited the lead nitrate induced liver damage.

## 6. ANTI-HIV ACTIVITIES

Promila et al. [33] updated in his review that root extract of this plant has been shown a decrease in the regular resistance against HIV and this anti HIV effect was disclose by reduction in eosinophil count, stimulation of B lymphocytes, macrophages, level of hemoglobin and polymorphonuclear leucocytes. Dissanayake et al. [34] showed that the root extract of *T. cordifolia* affects the immune system of HIV positive patient. Saha and Ghosh [12] reported that the stem extract of *Tinospora cordifolia* reduces the ability of eosinophil count, stimulation of B lymphocytes, macrophages, level of hemoglobin, and polymorpho nuclear leucocytes. Singh [35] described in his review that Giloy's use as an immune stimulant and this study advocate that giloy may upgrade the immune systems of patients with HIV and other immune disorders, while also alleviating common side effects of these conditions.

## 7. ANTI-CANCER ACTIVITIES

Kumar and Ojha [36] reported that the active principles from *T. cordifolia* enhance host immune system by increasing immunoglobulin and blood leukocyte levels and by the stimulation of stem cell expansion. Kumar et al. [37] reported that it has the ability to reduce solid tumour volume by 58.8%, which is comparable to cyclophosphamide, a known chemotherapeutic agent. Patel and Mansoori [38] reported that these immune stimulating properties can be used in the prevention of tumour mediated immunosuppression and hence could be a drug choice for various cancers *T. cordifolia* shows anti-cancer activity, this activity is mostly shown in animal models. Jagetia and Rao [39] reported that root extract of *T. cordifolia* has been shown radio protective role due to considerably increase in body mass, tissue weight, tubular diameter and dichloromethane extracts of TC shows cytotoxic effects owing to lipid peroxidation and release of LDH and decline in GST. He also noted that in pre-irradiating mice, root extract has widely affected radiation, induced rise in lipid peroxidation and resulted in the decline of GSH in testes. Ali and Dixit [40] reported the anticancer activity of *T. cordifolia* palmatine extract in animal models, alkaloid using response surface methodology (RSM) and concluded that the extract indicates the anticancer potential in 7, 12-dimethylbenz (a) anthracene DMBA induced skin cancer model in mice. Verma et al. [41] reported anticarcinogenic and antimutagenic activity of *T. cordifolia*, extract was used, in C57 B1 mice and swiss albino mice respectively. In antimutagenic study, a single application of *T. cordifolia* extract at a dose of 200, 400 and 600 mg/kg dry weight, 24 hrs prior the i.p. administration of cyclophosphamide (at the 50 mg/kg), appreciably prevented the micronucleus formation in bone marrow of mice, in a dose dependent manner. In melanoma assay, C57 B1 mice when received 50% methanolic extract of *T. cordifolia* at a dose 750 mg/kg body weight for 30 days showed increase in life span and tumor size was significantly reduced as compared to control. Mishra and Kaur [42] investigated the anti-brain cancer potential of 50% ethanolic extract of *Tinospora cordifolia* (TCE) using C6 glioma cells. TCE significantly shorten cell proliferation in dose-dependent manner and induced differentiation in C6 glioma cells, resulting in astrocyte-like morphology as indicated by phase contrast images, GFAP expression and process outgrowth data of TCE treated cells which exhibited higher number and longer processes than untreated cells. The active principles from *T. cordifolia* enhance host immune system by increasing immunoglobulin and blood leukocyte levels and by the stimulation of stem cell proliferation. It has the

potentiality to reduce solid tumour volume by 58.8%, which is comparable to cyclophosphamide, a known chemotherapeutic agent [43]. These immunostimulating properties can be used in the prevention of tumour mediated immunosuppression and hence could be a drug choice for various cancers [42].

## 8. ANTI-MICROBIAL ACTIVITIES

Methanolic extract of *T. cordifolia* has been reported against microbial infection [44]. Chakraborty et al. [45] reported that antibacterial activity of *T. cordifolia* extract has been bio assayed against *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumonia*, *Proteus vulgaris*, *Salmonella typhi*, *Shigella flexneri*, *Salmonella paratyphi*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Enterobacter aeruginosa*, *Enterobacter aerogene*. Saha and Ghosh [12] reported *T. cordifolia* extract against bacterial growth and improved phagocytic and intracellular bacterial amplitude of neutrophils in mice. Agarwal et al. [46] reported the antimicrobial activity of the *T. cordifolia* with different solvents on different micro-organism, showed good antifungal and antibacterial activity. Sharma et al. [8] reported the antimicrobial activity of stem extracts by *in-vitro* analysis against both gram-positive and gram-negative bacteria and showed good therapeutic activity on the infectious disease. It has taken a methanolic extract of *T. cordifolia* against both bacteria group. Shanthi and Nelson [47] reported the aqueous, ethanol and acetone extract of *T. cordifolia* inhibited the activity on clinical isolates of urinary pathogens *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. Singh et al. [48] reported silver nanoparticles from the stem of *T. cordifolia*, which possess antibacterial activity against the different strains of bacterias. Prajwala et al. [49] have reported the antifungal activity of *T. cordifolia*, which was determined using the agar well plate diffusion method. The aqueous extract of *T. cordifolia* showed potent activity against a fumigates *Aspergillus flavus*, and *Aspergillus niger* (fungus) in the study. Agarwal et al. [46] also studied *in-vitro* extract of *T. cordifolia* was obtained using 100% ethanol by maceration process. They prepared etholic extract seven different concentrations and tested against *S. mutans* in brain-heart infusion agar medium. Plates were incubated aerobically at 37°C for 48 h, using vernier caliper and measured the zone of inhibition. 0.2% chlorhexidine and dimethylformamide were used as positive and negative controls, respectively. This experiment data were analysed by descriptive-analytic tests which showed the maximum antibacterial activity of *T. cordifolia* a volume of 40 µl at 2% concentration with a zone of inhibition of 19 mm. A 30 µl volume of 0.2% chlorhexidine showed a zone of inhibition of 28

mm and dimethylformamide showed no zone of inhibition. Khan [50] tested the antifungal activity *Tinospora cordifolia* aqueous extract (TCAE) *in-vitro* against the isolates of different *Aspergillus species*. To evaluate *in vivo* activity, different doses (10, 25 and 50 mg/kg) of TCAE were orally administered in *A. fumigatus*-infected mice for seven days and found that the effectiveness of aqueous extract on the basic survival rate and assessing the fungal burden in the kidney of the treated mice. Prasad and Chauhan [51] studied the anti-oxidant and antimicrobial properties phenolic extract of *T. cordifolia* stem and root. Total reducing power, hydrogen peroxide scavenging activity assay, and hydroxyl radical scavenging activity were checked using different *in-vitro* assays. The ethanolic extract showed maximum 87.2% and 91.0% free radical scavenging activity concerning H<sub>2</sub>O<sub>2</sub> scavenging and hydroxyl free radical scavenging assay.

## 9. ANTI-OXIDANT ACTIVITIES

Upadhyay et al. [52] reported the *in-vitro* antioxidant activity of *Tinospora cordifolia*. It has been observed that *Tinospora cordifolia* exhibited excellent antioxidant activity in methanol, ethanol and water extracts. The observed high antioxidant activities of the extracts designate the potential of the stem as a source of natural antioxidants or nutraceuticals to reduce oxidative stress with consequent health benefits. Sivakumar and Rajan [53] reported the methanolic extract of stem of *T. cordifolia* has anti-oxidant activity, by increasing the erythrocytes membrane lipid peroxide and catalase activity. He also noted that it also decreases the activity of SOD, GPx in alloxan induced diabetic rats. Upadhyay et al. [54] reported the extract of *T. cordifolia* has its free radical scavenging properties. Sengupta et al. [55] reported the leaf extract of *T. cordifolia* have an alpha-glucosidase inhibitor, characterized as saponarin was found to be also significant antioxidant and hydroxyl radical scavenging activity. Due to the presence of alkaloids it shows protection against aflatoxin-induced nephrotoxicity [53,56]. Saha and Ghosh [12] reported the *T. cordifolia* aqueous extract has a radio protective activity, enhancing the survival of mice against a sub-lethal dose of gamma radiation. Sivakumar and Rajan [53] also reported the methanolic, ethanolic, and water extracts of *T. cordifolia* for their antioxidant activity, in which the stemic ethanol extract increased the erythrocytes membrane lipid peroxide, catalase activity and decrease the superoxide dismutase, glutathione peroxidase in alloxan-induced diabetic rats. The leaves extract of methanol, partitioned in water with ethyl acetate and butanol at 250 mg/ml, and showed their antioxidant activity, extracts of methanol

phosphomolybdenum and metal chelating activity were high followed by ethyl acetate, butanol and water extract. It also decrease level of free radical species of diabetic rat and up-regulate the anti-oxidant enzyme, scavenging activity for free radical of methanol extract was high compared with phenol extract [53]. This plant modifies the different enzymatic system which controls the production of these reactive species and maintains the oxidative load by regulating the lipid peroxidation process and glutathione level [57]. Altemimi et al. [58] reported that antioxidant assay by different *in-vitro* models, lipid peroxidation inhibitory activity, DPPH radical scavenged, and superoxide radical scavenging activity from dried leave of *T. cordifolia* and extracted with chloroform, methanol, ethanol hexane, and water. He noted that other solvent extracts showed weak antioxidant activity, whereas ethanol extract had high antioxidant activity. The results suggested that the antioxidant compound is better in ethanol extract and there is a direct correlation between the total polyphenols extracted and its anti-oxidant activity.

## 10. ANTISTRESS ACTIVITY

Sarma et al. [8] reported that ethanolic extract of *T. cordifolia* at the dose of 100 mg/kg gives significant anti-stress activity in all parameters compared with standard drug diazepam (dose of 2.5 mg/kg). Kulkarni et al. [59] reported in his review that in Ayurveda, it acts as Medhya Rasayana or brain tonic by expanding mind power like memory and reliving. Kalikar et al. [60] reported that *Tinospora cordifolia* has been studied for its anti allergic effect and it was found that *T cordifolia* provided significant relief from sneezing, nasal discharge, nasal congestion, and nasal pruritus compared with placebo with congruous improvements on examination of the nasal smears and nasal mucosa.

## 11. HYPOLIPIDEMIC EFFECT

Prince et al. [61] reported the hypolipidemic effect of an aqueous extract of the root of *Tinospora* on the rats weighing 2.5 and 5.0 g/kg body weight on sixth weeks, that resulted in decrease tissue cholesterol, reduction in serum, phospholipids, and free fatty acid in alloxan diabetic rats and found that the dose of root extract 5.0 g/kg body weight showed the highest hypolipidaemic effect. He also infers that when the level of serum lipids in diabetes increased, they represented coronary heart disease; lower the serum lipids level subside the risk of vascular disease.

## 12. HEPATIC DISORDER

Sharma and Dabur [62] tested the protective effects of *Tinospora cordifolia* water extract (TCE) on hepatic and gastrointestinal toxicity and found a significant rise in the levels of gamma-glutamyl transferase, aspartate transaminase, alanine transaminase, Triglyceride, Cholesterol, HDL and LDL in alcoholic sample whereas their level get down modulate after TCE intervention, patients showed the normalized liver function of *T. cordifolia* stand to lessen the symptoms.

## 13. WOUND HEALING

Hashilkar et al. [63] evaluating the wound healing depiction of alcoholic extract of *T. cordifolia* and its effect on dexamethasone suppressed healing. Incision, excision, and dead space of the wound models were employed to investigate the wound healing potential of the plant increased tensile strength extract of *T. cordifolia* may be allocated to the promotion of collagen synthesis and the extract of *T. cordifolia* did not reverse dexamethasone suppressed wound healing.

## 14. ANTI ALLERGIC ACTIVITY

Badar et al. [64] reported that *Tinospora cordifolia* has anti allergic effect. He found that *T cordifolia* provided significant relief from sneezing, nasal discharge, nasal obstruction, and nasal pruritus compared with placebo with compatible improvements on assesment of the nasal smears and nasal mucosa.

## 15. ANTI-INFLAMMATORY ACTIVITY

Rajalakshimi et al. [65] reported that *Tinospora cordifolia* showed remarkable increase in the reaction time (pain threshold) in doses of 100 mg/kg, 200 mg/kg, 100 mg/kg with 5 mg/kg of diclofenac after 30, 60 and 90 minutes of administration. In the same above doses, *Tinospora cordifolia* showed 32.63%, 36.63% and 40.5% inhibition of paw edema respectively at the end of three hours.

## 16. EFFECT ON MEMORY

Malve et al. [66] reported that *T. cordifolia* has been shown to enhance cognition in normal rats and reverse cyclosporine-induced memory deficit. Upadhyay et al. [54] also reported both the alcoholic and aqueous extracts of *T. cordifolia* produced a decrease in learning scores in Hebb William maze and retaining memory, indicating enhancement of learning and memory.

## 17. CONCLUSION

The above mentioned medicinal properties of *Tinospora cordifolia* has been listed as an important plant amongst the 32 prioritized plants by National Medicinal Plants Board (NMPB), New Delhi of Government of India. *Tinospora cordifolia* has been used in Indigenous Systems of Medicine, as indicated in various classical texts of Ayurvedic System of Medicine, viz. Charak, Sushrut and Ashtang Hridaya and other ancient treatises. It also finds a special mention for its use in tribal or folk medicine in different parts of the country. *Tinospora cordifolia* is an endangered rasayana herb of India and holds a special position as a potent adaptogen and aphrodisiac in Ayurvedic System of Medicine. The plant is rich in many phyto-constituents that are useful in drug designing. These studies place this indigenous drug a novel candidate for bioprospection and drug development for the treatment of such diseases as cancer, liver disorders, ulcers, diabetes, heart diseases and postmeno-pausal syndrome, etc. where satisfactory cure managements are still not available.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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