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5. Medicinal and Pharmacological Properties *Tinospora Cordifolia*- An Important Therapeutic Medicinal Plant of India

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5.1 Introduction:

Nature is a hub for many medicinal plants which have been in use by mankind for its therapeutic value. Most of the medicinally important compounds now used as modern drugs have been isolated from these natural sources. Traditional medicine has a very important role in the primary health care system in developing countries like India. It is easily affordable and accessible for poor communities. Synthetic drugs are economically high in cost and also cause adverse side effects on human beings. In order to replace synthetic drugs, there is need for screening different plants for their medicinal or therapeutic value.

According to WHO, 80% of world population mainly depends on traditional medicine which involves the direct use of plant extracts or their active constituents (Pandey *et al*., 2008)? India is home for about more than 45000 plant species, rich in source of medicines or medicinal compounds or natural products.

India is regarded as one of the nation of mega biodiversity as it is rich in flora and fauna. Natural products obtained from medicinal plants are gaining importance in the field of medicine and research. India is also rich in ancient traditional systems of medicine like Ayurveda, Siddha, Unani, Homeopathy and folk medicine.

These traditional systems of medicine provides the immense knowledge about various important medicinal plants used in primary health care and also cure for common ailments (Tiwari et al., 2018).

Tinospora cordifolia is a medicinal plant whose status in the field of natural medicine and Ayurveda is of the highest order. Vernacularly speaking, *Tinospora cordifolia* is known "*Guduchi*" whose origin is rooted to Sanskrit; and is known as "Amruthaballi" in Kannada and is an important drug of the Indian System of Medicine (ISM). *T. cordifolia* is an esteemed medicinal plant whose uses and application with reference to human benefits have been praised to indescribable heights in various ayurvedic and Vedic scriptures and the practices.

It is widely and popularly used in the ayurvedic and local forms of medicine is studied in the phytochemical and different components that exhibit the properties that have been celebrated and upheld in the age old traditions and medicinal practices (Gaur *et al., 2014)*.

5.2 Plant Morphology:

Tinospora cordifolia is a perennial climber used in folk and Ayurvedic systems of medicine all over India. All parts of the plant are used, but leaves stem and roots are the most important parts which are medicinally important. It belongs to family Menispermaceae. It is extensively used in Ayurvedic medicine. It is glaborous, succulent, woody climber. It is native to India also found in tropical regions of Asia (Malaysia, Burma and Sri Lanka) and Africa. The stem appears grey or creamy white. The surface of the stems appears to be closely studded with warty tubercles and the surface skin is longitudinally fissured, having3-5 cm length and 3-8 mm in diameter (Reddy et al., 2015). The wood is white in colour, soft and porous. The freshly cut stem when exposed to air quickly turns light yellow. Leaves are simple, alternate, exstipulate, long, petiolate, cordate in shape with multicoated reticulate venation and bright green in colour. Thread like aerial roots arise from branches. Flowers are small and unisexual axiliary and terminal racemes.

The differentiations in the sexes are seen in the form that the male flowers are usually clustered and the female flowers are solitary in positioning. The sepals and petals are 6 in number and are usually free or grouped in 2 or 3 numbers. The fruits are found in an aggregate of 1-3 drupes with scarlet or orange color. The seeds are curved and pea sized and are transverse dehiscent in nature. The roots which are present in this plant are seen in both underground and aerial form.

5.3 Taxonomic Classification:

Kingdom	: Plantae – Plants
Subkingdom	: Trachaeophyta – Vascular Plants
Super-division	: Spermatophyta-Seedbearingplants;
Division	: Magnoliophyta-Flowering;
Class	: Magnoliopsia-Dicotyledons
Subclass	: Polypeptalae-Petals are free;
Series	: Thalamiflorae-Manystamensandflowerhypogynous
Order	: Ranunculales
Family	: Menispermaceae-The Moonseed family
Genus	: Tinospora
Species	: cordifolia

In India, *Tinospora cordifolia* is known by different name in various different languages. (**Tiwari *et al*., 2018; Gaur *et al*., 2014**)

Latin	: Tinospora cordifolia (willd.)Hook. F. and Thomson
English	: Gulancha/ Indian Tinospora
Sanskrit	: Guduchi, Madhuparni, Amrita, Chinnaruha, Vatsadaani, Tantrika, Kundalini and chakralakshanika.
Hindi	: Giloya, Guduchi
Bengali	: Gulancha
Telugu	: Thippateega
Tamil	: Shindilakodi
Marathi	: Shindilakodi
Gujarathi	: Galo
Kannada	: Amrita balli, Madhupa

Tinospora cordifolia is an important medicinal plant used in Indian systems of medicine and used since ages. It is commonly called as Indian bitter. It is prescribed in fevers, diabetes, dyspepsia, jaundice, urinary problems, skin diseases and chronic diarrhoea and dysentery. It has been also useful in the treatment of heart disease, leprosy, and helmenthiasis. The stem is used in cure for many diseases and is highly rich in starch which is considered to be highly nutritive and digestive (Kirtikar *et al*., 1933).

5.4 History and Ayurvedic Aspects:

The use of this medicinal plant has been described in detailed manner in Vedic and ayurvedic scriptures. The plant is known as Guduchi or Amrita in Sanskrit which points to the nature of this plant in the rejuvenating and the retainment of youth and life span of the consumer. In other words, the fountain of life force is an apt title for this medicinal plant. Ayurveda is a 5,000-year-old traditional system of medicine know in India, It describes three elemental substances such as Kapha, Vata and Pitta. As per Ayurveda, Ashtang Hridaya and Sushrut, Charak and other treaties like BhavaPrakash and Dhanvantri Nighantu, T. cordifolia has different names as: Amara, Amritvalli, Chinmarrhuha, Chinnodebha and Vatsadanietc, and most commonly called as Guduchi or Amrita. In SushurtaSamhita, under Tikta-SakaVarga, it is traditionally prescribed for the treatment of several diseases like Svasa (asthma), MahaJvara (fever), Aruci (anorexia) and kustha (leprosy). In AshtangHridaya and Charak Samhita, there is also a great evidence for the treatment of different diseases like Jvara (fever), Vat Rakta (gout) and Kamala (jaundice).

In Bhavya Prakash, it is considered as diuretic, astringent, bitter tonic and potential curative and aphrodisiac against jaundice, diabetes, chronic diarrhea, and dysentery and skin infections. In Dhanvantri Nighantu, it has been described for treatment of bleeding piles, curing itching, erysipelas and promoting longevity. It is also known to possess properties like Deepanam (kindles digestive fire), Laghu (light), Dhatukrit (builds the sevenbodilytissues), Chakshushyam (good for the eyes), Bayasthaapankarakam (maintains youthfulness and longevity) and Medhayam (rejuvenating for the mind). European practitioners in India considered Tinospora as a major source of medicine like tonic, diuretic and antiperiodic and further it was comprised in Bengal Pharmacopoeia of 1868.

It is reported in Ayurvedic literature T. cordifolia is a major constituent of formulations used for the treatment of several disease such as dyspepsia, urinary related diseases, debility and fever. Some of the important formulations prepared from T. cordifolia are: Guduchitaila, Sanjivanivati, Kanta-Kari avaleha, Guduchyadichurna, Chyavnaprasha, Guduchughrita, Guduchisatva, Brihatguduchitaila, Amrita guggulu, amritashtakachurna and manymore. T. cordifoliais the most extensively used as a remedial herb in Folk and tribal medicine for the treatment of various diseases. T. cordifolia is considered to be highly valuable in Ayurveda for its numerous medicinal properties like rejuvenating, immune-boosting, anti-rheumatic and detoxifying properties. In modern medicine, T. cordifolia is presently used for treatment of cold and flu prevention, skin disorders, liver disorders, immune support, gout, arthritis and lately to overcome the adverse effects of chemotherapy. Tinospora cordifoliais an important drug plant used in traditional medicinal system and provides basis for the possible use of this plant in modern medicine.

Recent scientific studies help us to understand the potential prospects for the development of effective therapeutic compounds. The present review aims to highlight the medicinal properties of Tinospora cordifolia and its potential prospects for the further scientific investigation.

5.5 Phytochemistry/ Chemical Constituents:

The detailed scientific studies have yielded the discovery of various compounds in the plant extract of various solvent natures that are either directly or indirectly responsible for the expression of biological characters in the plant or host system. e different classes of compounds which are found in this plant are classed in groups like alkaloids, steroids, terpenoids, polysaccharides, glycosides and different aromatic and aliphatic compounds that are present in their phytoactive form that are responsible for the wide range of medicinal and therapeutic properties. The presence of these compounds is found in various plant parts but highly concentrated in the stem, leaves and root part of the plant.[5] The main compound of this plant is berberine and furan lactone and furthermore compounds like tinosporone, tinosporic acid, cordifolisides A to E, giloin, gilenin, crude giloininand, arabinogalactan polysaccharide, picrotene, bergenin, gilosterol, tinosporol, tinosporidine, sitosterol, cordifol, heptacosanol, octacosonal, tinosporide, columbin, chasmanthin, palmarin, palmatosides C and F, amritosides, cordioside, tinosponone, ecdysterone, makisterone A, hydroxyecdysone, magnoflorine, tembetarine, syringine, glucan polysaccharide, syringineapiosylglycoside, isocolumbin, palmatine, tetrahydropalmaitine, jatrorrhizine are few of the compounds that have been isolated from the plant.

The presence of three compounds like cycloeuphordenol, Cyclohexyl-11-heneicosanone and 2-Hydroxy-4-methoxy-benzaldehyde has been isolated from the plant and has been seen to be present in various other plants. The presence of proteins and miscellaneous compounds has been attributed to the medicinal properties of the plant (Wichtl et al., 2000, Kavya et al., 2015). (Table 5.1).

A study by **Khosa *et al.*, 1971** and **Nasreen *et al.*, 2010** revealed *Tinospora cordifolia* consists of different classes of chemical constituents such as alkaloids, diterpenoid, lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides etc.

In addition to this, many compounds present in the plant that contribute to the medicinal and therapeutic properties of *T. cordifolia* plant. The plant contains a high amount of fiber totaling to an total estimate of 15.9% and the protein content to about 4.5-11.2%, the total carbohydrate estimate to about 61.7 & and a low fat amount estimating to about 3.2% and the mineral content totaling to about 0.845% of potassium, 0.006% chromium, 0.28% of Iron and 0.131% of calcium. All these compounds are involved directly or indirectly in the pathways or regulatory, metabolic and cellular nature. Kirti *et al.,* 2004, Jamal *et al.*, 2016, Sharma *et al.*, 2012

5.6 Medicinal and Pharmacological Aspects of Tinospora Cordifolia:

The plant has been titled to many properties that have been used from time immemorial and few of them include curative properties against Jaundice, fever, gout, urinary and upper respiratory infections and preventive measures against skin infections, chronic diarrhoea, bleeding piles, dysentery, itching and erysipelas. The plant is known for its potent aphrodisiac nature and its rejuvenating nature. The plant extract influences the secretion of bile liquids and is known to enrich the blood constituents. The effect that the plant extract has in both adult and children systems is similar and this is a good factor in the administration of the plant drug irrelevant to the host age which is not the case in synthetic drugs which base the age of the consumer to be a major factor in drug administration.[8,10,11]

The plants show anti-diabetic properties due to the presence of tannins, alkaloids, flavonoids, glycosides, saponins and steroids. The plant has seen to have effect on both the sexual arousal and the sexual performance of the biological systems and these drugs have stimulatory effect on the copulatory behavior and thereby entitled to aphrodisiac activity. The most admirable character of the plant extract is the effect it bears in the cognitive field; its ability to affect the learning and memory cortex of the human intelligence is an admirable trait and this trait has attracted the interest of various scientific and industrial bodies. The plant also bears anti-oxidant, anti-inflammatory, anti-tuberculosis; wound healing, immunomodulatory and immunoprotective, hepatoprotective, anti-osteoporotic, anti-cancer, anti-tumor, anti-malaria, cardio protective nature and many more properties that make them a topic of great importance and interest (Shanti *et al.,2013,* Wichtl *et al.,2000, Kavya et al.,2015).* Many biologically active compounds have been isolated from different parts of the *Tinospora cordifolia*. These compounds have been reported to have different biological roles in pathological conditions. Reddy et al., 2015.

5.7 Anti-Cancer Activity:

Tinospora cordifolia possess anti-cancer activity, this activity is commonly proven in animal models. The extraction of alkaloid palmatine from *Tinospora cordifolia* by using response surface methodology (RSM) clearly indicate the anticancer property in 7, 12-dimethylbenz (a) anthracene DMBA induced skin cancer model in mice in a study conducted by Ali et al., 2013. The anti-cancer activity of secondary metabolite (such as magnoflorine, palmatine, jatrorrhizine, yangambin etc.) isolated from guduchi were tested in different type of tumor cells and among them ‘palmatine’ and ‘yangambin’ reported to treat KB cells while tinocordiside for colon cancer cell and oral cancerous cell (KB) respectively in a study conducted by Bala *et al*., 2015.

A single application of *Tinospora 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), substantially prevented the micronucleus formation .in bone marrow of mice, in a dose dependent manner. C57 Bl mice when acquired 50% methanolic extract of *Tinospora cordifolia* at a dose 750 mg/kg body weight for 30days showed increase in life span and tumor size was considerably reduced as compared to control according to a study conducted by Rahul Verma *et al*.,2011. Mishra *et al*., 2013 studies investigated the anti-brain cancer potential of 50% ethanolic extract of *Tinospora cordifolia* (TCE) using C6 glioma cells. The extract extensively reduced cell proliferation in dose- dependent manner and induced differentiation in C6 glioma cells.

According to a study, the hydro alcoholic extract of aerial roots of *T. cordifolia* when exposed to the liver as well as extra hepatic organs of Swiss Albino mice at 50 and 100mg/kg body weight shows an increase in Glutathione (GSH) level and other metabolizing enzymes. In addition to this, it was also reported, there is a significant decrease in production of malonaldehyde (MLD) level indicating a decrease in free radical formation providing an anti -oxidative state of cell was reported by Singh *et al*., 2006.

A research study conducted by Thippeswamy *et al*., 2007**,** reported that mice having Ehrlich ascites tumor on exposure to hexane extract of *Tinospora* shows inhibition of proliferation of tumor cell (G1Phase) and also enhanced the expression of Bax gene which led to caspases induced apoptosis.

According to study by *Chaudary et al*., 2008**,** it was reported that Guduchi has been reported to possess antitumor activity in a study conducted in mice through a two stage carcinogenesis. This study showed there was decrease in papillary tumors, its weight and its occurrence and also increased the levels of phase II enzymes in the treatment group. As most of the chemotherapeutic drugs are synthetic and have many adverse side effects on patient's health. But *T. cordifolia* is considered to be one of the safest medicinal herbs to treat cancer patients as it has very less side effects.

5.7.1 Anti-Toxin activity:

Guduchi have a potential ability to forage free radical and possess a protective effect by altering different hormone and mineral levels. In a toxicity study conducted by Gupta **et al., 2011**, in Swiss albino mice, it was reported that *T. cordifolia* has reversed the toxicity caused by aflatoxin in kidney and significantly increased the Glutathione hormone level and enzyme activities of catalase and glutathione reductase and decreased the ROS. This antitoxin activity is brought by the alkaloid isolated from Tinospora.

According to Lead nitrate toxicity study in swiss albino mice conducted by **Sharma et al., 2010**, reported a decrease in number of erythrocyte and leucocyte count in blood serum. However, the leaf and stem extract of guduchi has potential to combat these changes in hematological value by overcoming the lead induced toxicity.

Oral administration of plant extract in swiss albino mice countered the effects caused by lead nitrate in mice liver.

According to this study, observed that there is decrease in the level of enzymes like glutamic pyruvic transaminase (GPT) or alanine aminotransferase (ALT) and aspartate aminotransferase (AST) and rise in enzyme level of catalase foer scavenging free radicals was reported by *Sharma* et al., 2010.

Another study by Hamsa *et al., 2012*, reported that *T. cordifolia* has found its importance in overcoming cyclophosphamide induced toxicity by significantly elevating the extent of lowered GSH content, cytokines and gradually declining inflammatory cytokines (Tumor necrosis factor) level in urinary-bladder and hepatic cell preventing the damage which confers its anti-toxin activity.

5.7.2 Anti-Diabetic Activity:

Pharmacological research has verified in vivo antidiabetic potential from various extracts of T. cordifolia. The compounds such as alkaloids, cardiac glycosides, saponins, flavonoids, tannins and steroids isolated from guduchi possess anti-diabetic property. Alkaloids isolated from guduchi noted to possess the effect like insulin hormone and indicate insulin mediated actions. These compounds have been stated to embody different target activities in diabetic conditions, for that reason enabling the potential application in experimental and clinical research.

Kannadhasan *et al., 2010*, find out about stated that 30 days cure of Sedimental extract of *Tinospora cordifolia* (SETc) (1000 mg/kg/p.o.) on diabetic patients was tested for its efficacy and simply establishes the antidiabetic activity with antiobese body. The ethanolic extract of *T. cordifolia* leaves in different dosages (200 and 400 mg/kg b.w.) administered orally for 10 days and 30 days in streptozotocin diabetic albino rats. It is absolutely confirmed that TC has extensive antidiabetic activity in diabetic animals and has an efficacy of 50% to 70% compared to insulin was observed by Chandra Shekar *et al., 2013*. Borapetoside C isolated from Tinosporacrispa (5 mg/kg, i.p.) attenuated the increased plasma glucose in diabetic mice, accelerated glucose utilization, delayed the development of insulin resistance and then improved insulin sensitivity was reported in a study conducted by Ruan *et al., 2012*. The activation of insulin- triggered IR-Akt-GLUT2 expression in liver and the enhancement of insulin sensitivity may additionally have contributed to the hypoglycemic action of borapetoside C was reported by Ruan *et al., 2012*.

The isoquinoline alkaloid rich fraction from stem, including, palmatine, jatrorrhizine, and magnoflorine have been stated for insulin-mimicking and insulin- releasing effect each in vitro and in vivo was reported by Patel et al, 2011.In Ehrlich ascites tumor cells model, water, ethanol and methanol extracts of the herb confirmed glucose uptake stimulatory activity was reported by Joladarashi *et al.,2014*.

The protecting effects of *T. cordifolia* root extract had been reported in presence of higher levels of anti-oxidant molecules and enzymes. Tinospora root extract has been proven to drastically counterbalance the diabetes-associated oxidative stress in the maternal liver by reducing the levels of malondialdehyde and reactive oxygen species and the elevated levels of glutathione and total thiols was reported in a study conducted by Shivananjappa *et al., 2012*.

The stem extract of *T. cordifolia* is stated to have anti-diabetic potential by means of improving the insulin efficiency through its secretion from beta pancreatic cell and promoting a variety of anti-diabetic pathway such as inhibiting glucose formation by means of enhancing glycogenesis etc. thereby reducing the endogenous glucose. It was reported by Sangeetha *et al., 2011*.

Oral administration of leaf extracts of *T. cordifolia* has also observed anti-diabetic potential when examined in diabetic rat model (streptozotocin induced diabetes) through distinct peripheral pathways such as glycogen storage, transportation of glucose and other mechanisms was observed in a study conducted by **Singh et al., 2013.**

5.7.3 Immunomodulatory Activity:

In a clinical study by Sharma *et al.,* 2012 it was reported, chemical constituents such as cordifolioside A and syringin isolated from Tinospora cordifolia are reported a simmunomodulating agent.

As *T. cordifolia* stem is known to alter the level of enzymes such as catalase which promotes stimulation of lymphocyte cells thereby maintaining the immune strength, and highlighting the immuno-protective role of this plant in a study conducted by Aher *et al.,* 2012.

Tinospora is known to enhance antimicroboal activity to protect immunity was reported in Macrophage cells exposed to extract of this medicinal plant in a study conducted by More *et al.,* 2012. Aqueous extract of *T. cordifolia* induces cellular mitosis, thus stimulating the production and activation of cytokine and immune effect or cells in a study conducted by Upadhyaya *et al*., 2012.

A clinical study reported by Castillo *et al*., 2014, *T. cordifolia* lotion shows drop in the level of interleukin i.e. IL-1 and IL-6 in scabies animal model and therefore showing its anti-scabies activity. T. cordifolia is a potent agent for the prophylaxis of immune susceptible diseases as it is able to increase the response of immune cell and neutrophil activity was reported by Sudhakran et al., 2006.

Preclinical tests were conducted by using chemical compounds of *T. cordifolia* such as alkaloids, steroids, aliphatic compounds in a rat model showed a great immunoprotective activity.G1-4A is recognized as a poly- saccharide compound isolated from *T. cordifolia* showed significant increase in the proliferation and differentiation of immune cells i.e. T-cell and B-cell associated with the expression of the anti-apoptotic gene was reported Jahfar *et. al*., 2003, Raghu *et al*., 2009. α-D -glucan compound obtained from *T. cordifolia* has shown to maintain the body physiology by activating the cells of lymphocytes was reported by Koppada *et al*., 2009.Polymorphonuclear leucocyte (PMN) cells are important components of the host defense system. Various Extracts of *T. cordifolia* stimulated the PMN cells for phagocytosis was reported by Salkar *et al*., 2014.

An aqueous extract of *T. cordifolia* named as ‘Ghana’ in Ayurveda was tested on the edema rat model, showed reduction in the edematogenic agents and thus has a potent immunostimulatory action was reported by Umretia *et al*., 2013.

5.7.4 Anti-Microbial Activity:

A study by Singh et al., 2014, silver nanoparticles synthesized from the stem of *T. cordifolia* was found to possess a good antibacterial activity against Pseudomonas aeruginosa in a patient suffering from burn injury. Many strains of bacteria such as S. typhi, K. pneumoniae, E. coli etc. have been tested with different extracts of *T. cordifolia* which showed potential antibacterial activity by inhibiting their growth or controlling the existence of these bacteria in a studies conducted by Narayana *et al*.,2011, Jeyachandran *et al.*,2003, Duraipandiyan et al., 2012. A study by Duraipandiyan et al., 2012 reported that the stem of T. Cordifolia contains an active chemical compound which was found to be effective against E. faecalis and B. subtilis (bacteria and fungus like T. simii and T. rubrum.

The stem and leaves of this plant are capable of preventing urinary tract infections according to a study, which showed maximum inhibitory activity against the clinical urinary pathogens such as Klebsiella pneumonia and Pseudomonas aeruginosa in a study conducted by Shanti *et al*., 2013. A study conducted by Narayanan *et al*., 2011, reported that this medicinal plant has significant effect by decreasing the resistance to different antibiotic therapy by the urinary pathogens and thus checks the microbial infectivity.

5.7.5 Antioxidant Activity:

According to a study conducted by Subramanian *et al*., 2013, in a rat model, Arabinogalactan, a plant derived polysaccharide shows protection against free radicals indicating antioxidant property. Another study conducted by Jayaprakash et al., 2015, reported *Tinospora* modifies the levels of different enzymatic reactions which controls the synthesis of reactive species and controls oxidation by regulating lipid peroxidation.

Tiwari et al., 2018, study reported, *Tinospora* cordifolia is also known to possess other significant properties such as anti HIV activity, anti-osteoporotic activity etc.

5.8 Conclusion:

In the recent years there has been an increasing interest in the use of plant based products, as they are safe compared to synthetic drugs. The present review clearly indicates that Tinospora cordifolia is an important medicinal plant with impressive biological properties like antidiabetic, antimicrobial, antioxidant, etc. It has many pharmacological properties and used in the preparation of tin all the traditional medicinal preparations. It can be grown in many geographical regions with varying climatic conditions.

The *Tinospora cordifolia* plant had been appreciated to high levels for the medicinal, therapeutic, curative, healing and relieving nature. In keeping view of importance characters, an effort has to be made for large scale cultivation of *T. cordifolia* in different regions of India.

Work should be strengthened for isolation, purification and identification of active principles by using advanced technology. More studies should be conducted on various pharmacological activities *T. cordifolia* for the development of new therapeutic drugs.

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Plate I: Morphology of Tinospora cordifolia (plant, flowers, Fruits, stem)

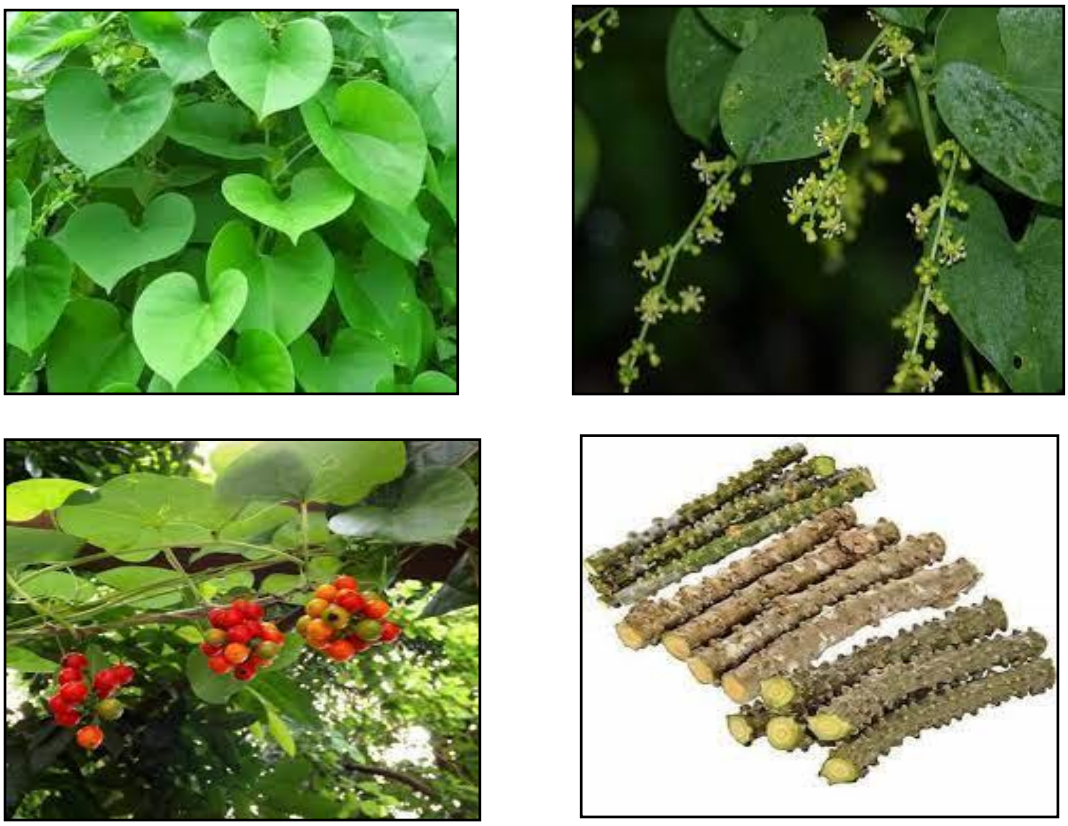
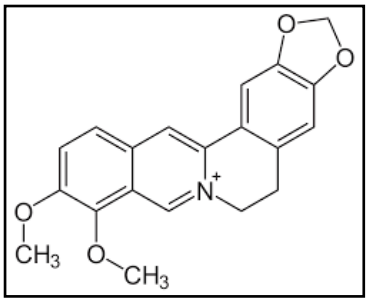


Table 5.1: Chemical constituents of *Tinospora cordifolia*

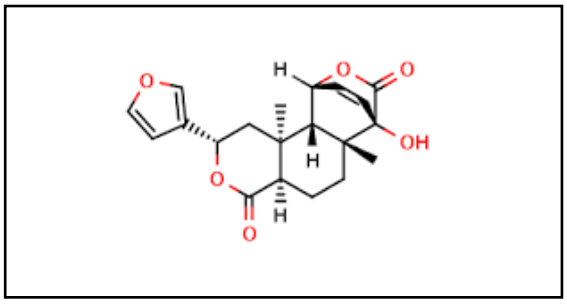
Class	Chemical constituents	Activity	Plant part
Alkaloids	Berberine, Magnoflorine, CholinePalmatin, Tembetarine, Tinosporine, Isocolumbin, Aporphine alkaloids, Jatrorrhizine, Tetrahydropalmatine	Anti-viral infections Neurological, Immunomodulatory anti-diabetes, Anticancer	Stem and Root
Steroids	20 δ - Hydroxyecdysone, δ-sitosterol, β – sitosterol, Giloinsterol Ecdysterone, Makisterone A	1. Inhibits TNF-α, IL-1 β, IL-6 and COX-2. inflammatory arthritis, IgA neuropathy	Shoot
Glycosides	Tinocordiside, Tinocordifolioside, Cordioside, 18-norclerodane glucoside, CordifoliosideSyringin ,	anticancer activities Treats neurological disorders like ALS,	

Class	Chemical constituents	Activity	Plant part
	Syringinapiosylglycoside, FuranoidditerpeneGlucoside, Palmatosides, Cordifolioside A, B, C, D and E, Pregnane glycoside.	Parkinsons, Dementia	Stem
Diterpenoidl-actones	Furanolactone, Tinosporon, Tinosporides , Columbin, Clerodane derivatives, Jateorine	Anti-inflammatory, Anti-microbial, anti-viral. Anti-hypertensive, VasorelaxantInduce apoptosis in leukemia by activating caspase-3and bax, inhibits bcl-2	Whole plant
Sesquiterpenoid	Tinocordifolin	Antiseptic	Stem

Chemical Structures:



Berberine



Tinosporin