

Guduchi: A Potential Drug in Ayurveda

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ABSTRACT: To receive on *Tinospora cordifolia* as a multipurpose Herb in ayurveda. This review article describes the prominence of a medicinal plant *Tinospora cordifolia* in therapeutics such as use of crude extract of plant for the amelioration of various diseases, morphology, growth constriction, biochemical composition, biological activities, research work done, projects sanctioned to this plant species and the further prospects of this important neglected plant species for research in the field of plant tissue culture, natural products and nano-biotechnology.

KEYWORDS: Guduchi, *Tinospora cordifolia*, Immunomodulator, Antimicrobial activity, Antibacterial activity, Antioxidant activity, Therapeutic uses

I. INTRODUCTION:

The World Health Organisation (WHO) reported that more than 80% of the world population trust on traditional medicine particularly on plant drug for their primary health care needs. In India local empirical knowledge about medicinal properties of plants is the basis for their uses as a home remedies. Plants have been the base of many traditional medicines throughout the world for thousands of year and especially in India the science of Ayurveda has been continued to provide new remedies through these plant products to mankind. A research paper entitled "A Neanderthal flower burial in northern Iraq" published in the renowned journal named 'Science' in the year 1975 revealed that fossil studies have confirmed the use of plants 'a means of therapy' in the Middle Paleolithic age some 60,000 years ago^[1]. This plant, *Tinospora cordifolia* commonly known as Guduchi and Dravyaguna Vijnan, 1999) or Amrita is a very much important herb in Ayurvedic system of medicine belonging to Family Menispermaceae. The different medicinal preparations of guduchi are used in various somatic, psychosomatic and lifestyle disorder of human being since times

immemo Systemic and proper use of Guduchi can cure various life threatening disorder like diabetes, arthritis, fever, malignancy etc. Guduchi has a definite role as a hepatoprotective and as an immune booster. Few Selective herbs are mentioned in ayurveda having pharmacological action on Tridosha Guduchi is one of them^[2].



Figure 1: Leaf of *Tinospora cordifolia*

National and International name of *Tinospora Cordifolia*^[2]

National Name International Name

Hindi : Gulancha

Bengali : Gilo

Gujrati : Gulvel

Kannar : Amrutaballi

Malyalam : Amritu

Marathi : Gulvel

Punjabi : Gilo

Tamil : Amrutavalli

Telegu : Amruta

Assamese : Amarlata

Kashmiri : Gilo

Oriya : Gulancha

Urdu: Gilo.

Arab : Gilo
Burma : Singomone
Nepal : Garjo
Persian : Gulbel
Sikkim : Gurjo
French : Gulancha
Deccan : Gulbel
China : K'uan Chu Hsing
Cantonese: Fun Khu hang

CULTIVATION

The plant is propagated by cuttings. It is perfectly suited to and grows well in almost any type of soil as well as under varying climatic conditions.

COLLECTION

The root and stem are collected in hot season when the bitter principle is most abundant and concentrated. For its Satwa (starch) preparation fresh stem should be collected at the flowering time when there is no leaves in the stem to get both qualitative and quantitative starch.

PHARMACOGNOSY^[1]

1. Namjoshi A.N. et al (1955) have investigated the microphotographic reproduction of starches and have made comparative examination of Guduchi Satwa (starch) with commercial starches.
2. Mehra P.N et al (1969) have revealed that the market sample of Guduchi Satwa contains starches from other sources rather than *Tinospora cordifolia*. The yield of Satwa was 0.4% with respect to fresh stem and 1.2% with respect of dry stem.
3. Bonde S.D. et al (1989) have studied wood anatomy of *Tinospora sinensi*. (Lour) Merrill in relation with *T.cordifolia* Miers and added that *T.sinensis* is often mixed as adulterants or substitute for *T.cordifolia*.
4. Subbiah V.R. et al (1990) have reported that the aerial roots of *T.cordifolia* shows both gravitropic and phototropic response along with vascular difference and functions.

PHARMACOLOGY

Pharmacological study of *Tinospora cordifolia* as an immunomodulator^[3]

Immunomodulators are natural or synthetic agents, which by modifying the immune system affect a therapeutic benefit. They may have ability to augment (immune stimulant and /or immune enhancer), restore (immune restorative), inhibit (immune suppressant) or help to produce (adjuvant) the desired immune response. The

present work described that *Tinospora cordifolia* alcoholic extract shows immunomodulator activity. The various parameters determined were Delayed Type Hypersensitivity (DTH), effect on the bone marrow cellularity and α -esterase cells and zinc sulphate turbidity test. Orally administration of *T. cordifolia* alcoholic extract (100 mg/kg, p. o) was found to increase in the there was distinct increase in foot pad thickness after treatment with *T. cordifolia* alcoholic extracts which indicates immunomodulatory effects of *T. cordifolia* as compared to vehicle and cyclophosphamide treated groups. Also significant increase in the WBC counts and bone marrow cells significantly indicating stimulatory effect on haemopoietic system. In zinc sulphate turbidity test *T. cordifolia* treated rats serum showed the more turbidity (cloudy) which indicate the increase in the immunoglobulin level as compared to vehicle, SRBC sensitized and cyclophosphamide treated group. Finally it can be concluded that *Tinospora cordifolia* (stem) mango plant climber shows potent immunomodulatory action.

Immunomodulatory Potential of the Aqueous Extract of *Tinospora Cordifolia*^[4]

Immunomodulation relates to potentiation or suppression of the immune responses of the host, depending on the requirement of the situation. *Tinospora cordifolia* (T.C.), an indispensable medicinal plant, has been used for the treatment of various diseases and has been recommended for improving the immune system. In the current study, they have evaluated the cytotoxicity and immunomodulatory activity of the aqueous extract of T.C. using in vitro and ex vivo models.

The results of this study confirm the earlier claims that *Tinospora cordifolia* has immunomodulatory potential and further demonstrates that this activity is mainly due to the aqueous extract of TC, a glycoprotein isolated from the stem of *Tinospora cordifolia*. This aqueous extract primarily acts on the macrophages and stimulates the production of effector molecules like nitric oxide and cytokine mediators and also augments the antigen specific recall response indicating its ability to enhance antigen presenting ability of macrophages.

Immunomodulatory effects on macrophage activation^[5]

Macrophages are the first line of defense and constitute important participants in the bi-directional interaction between innate and specific

immunity. Macrophages are in a quiescent form and are activated when given a stimulus. In the present study, there have used *Tinospora cordifolia*, commonly known as Guduchi, to see its effect on macrophage activation. The direct drug treatment to J774A cells showed activation as assessed by biochemical assays. Enhanced secretion of lysozyme by macrophage cell line J774A on treatment with *Tinospora cordifolia* and lipopolysaccharide was observed, suggesting activated state of macrophages. Enhanced lysozyme production was reported at different time intervals (24 hrs and 48 hrs). This led us to check the effect of the drug on the functional activity of macrophage with respect to microbicidal properties by disk diffusion antibiotic sensitivity test. The enhanced inhibitory effects of *T. cordifolia* (direct effect) and *T. cordifolia* treated cell supernatant (indirect effect) on the bacteria (*E. coli*) indicates the susceptibility of bacteria. This study is an attempt to check the potential significance of the *T. cordifolia* to be used as immunomodulator for activation of macrophages.

The results of present study show experimental basis of immunomodulation by biological response modifier (BRM). This study addresses a very pertinent question of bio-medical sciences dealing with the scientific basis, particularly immunomodulatory effects, of the herbal medicine preparations on the macrophage activation, as macrophages are known to represent the first line of defense against invading microorganisms or in a state of altered self.

***Tinospora cordifolia* Enhances immunity in Children^[6]**

The immune system in children is constantly developing and they are at an increased risk of infections. It is vital to help enhance immunity by vaccination but more people are turning towards traditional medicines today. The vast flora of the world offers newer options to this effect and is worth exploring. *Tinospora cordifolia* (Guduchi) is one such plant which has been traditionally used for various health conditions and is also proven to be an immunomodulator.

The study confirms the earlier claims of immunostimulatory properties of *Tinospora cordifolia* and offers a newer horizon to explore for boosting immunity in health or in immunodeficiency states. It can be concluded that *Tinospora cordifolia* can be used as an adjuvant to vaccination in order to boost the immune system in children.

Immune-Stimulatory and Therapeutic Activity of *Tinospora cordifolia*^[7]

The present study was aimed at determining the activity of aqueous and methanolic extracts of *Tinospora cordifolia* (AETC and METC) against *Salmonella typhimurium*. In vitro anti-*Salmonella* activity of *T. cordifolia* was determined through the broth dilution and agar well diffusion assays. The immune-stimulating potential of AETC or METC was determined by measuring the cytokine levels in the culture supernatants of treated murine J774 macrophages. Antibacterial activity of AETC or METC was determined by treating *S. typhimurium*-infected macrophages and BALB/C mice. The toxicity of AETC or METC was determined by measuring the levels of liver inflammation markers aspartate transaminase (AST) and alanine transaminase (ALT) and antioxidant enzymes. Macrophages treated with AETC or METC secreted greater levels of IFN- γ , TNF- α , and IL-1 β . METC showed greater activity against *S. typhimurium* infection in macrophages and mice as well. Treatment with METC resulted in increased survival and reduced bacterial load in *S. typhimurium*-infected mice. Moreover, METC or AETC treatment reduced the liver inflammation and rescued the levels of antioxidant enzymes in *S. typhimurium*-infected mice. The results of the present study suggest that the use of *T. cordifolia* may act as a double-edged sword in combating salmonellosis.

It can be concluded that aqueous and methanolic extracts (AETC or METC) of *T. cordifolia* possess immune stimulatory, antimicrobial, hepatoprotective, and antioxidant properties. Interestingly, AETC or METC inhibited the intracellular multiplication of *S. typhimurium* in macrophages. Moreover, treatment with AETC or METC was also effective in eliminating *S. typhimurium* infection from infected mice. Therapy with AETC or METC protected the mice against *Salmonella*-induced liver damage and rescued the depleted levels of SOD and CAT in the infected mice. However, further study is needed to explore its potential implication to treat infectious diseases in human population.

In Vitro Antibacterial Activity of *Tinospora cordifolia* Stem Extract on *Escherichia coli*^[8]

The present study was undertaken to investigate the in vitro antibacterial activity of *Tinospora cordifolia* stem extract against *Escherichia coli* O78. In serial two fold dilution of

T. cordifolia stem aqueous extract, 1×10^7 colony forming units (CFU) of *E. coli* were added. The turbidity corresponding to the bacterial growth in different dilutions was measured as optical density at 600 nm with a spectrophotometer. The maximum activity of extract was observed at its 1:32 dilution and minimum inhibitory concentration was found to be 1:64 dilutions. All the dilutions showed significantly lower CFU as compared to control positive. However, the lowest count was observed at 1:32 dilution of 15 per cent extract with maximum percent inhibition of bacterial growth (53.59 per cent) as compared to all other dilutions (1:2 to 1:128). It can be concluded that *Tinospora cordifolia* stem extract possessed antibacterial activity against *Escherichia coli* O78.

The overall results of in vitro antibacterial activity of aqueous extracts of *Tinospora cordifolia* against *E. coli* indicated that the extract has potential to be used commercially for control of *E. coli* infection. But further in vivo trials on domestic animals and poultry infected with *E. coli* need to be conducted to evaluate its clinical efficacy before recommending for field use on large scale. However, it can be concluded that in the light of increased antibiotic resistance, the present investigation is of importance for preparing *T. cordifolia* based antimicrobials.

Antimicrobial activity dried aqueous extract of *Tinospora cordifolia*^[9]

Guduchi (*Tinospora cordifolia* (Willd.) Miers) is one of the most versatile rejuvenating herbs, possessing numerous therapeutic attributes. Recent reports investigated and ascertained its role as a potent antimicrobial herb. No published reports on antimicrobial profile of its dosage form-Guduchi Ghana are available till date. Present study was therefore attempted to evaluate comparative antimicrobial efficacies of Guduchi Ghana prepared by two different methods – (i) classical Ayurvedic method and (ii) modified method. Recommended microbial strain like; *Salmonella typhi*, *Escherichia coli*, *P. aeruginosa* and *Staphylococcus aureus* were used in this study for the same purpose. Both samples showed significant antibacterial activity and possess great potential against microorganisms, where Guduchi Ghana prepared by classical method showed better results. Physicochemical analysis showed insignificant difference between samples. Phytochemical analysis for various functional groups revealed the presence of glycosides, alkaloids, tannins, phenols, starch and sterols in

both samples, which might be accountable for their antimicrobial potential. No microbial load was detected within both samples. The results also validate the traditional uses of Guduchi in various skin ailments. Present study may prove a torch bearer for future studies to understand its biological activities.

The results obtained in this study suggest that selected Guduchi Ghana showed significant antibacterial activity and possess great potential against microorganisms. Thus its active constituents can be helpful in the therapeutic treatments. The obtained results validate the classical guidelines that Guduchi Kwatha for Guduchi Ghana should be prepared by adding 4 time water and $\frac{1}{4}$ reduction of the same after heating. The phytochemical analysis for various functional groups revealed the presence of glycosides, alkaloids, tannins, phenols, starch and sterols in both samples, which might be accountable for their antimicrobial potential. The results also validate the traditional uses of Guduchi in various skin ailments. Present study provides leads for future studies to ascertain its curative role through pharmacological and clinical studies.

In vitro Antimicrobial Activity of *Tinospora cordifolia*^[10]

The present investigation was carried out to evaluate the in vitro antifungal and antibacterial activity of hydro alcoholic extract of *Tinospora cordifolia* creped on *Azadirachta indica* Tree (TC1) in comparison with that of *Tinospora cordifolia* (TC2) creped on fencing. Hydroalcoholic extract of *T. cordifolia* stem was prepared by maceration technique. The microorganisms used as antibacterial and antifungal were *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas sp*, *Aspergillus niger*, *Aspergillus fumigates*, *mucor sp* and *Pencillium*. The extract of TC1 exhibit effective antimicrobial activity against all the organisms, while the extract of TC2 exhibits inhibition zone on limited species such like *Staphylococcus aureus* (12 mm), *Klebsiella pneumonia* (10 mm), *Pseudomonas sp* (8 mm), *Aspergillus niger* (6 mm), *Aspergillus fumigates* (8 mm) and *mucor sp* (12 mm). The results suggest that *T. cordifolia* creped on neem tree having the potential antimicrobial activity similar to *Azadirachta indica*. This can explain that the host plants (*T. cordifolia*) will incorporate the medicinal virtue when they survive on neem plants. It is expected that using *T. cordifolia* as therapeutic

agents for treating infections in traditional medicine.

It may be concluded from this study that *Tinospora cordifolia* stem extract creeping on *Azadirachta indica* has potential antimicrobial activity similar to that of neem tree when compared to *Tinospora cordifolia* creeping on fencing. This can explain that the host plant will gain some of the activities when they survive on medicinal plants. It is essential that research should continue to isolate and purify the active components of this natural herb and use in experimental animals.

Anti-Oxidant and Antimicrobial Studies of *Tinospora cordifolia* (Guduchi/Giloy) Stems and Roots under In Vitro Condition^[11]

Plants produce a diverse range of bioactive molecules, making them a rich source of different types of medicines and healing properties. The present study was aimed to evaluate the anti-oxidant and antimicrobial properties of stem and root of *T. cordifolia*. Total phenolic contents of different solvent extracts were determined and found that ethanol extract had the highest phenolic content of 0.3213 mg g⁻¹. Antioxidant assays were also carried out by using different in vitro models such as total reducing power, hydrogen peroxide scavenging activity assay and hydroxyl radical scavenging activity. The Ethanol extract showed the highest total antioxidant activity. The H₂O₂ scavenging and hydroxyl free radical scavenging activity was maximum 87.2 % and 91.0% found in case of ethanolic stem extract respectively. The antimicrobial activity of ethanolic and methanolic extract of root and stem of *T. cordifolia* were also evaluated against some pathogenic microorganisms viz. *E. coli*, *B. subtilis*, *A. niger* and *Candida sp.* it was found that the various concentration of extract viz. 50, 100, 150 and 200 mg ml⁻¹ were tested. It was observed that the increasing in concentration there was also increasing in antimicrobial activity revealed by increase in size of zone of inhibition. The methanolic stem extract exhibits highest antimicrobial activity against all four pathogens. The study shown that the extract of *T. cordifolia* has a wide range of anti-oxidant as well as antimicrobial activity against bacterial as well as fungal pathogens.

Anti-oxidant activity of *Tinospora cordifolia* Leaves using in vitro models^[12]

Plants produce a diverse range of bioactive molecules, making them a rich source of different types of medicines. A regular and wide

spread use of herbs throughout the world has increased serious concern over their quality, safety and efficacy. Thus, a proper scientific evidence or assessment has become the criteria for acceptance of herbal health claims. In the present study, there examined the anti-oxidant effects of leaves of *Tinospora cordifolia*. Dried and powdered leaves of *T. cordifolia* were extracted with hexane, chloroform, methanol, ethanol and water. Total phenolic and flavonoid contents of different solvent extracts were determined. Of the different solvent extracts, ethanol extract had the highest phenol and flavonoid content of 5.1±0.25 mg/g and 0.52±0.02 mg/g respectively. Antioxidant assays were carried out by using different in vitro models such as total reducing power, total antioxidant activity, lipid peroxidation inhibitory activity, DPPH radical scavenging activity and superoxide radical scavenging activity. Ethanol extract showed the highest total antioxidant activity of 41.4±0.45 μM Fe(II)/g. The EC₅₀ values of ethanol extract for lipid peroxidation inhibitory activity and DPPH radical scavenging activity was found to be 0.1 and 0.5 mg/ml respectively. The anti-oxidant activities of other solvent extracts were poor when compared to the ethanol extract. These results suggest that, the active antioxidant compounds are better extracted in ethanol and there is a direct correlation between the total polyphenols extracted and its anti-oxidant activity. The in vitro anti-oxidant activity of *T. cordifolia* justifies the ethno medical use of this plant.

Studies on Antioxidant Activity and Total Phenolic Content of *Tinospora cordifolia* Stem Using in Vitro Models^[13]

In the present study, there examined the anti-oxidant effects of *Tinospora cordifolia* stem. Dried and powdered stem of *Tinospora cordifolia* was extracted with ethanol and methanol. Total phenolic content of different solvent extracts were determined, to find the correlation between phenols and antioxidant activity. Ascorbic acid was used as standard. Antioxidant assay was carried out by using DPPH (1, 1-Diphenyl-2-picrylhydrazyl) radical scavenging activity. Ethanolic stem extract showed the highest free radical scavenging activity (56.35%). The antioxidant activity of methanolic extract was poor when compared to the ethanolic extract. Ethanolic stem extract had the highest phenol content of 66.28 ± 0.82 mg/g. These results suggest that, Phytocompounds were better extracted in ethanol and there is direct correlation

between the total polyphenols extracted and its antioxidant activity.

Present study revealed that ethanol was the better extractive solvent for antioxidant activities. The present result coincides with view of that ethanol extract of HC9 (A herbal composition comprised of nine different plant materials viz. *Picrorhiza kurroa*, *Cyperus rotundus*, *Zingiber officinale*, *Cedrus deodara*, *Tinospora cordifolia*, *Holarrhena antidysenterica*, *Swertia chirata*, *Cyclea peltata* and *Hemidesmus indicus*) exhibited significant DPPH radical scavenging activity with IC₅₀ value of 172.89 µg/ml as compared to the aqueous extract (HC9 aq.).

These results suggest that the higher levels of antioxidant activity were due to the presence of phenolic components. The same relationship was also observed between phenolics and antioxidant activity in roship extracts.

In the present study estimation of total phenolic content of *T. cordifolia* revealed that ethanol stem extract had highest phenol content. It suggests that phenol content is responsible for the highest DPPH radical scavenging activity of ethanol stem extract in the present study. Similar results were also reported by who observed high correlation between phenolic composition and antioxidant activities of extracts of some medicinal plants viz. *Azadirachta indica*, *Hemidesmus indicus*, *Manilkara zapota*, *Psorelea corylifolia*, *Rubia cordifolia* and *Tinospora cordifolia*.

The result of the present study suggests that *T. cordifolia* can be used as a source of antioxidant for Pharmacological preparation which is very well evidenced by the present work.

Anti-Bacterial Activity^[14]

The investigation is aimed to carry out the antibacterial activities of ethanol extracts of leaf, stem, leaf derived callus and stem derived callus of *Tinospora cordifolia* (Willd.) Hook.F.Thoms (Menispermaceae). The leaf and stem segments of *Tinospora cordifolia* were cultured on MS medium supplemented with auxins and cytokinins. In the case of leaf derived callus maximum biomass was recorded on medium containing 2,4-D, NAA and BAP combination while NAA and BAP combination showed good response for callus induction in stem. The antimicrobial activities of ethanol extracts of leaf, stem, leaf derived callus and stem derived callus were screened against ten human pathogenic bacteria including both Gram-positive and Gram-negative types by agar well diffusion method. All the tested extracts were

bioactive with more pronounced effect on Gram-positive bacteria than Gram-negative bacteria.

Present investigation showed significant antibacterial activity by extracts of callus derived from both stem and leaf of *Tinospora cordifolia* compared to its field grown plant extracts. Stem derived callus extract showed greater inhibitory activity against *E.coli* while the leaf derived callus extract showed maximum inhibitory activity against *S. aureus* and *S. epidermidis* compared to their field grown plant extracts. This significant difference between antibacterial activity of callus and field grown plant extracts is attributed to enhanced berberine content of callus compared to its field grown plant parts.

Studies on In Vitro Antibacterial Activity of *Tinospora cordifolia* Stem Extract on *Escherichia coli*^[8]

The present study was undertaken to investigate the in vitro antibacterial activity of *Tinospora cordifolia* stem extract against *Escherichia coli* O78. In serial two fold dilution of *T. cordifolia* stem aqueous extract, 1x10⁷ colony forming units (CFU) of *E. coli* were added. The turbidity corresponding to the bacterial growth in different dilutions was measured as optical density at 600 nm with a spectrophotometer. The maximum activity of extract was observed at its 1:32 dilution and minimum inhibitory concentration was found to be 1:64 dilutions. All the dilutions showed significantly lower CFU as compared to control positive. However, the lowest count was observed at 1:32 dilution of 15 per cent extract with maximum percent inhibition of bacterial growth (53.59 per cent) as compared to all other dilutions (1:2 to 1:128).

It can be concluded that *Tinospora cordifolia* stem extract possessed antibacterial activity against *Escherichia coli* O78. The overall results of in vitro antibacterial activity of aqueous extracts of *Tinospora cordifolia* against *E. coli* indicated that the extract has potential to be used commercially for control of *E. coli* infection. But further in vivo trials on domestic animals and poultry infected with *E. coli* need to be conducted to evaluate its clinical efficacy before recommending for field use on large scale. However, it can be concluded that in the light of increased antibiotic resistance, the present investigation is of importance for preparing *T. cordifolia* based antimicrobials.

A clinical study on Diabetes Mellitus type-II^[15]

Madhumeha (Type 2 Diabetes Mellitus) is a global burden. At present, it occupies significant position among non-communicable diseases. It is a major cause of mortality and morbidity in middle age group people. Alterations in metabolism have been main culprit in the pathology of Type 2 Diabetes Mellitus. There are several challenges in diabetes management, including a rising prevalence in urban and rural areas, lack of disease awareness among the public, limited health care facilities, high cost of treatment, suboptimal glycemic control and rising prevalence of diabetic complications. India has to take drastic and urgent steps to develop an integrated national system for early detection and prevention and better management of Diabetes Mellitus. The present clinical study conducted to evaluate the effectiveness of Guduchi sattava in relieving the symptoms of hyperglycemia. Fifty newly diagnosed Madhumeha patients of either sex in the age group of 30-70 years are included in this study. Guduchi sattava (1g daily) are given orally for 90 days with plan water with and without diet restriction and exercise. Type 1 Diabetes Mellitus, Diabetes Mellitus with pregnancy, Gestational diabetes etc are excluded here. All patients are evaluated based on clinical features, and laboratory parameters like blood glucose level, lipid profile and HbA1C. The present study concluded that Guduchi sattava has definite hypoglycemic effect and more effective on fasting glucose level than postprandial glucose along with diet and exercise.

At the end of study the result reveals that the drug Guduchi sattava has been used from remote antiquity for the cure of the ailing and afflicts. Oral administration of Guduchi sattava is very effective for the treatment of Madhumeha along with diet & exercise. Guduchi sattava is cheap, innocent, and easily available. Hence, it will pave the path for better treatment of the patients suffering from Madhumeha.

The Analgesic, Anti-Inflammatory and Anti-Pyretic Activities of *Tinospora cordifolia*^[16]

Tinospora cordifolia (*T. cordifolia*) is a valuable resource due to its traditional uses in the treatment of pain, fever and inflammation, but no sufficient scientific literature is available online to confirm its traditional uses in these ailments.

This study was carried out to validate the traditional uses of *T. cordifolia* in treating pain, inflammation and pyrexia, using albino mice as an experimental animal model. The analgesic effects of *T. cordifolia* extract were assessed by using the

acetic acid-induced writhing test, hot plate test and tail-flick test. The carrageenan test was performed to assess anti-inflammatory potential, and antipyretic activity was evaluated by the brewer's yeast-induced pyrexia method.

The results showed that the *T. cordifolia* extract exhibited significant analgesic effects in a dose-dependent manner in the three pain models tested. The extract also exhibited significant anti-inflammatory effects in the carrageenan-induced inflammation test and antipyretic effects in the brewer's yeast-induced pyrexia test in dose-dependent manner compared to the effects observed in the control group animals.

From the findings of the present study, it can be concluded that *T. cordifolia* extract has strong analgesic, anti-inflammatory and antipyretic effects. Further studies are required to investigate the therapeutic activities of the phytochemical constituents of *T. cordifolia* against pain, inflammation and pyrexia.

Anti-diabetic properties of *Tinospora cordifolia* stem Extracts^[17]

The oral administration of various extracts (hexane, ethyl acetate and methanol) of *Tinospora cordifolia* stem (TCS) were found to have potent antidiabetic activity that reduces blood sugar level in streptozotocin-(STZ) induced diabetic rats. In this study, the chronic (100 days) antihyperglycemic effect of the extracts at a dose of 250 mg/kg b.w.p.d of TCS were investigated. Insulin was used as a reference drug at a dose of 3 I.U/kg.b.w.p.d. Fasting blood glucose, glycosylated hemoglobin (HbA1C), serum insulin, C-peptide and liver enzymes levels were evaluated in normal, diabetic and treated rats. Supplementation of methanol extract significantly reduces the fasting blood glucose level when compared to other 2 extracts. Moreover this supplementation significantly decreases the glycosylated hemoglobin level as compare to diabetic control ($p < 0.001$), reduced glucokinase and increased glucose-6-phosphatase activity were reversed significantly by the treatment of TCS methanol extract in respect to diabetic group. In the TCS treated groups, the insulin and C-peptide levels were improved which shows the regeneration of β -cell which secretes insulin, histopathological studies of pancreas of TCS methanol extract treated groups substantiate the regenerating capacity of extract.

Antidiabetic Potential and Identification of Phytochemicals from *Tinospora cordifolia*^[18]

Tinospora cordifolia an ayurvedic herb has different classes of phytochemicals with medicinal significance in diabetes management. The hypothesis and possible mode of action of these phytochemicals used as antidiabetic drug has been already reported. So, we focused on identification of the *T. cordifolia* phytochemicals as well as the compounds responsible for antidiabetic activities in context of α -amylase inhibition.

Total phenol estimation and Thin layer chromatography (TLC) of *T. cordifolia* extracts and assay of α -amylase inhibition was done. Positively responding extracts were analyzed by liquid chromatography mass spectrometry (LCMS). Obtained LCMS data was processed using online databases like MassBank, ChemSpider and Phenol Explorer for characterization of compounds.

Total Phenolic content of *T. cordifolia* extracts showed significant variations in their concentrations with highest phenolic content in ethanol extract, while highest α -amylase inhibition was showed by ethyl acetate extract. Extracts with more than 40% inhibitory activity were subjected to LCMS; analyzed by MassBank, ChemSpider resource and phenol explorer database for compound identification. Identified compounds were searched in the literature for reported antidiabetic activity and we found seven; Cyanidin 3-O-sambubiosyl 5-O-glucoside, Hesperetin 7-Rhamnoglucoside, quercetin 3-O- β -xylopyranosyl-(1 \rightarrow 2)-O- β -galactopyranoside, Blumenol C malonylglycosyl galacturonide [M+H]⁺, Verbascoside, Quercetin-3-glucuronide, and Catechin/Epicatechin-(epi) gallocatechin dimer.

The phytochemical profiling of *T. cordifolia* presented in this study revealed a diverse range of bioactive phenolics. Also it can be predicted that the potent antidiabetic activity of *T. cordifolia* is due to presence of compounds inhibiting α -amylase and α -glucosidase enzymes.

Effect of *Tinospora Cordifolia* in Chronic Bronchitis Patients^[19]

Chronic Bronchitis (CB) is defined as a chronic cough and sputum production for at least 3 months a year for 2 consecutive years. It is covered under the umbrella term of Chronic Obstructive Pulmonary Disease (COPD).

Randomized, Single Blind, Placebo Controlled Study was conducted in the M.G.M Medical College, Jamshedpur, Jharkhand. In this study 100 patients were enrolled. These patients

were randomly divided into two groups of 50 each. Chronic bronchitis patients between 18 to 70 years age group were included in this study. Patients with complications of respiratory failure were excluded from the study.

There is statistically significant ($P < 0.05$) increase in percentage of predicted values of FEV1 and Peak Expiratory Flow in test group as compared to Placebo group. There was statistically significant ($P < 0.05$) reduction in episodes of acute exacerbations in Test group as compared to Placebo group. There was significant clinical improvement in Test group as compared to Placebo group. The *Tinospora cordifolia* group had better improvement in quality of life as compared to Placebo group.

Tinospora cordifolia reduces repeated infections, improves signs and symptoms, improves quality of life and also improve lung functions. So it can be given as adjuvant therapy in chronic bronchitis patients in addition to standard treatment.

Neuroprotective activity^[20]

Neuroinflammation has been implicated in the pathogenesis or the progression of the variety of acute and chronic neurological and neurodegenerative disorders including Alzheimer's disease.

The present study is to investigate the ethanolic extract of *Tinospora cordifolia* on LPS induced behavioral alterations, oxidative stress and neuronal damage in rats.

Adult male Wistar rats were divided into five groups six in each. Group I treated with normal saline (0.9% NaCl i.p.), group ii treated with normal saline + LPS (100 μ g/kg i.p.), group iii treated with Aspirin (200 mg/kg) + LPS (100 μ g/kg), Group IV treated with EETC (200 mg/kg) + LPS (100 μ g/kg) and Group V treated with EETC (400 mg/kg) + LPS (100 μ g/kg) for 14 days followed by single challenged of LPS to all the groups except control rats. On 15th day onwards, various behavioral assessment such as body weight, rectal temperature, locomotor activity, cognitive and memory assessment were carried out. Rats were sacrificed, and brain was isolated and estimated antioxidant levels (GSH, SOD, TBARS and CAT) and neuronal damage in the region of hippocampus were analyzed.

LPS treated rats significantly ($P < 0.001$) decreased the body weight, locomotor activity, latency period in passive avoidance test and anti-oxidant levels in GSH, SOD and CAT and

increased the rectal temperature and lipid peroxidase level (TBARS) compare to control rats. Pretreated with Aspirin 200 mg/kg rats and EETC (200 and 400 mg/kg) rats significantly attenuated the LPS induced behavioral alteration, oxidative damage and neuronal damage.

The ethanolic extract of *Tinospora cordifolia* showed neuroprotective activity due to the presence of phytochemical constituents such as alkaloids, glycosides, diterpenoid lactones, berberine, flavonoids, saponins.

Hypoglycemic and anti-hyperglycemic activity^[21]

Over the centuries, herbs have served as a major source of medicines for prevention and treatment of diseases including diabetes mellitus. These herbs are getting more importance around the globe and many studies have provided safety and efficacy of such herbal drugs in different condition. Guduchi (*Tinospora cordifolia* [Willd.] Miers) is reported as highly potent Pramehahara (anti-diabetic) herb in Ayurveda and Guduchi Satva (GS) is popularly used to treat Paittika type of Prameha. In the present study, GS prepared from the stem of *T. cordifolia* was evaluated for hypoglycemic and anti-hyperglycemic activity in 18 h fasted mice. GS was suspended in distilled water and administered to animals at the dose of 130 mg/kg that showed the marginal reduction in blood sugar level (BSL) at all the time intervals in normoglycemic mice. In anti-hyperglycemic activity, administration of GS prior to glucose overload failed to attenuate BSL at all-time interval in comparison to glucose control group. The study concludes that mild hypoglycemic insignificant anti-hyperglycemic activities of GS. GS is having mild hypoglycemic activity while it does not have a significant anti-hyperglycemic activity against glucose overload.

Analgesic Activity^[22]

Pain is a very well-known signal of ill health and analgesics are the drugs that are used to relieve pain. The main problem with these drugs remains that of side effects. Safer alternatives are natural herbs. Guduchi (*Tinospora cordifolia*) is one such plant with analgesic potential but few studies are there.

To evaluate the analgesic activity of commercially available extract of Guduchi (*T. cordifolia*).

For this purpose commercially available extract of Guduchi (*T. cordifolia*) by Himalaya

Drug Company, Bangalore was used. Albino rats were divided randomly in three groups of six rats each. Group 1 (control) received distilled water orally, group 2 (test) received *T. cordifolia* extract in dose of 300 mg/kg orally and group 3 (standard) received Pentazocine in dose 10mg/kg intraperitoneally. Analgesic activity was evaluated using hot plate and abdominal writhing method. All the observations were analysed statistically using student's t-test.

T. cordifolia extract significantly ($p < 0.05$) increased the response time and decreased the number of writhes in hot plate method and abdominal writhing method respectively, on comparison with the control group.

The above findings suggest that this commercially available extract of Guduchi (*T. cordifolia*) possess analgesic activity. This analgesic activity probably involves peripheral as well as central mechanisms as the extract showed analgesic activity in both hot plate and abdominal writhing method.

Hepatoprotective Activity^[23]

The result of hepatoprotective study indicated that Satwa of *T. sinensis* has comparatively higher hepatoprotective activity than *T. cordifolia*, although both formulations could have significant protection against paracetamol induced hepatic toxicity. Both the plants therefore may be used as guduchi as described in Ayurvedic literature. Our data on hepatoprotection however, could not support the claim about Neem-guduchi. Finally, it has been suggested that further comparative characterization of chemical constituents of each species is essential to reveal the potent Hepatoprotective components along with their proportionate combination.

II. CONCLUSION:

The historical evidence confirms the *Tinospora cordifolia* is a competent plant as multipurpose resource for life. Different active compounds are demonstrating the varied adaptability of the plant. With so much to offer to the scientific world of medicine, the plant *Tinospora* truly acts as an incredible source. The present review highlights the various therapeutic uses of *Tinospora cordifolia* mentioned by great Ayurveda sages and recommends that there is huge scope of further scientific research on various therapeutic aspect of this important medicinal plant. It also have anti- Diabetic, antioxidant, immunomodulatory activities, Immunity enhancer,

Antibacterial activity, Antimicrobial activity, Antioxidant, Anti-inflammatory, Anti-pyretic, in Chronic bronchitis, Neuroprotective activity, Hypoglycemic Activity, Analgesic Activity and Hepatoprotective activity.

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