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A Review Article on Phytochemistry and Pharmacological Activity of *Tinospora cordifolia* (Giloy)

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ABSTRACT

Tinospora cordifolia (Giloy) which is the most important as well as very common herb and normally used as a common ingredient in various Ayurvedic, Unani and Siddha system of medicines. This review article has mainly contains the information's on its introduction, chemical constituents of Tinospora and the therapeutic benefits of this plant like Antiulcer, Antidiabetic, Antiinflammatory, Anticancer, Anti AIDS, Antiallergic activities, neuroprotective effect, antidiarrheal activity, analgesic activity, immunomodulatory activity, antioxidant activity, gastro protective activity etc. The pharmaceutical significance of *Tinospora cordifolia* is mainly because of root, stem, leaf which contain phytoactive compounds such as alkaloids, steroids, glycosides, lactones, polysaccharides, etc. Almost the parts of this plant constitute immunomodulatory properties. *Tinospora cordifolia* is one of the most important medicinal plants used in Ayurvedic medicine for the treatment of colds, fever, diabetes, and even rheumatoid arthritis.

1. INTRODUCTION:

Tinospora Cordifolia is a climbing shrub that belongs to the family *Menispermaceae* which is commonly known as Guduchi, Amrita, Gurach, Tinospora. Giloy is a large, glabrous deciduous climbing shrub. The stems of this plant are rather succulent with long filiform fleshy aerial roots from the branches. The bark of it is gray brown in colour and watery. The leaves having membranous and cordate shapes. The flowers are small and greenish yellow. *Tinospora cordifolia* is found throughout tropical Asia ascending to a height of 300 mts. [1]

Fig 1: *Tinospora cordifolia*

Tinospora cordifolia family consists of about 70 genus & 450 species that are found in tropical regions. Which is found throughout India & also in parts of Sri Lanka, Bangladesh and China? The plant of *Tinospora cordifolia* is designated as Rasayana in Ayurveda and is very well known for building up the immune system and body's defense against definite infecting Micro-organisms. [2]

2. GEOGRAPHICAL SOURCE:

This plant comes under the class Magnoliopsida, orders Ranunculales, and belongs to the *Menispermaceae* family. The species is widely distributed in India, extending from the Himalayas down to the southern part of peninsular India. It is also found in neighboring countries like Bangladesh, Pakistan, and Sri Lanka. *Tinospora cordifolia* is also reported in South East Asian countries such as Malaysia, Indonesia, and Thailand, etc.

Habitat: *Tinospora cordifolia* prefers a wide range of soil, acid to alkaline and it needs a moderate level of soil moisture. It is found in tropical India ascending to an altitude of 1000 feet

and in South Asia, Indonesia, Philippines, Thailand, Myanmar, China, and in Sri Lanka worldwide.[3]

The plant occurs throughout tropical regions of India extending from Kumaon to Assam and Myanmar, Bihar, Konkan to Sri Lanka. [1]

3. BOTANICAL DESCRIPTION:

It is a large, glabrous, deciduous, climbing shrub. The structure of the stem is fibrous, the transverse section exhibits a yellow type wood with radially arranged wedge their shape wood's bundles, containing large vessels, separated by narrow medullary rays. The colour of the bark is creamy white following to grey, deeply left spirally and the stem contains rosette like lenticels. The leaves are membranous and cordate in shape. Flowers are in axillary position, 2-9 cm long unisexual, small and yellow in color. Male flowers are clustered and females are usually solitary. The seeds are curved. Fruits are fleshy and single seeded. growth of flowers during the summer and fruits during the winter. [4]

4. MORPHOLOGICAL DESCRIPTION:

TC is a huge deciduous, extensively spreading climbing shrub within several coiling branches. Many parts of TC have the following type of morphology.

4.1 Stem-

The stem of this plant is rather succulent with long, filiform, fleshy, and climbing in nature. Aerial roots arise from the branches. The bark is creamy white followed by grey in colour and deeply left spirally.

4.2 Root-

The Arial roots of TC are present, these aerial roots are characterized by tetra to penta-arch primary structure. The cortex of the root is divided into the outer thick walled and inner parenchymatous zone.

4.3 Leaves-

Leaves of this plant are simple, alternate, ex- Lamina is ovate, 10-20 cm long, 7 nerved, and deeply cordate at the base and membranous.

4.4 Flowers-

Flowers are unisexual, racemes, greenish yellow it appears when the plant is leafless. Male flowers are clustered and female flowers exist in a solitary inflorescence. Sepals are 6 in 2 series of 3 each. Outer ones are smaller than the inner sepals. Petals are also 6, smaller than sepals, free and membranous. Flowering occurs from March to June.

4.5 Fruit-

They are orange-red in colour, fleshy, aggregate, and ovoid, smooth, drupelets on a thick stalk with subterminal style scars. Fruits develop during winter.

4.6 Seed-

The curved seed has been reported in this species. Hence this family is named as a moonseed family. The seeds are curved in shape, the embryo also turned in to curve shape automatically. Moreover, the endocarp is variously ornamented and provides important taxonomic characters. [5]

Fig. 1 *Tinosporacordifolia* plant

Fig 2. *Tinosporacordifolia* stem

Fig. 5 *Tinosporacordifolia* flowers

Fig. 6 *Tinosporacordifolia* fruits

Fig. 3 *Tinosporacordifolia* aerial roots

Fig.4*Tinosporacordifolia* leaves

Fig. 7 *Tinosporacordifolia* seeds

5. VERNACULAR NAMES:

Latin: *Tinospora cordifolia* (Willd.) Hook.f. & Thomson

English: Tinospora Gulancha / Indian Tinospora

Sanskrit: Guduchi, Madhuparni, Amrita, Chinnaruha, Vatsadaani, Tantrika Kundalini, and Chakralakshanika

Hindi: Giloya, Guduchi (Hindi)

Bengali: Gulancha

Telugu: Tippaatigo (Telugu)

Tamil: Shindilakodi

Marathi: Shindilakodi

Gujarati: Galo

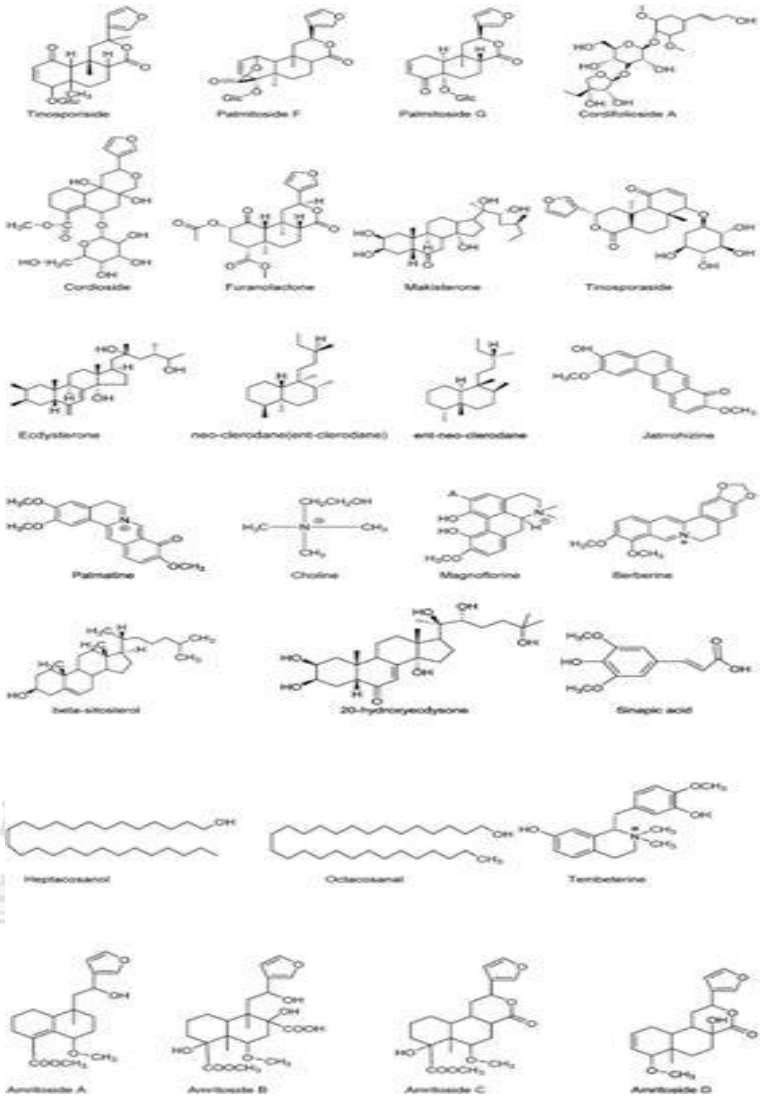
Kannada: Amrutha balli

6. CHEMICAL CONSTITUENTS:

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. The stem contains clerodane furano diterpene glucoside(Amritoside A, B, C, and D) and the structure has been established by different spectroscopic studies. [6]

Some of the essential constituents of *T. cordifolia*.

Active Component	Compounds
Terpenoids	Tinosporide, Furanolactone diterpene, Furanolactone clerodane diterpene, furanoid diterpene, Tinosporaside, ecdysterone makisterone and several glucosides isolated as poly acetate, phenylpropene disaccharides cordifolioside A, B and C, cordifoliside D and E, Tinocordioside, cordioside, palmatosides C and F, Sesquiterpene glucoside tinocordifolioside, Sesquiterpene tinocordifolin.
Alkaloids	Tinosporine, (S), Magnoflorine, (S), Berberine, (S), Choline, (S), Jatrorrhizine, (S), 1,2-Substituted pyrrolidine(S), Alkaloids, viz. jatrorrhizine, palmatine, beberine, tembeterine, choline.
Lignans	3 (a, 4-dihydroxy-3-methoxybenzyl)-4-(4-hydroxy-3-methoxybenzyl), (S)
Steroids	Giloinsterol, (S), ß-Sitosterol, (S), 20a-Hydroxy ecdysone, (S).
Others	Giloin, Tinosporan acetate, Tinosporal acetate, Tinosporidine, Heptacosanol, Octacosanol, sinapic acid, Tinosponone, two phytoecdysones· an immunologically active arabinogalactan.



This plant mainly contains alkaloids, glycosides, steroids, sesquiterpenoid, aliphatic compound, essential oils, a mixture of fatty acids, and polysaccharides. Alkaloids which include berberine, bitter gilonin, non-glycoside gilonin gilosterol. Major phytoconstituent in *Tinospora cordifolia* includes tinosporine, tinosporide, tinosporaside, cordifolide, cordifol, heptacosanol, clerodane furano diterpene, diterpenoid furanolactone tinosporidine, columbin, and Beta-sitosterol, Palmatine, Tembertarine, Magniflorine, Choline, and Tinosporin which are obtained from its stem. [1]

No	Type of chemicals	Active chemical constituent	Plant part
1	Alkaloids	Berberine , PalmatineTembetarine, Magnoflorine ,Choline, Tinosporin, Isocolumbin, Palmatine, Tetrahydropalmatine , Magnoflorine	Stem and root
2	Glycosides	18-norclerodane glucoside Furanoidditerpeneglucoside Tinocordiside ,Tinocordifolioside , Cordioside, Cordifolioside A, CordifoliosideB,Syringin , Syringin-apiosylglycoside, Palmatosides C, Palmatosides F, Cordifoliside A, Cordiofoliside B, Cordifoliside C, Cordifoliside D, Cordifoliside E	Stem
3	Diterpenoid lactones	Furanolactone , Lactones Clerodane derivatives , diepoxy-cleroda-13 (16), 14-dieno-17,12S: 18,1S-dilactone]and Tinosporon, Tinosporidesand Jateorine , Columbin	Whole plant
4	Steroids	β -sitosterol , δ-sitosterol, 20β- hydroxyecdysone, Ecdysterone , Makisterone A ,Giloinsterol	Aerial parts and stem
5	Sesquiterpenoid	Tinocordifolin	Stem
6	Aliphatic compouds	Octacosanol , Heptacosanol compound Nonacosan-15-one	Whole plant
7	Micelleneous compounds	3,(α,4-di hydroxy-3-methoxy-benzyl)-4-(4- Compounds hydroxy-3-methoxy-benzyl)-tetrahydrofuran. Jatrorrhizine, Tinosporidine, Cordifol,Cordifelone,N-trans-feruloyltyramine as diacetate,Giloin, Giloinin, Tinosporic acid	Whole plant and root

7. TAXONOMY:

Kingdom: Plantae

Subkingdom: Tracheophyta – Vascular Plants

Super-division: Spermatophyta – Seed bearing plants

Division: Magnoliophyta – Flowering

Class: Magnoliopsida – Dicotyledons

Subclass: Polypetalae – Petals are free.

Series: Thalamiflorae – Many stamens and flower hypogynous

Order: Ranales

Family: *Menispermaceae* – The Moonseed family

Tribe: Tinosporeae

Genus: *Tinospora*

Species: C*ordifolia*

8. MEDICINAL PROPERTIES:

In the ayurvedic medicine system, Giloy has a very good impact on the reproductive system, blood, and fat. It also has been used to treat a variety of diseases, from gout to jaundice and tuberculosis, only a few of these uses are currently supported by scientific evidence. [1]

8.1 As an immunomodulator-

Methanol, chloroform, n- butanol extracts of T. crispa were demonstrated, which possess the property of enhancing activity on the immune system, *T. cordifolia* used as medicine for other immunological disorders such as autoimmune disease or cancers T. crispa extract induces cytokines which are likely to be involved in anti-inflammatory activity It didn't suggest the T.crispa could inhibit other arms of the immune responses because, *T. cordifolia*, a closely-likely plant compounds are shown to enhance both immunities. Their compounds reveal a potent effect on the immune system.[7]

The activity of a crude drug formulation was evaluated in an experimental amoebic liver abscess in golden hamsters and in immunomodulation studies. The extract formulation includes the following 5 plants.

Boerhavia diffusa,

Tinospora cordifolia

Berberis aristata

Terminalia chebula

Zingiber officinale

The drugs having a maximum cure rate of 73% at a dose of 800 m/kg/day in hepatic amoebiasis which reducing the average degree of infection (ADI) to 1.3 as compared to 4.2 for sham-treated controls. Immunomodulation studies show humoral immunity which was enhanced as evidenced. The T-cell counts do not affected in the animals treated with the formulation of the drug but the cell-mediated immune response was stimulated and observed in the leukocyte migration inhibition (LMI) tests. [1]

Tinospora cordifolia inhibits the in-vitro immune hemolysis of antibody coated sheep erythrocytes by guinea pig serum. Immune hemolysis was less due to inhibition of the C3-convertase of the classical complement pathway. The compounds of *Tinospora cordifolia* rise to significant which increasing antibodies in guinea pig serum. Cordioside (*Tinospora cordifolia*-2), cordiofolioside A (*Tinospora cordifolia*-5), and cordiol (*Tinospora cordifolia*-7) were activated macro phase with increasing the incubation times. It is isolated and characterized in a different class of active compounds and reported their immunomodulatory activity. [2]

8.2 Hepatic Protective Activity-

The protective effects of *Tinospora cordifolia* water extract (TCE) on the liver and GIT toxicity were reported at a significant increase in the levels of gamma-glutamyl transferase (GGT), aspartate transaminase(AT), alanine transaminase(AT), Triglyceride, Cholesterol, High Density Lipoprotein and LDL ($P < 0.05$) in an alcoholic sample whereas the level gets less regulated after TCE intervention, patients shows the normal liver function of *Tinospora cordifolia* stand to relieve symptoms.[8]

T. cordifolia is known as Guduchi, It is one of the most valuable medicinal herbs of the Ayurveda system. The term 'Amrita' is used to this herb in recognition of its ability to impart youthfulness, vitality, and longevity to its patron. In the modern medicine system, well known for its property of hepatoprotective, adaptogenic, immunomodulatory activities, and anti-fibrolytic activity. The active principle of Tinosporin corrects the immunosuppression which is associated with deranged hepatic function. Kupffer cells are the major determinants of the outcome of liver injury. The effect of *Tinospora cordifolia*. was evaluated on Kupffer cell of the liver, using the carbon clearance test as a parameter. Antihepatotoxic activity of *T.cordifolia* drug was studied in the albino rats intoxicated with Carbon tetrachloride. Liver function was

assessed on morphological, biochemical (SGPT, SGOT, Serum alkaline phosphatase, Serum bilirubin), and functional tests. A study conducted in 1994 on *T. cordifolia* shows that it had decreased fibrosis in rats, induced by CCl4 and significantly improved the suppression of Kupffer cell function in another rat model of chronic liver damage which is induced by heterologous serum. It causes the possibility of an anti-fibrotic effect of *Tinospora cordifolia* is mediated through the activation of kupffer cells. [9]

8.3 The neuroprotective effect-

The neuroprotective role of T.C. is to prevent certain age-related neurological disorders like and Alzheimer's disease. As our study observed the neuroprotective role of *Tinospora cordifolia* (TC) in the case of Parkinson's Disease. Neuroinflammation is the major cause found in PD progression. *Tinospora cordifolia*, commonly referred from the family *Menispermaceae* is a creeping herb which found in India and neighbouring tropical areas. It has been traditionally used in Ayurvedic medicinal system to treat conditions such as fever, inflammation, pain, asthma, epilepsy, and memory decline. The various properties of T.C. involved in the Neuroprotection, like as the binding and detoxification of metal ions, free radical scavenging, and increasing the antioxidant activity. [10]

8.4 Against AIDS Activity –

Tinospora cordifolia may also be beneficial for people with HIV and autoimmune disorders. Giloy's traditional use as an immune stimulant led researchers to study *T.cordifolia* effects on patients with HIV. According to a study b"Indian Journalof Pharmacology," 60% of HIV patients who received *Tinospora cordifolia* treatment reported a decrease in disease related symptoms, as opposed to only 20% who received placebo treatment. The study suggests that *Tinospora cordifolia* may improve the immune system of patients with HIV and immune disorders, while alleviating the normal side effects of these problems. [1]

8.5 Wound Healing Activity-

The methanolic extract possesses significant wound healing promoting the activity of *T. cordifolia*. The study suggested that the methanolic extract of *T. cordifolia* possesses better wound healing potency, it was evident by the increased percentage of wound contraction; less in

the period of the epithelialization, increase in collagen deposition, and which is an increase in tensile strength in granulation cells.

8.6 Stress and Depression Activity –

T. cordifolia is claimed to be useful in the maintaining healthy brain function and it is also in stress management The root of Gulvel is traditionally used for its anti-stress activity. Its anti-stress activity system was confirmed by its effects on brain neurotransmitters in stressed rats. The supportive evidence is in terms of normalization of stress induced biochemical changes into norepinephrine, dopamine, and 5-hydroxytryptamine in experimental at rat models and improved levels of 5-hydroxyindoleacetic acid (5-HIAA) in mice with ethanolic roots extracts *Tinospora cordifolia* is one of the components of polyherbal formulation. The extracts of the drug have been shown to antidepressant effects on learned helplessness into mice and rat models of depression. [11]

8.7 Radio Protective Activity-

For the radioprotection, various mechanisms like as free radical scavenging, calcium channel blocking, inhibition of lipid peroxidation, enhancement of the DNA repair, and like of stem cell proliferation are considered important. *Tinospora cordifolia* has several of the above-mentioned properties under different experimental problems. Therefore it became necessary to investigate its wholesome radioprotective efficacy in experimental animals in terms of full body survival, Genotoxicity, cell proliferation, hematological parameters.[12]

8.8 Antifeedant Activity-

Full plant or chloroform extract of TC is used for the estimation of antifeedant activity. TC is a potent source of natural antifeedant and its activities against selected important agricultural lepidopteran field pest *Spodoptera litura, Helicoverpa armigera, Earias vittella*, and *Plutella xylostella.* At least antifeedant activity is shown by hexane extract significant activity by the methanolic extract. CC responsible for the activity is tinocordin, tinosporide, columbin, and 8-hydroxy columbin.[13]

8.9 Antioxidant Activity-

TC's stem increases erythrocytes membrane lipid peroxide and catalase activity and decreases the activity in alloxan-induced rats. Ethanol stem extract has 56 percentage free radical scavenging activity. The stem of TC has the maximum phenol content which is responsible for max 1,1-diphenyl-2-picrylhydrazyl radical scavenging activity. Alpha-glucosidase inhibitor present into the leaf extract of *Tinospora cordifolia* also has both radical scavenging and antioxidant activity. Full plant or ethanol extract is used to estimate this activity. CC accountable for its activity is epicatechin, tinosporin, iso-columbin, and palmatine. [13]

TC has been observed that *Tinospora cordifolia* exhibited excellent antioxidant activity system in methanol, ethanol, and H2O extracts. It is observed maximum antioxidant activities of extracts indicate the potential of the stem as a source of the natural antioxidants or nutraceuticals to reduce oxidative stress which with consequent health benefits. [1]

8.10 Against Dengue Activity -

Capsule developed from *Tinospora cordifolia* is useful in the treatment of Dengue. It is very much useful in the ayurvedic medicinal system. [1]

8.11 Antitumor Activity-

Detail chemical components of *Tinospora cordifolia*, clerodane diterpenes, shows possible cytotoxic activity against tumor cells. Nowadays, antitumor effects of the TC species accept continue extensively research in vivo and in vitro. Mechanisms of the antitumor activity of TC species continue primarily repaired on the cytotoxicity and cell apoptosis induced. Epoxy clerodane diterpenes continued calculated because the activity against diethylnitrosamine-induces hepatocyte carcinoma; the results achieved that kick in blocking carcinogen metabolic activation enhancing carcinogen detoxification. According to the latest research, alkaloids, chemical constituents from plants have the essence of exceptional antitumor activity, high effect better tolerance, and slight side effects. Present research displayed the fungal taxol had strong activity against human cancer cell lines Moreover, single or synergistic formulations of *T. cordifolia* with *Zingiber officinale* accept continue worn in ancient India medicinal to treat rheumatoid arthritis. *Tinospora cordifola* has continued considered to exert other

pharmacological activities. Cordifolio side A mainly isolated in *T. Cordifolia*. It has a potential in vivo radioprotective effect and in vitro Cytoprotective activity. Impressive radioprotective efficacy may be related to the attenuation of radiation induced decrease of adherence and spreading, be max of IL-and GM-CSF1 levels, reduction of apoptosis.[14]

8.12 Antifertility Activity-

The development of the latest fertility regulating drug from medicinal plants is an attractive proposition.

T. cordifolia (family: *Menispermaceae*) is the traditional plant normally known as "Neem-giloy". The roots of T. cord!folia are used for alloxan diabetes 1 Pharmacological screening of crude drug methanolic extract of *T. corclifolia* stem showed immune-modulatory, anti-potentiating activities.

Few species have also been used for the treatment of type-2 diabetes the nowadays study was undertaken to evaluate the anti-fertility effects of *T. cordifolia* stem extract.[15]

8.13 Antimalarial Activity-

The plant extracts of TC have pharmacological activities such as hypoglycaemic activity, which acts as a CNS depressant and also show muscular relaxant properties. The medicinal properties effect is exactly confined to the root. TC is used in malaria, cough, leprosy, and their decoction which is consumed orally for stomachache caused by indigestion, dysentery, enlarged spleen, skin disease, and also like a diuretic. T.cordifolia normally known as ‘Giloy’ in Hindi it is a glabrous climber, a succulent shrub with corky grey dotted bar leaves, broadly ovate, deeply cordate, and shortly acuminate. Their Flowers are small in size and greenish yellow on the old wood in 7.5–15 cm long, slender, usually solitary in female, and clustered in male. The fruit is the size of a pea and red in colour. Starch obtained from roots is used in chronic diarrhoea and dysentery. The paste of TC was mixed with olive oil is applied to cure pimple. Root’s Powder is used to cure breathing problems, piles, ulcer, cough, chronic fever, leprosy, blood pressure, snake bite, headache, hiccups, skin disease, whooping cough, splenomegaly, general debility, dyspepsia, dysentery, fever, urinary diseases, diarrhoea, diabetes, visceral obstruction and as tonic and emetic. The roots of C.pareira L. and the stem of *T. cordifolia* Hook.f. & Thoms were

washed thoroughly with distilled water, air-dried, and weighed. After cutting into small pieces these were homogeneous in ethanol. The matter was filtered and centrifuged at 2000 rpm for 10 min (Sigma 3k-30). The supernatant was air-dried, the residual concentrated solid material was used as plant extract. The extract was weighed and stored at 4°C until further use. [16]

Sr. No	Activity	Part/Extract
1.	Neuroprotective effect	Aerial parts/Ethanol extract
2.	Antiulcer activity	Whole plant/ Ethanol & aqueous extracts
3.	Antidiarrhoel activity	Whole plant/Ethanol & aqueous extract
4.	Analgesic activity	Whole plant/Ethanol extract
5.	Aphrodisiac property	Aqueous & hydroalcoholic extract
6.	Immunomodulatory activity	Whole plant/Aqueous extract
7.	Antidyslipidemic activity	Stem Extract
8.	Antioxidant activity	Whole plant/Ethanol extract
9.	Anti-inflammatory activity	Stem/Aqueous extract
10.	Gastroprotective activity	Whole plant
11.	Nootropic effect	Whole plant/Ethanol extract
12.	Radioprotective & cytoprotective activity	Stem/Ethanol extract
13.	Antifeedant activity	Whole plant/ Chloroform extract
14.	Ameliorative effect	Root/Ethanol extract
15.	Cardioprotective effect	Whole plant/ Alcohol extract
16.	Hepatoprotective activity	Whole plant/ Aq. extract
17.	Hypoglycemic activity	Stem/ Aq. extract
18.	Antipsychotic activity	
19.	Antidepressant activity	
20.	Antiosteoporotic activity	
21.	Antineoplastic activity	
22.	Antifertility effect	
23.	Antiasthamatic activity	
24.	Antitumor activity	
25.	Diabetic neuropathy	
26.	Hepatocellular carcinoma	
27.	Antimalarial activity	
28.	Antibacterial activity	
29.	Anticancer activity	
30.	Antipyretic activity	
31.	Allergic rhinitis	

Pharmacological activities reported from *Tinospora cordifolia*

Sr. N	Activity	Chemical constituent	Class
1.	Neuroprotective effect	Berberine, choline, Tembetarine, Tinosporin, Palmitine, Jatrorrhizine	Alkaloids
2.	Aphrodisiac property	Berberine, Palmatine, Tembatarine, Magnoflorine, Tinosporin, Isocolumbin	Alkaloids
3.	Immunomodulatory activity	Cordifolioside A, Tinocordiside, Syrigin	Glycosides
4.	Antidyslipidemic activity	Berberine	Alkaloids
5.	Antioxidant activity	(-)Epicatechin, Tinosporin, Isocolumbin, Palmatine,	Alkaloid, Diterpenoid lactone
6.	Anti-inflammatory activity	Furanolactone, Tinosporin, Tinosporide, Jateorine, Columbin, Clerodane derivatives	Diterpenoid lactones
7.	Gastroprotective activity	Epoxyclerodane diterpene	Terpenoids
8.	Radioprotective & cytoprotective activity	Cordifolioside A	Terpenoid
9.	Antifeedant activity	Tincordin, Tinosporide, Columbin, 8-hydroxy columbin	Terpenoid, Diterpenoid lactone
10.	Ameliorative effect	Tinosporin, Isocolumbin, Palmatine, Magnoflorin, Tetrahydropalmatine	Alkaloids, Terpenoids
11.	Cardioprotective effect	Furanolactone, Tinosporin, Tinosporide, Jateorine, Columbin, Clerodane derivatives	Alkaloids, Terpenoids
12.	Hepatoprotective activity	Magnoflorin, Tinosporin, Isocolumbin, Palmatine, Tetrahydropalmatine	Alkaloids, Terpenoids
13.	Antipsychotic activity	Berberine, Choline,Tembetarine, Magnoflorine, Tinosporin, Palmetine, Isocolumbin, Aporphine alkaloids, Jatrorrhizine, Tetrahydropalmatine	Alkaloids
14.	Antidepressant activity	Tinosporin, berberine, Jatrorrhizine	Alkaloids
15.	Anticancer activity	Magnoflorine, palmatine, Tinocordiside, Cordifolioside A	Alkaloids, Terpenoids
16.	Antiarthritic activity	B- sitosterol, Makisterone A, Giloinsterol	Steroids
17.	Antidiabetic activity	Berberine, choline, Tembetarine, Palamtine, Jatrorrhizine	Alkaloids
18.	Antimicrobial activity	Furanolactone, Tinosporon, Jateorine, Columbin	Diterpenoid lactones

Chemical constituents responsible for Bioactivity

8.14 Antidiabetic and Hyperglycemic Activity-

This drug is widely used for the treatment of the diabetes mellitus. The aqueous *Tinospora cordifolia* root extract to diabetic rats caused a significant reduction in the blood glucose and brain lipids. The extract of this drug caused growth in body weight, total haemoglobin, and hepatic hexokinase. The root extract of this drug also lowers hepatic glucose -6-phosphatase and serum acid phosphatase, and also alkaline phosphatase and lactate dehydrogenase in the diabetic rats therefore it has a hypoglycaemic and hypolipidaemic effect. The extract of this drug also prevented and decrease in body weight. The alcoholic, aqueous, and chloroform extracts of the leaves of *Tinospora cordifolia* in doses of 50, 100, and 200 mg/kg to the body weight to normal and alloxan-diabetic induced rabbits..An Ayurvedic formulation Transina (TR) contains *Tinospora cordifolia* and the other drugs were studied for the hyperglycaemia and superoxide dismutase activity of pancreatic islet cells.[20]

The extract of *T. cordifolia* stem ameliorates the derangements in lipid metabolism caused by diabetes mellitus in streptozotocin induced diabetic rats. [13] The oral administration 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. [14] The polyherbal formulation, Dihar containing eight different herbs viz., *Syzygium cumini, Momordica charantia, Emblica officinalis, Gymnema sylvestre, Enicostemma littorale, Azadirachta indica, T. cordifolia, and Curcuma longa* significantly reduces the level of lipid peroxidation and increases the activity of antioxidant enzymes in streptozotocin induced diabetic rats. [12] The ethyl acetate, dichloromethane, chloroform, and hexane extracts of *T. cordifolia* stem were evaluated for alpha-glucosidase inhibition activity and resulted that the dichloromethane extract was the most effective i.e. 100% inhibition of the alpha glycosidase than others. [15] The ethanol extract of *T. cordifolia* demonstrates an androgenic activity. Saponarin isolated from leaf extract of *T. cordifolia* showed hypoglycemic activity at doses of 20-80 mg/kg. The hydroalcoholic and chloroform extracts of *T. cordifolia* stem demonstrates significant antidiabetic property at 250 and 500 mg/kg dose-dependently in alloxan induced diabetic rats.[1]

8.15 Anticancer Activity-

TC indicates anti-cancer activity, this activity was mostly shown in animal models. The root extract of TC has been indicated the radioprotective role due to an extensive increase in body weight, tissue weight, tubular diameter. Dichloromethane extracts of T.C indicate cytotoxic effects owing to lipid peroxidation and release of LDH and decline in GST. In pre-irradiating mice, root extract has widely affected radiation, induced a rise in lipid peroxidation, and resulted in the decline of GSH in testes.[21]

The active principles from TC extend the host immune system with increasing immunoglobulin and blood leukocyte levels and by the stimulation of stem cell proliferation. TC can minimize solid tumour volume by 58.8%, which is comparable to cyclophosphamide, a known chemotherapeutic agent. These immunostimulating properties can be used in the prevention of tumour mediated immunosuppression and hence could be a drug choice for various cancers.[1]

8.16 Cardiovascular Activity-

The dose-dependent negative ionotropic and chronotropic effects with both aqueous & ethanolic extracts of *T. cordifolia*.[22]

The result of the present study indicated that the prior administration of methanolic extract of *Tinospora cordifolia* attenuates isoprenaline-induced MI. The cardioprotective activity of

Tinospora cordifolia probably related to its ability to strengthen the myocardial membrane by its membrane stabilizing activity.[23]

Potassium supplementation can reduce cardiac arrhythmias and also prevent the occurrence of the same thus supporting the cardiac functioning. Ayurveda mentions the utility of Guduchi in Hridaya Daurbalya- as it enhances cardiac wellness.[24]

8.17 Nootropic Activity-

Tinospora cordifolia is named as a Medhya Rasayana and used for bhrama in Ayurveda. Their memory enhancing Activity has been claimed in different traditional systems of medicine. Ayurveda includes 3 aspects of mental ability concerning learning and memory, being dhi (learning), dhuti (retention), and smriti (recall). It is found in a place in traditional herbal medicine as a neuropsychopharmacological agent for enhancing memory and improving learning.

The pure aqueous root extract of Gulvel showed enhanced verbal learning in a 21-day randomized double-blind placebo-controlled study (Bairy 2004). A significant response to gulvel was reported in children with a moderate degree of behavioral disorders and mental, with improvement in intelligence quotient levels.[25]

Giloy is a cognitive enhancer and potent immunomodulator for the treatment of neurodegenerative diseases. This has been proved through research in which rat's memory was corrected by aqueous and alcoholic extract supplementation after giving cyclosporine which is an immunosuppressant drug.[26]

8.18 Anti-inflammatory Activity-

A study was conducted by Siddalingappa C M *et al.* It has been observed that *Tinospora cordifolia* showed a significant 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. [1]

The decoction of *T. cordifolia* showed anti-inflammatory activity on carrageenan-induced hind paw oedema in rats 62. The effect of extract of stem of *T. cordifolia* was studied on the contractile response due to various agonists (such as histamine, 5-HT, bradykinin, prostaglandins E1 and F2α, cholinomimetics, and KCl) on smooth muscles of rat in the dose of 100 to 600 µg/mg. The procedure of antagonistic action of TC has been discussed in light of the involvement of various autocoids in the pathophysiology of clinical joint inflammation. The mechanism of potentiating effects of TC on N/A induced responses was suggested to be due to an uptake blocking effect of TC or to an inhibition of metabolism by COMT since MAO inhibition would also produce potentiation of 5-HT responses.[6]

8.19 Antipyretic Activity-

Fever, inflammation, and pain are traditionally treated with *T. cordifolia* preparations these preparations can reduce carrageenan-induced edema, indicating their anti-inflammatory potential. Anti-inflammatory effects of *T. cordifolia* were also detected in autoimmune arthritis mediated by decreased synthesis of proinflammatory cytokines, tumor necrosis factor-a. Some data also suggest that *T. cordifolia* can mediate the peripheral and central nervous system mechanisms and exert analgesic effects. Also, *T. cordifolia* has antipyretic effects against fever. The anticancer drug cyclophosphamide has been concluded to downregulate the cytokines IL-2 and interferon-g and to upregulate the proinflammatory cytokine TNF-a; such effects could be successfully reversed via treatment with *T. cordifolia*. [27]

8.20 Allergic Rhinitis Activity-

In vitro studies examining the mixture demonstrated antihistaminic and anti-inflammatory properties and were found to be equivalent to cetirizine. *Tinospora cordifolia* extracts a study conducted. It indicated that it's significantly decreased all symptoms of allergic rhinitis. Nasal smear cytology and leukocyte count correlated by clinical findings. TC was well tolerated.[28]

Treatment of patients with extract of Giloy decreases eosinophil and neutrophil count while goblet cells are absent. This herb can also be used for other forms of hypersensitivity.[26]

9. SOME OTHER PROPERTIES:

- The root and stem of TC as an antidote to snake bite and scorpion sting.
- The stem of TC is bitter in taste, stomachic, diuretic, stimulates bile secretions, allays thirst, enriches the blood, and cures jaundice.
- The juice of plant stem is useful in diabetes, dyspepsia, vaginal and urethral discharge.
- The bark of this plant acts as Anti-allergic, Anti-spasmodic, Anti-pyretic, Anti-leprotic.
- The powder of root and stem is used along with milk for the treatment of cancer.
- The full plant of T.C used in scabies in swine, diarrhoea, Urinary diseases, syphilis, skin diseases, bronchitis, to promote longevity, increase the body's resistance, and Stimulate the immune system.
- The dried fruit powder mixed with ghee or honey is used as a tonic and also in the treatment of jaundice and rheumatism.
- The dry stem crude extract of this plant which was polysaccharide in nature shows a polyclonal B-cell mitogen activity and Active components of stem extract enhanced the humoral response in mice.
- Giloy (*Tinospora cordifolia*) juice which is a mixture of Giloy herb and Tulasi leaves is used against monkey malaria.
- The stem aqueous extract of *Tinospora cordifolia* shows an anti-inflammatory effect in both acute and sub-acute models of inflammation.
- TC shows anti-allergic Rhinitis activity. Allergic rhinitis is the atopy disease that implies hypersensitivity response exposure to pollens of grass, weeds, trees, dust, etc.
- The *T. cordifolia* stem aqueous extract shows radioprotective activity.
- It is used in the treatment of jaundice because it reduces body heat.

- The stem of this plant regulates the blood sugar level due to the presence of alkaloids. [4]

CONCLUSION

The scientific research on the plant of TC suggests a huge biological potential of this plant. It is strongly believed that detailed information as presented in this article review on the phytochemical properties, various biological properties of the extracts of plant TC might provide detailed proof about the use of this plant in many medicines. The variations in phytochemical properties and efficacy of the medicinal values of TC is dependent on geographical locations and seasons At the same time, the organic and aqueous extract of TC might be further exploited in the future as a source of useful phytochemical properties and compounds for the pharmaceutical industry.

It is such a miraculous herb having the choice to be used in every ailment.

The therapeutical actions attributed to TC in Ayurvedic texts have evidence suggesting that this drug has immense potential in modern pharmaco-therapeutics.

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