



A review on Pharmacogenetic study of *Tinospora Cardifolia*.

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Abstract –

Tinospora cordifolia (Guduchi) is a large, glabrous, perennial, deciduous, climbing shrub of weak and fleshy stem found throughout India. It is a widely used plant in folk and Ayurvedic systems of medicine. The chemical constituents reported from this shrub belong to different classes, such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides. Various properties of *T. cordifolia*, described in ancient texts of Ayurveda, like Rasayana, Sangrahi, Balya, Agnideepana, Tridoshshamaka, Dahnashaka, Mehnashaka, Kasa-swasahara, Pandunashaka, Kamla-Kushta-Vataraktanashaka, Jwarhara, Krimihara, Prameha, Arshnashaka, KricchHridroganashak, etc., are acquiring scientific validity through modern research adopting "reverse pharmacological" approach. . It is known for its immense application in the treatment of various diseases in the traditional ayurvedic literature. *T. cordifolia*, also named as "heavenly elixir," is used in various ayurvedic decoctions as panacea to treat several body ailments. (Mishra R,) Its root stems, and leaves are used in Ayurvedic medicine. *T. cordifolia* is used for diabetes, high cholesterol, allergic rhinitis (hay fever), upset stomach, gout, lymphoma and other cancers, rheumatoid arthritis, hepatitis, peptic ulcer disease, fever, gonorrhea, syphilis, and to boost the immune system (WebMD) Potential medicinal properties reported by scientific research include anti-diabetic, antipyretic, antispasmodic, anti-inflammatory, anti-arthritic, antioxidant, antiallergic, anti-stress, anti-leprotic, antimalarial, hepato-protective, immunomodulatory and anti-neoplastic activities. This review brings together various properties and medicinal uses of *T. cordifolia* described in Ayurveda, along with phytochemical and pharmacological reports.

INTRODUCTION –

Tinospora cordifolia, commonly called as “GUDUCHI,” Amrta, and Cinnodbhava in Sanskrit; Gllow in Punjabi; Tippa-Teega in Telugu; Shindilakodi in Tamil⁽¹⁾; Amruthu and Chittamruthu in Malayalam; Amruthaballi in Kannada; Bândaül pich in Khmer; Rasakinda in Sinhala; Boraphét in Thai; Guduchi and Gulvel in Marathi; Gurch and Guluncha in Urdu; Ningthou khongli in Manipuri; Theisawntlung in Mizo; Gulancha in Bengali; Guluchi in Odia; Gujro in Nepali; Galac and Garo in Gujarati; Geloy, Guruc and Gurcha in Hindi; Amritvel in

Konkani; Hogunilot in Assamese; and Gurjo in Sikkhim, belongs to the family Menispermaceae. It is genetically large, diverse climbing shrub with flowers of greenish-yellow color and the flowering season expands over summer and winter. It is indigenous to topical areas of India, Myanmar, Sri Lanka. It is used in the treatment of various diseases and infections such as diabetes, high cholesterol, allergic rhinitis, Gout, upset stomach, lymphoma, and some cancers also. Guduchi (*Tinospora cordifolia* (Wild.)Miers ex Hook.F. & Thoms.) is one of the noncontroversial and extensively used herbs in Ayurvedic medicine. It belongs to family Menispermaceae. Gulancha, amrita, Giloya, gulvel, and other names have been given to it. ⁽²⁾ The plant family Menispermaceae consists of 70 genes and roughly 450 species found in tropical areas.⁽³⁾ All parts such as roots, stem, leaves, flower, fruits, and the entire plant of Guduchi have therapeutic value as it contains a variety of phytochemicals with various pharmacological properties.⁽⁴⁾ According to the World Health Organisation, 80% of the world's population mostly uses traditional medicines that involve plant extracts or their active ingredients. ^[5] It is an important drug used by Ayurveda practitioners in various disease conditions and also for maintenance of health. ⁽⁶⁾A majority of the Ayurvedic lexicons admire the potential health benefits of this drug and compare it to the celestial nectar which brings about immortality, hence the name Amruta is attributed to this. ⁽⁷⁾It is a famed rejuvenator and nootropic, used very commonly in treatment of ailments such as fever, diabetes and skin disorders.⁽⁸⁾ The antioxidant and anti-inflammatory activities of Guduchi have also been extensively investigated, highlighting its role in combating oxidative stress and reducing inflammation. Moreover, Guduchi demonstrates promising hepatoprotective properties, making it a potential therapeutic agent against liver disorders.⁽⁹⁾ It exhibits neuroprotective effects by enhancing cognitive functions and protecting against neurodegenerative diseases. ⁽¹⁰⁾

Additionally, Guduchi exhibits antidiabetic activity by regulating blood glucose levels and enhancing insulin secretion. Its anticancer properties have been attributed to its ability to inhibit tumor growth⁽¹¹⁾ and induce apoptosis in cancer cells. Furthermore, Guduchi possesses antimicrobial properties, inhibiting the growth of various bacteria, viruses, and fungi.⁽¹²⁾

PLANT PROFILE –



Fig No 1

SYNONYM OF GUDACHI –

1. Guduchi - That which protect
2. Amruta - That which can act similar to the celestial nectar which can make the person immortal.
3. Chakrangi, Chakralakshanika - Referring to the radiating medullary rays visible on transverse section.
4. Chinnaruha, Chinnodbhava - Referring to its propagation by stem cuttings.

FAMILY –

Menispermaceae

TAXONOMY –

- Kingdom: Plante-plants
- Subkingdom : Trachephyta – Vascular plant.
- Division: Magnoliopsida- Flowering
- Super division : Spermatophyta – seed bearing plant
- Class: Manoliopsida-Dicotyledons
- Subclass : Polypeptalae –petal are free
- Order: Ranunculales
- Tribe :Tinosporeace
- Family: Menispermaceae – The Moonsee family
- Genus: Tinospora
- Species: T.cordifolia

MORPHOLOGICAL CHARACTERISTICS –

- Gurcha is a gregarious glabrous, twiner.
- Older stems are up to 2 cm in diameter and have corky bark.
- Aerial roots arise from nodal scars of branches.
- Stem and branches are specked with white vertical lenticels.
- Bark is grey-brown or creamy white, warty, papery thin, and peels off easily.
- Leaves are 5–15 cm, ovate, and acute.
- They are membranous when young but become more or less leathery with age.

CHEMICAL CONSTITUENTS –

Important components of Gulvel include tinosporine, tinosporaside, cordifolide, cordifol, and heptacosanol[19]. Gulvel has a high fibre content (15.9%), enough protein (4.5%-11.2%), enough carbohydrates (61.66%), and a low fat content (3.1%). It contains 292.54 calories per 100 g of nutritional value. It contains significant amounts of potassium (0.845%), chromium (0.006%), iron (0.28%), and calcium (0.131%), all of which are crucial for a variety regulatory functions[20]. Tinosporine, tinosporide, tinosporaside, cordifolide, cordifol, heptacosanol,

clerodane furano diterpene, diterpenoid furanolactone tinosporidine, columbin, and bsitosterol are among the major phytoconstituent in *Tinospora cordifolia*.

Its stem has been reported to contain Berberine, Palmatine, Tembatarine, Magniflorine, Choline, and Tinosporin.

Activity	Chemical Constituents	Class
Neuroprotective effect	Berberine, choline, Tembatarine, Tinosporin, Palmitine, Jatrorrhizine	Alkoloides
Aphrodisiac property	Berberine, Palmatine, Tembatarine, Magnoflorine, Tinosporin, Isocolumbin	Alkoloides
Immunomodulatory activity	Cordifolioside A, Tinocordiside, Syrigin	Glycosides
Antidyslipidemic activit	Berberine	Alkaloid
Antioxidant activity Antiinflammatory activit	-)Epicatechin, Tinosporin, Isocolumbin, Palmatine, Furanolactone, Tinosporin, Tinosporide, Jateorine, Columbin, Clerodane derivative	Alkaloid, Diterpenoid lactone Diterpenoid lactones
Gastroprotective activity	Epoxyclerodane diterpene	Terpenoids
Radioprotective & cytoprotective activity	Cordifolioside A	Terpenoid
Antifeedant activity	Tincordin, Tinosporide, Columbin, 8hydroxy columbin	Terpenoid, Diterpenoid lactone
Ameliorative effect	Tinosporin, Isocolumbin, Palmatine, Magnoflorin, Tetrahydropalmatine	Alkaloids, Terpenoids
Cardioprotective effect	Furanolactone, Tinosporin, Tinosporide, Jateorine, Columbin, Clerodane derivatives	Alkaloids, Terpenoids
Hepatoprotective activity	Magnoflorin, Tinosporin, Isocolumbin, Palmatine, Tetrahydropalmatine	Alkaloids, Terpenoids

Antipsychotic activity	Magnoflorin, Tinosporin, Isocolumbin, Palmatine, Tetrahydropalmatine	Alkaloids, Terpenoids
Antipsychotic activity	Tetrahydropalmatine, Berberine, Choline, Tembetarine, Magnoflorine, Tinosporin, Palmetine, Isocolumbin, Aporphine alkaloids, Jatrorrhizine, Tetrahydropalmatine	Alkaloids, Terpenoids
Antidepressant activity	Tinosporin, berberine, Jatrorrhizine	Alkaloids
Anticancer activity	Magnoflorine, palmatine, Tinocordiside, Cordifolioside A	Alkaloids, Terpenoids
Antiarthritic activity	B- sitosterol, Makisterone A, Giloinsterol	Steroids
Antidiabetic activity	Berberine, choline, Tembetarine, Palamtine, Jatrorrhizine	Alkaloids
Antimicrobial activit	Furanolactone, Tinosporon, Jateorine, Columbin	Diterpenoid lactones

Table 3: Chemical constituents responsible for the bioactivity.

MEDICINAL PROPERTIES –





T. cordifolia is used in ayurveda as an antiperiodic, antispasmodic, antiinflammatory, antipyretic, antiarthritic, antipyretic, antiallergic and antidiabetic, antiasthmatic, and anticancer herb (Wikipedia).



PHYTOCHEMISTRY –

From *T. cordifolia*, various constituents have been isolated and clarified. These substances come from a variety of groups, including sesquiterpenoids, glycosides, aliphatic compounds, phenolics, diterpenoid lactones, alkaloids, and steroids[51] ..

Type of chemical	Active component and their distribution
Alkaloides	The following terms are used in this sentence: tinosporin (L), tinospporic acid (L) (W), berberine (s), palmitine (s)(R), tembatarine (S)(R), choline (S)(R), tinosporine (s)(R), isocolumbin (R), and tetrahydropalmatine (R)
Glycoloides	18 Syringin (S), Syringin apiosyl glycodide (S), Palmayosides C and P, Nonderodane glycoside (S), Furanoid diterpene glycoside (S), Tinocordiside (S), Tinocordifoliside (S), Cordioside (S), Cordioside A, B, C, D, Syringin (S), Syringin apiosyl glycodide (S), Syring (S).
Diterpenoides lactones	Tinosporon columbin (S), clerodane derivatives (W), tinosporon (W), tinosporisides (W), jateorine (W), columbin (W), tinosporal, and tinosporide are some examples of diterpenoids.
Steroides	Sitosterol (S), hydroxyecdysone (S), makisterone A (S), giloinsterol (S), octacosanol (S), heptacosanol (S), nonacosan-15-one (S), and tetrahydrofuran (S)
Sesquiterpeniids	Einocordifolin (s)

Pharmacognosy & Ethnomedicinal folk & Tribal Uses of *Tinospora Cordifolia*[18] Table 1: Pharmacognosy and ethanomedical folk and tribal uses of Gulvel.

Sr. No	Part of plant	Uses	Image
1	Leaves: cordate, Membranous, juicy	The leaves are beaten with honey and applied to ulcers and also treatment of gout and erysipelas (bacterial skin infection)	
2	Root: long thready like	The root is powerful emetic and used for visceral obstruction; its watery extract is used in leprosy. Antidote for snake bite	
3	Stem: Fleshy	The stem is bitter stomachic, stimulates bile secretion, diuretic, enriches the blood, useful in skin diseases and cures jaundice; The juice is useful in diabetes, vaginal and urethral discharges, low fevers and enlarged spleen. Stem as an infusion used as a vermifuge, jaundice, against intestinal worms. Stem as decoction used for washing sore eyes and syphilitic sores, antipyretic, antimalarial. Stem used for chronic diarrhoea and some form of obstinate chronic dysentery, deal with intestinal problems and improves digestion.	
4	Fruit: Pea shaped, fleshy.	Dried and powdered fruit, mixed with ghee or honey, is used as a tonic and also in the treatment of jaundice and rheumatism.	

5	Bark: Thin, greyish or creamy white in colour	Anti-allergic, Anti-spasmodic, Anti-pyretic, Antileprotic	
6	Whole plant	The whole plant is used in scabies in swine, diarrhoea and stomach trouble. Urinary	
		diseases, syphilis, skin diseases, bronchitis, promote longevity and increase body's resistance. Stimulate the immune system.	

Pharmacognostical Description-

Tinospora cordifolia drug has undergone number of experiments for its various positive therapeutic abilities to wreath the whole body parts of human being. In Rasayana and in Ayurveda it play very important role in human being life. In Thailand it is used to inhibit the growth of intestinal protozoan parasite such as *Blastocystis hominis*. It is basically used in treatment against Hiccups and prevents to make Hyperacidity and Leucorrhoea, asthma, skin disease, eye disorders, in fractures.

• Stem-

Stem is greyish green with smooth surfaces with swelling nodes with warty protuberances due to its circular lenticles. Dried stem outer bark is thin and papery brown to greyish in colour. It is differentiating into outer zone of thick walled brown coloured with compressed cells while inner zone is thin walled colourless and arranged in 3-7 rows of cells. Cortex has wide amount of parenchymatous zone which contains starch (Aiyer KN et al., 1963; Khosa RL et al., 1971).

• Leaf –

The leaves are simple, alternate and exstipulate in order. Leaf blades are ovate to roundish, chordate with smooth surfaces, while lower surface of leaves are pale coloured while upper surface is glaucous.

The vascular bundle has radial rows of xylem tissue while inner side

has rows of cambium and outer covering is formed of phloem tissues. The cross section of lamina has dorsiventral structure with mesophyll differentiated into palisade layer made up of columnar cells has mesophyll. Mesophyll is differentiated into palisade and spongy tissue. The palisade layer is walled with columnar cells. Starch is present in whole tissues (Raghunathan K et al., 1969). The petiole is slender in shape. It shows single layered epidermis and a wide zone of cortex with 3-4 layered of fibrous pericycle and 8-10 vascular bundles arranged in ring zone of central parenchymatous pith.

• **Root** –

The young aerial roots are threadlike, squarish like structures which grow downward and lengthening reach the ground. The mature aerial roots are fleshy in structure but the dried roots are 3-6cm in diameter and have creamy white in colour that is odourless and bitter in taste. Starch is present in parenchymatous layer of aerial root. The starch grains are oval, elliptical in shape with concentric striations and has central hilum ((Aiyer KN et al., 1963; Khosa RL et al., 1971). Flowers The flowers are unisexual, greenish yellow in colour. Male flowers are aggregated in form and female flowers are solitary inflorescence. Sepals are 6 in 2 series of 3 each. Outer ones are smaller than inner sepals. Flowering occurs in March and June month (Kirtikar KR et al., 1975).

• **Fruit** –

It is orange red in colour. It is ovoid, smooth, and fleshy and has thick stalk with sub terminal style scars. Fruits are developing during in winter season (Nadkarni KM., Seed This family is moonseed family. The seeds are curved in shape. The embryo is turned **Seed** –

• This family is moonseed family. The seeds are curved in shape. The embryo is turned into curve shape automatically and it provides taxonomic properties. into curve shape automatically and it provides taxonomic properties. 1976).

Therapeutic Applications –

The biologically active compounds such as alkaloids, steroids,, aliphatic compounds, and polysaccharides etc are extracted from the different parts of plant. These compounds have different biological roles in different disease conditions (Upadhyay AK. et al, 2010;Rout GR. et al,2006;Sharma U. et al,2012;Patel SS. et al,2009;Gupta R.etal.,2011; Jagetia GC. et al,2006;Patel MB et al.,2011;Ly PT et al.,2007;Karpova EA et al.,1991;Kapil A

etal.,1997;Cheun S et al.,2000; Baldwin AS et al.,2001; Yang JH. et al.,2010;Zhao F et al.,2008;Kim SK et al.,2008;Haenen GR et al.,1999;Jahfar M et al.,2003; Sengupta S et al.,2009).

The Major biological property of *Tinospora cordifolia* includes:

1. Anti-toxic Effects

Tinospora cordifolia extracts reported to scavenge free radicals due to presence of antioxidant activity due to the presence of Aflatoxicosis (Gupta R et al. 2011).It protects against nephrotoxicity. It enhances the activity of Ascorbic acid, Protein activities of antioxidant enzymes in kidney. It also induced the liver damage (Sharma V., 2010).

2. Anti HIV Activities

Root extract of this plant decrease the level against HIV. This anti HIV effect to reduce in eosinophil count, stimulation of B lymphocytes, Macrophages (Kalilae MV et al. 2008; Akhtar S et al., 2010).

3. Anticancer Activities

Tinospora cordifolia extracts used in radioprotective role to increase in body weight, tissue weight to inhibit the harmful effects of sublethal gamma radiations in male Swiss albino mice. *Tinospora cordifolia* extracts rise in lipid peroxidation and decrease the level of cell viability, decrease the level of GSH S-transferase activity (Rao SK et al., 2008).Lipid peroxidation is an important related to cell death and cause the impairment of membrane function through the increase the membrane permeability and membrane protein oxidation and cell death. Polysaccharide fractions from *Tinospora cordifolia* effective in reduce the metastatic potential of melanoma cells. *Tinospora cordifolia* extracts increased the levels of proinflammatory cytokines, including IL-1 β , IL-6, TNF α , granulocyte monocyte-colony stimulating factor and the vascular endothelial cell growth factor to increase the level of tissue inhibitor of metalloprotease-1 in the B 16- F10 extract(Leyon PV et al.,2004). The effect of *Tinospora cordifolia* extract is better than doxorubicin treatment (Jagetia GC. et al., 1998)

4. Antimicrobial Activities

Tinospora cordifolia extracts against microbial infections (Narayana AS., 2011). It assayed against *E. coli*, *S. aureus*, *K.pneumonia*, *P.vulgaris*, *S. typhi*, *Shigella flexneri*, *S.paratyphi*, *S.typhimurium*, *P.aeruginosa*, *E.aerogene*.

Tinospora cordifolia extracts against bacterial growth and improved phagocytic and intracellular bacterial capacities of neutrophils in blood (Sengupta S et al. 2009).

5. Antioxidant Activities

Tinospora cordifolia extracts increase the erythrocytes membrane lipid peroxide and catalase activities. Extracts of *Tinospora cordifolia* has free radical scavenging properties and has alpha glucosidase inhibitor. It has presence of alkaloids to protect against aflatoxin –induced nephrotoxicity (Gupta V et al. 2011). F. Anti-inflammatory Activities *Tinospora cordifolia* is induced oedema arthritis and human arthritis. The dried leaves of *Tinospora cordifolia* produced anti-inflammatory effect in acute and sub acute models of inflammation. *Tinospora cordifolia* is more effective than acetylsalicylic acid. It helps in joint inflammation (Jana et al., 1999).

6. Antidiabetic Activities

Tinospora cordifolia is used in Diabetes mellitus. It reduces the blood glucose and brain lipids. The extracts used to increase the in body weight, total haemoglobin and hepatic hexokinase. The root extract lowers hepatic glucose-6- phosphate and serum acid phosphatase, alkaline phosphatase and lactate dehydrogenase . The extract also prevents a decrease in body weight (Stanley and Menon, 2001).

7. Anti-stress Activities

Ethanol extract of *Tinospora cordifolia* exhibited the antistress activities compared with diazepam (Sarma et al., 1996).

8. Anti-ulcer Activities

Ethanol extract of *Tinospora cordifolia* induced protective against restrain stress to induced ulcerization as compared the diazepam (Sarma et al., 1995).

9. Anticlastogenicity activity Anticlastogenic potential of the ethanolic extract of *T. cordifolia* stem against arsenic-induced genotoxicity was evaluated in 25 animals which are divided into five groups and each group contains five animals and bone marrow cells were collected in

Hank's Balanced Salt Solution and smeared on a slide followed by double staining (Giemsa and Harris hematoxylin). High index of micronucleus frequency was observed in the Groups 2 and 3 in contrast to Group 1 (control) while micronucleus frequency dramatically reduced in 4 and 5 groups. Investigation has shown that the test plant stem extract may have antimutagenic or anticlastogenic property so it is noteworthy in the preventive aspects of chemical carcinogenesis and several types of disorders caused by genetic damages due to arsenic toxicity and *T. cordifolia* may be used as a preventive herbal drug against chemical or arsenic toxicity [14].

10. Neuroprotective activity

The experiment conducted shows that *T. cordifolia* ethanolic extract on 6-hydroxy dopamine-induced Parkinson's disease by protecting dopaminergic neurons and reducing iron accumulation. Aerial parts or ethanolic extracts are used to estimate this activity.

11. Antidiarrheal activity

Whole plant and ethanol or aqueous extracts are used for the estimation of antidiarrheal activity. The in vivo activity of extracts was assessed using castor oil (induces diarrhea by inducing nitric oxide, stimulating prostaglandin synthesis, and increasing peristalsis) and magnesium sulfate (prevents reabsorption of water and promotes cholecystinin release from duodenal mucosa) induced diarrhea by means of evaluating onset of diarrhea, frequency if wet and total stools, weight of wet stool, and total weight of stools [15].

12. Analgesic, anti-inflammatory, and antipyretic activity

Whole plant or ethanol extract is used for analgesic activity. It was assessed by hot plate and abdominal writhing method in albino rats [16]. Stem or aqueous extract is used for antiinflammatory activity. It was exhibited significantly in the carrageenan-induced inflammation test (paw edema model in rats). Chemical constituents responsible for this activity are furanolactone, tinosporin, tinosporide, jateorine, columbin, and clerodane derivatives. Formulation guduchi ghrita is used to estimate antipyretic activity. Experiment was conducted in albino rats against yeast-induced pyrexia.

13. Aphrodisiac activity

Aqueous and hydroalcoholic extracts were used to estimate the activity. This activity was studied on male Wistar albino rats. The study gives the mount frequency, mount latency, intromission frequency, intromission latency, anogenital sniffing, and genital grooming [17]. Chemical constituents responsible for this activity are berberine, palmatine, tembatarine, magnoflorine, tinosporin, and isocolumbin.

14. Antidyslipidemic activity

The part used for estimation is stem extract. Alloxan-induced diabetic male adult rats of Charles Foster strain were used to carry out the experiment. Chemical constituent responsible for this activity is Berberine [18].

15. Gastroprotective activity

Whole plant is used to estimate this activity. Epoxyclerodane diterpene isolated from *T. cordifolia* Miers (Guduchi) on indomethacin has induced gastric ulcer in rats as extracellular domain exerts its antiulcer activity by reinforcement of defensive elements and diminishing the offensive elements. Epoxyclerodane diterpene is the chemical constituent responsible [19].

16. Nootropic Effect

Whole plant or ethanol extract is used to estimate the nootropic effect of *Tinospora*. The nootropic property of nbutanolic fraction (TBF) of the ethanolic extract of *T. cordifolia* stem which contains saponin was evaluated by Amnesic rats using radial arm maze task performance and Barnes maze test. The result showed decreased in AchE concentration which indicates the involvement

17. Cardioprotective activity

Whole plant or alcoholic extract of the herb is used here. The effect of *Tinospora* was dose dependent; as the dose was increased, the extract showed the increased effect as reflected by progressive decrease in plasma calcium and sodium levels and increase in potassium levels at higher doses when compared to that of verapamil. Hence, *cordifolia* is used for the treatment of atrial and ventricular fibrillation, flutter, and ventricular tachyarrhythmias [21]. Chemical

constituents are furanolactone, tinosporin, tinosporide, jateorine, columbin, and clerodane derivatives.

18. Radioprotective and cytoprotective activity

Stems or ethanolic extracts of *Tinospora cordifolia* are used for the experimentation. The stem extract contains cordiofolioside-A which is a primary active constituent (terpenoid) of TBF of *T. cordifolia* against 4 Gy- γ radiation in mice and cyclophosphamide-induced genotoxicity [22]. Root extract of *T. cordifolia* (TCE) used for evaluating the possible radioactive potential against 2.5 Gy gamma radiation in adult Swiss albino mice. Mice were divided into four groups. Each group was administered differently with double distilled water and exposed to 2.5 Gy gamma radiation, and biochemical alterations were noted in the blood of mice at various postirradiation intervals. Results have shown that there is considerable decrease in the level of total proteins, glutathione (GSH), CAT, and superoxide dismutase activity along with significant increase in cholesterol, lipid peroxidation due to irradiation of mice. There is enhanced activity of various antioxidant enzymes and reduction of the radiation-induced variations in total proteins, cholesterol, and LPO levels in the blood serum in TCE before irradiation. The investigation indicated that *T. cordifolia* root extract reduces the bioeffects of gamma radiation in mammals [23].

19. Antifeedant activity

Whole plant or chloroform extract of *Tinospora* is used for the estimation of antifeedant activity. *Tinospora* is a potent source of natural antifeedant and activities against selected important agricultural lepidopteran field pest *Spodoptera litura*, *Helicoverpa armigera*, *Earias vittella*, and *Plutella xylostella*. Least antifeedant activity was shown by hexane extract and significant activity by methanolic extract [24]. Chemical constituents responsible for the activity are tincordin, tinosporide, columbin, and 8-hydroxy columbin.

20. Ameliorative activity

Root or ethanol extract is used for the estimation of activity. *T. cordifolia* was found to show protective effect by lowering down the content of thiobarbituric acid reactive substances and enhancing the reduced GSH, ascorbic acid, protein, and the activities of antioxidant enzymes such as superoxide dismutase, CAT, GSH peroxidase, GST, and glutathione reductase in

kidney. Protection against aflatoxin-induced nephrotoxicity is due to the presence of chemical constituents such as a choline, tinosporin, isocolumbin, palmatine, tetrahydropalmatine, and magnoflorine (alkaloids) in *Tinospora cordifolia* extract [25].

21. Hepatoprotective activity

Whole plant or aqueous extracts are used for the estimation of the activity while experimentation. Ethanolic extract of all the parts of *Tinospora* showed hepatoprotective effect by reduction in serum enzymes alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, and total bilirubin accompanied by pet ether and aqueous extracts. Some of the alkaloids and terpenoids such as magnoflorin, tinosporin, isocolumbin, palmatine, and tetrahydropalmatine present in the herb are responsible for hepatoprotective activity [26].

22. Antipsychotic activity

Aqueous and ethanol extracts are used here. Amphetamine challenged mice model has to be used for experimentation. *Tinospora* is an active central nervous system stimulant and helps in various neurological activities. Berberine, choline, tembetarine, magnoflorine, tinosporin, palmetine, isocolumbin, aporphine alkaloids, jatrorrhizine, and tetrahydropalmatine are the alkaloids responsible for the activity [27]. The other pharmacological activities of *T. cordifolia* include antidepressant (Swiss albino mice were used and activity was evaluated using tail suspension test and forced swim test), antisteoporotic (female Sprague-Dawley rats), antifertility (male rats), antiasthmatic (mice were sensitized with intraperitoneal ovalbumin followed by intranasal ovalbumin in vivo asthma model), diabetic neuropathy (streptozotocininduced Wistar albino diabetic rats and in vitro aldose reductase inhibition assay and in vivo results were analyzed with Mann–Whitney test), and allergic rhinitis (double-blind placebo controlled trial) [1].

23. NATURAL BINDER

Mucilage was extracted from the fresh stems of *T. cordifolia* which was characterized for physicochemical parameters. Using 2%, 4%, 6%, 8%, and 10% concentration of mucilage of *T. cordifolia* as natural binder, diclofenac sodium tablets (f1-f6) were prepared by dry granulation method. The results show that all the pre- and postcompression parameters of the formulated

tableted were in compliance with pharmacopoeial limits and the drug release mechanism from of cholinergic system in nootropic activity of TBF [20].

formulation f1-f6 was found to be polymer disentanglement and erosion. Experimental findings revealed that *T. cordifolia* mucilage can be used as release retardant agent in the formulation of sustained release dosage forms [28]

CONCLUSION –

All types of life can benefit from a plant like *Tinospora cordifolia*, which serves a variety of functions. According to reports, plant extracts contain active substances in the form of alkaloids, glycosides, lactones, and steroids, as was already mentioned. All of these active substances have various immunomodulatory and physiological functions, highlighting the plant's wide range of adaptability. It is firmly believed that comprehensive information, such as that provided in this review, on the phytochemical and diverse biological features of the extracts, may give comprehensive proof for the use of this plant in various medicines. Future research could expand the usage of *Tinospora cordifolia*'s organic and aqueous extract as a source of beneficial phytochemical components for the pharmaceutical sector. The therapeutic value of *Tinospora cordifolia* has been confirmed by the pharmacological and clinical investigations included in the current review. Chemical components found in the plant suggest that it may someday act as a "lead" in the creation of new treatments for illnesses. Numerous positive effects include antioxidant, hepatoprotective, antimicrobial, antihyperglycemic, antipyretic, antihyperlipidemic, cardiovascular-protective, antiinflammatory, osteoprotective, neuroprotective, antianxiety, analgesic, antidiarrheal, and antistress properties.

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