



REVIEW ON BIOACTIVE COMPOUNDS AND PHARMACOLOGICAL ACTIVITY OF TINOSPORA CORDIFOLIA (THE QUEEN OF ALL HERBS): AND THEIR RECENT ADVANCEMENTS

Pooja Kushwah¹, Yogesh Chand Yadav^{2*} Rubi Rana³

¹ PG Scholar Department of Pharmacology, Faculty of Pharmacy, Uttar Pradesh University of Medical Sciences, Saifai, Etawah, Uttar Pradesh, India² Department of Pharmacology, Faculty of Pharmacy, Uttar Pradesh University of Medical Sciences, Saifai, Etawah, Uttar Pradesh, India ³Faculty of Pharmacy Raja Balwant Singh Engineering Technical Campus Bichpuri Agra, Uttar Pradesh, India

ABSTRACT

Tinospora Cordifolia (Giloy), an Indian-native evergreen climbing shrub, has long been utilised in Ayurvedic ethnomedicine to treat very serious and frequently recurring inflammation and to support a good immunity system. From a small division of Uttarakhand, kumaon to Assam, in Bihar, pashchim Bengal, Karnataka, and Kerala, it is spread across over the whole nation of India and also found in other countries, North Africa, Bangladesh, Myanmar, land of the malays, Vietnam, and other parts of the world. A Guduchi is rich in micronutrients as well as protein including iron (Fe), zinc (Zn), copper (Co), calcium (Ca), phosphorus(P), and manganese (Mn). Many plant secondary metabolic products, including steroids, glyco-sides, flavonoids, alkaloids, and terpenes etc are also present. It has a wide spectrum of phytochemical ingredients and has medicinal qualities including analgesic, antibacterial, anti-inflammatory, and antihelminthic. Scientific studies on this medication may offer a fresh perspective and new methods for corona virus treatment, management, and design of novel curative entities. In this review, Tinospora cordifolia's therapeutic benefits and pharmacological activity are discussed.

Keywords: Amrita, Giloy, Guduchi , Heart Leaved Moonseed, Tinospora Cordifolia.

INTRODUCTION

Tinospora Cordifolia is family menispermaceae. Since ancient civilizations, plant species have been used to treat human sickness without considering the chemical components and biological activity [1,2]. The study of secondary metabolites and their medical uses is known as "natural products chemistry." [3]. While there are between 250,000 and 400,000 plant species, only 15% have been evaluated for phytochemicals and 6% have been tested for their biological activity. [4,5]. Secondary metabolites and essential oils with therapeutic value are widely distributed in medicinal plants. Aside from being affordable, secure, and easily accessible, medicinal plants are considered to have significant advantages for treating a range of illnesses. [6,7]. Guduchi is one of the healing herbs rich in secondary metabolites, used for generations in traditional and ayurveda system of medicine use to cure wide range of illness. Tinospora cordifolia mature

stem portions that have been dried are used to make the medicine. It is one among the plants that has long been utilised as a medication in the Indian System of Medicine. According to Hindu mythology, plant is referred to as Giloy in Hindi, and it is the divine remedy that has prevented divine creatures from growing old and has kept them youthful forever [8]. Guduchi is undoubtedly one of the herbs with the greatest potential for fighting the illness. This plant has hypoglycemic, antiallergic, anti-inflammatory, immunosuppressive and immunomodulatory properties [9]. The Tinospora cordifolia's involvement in the prevention and treatment of COVID19 has been attempted to be illustrated in the current review [10]. Alkaloids, steroids, phenolics, polysaccharides, diterpenoid lactones, glycosides, and sesquiterpenoid active substances from watery Guduchi extracts have been described for their cytotoxicity in experimental rat models [11]. In HIV patients, tinospora cordifolia

extract has also demonstrated immunomodulatory effects. *Tinospora cordifolia*'s immunomodulatory and hepatoprotective effects were examined in a rat model of CCl₄ intoxication. [12] *Tinospora cordifolia* contains alkaloids including magnolorine, isocolumbin, palmatine, choline, tinosporin, and tetrahydropalmatine, which means it can scavenge free radicals and guard against nephrotoxicity brought on by alatoxin, according to a study. Its aqueous extract exhibits metal chelation and free radical scavenging as indications that it possesses radioprotective effects. [13].

Botanical Distribution: With extended twining branches, it's a large woody succulent climbing bush. Large, heart-shaped leaves measure 6–12 cm length and 7–12 cm width. Petioles are 5–15 cm large and glabrous. Flowers are unisexual and have two or three tiny, fascicled blossoms that are yellow and greenish in colour. Slender and 5–10 cm long, the male inflorescence bears six glabrous, green sepals arranged in two whorls. Female inflorescences, on the other hand, are 2–6 cm long and have one bloom per node. Like a male flower, a female flower contains sepals and petals. Fruits have a strong stem with a subterminal crimson or orange-colored tint and are 7-8 mm long. When totally developed, the natural products are pea-shaped, gleaming, druping, and blood red. Fruits grow in the winter, whereas flowers do so in summer. Cuttings are utilized to spread it. The leaves provide wonderful livestock feed. On the surface of the stem's greyish colour are tubercles. The leaves have wide, heart-shaped edges.

Pharmaceutical Description: Several studies have been conducted on the *tinospora cordifolia* medication to examine its potential therapeutic benefits for treating the entire human body. It plays a significant part in human existence in both Rasayana and Ayurveda. It is applied in Thailand in order to stop the intestine protozoan expansion parasites that is *Blastocystis hominis*. This is primarily applied to cure hiccups and prevent the development of hyperacidity, leucorrhea, asthma, skin conditions, eye conditions, and fractures. A gigantic, deciduous, broadly spreading and climbing bush with different long, twining branches is called *Tinospora corifolia*. Various areas of the body display various morphological characteristics, which are discussed here.

Roots are lengthy, filiform, aerial, and threadlike, and squairsh; they sprout from mature branches or reduce stem fragments, grow downward, and occasionally reach the ground by constantly growing [14]. Tetra to penta-arch main structure is a characteristic of microscopic studies of aerial roots. However, the root's cortex is divided between an outside thick walled zone

and an inner parenchymatous zone. [15]. The dried aerial roots have a harsh flavour and are odourless, creamy white or light grey, brown in colour. The aerial root's parenchyma contains starch throughout. According to [16], the root is used in leprosy, as an antiemetic agent for visceral congestion, diarrhea, and dysentery.

Stem is smooth and has a greyish green colour, round lenticles, swelling nodes, and warty protrusions. The papery, thin outer bark of dried stems ranges in colour from light to dark grey. It separates into an exterior zone with thick walls that is brown in colour and has compacted cells, and the inner zone has thin walls that is colour-less and has 3–7 rows of cells. Starch-containing parenchymatous zones are abundant in the cortex [15, 17]. Guduchi has a climbing, tall, filament-like, fleshy stem that looks somewhat juicy. Roots that are aerial are born from the branches. The beautifully spiraled bark has a spectrum of shades from creamy white to grey. [17]. Jaundice, skin conditions [18], and fever [19] can all be treated with stem extract individually or in combination with honey; therefore, known as stem starch (satva). For scorpion and snake bites, a mixture of roots and stems should be used [20]. The leaves of guduchi are Simple, alternating, and exstipulate in sequence, the leaves. The oblong to roundish, chordate, smooth-surfaced leaf blades have a pale-colored lower surface and a glaucous top surface. There are rows of radial xylems in the vascular bundle. tissue, rows of inner cambium tissue, and an outer coating made of pholem tissues. Mesophyll has developed into the palisade layer, which is made up of columnar cells, in the cross section of the lamina. Palisade and spongy tissue are two separate types of mesophylls. Columnar cells line the walls of the palisade layer. The tissues as a whole contain starch [21]. Together with cow's milk, the use of powdered leaves and their decoction is for treating gout, fever, jaundice, ulcer, wounds, and managed blood sugar [22].

Flowers only open and bloom when there is no leaves present. They are unisexual, receptive, and greenish yellow in color. Male and female flowers both grow in clusters and solitary inflorescences, respectively. There are two pairs, each with three sepals, for a total of six. The inner sepal is more compact than the outer sepal. The six free, membranous petals are smaller than the sepals. From March through June, flowers bloom [23]. Guduchi (**giloy**) has an orange-red hue fruits. It has an oval shape, is smooth and meaty, and has stout stalks covered with subterminal scars. Fruits start to ripen in the winter [24]. They are used to treat rheumatism and jaundice.

White, curving, bean-shaped seeds are present [15]. Moreover, the embryo naturally assumed a curved form [25].

Table 1: Tinospora cordifolia with different application and their properties .

Conditions	Utilization	Effects
recurring fever	Juice of giloy stem	Antipyretic, enhanced the platelet level
Having diarrhoea	stem juice	makes macrophage activity more active
Yellowing of the skin	stem juice	Anti-oxidant
Emaciation	use clothes soaked in giloy juice	Hypo-lipidemic immunomodulators
Leukorrhea	Giloy paste with seeds of piper nigrum	Antiinflammator
Bronchial Asthma	Chewing root or drinking giloy juice	Antiallergic
Infections on skin	Paste of leaves and juice	Antiaging, antibacterial
A bug bites	leaves paste and drinking juice	Antiinflammatory
Diabetes	Juice	Hypo-glycemic
Problem related to digetion	stem powder	Refresh appetizing properties
Arthritis	stem powder	Antiinflammatory & anti-arthritic
Cancer disease	stem juice	Antiproliferative
Cuts	Leaves paste	Healing ,constringent properties

Table 3: T. cordifolia's medicinal compounds and their biological functions

Name of famous Product	Brand Name	Biological Activities
Juice of Giloy	Patanjali	Helpful for fever, gout, jaundice, and anaemia Flushing out pollutants serves as an excellent detoxifier and also improves skin health and regulates respiratory issues.
Capsules	Bliss	Liver health is preserved, system blood sugar levels are balanced, and the digestive is strengthened.

Giloy-Ghanvati	Herbal Canada	Improves digestion, aids in immune development, and offers protection against a variety of illnesses
Guduchi - ghrita	Patanjali	Treats skin conditions and gout
Giloy ghan vati	Desh Rakshak	Aids in the treatment of gastroenteritis and offers protection from infectious disorders, persistent fever, cough, and cold
Brave heart capsule	Ojas veda	Reduces blood pressure, lipid levels, particularly cholesterol and LDL cholesterol, and regulates cardiac function.
Immuniv eda-Chyawan prash	Cureveda	Increases bioavailability, boosts immunity and respiratory health, and gives users more power, energy, and endurance.
Guduchi sattva	DAV Pharmacy	Burning feeling is soothed, effective in liver conditions Diabetes, cough, and fever
Madhu-mehari	Maharishi Ayurveda	Lowers blood and urine sugar levels, aids in energy recovery
Panchani mbadi-churna	Ambic	Ascites, arthritis, diabetes, eczema, dermatitis, and other skin conditions.

PHARMACOLOGICAL ACTIVITY

Antidiabetic Property: Anti-Diabetic Measures By controlling blood glucose levels, the stem of this plant is used to treat diabetes [26]. According to reports, it functions as an anti-diabetic medication by inhibiting gluconeogenesis and glycogenolysis and explaining oxidative stress, which promotes insulin production. According to [27], the nearness of cardiac glycosides, tannins, flavonoids, saponins, steroids, and alkaloids including Magnoflorine, Palmetine, and Jatrorrhizine, and other compounds is what gives this plant species its anti-diabetic benefits. According to [28], the crude stem extract in Salivary, amylase, and glucosidase enzymes are inhibited by ethyl acetate, dichloromethane, chloroform, and hexane , increasing post-prandial glucose levels, this suggests that the extract may have potential anti-Diabetes mellitus disease effects. According to reports, this plant's root extract contains anti-diabetic qualities that lower levels of hydroperoxidase, vitamin E, and glycosylated haemoglobin [29]. Plant extracts are effective against hyperglycemia, oxidative stress, hypertriglyceridemia, and hyperinsulinemia brought on by fructose. The treatment with Giloy aqueous extract prevented a 59.8% increase in the rats given fructose's

glucoseinsulin index and a 21.3% rise in insulin, lipids, and glucose levels [30].

Antioxidant Property: *T. cordifolia* has demonstrated potential antioxidant and antibacterial properties. Alkaloids, glycosides, flavonoids, Hormones, tannins, terpenoids, Saponins, & sugar are among the phytochemically active substances found in the plant's leaf extracts [31]. In alloxan-induced rats, the stem of Guduchi enhances erythrocyte membrane lipid peroxide, catalase activity and reduces activity. The capability to scavenge free radicals in ethanol stem extract is 56%. The important 1,1-diphenyl-2-picrylhydrazyl radical eliminating property of TC is found in stem, which also has the highest phenol concentration [32]. Its leaf extract powder has better antioxidant properties than its stem extract powder [33]. Due to the alkaloid components' anti-oxidant properties, its root extract protects against aflatoxin-induced nephrotoxicity [34]. *Tinospora cordifolia* may be used as a nutraceutical and/or as an antioxidant in food systems and biological systems. When compared to other solvents, *tinospora cordifolia* extricates in methanolic, ethanolic, and water showed exceptional antioxidant potential. They also demonstrated metal chelation and decreasing control exercises. [35].

Anti-Toxic Property: Due to the existence of antioxidant activity brought on by the presence of flatoxicosis, Giloy extracts have been observed to neutralise free radicals. By boosting glutathione peroxidase, catalase, glutathione, superoxide dismutase, glutathione stransferase, ascorbic acid and glutathione-reductase in the kidney, the extricate has been appeared to decrease the impacts of thiobarbituric corrosive. The nephrotoxicity brought on by aflatoxin is lessened by alkaloids produced from plants, such as choline (a part of the terpenoid gather of alkaloids), palmatine, isocolumbin, tino-sporin, and tetra-hydropalmatine [36]. It guards against kidney toxicity. It increases the kidney's ascorbic acid and protein-based antioxidant enzyme activities. Also, it caused liver damage [37]. Lead nitrate initiated liver harm was dodged by taking plant extricates (stem and leaf) orally [38].

Anti-Microbial Property: According to a study, *Pseudomonas aeruginosa* was discovered in a patient with burn injuries, and silver nano-particles made from stem of Giloy shown strong anti-bacterial action [39]. Stem and leaves of giloy had the most restricting effects on clinical Urinary infections including *K. pneumoniae* and *Pseudomonas aeruginosa*. The outcome, it shields against UTI (urinary tract infections) [40]. Guduchi has also proven to be important in reducing urinary pathogens' resistance to various antibiotic therapies and so controlling

microbial infectiousness [41]. *Shigella flexneri*, *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia*, *Proteus vulgaris*, *Salmonella typhi*, *Salmonella paratyphi*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, and *Klebsiella aerogene* were all tried for. *Tinospora cordifolia* extricates expanded the phagocytosis and intracellular bacterial capabilities of polymorphonuclear leukocytes (PMNs) in blood [42] and inhibited bacterial growth.

Anti -Inflammatory Property: Within the case of immune system joint pain, it has moreover been seen to have anti-inflammatory impacts, which are mediated by a diminish within the generation of pro-inflammatory cytokines such TNF, IL-1, IL-17, and IL-17 [43]. In both intense and sub-acute models of inflammation, the dried stem of Guduchi altogether diminished irritation. In cases of intense irritation, Guduchi has been demonstrated to be the more productive than acetylsalicylic corrosive, but within the cases of subacute in-flammation, phenylbutazone could be a superior alternative [44].

Immunomodulatory Property: In a clinical investigation, isolated chemical components including cordifolioside A and syringin of guduchi were revealed to be immunomodulating agents [45]. The stem of Guduchi affects the amount of immune-supporting enzymes like catalase and activates lymphocyte cells, demonstrating the immuno-protective function of this shrub. [46]. Concurring to a clinical examination, *T. cordifolia* moisturizer brings down the levels of interleukin-1 and IL-6 in scabies creature models. Its anti-scabies action is demonstrated by the inhibition of hyper-keratosis and the infiltration of in-inflammatory cells into scabietic gash [47]. *T. cordifolia* is additionally competent of upgrading safe cell and neutrophil action, underlining it as a strong operator for the avoidance of immunological touchy clutters [48]. The substance with immunomodulatory effect is a polysaccharide rich in monomer units of glucose, fructose, and arabinose. [45].

Anti-Cancer Property: One of the most feared diseases of the 20th century, cancer is one that is still spreading today and is becoming more common. Verbal squamous cell carcinoma (OSCC), which is clinically the foremost prevalent among Indian men, could be a visit sickness of the verbal depression in Asian countries. In vitro treatment of oral squamous cell carcinoma cell line with *T. cordifolia* extracts (TCE) resulted in strong cytostatic impact, dose dependent (25-75 g/ml) and time dependent (24-120 hours) hindrance of cell development, and acceptance of cell death. As a result, it might offer hope for treating cancer [49]. The anti-cancer activity of auxiliary - metabolites (such as magnoflorine, palmatine,

jatrorrhizine, and yangambin) is separated from guduchi was tested in various tumor cell types, with "palmatine" and "yangambin" specifically detailed to treat KB cells and "tinocordiside" for colon cancer cell and verbal cancerous cell (KB), separately. [50]. Contrarily, the majority of chemotherapeutic medicines are synthetic in origin and have a multitude of hazardous side effects, but *T. cordifolia* has very less toxic side effects. As far as the health of the patient is concerned, it may thus be regarded as the "safe medicine" for cancer treatment.

Anti-HIV activity: The root extract of this herb has been shown to reduce HIV resistance naturally. This anti-HIV activity was indicated by a decrease in eosinophil count, activation of B lymphocytes, macrophages, hemoglobin level, and polymorphonuclear leucocytes. [51,52].

Antiviral activity: Tinosporin, a diterpenoid, shown effectiveness against Human immunodeficiency virus, Human T-Lymphotropic virus, and other viral infections because it modulated immune response and inhibited the virus only when it targeted T- helper cells. [53].

Anti-larvicidal activity: Chalcone cordifolin [1-(2',3',4'-trihydroxyphenyl)-3-(4''-methoxyphenyl)-propene-1-one] is effective against *Spodoptera litura* larvae. demonstrated the growth of insects. [54].

Aggregation activity of Platelet: N-transferuloyl tyramine, a phenolic amide, has been demonstrated to exhibit platelet aggregation action. [55].

Conclusion

One of the species that is most extensively utilised in the pharmaceutical sector is the plant Guduchi (*Tinospora cordifolia*), which is well recognised, especially in traditional medicine. Some of its health benefits include antioxidant, hepatoprotective, antibacterial, anti-hyperglycemic, antipyretic, lipid-lowering, cardiovascular, anti-inflammatory, bone-protective, neuroprotective, anti-anxiety anxiety, pain relief, anti-diarrheal and anti-stress . The entire plant can be utilised for medicinal purposes. Guduchi, also known as the Divine nectar, is well known for being a potent medicinal plant. It is a key component in many types of revitalising tonics and has a wide range of medical applications, including supporting the immune system, skin, liver, spleen, stomach, blood, and intestines. It is also used to alleviate the negative effects of chemotherapy. The usage of this beautiful herb is becoming more and more popular as more and more people become aware of its benefits. That is understandable why this Ayurveda herb is frequently referred to as the "Queen of all herbs."

References

1. Kapil A, Sharma S. Immunopotentiating compounds from *Tinospora cordifolia*. *J Ethnopharmacol*. 1997;58(2):89-95.
2. Timilsina H, Modi B, Basnyat R. Phytochemical, antimicrobial and ethnobotanical study of *Calotropis gigantea*. *J Health Allied Sci*. 2020;10(2):23-7.
3. Cooper R, Nicola G. Natural products chemistry: sources, separations and structures. Boca Raton: CRC Press; 2014.
4. Joshi G, Kaur R. *Tinospora cordifolia*: a phytopharmacological review. *Int J Pharm Sci Res*. 2016;7(3):890.
5. Pathan MA. Review on *Tinospora cordifolia*. *Int J Pharm Drug Anal*. 2017;5(8):310-2.
6. Atal CK, Kapoor BM. Cultivation and utilization of medicinal plants. New Delhi: PID, CSIR; 1989.
7. Siddiqui HH. Safety of herbal drugs—an overview. *Drugs News Views*. 1993;1(2):7-10.
8. Sinha K, Mishra NP, Singh J, Khanuja SP. *Tinospora cordifolia* (Guduchi), a reservoir plant for therapeutic applications: a review.
9. Choudhary N, Siddiqui MB, Azmat S, Khatoon S. *Tinospora cordifolia*: ethnobotany, phytopharmacology and phytochemistry aspects. *Int J Pharm Sci Res*. 2013;4(3):891.
10. Khan MB, Rathi B. *Tinospora cordifolia*—an immunomodulatory drug in Ayurveda for prevention and treatment of COVID-19. *Int J Res Pharm Sci*. 2020;11(1):1695-9.
11. Tiwari P, Nayak P, Prusty SK, Sahu PK. Phytochemistry and pharmacology of *Tinospora cordifolia*: a review. *Syst Rev Pharm*. 2018;9(1):70-8
12. Bishayi B, Roychowdhury S, Ghosh S, Sengupta M. Hepatoprotective and immunomodulatory properties of *Tinospora cordifolia* in CCl₄ intoxicated mature albino rats. *J Toxicol Sci*. 2002;27(3):139-46.
13. Gupta R, Sharma V. Ameliorative effects of *Tinospora cordifolia* root extract on histopathological and biochemical changes induced by aflatoxin-B1 in mice kidney. *Toxicol Int*. 2011;18(2):94
14. Spandana U, Ali SL, Nirmala T, Santhi M, Babu SS. A review on *Tinospora cordifolia*. *Int J Curr Pharm Rev Res*. 2013;4(2):61-8.
15. Aiyer KN, Kolammal M. Pharmacognosy of Ayurvedic drugs. Series 1. Trivandrum: Central Research Institute; 1963.
16. Basha SK, Umamaheswari P, Rambabu M, Savitramma N. Ethnobotanical study of Mamandur Forest (Kadapa-Nallamali Range) in Eastern Ghats, Andhra Pradesh, India. *J Phytol*. 2011;3(10).

17. Khosa RL, Prasad S. Pharmacognostical studies on Guduchi (*Tinospora cordifolia* Miers). *J Res Indian Med.* 1971;6:261-9.
18. Reddy SS, Ramatholisamma P, Karuna R, Saralakumari D. Preventive effect of *Tinospora cordifolia* against high-fructose diet-induced insulin resistance and oxidative stress in male Wistar rats. *Food Chem Toxicol.* 2009;47(9):2224-9.
19. Bhatt RP, Sabnis SD. Contribution to the ethnobotany of Khedbrahma region of North Gujarat. *J Econ Tax Bot.* 1987;9(1):139-45.
20. Singh SS, Pandey SC, Srivastava S, Gupta VS, Patro B. Chemistry and medicinal properties of *Tinospora cordifolia* (Guduchi). *Indian J Pharmacol.* 2003;35(2):83.
21. Raghunathan K. The aqueous extract of *T. cordifolia* caused reduction of blood sugar in alloxan-induced hyperglycemic rats and rabbits. *J Res Indian Med.* 1969;3:203-11.
22. Reddy CS, Reddy KN, Murthy EN, Raju VS. Traditional medicinal plants in Seshachalam Hills, Andhra Pradesh, India. *J Med Plants Res.* 2009;3(5):408-12.
23. Kirtikar KR, Basu BD. Indian medicinal plants. Vol 2. Dehradun: International Book Distributors; 1975.
24. Nadkarni K, Nadkarni AK. Indian Materia Medica, Popular Prakashan Pvt. Ltd., Bombay. 1976;1:799.
25. Singh SS, Pandey SC, Srivastava S, Gupta VS, Patro B. Chemistry and medicinal properties of *Tinospora cordifolia* (Guduchi). *Indian J Pharmacol.* 2003;35(2):83.
26. Sangeetha MK, Balaji Raghavendran HR, Gayathri V, Vasanthi HR. *Tinospora cordifolia* attenuates oxidative stress and distorted carbohydrate metabolism in experimentally induced type 2 diabetes in rats. *J Nat Med.* 2011;65:544-50.
27. Patel MB, Mishra S. Hypoglycemic activity of alkaloidal fraction of *Tinospora cordifolia*. *Phytomedicine.* 2011;18(12):1045-52.
28. Chougale AD, Ghadyale VA, Panaskar SN, Arvindekar AU. Alpha glucosidase inhibition by stem extract of *Tinospora cordifolia*. *J Enzyme Inhib Med Chem.* 2009;24(4):998-1001.
29. Tripathi YB, Sharma M, Manickam M. Rubiadin, a new antioxidant from *Rubia cordifolia*. *Indian J Biochem Biophys.* 1997;34(3):302-6.
30. Reddy SS, Ramatholisamma P, Karuna R, Saralakumari D. Preventive effect of *Tinospora cordifolia* against high-fructose diet-induced insulin resistance and oxidative stress in male Wistar rats. *Food and chemical toxicology.* 2009 Sep 1;47(9):2224-9.
31. Kumar DV, Geethanjali B, Avinash KO, Kumar JR, Basalingappa KM. *Tinospora cordifolia*: the antimicrobial property of the leaves of Amruthaballi. *J Bacteriol Mycol.* 2017;5:363-71.
32. Upadhyay N, Ganie SA, Agnihotri RK, Sharma R. Studies on antioxidant activity and total phenolic content of *Tinospora cordifolia* (Miers.) stem using in vitro models. *Am J Phytomed Clin Ther.* 2013;1(8):617-27.
33. Sarala M, Velu V, Anandharamakrishnan C, Singh RP. Spray drying of *Tinospora cordifolia* leaf and stem extract and evaluation of antioxidant activity. *J Food Sci Technol.* 2012;49:119-22.
34. Gupta R, Sharma V. Ameliorative effects of *Tinospora cordifolia* root extract on histopathological and biochemical changes induced by aflatoxin-B1 in mice kidney. *Toxicol Int.* 2011;18(2):94.
35. Bhawya D, Anilakumar KR. In vitro antioxidant potency of *Tinospora cordifolia* (gulancha) in sequential extracts. *Int J Pharm Biol Arch.* 2010;1(5):448-56.
36. Gupta R, Sharma V. Ameliorative effects of *Tinospora cordifolia* root extract on histopathological and biochemical changes induced by aflatoxin-B1 in mice kidney. *Toxicol Int.* 2011;18(2):94.
37. Sharma V, Pandey D. Protective role of *Tinospora cordifolia* against lead-induced hepatotoxicity. *Toxicol Int.* 2010;17(1):12.
38. Saha S, Ghosh S. *Tinospora cordifolia*: one plant, many roles. *Anc Sci Life.* 2012;31(4):151.
39. Singh K, Panghal M, Kadyan S, Chaudhary U, Yadav JP. Antibacterial activity of synthesized silver nanoparticles from *Tinospora cordifolia* against multidrug-resistant strains of *Pseudomonas aeruginosa* isolated from burn patients. *J Nanomedicine Nanotechnol.* 2014;5(2):1.
40. Shanthi V, Nelson R. Antibacterial activity of *Tinospora cordifolia* (Willd.) Hook. F. Thoms on urinary tract pathogens. *Int J Curr Microbiol Appl Sci.* 2013;2(6):190-4.
41. Narayanan A, Raja S, Ponmurugan K, Kandekar S, Natarajaseenivasan K, Maripandi A, et al. Antibacterial activity of selected medicinal plants against multiple antibiotic resistant uropathogens: a study from Kolli Hills, Tamil Nadu, India. *Benef Microbes.* 2011;2(3):235-43.
42. Sengupta S, Mukherjee A, Goswami R, Basu S. Hypoglycemic activity of the antioxidant saponarin, characterized as α -glucosidase inhibitor present in *Tinospora cordifolia*. *J Enzyme Inhib Med Chem.* 2009;24(3):684-90.

43. Sannegowda KM, Venkatesha SH, Moudgil KD. *Tinospora cordifolia* inhibits autoimmune arthritis by regulating key immune mediators of inflammation and bone damage. *Int J Immunopathol Pharmacol*. 2015;28(4):521-31.
44. Utpalendu J, Chattopadhyay RN, Badri PS. Preliminary studies on anti-inflammatory activity of *Zingiber officinale* Rosc., *Vitex negundo* Linn. and *Tinospora cordifolia* (Willd.) Miers in albino rats. *Indian J Pharmacol*. 1999;31(3):232.
45. Sharma U, Bala M, Saini R, Kumar Verma P, Kumar N, Singh B, Kulkarni Munshi R, Bhalerao S. Polysaccharide enriched immunomodulatory fractions from *Tinospora cordifolia* (Willd.) miers ax hook. f. & Thoms. *Indian Journal of Experimental Biology*. 2012 Sep 1;50(9):612.
46. Aher V, Wahi AK. Biotechnological approach to evaluate the immunomodulatory activity of ethanolic extract of *Tinospora cordifolia* stem (mango plant climber). *Iran J Pharm Res*. 2012;11(3):863.
47. Tiwari P, Nayak P, Prusty SK, Sahu PK. Phytochemistry and pharmacology of *Tinospora cordifolia*: a review. *Syst Rev Pharm*. 2018;9(1):70-8.
48. Sudhakaran DS, Sirekha P, Devasree LD, Prem Singh S, Michael RD. Immunostimulatory effect of *Tinospora cordifolia* Miers leaf extract in *Oreochromis mossambicus*. *Indian journal of experimental biology*. 2006 Sep 1;44(9):726.
49. Singh SM, Singh N, Shrivastava P. Effect of alcoholic extract of Ayurvedic herb *Tinospora cordifolia* on the proliferation and myeloid differentiation of bone marrow precursor cells in a tumor-bearing host. *Fitoterapia*. 2006;77(1):1-1.
50. Bala M, Pratap K, Verma PK, Singh B, Padwad Y. Validation of ethnomedicinal potential of *Tinospora cordifolia* for anticancer and immunomodulatory activities and quantification of bioactive molecules by HPTLC. *J Ethnopharmacol*. 2015;175:131-7.
51. Kalikar MV, Thawani VR, Varadpande UK, Sontakke SD, Singh RP, Khiyani RK. Immunomodulatory effect of *Tinospora cordifolia* extract in human immunodeficiency virus positive patients. *Indian J Pharmacol*. 2008;40(3):107.
52. Akhtar S. Use of *Tinospora cordifolia* in HIV infection. *Indian J Pharmacol*. 2010;42(1):57.
53. Chetan B, Nakum A. Use of natural compounds, chitin and tinosporin for the treatment of targeted viruses (retroviruses) (HIV-1, HIV-2), HTLV and other viral diseases. Indian patent application IN 2010MU01350 A. 2010.
54. Shakil NA, Saxena DB. Isolation and structure of cordifolin, a novel insecticidal oxygenated chalcone, from the stem of *Tinospora cordifolia* Miers. *Nat Prod Commun*. 2006;1(7):1934578X0600100707.
55. Okuyama T, Shibata S, Hoson M, Kawada T, Osada H, Noguchi T. Effect of oriental plant drugs on platelet aggregation: III. Effect of Chinese drug Xiebai on human platelet aggregation. *Planta Med*. 1986;52(3):171-5.