IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 4, November 2024

Tinospora Cordifolia Chemical Constituents And Pharmacological Properties: A Review

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Abstract: *Tinospora cordifolia, commonly known as Guduchi or Amrita, is a widely used medicinal plant in traditional Ayurvedic medicine, belonging to the Menispermaceae family. It is known for its diverse therapeutic properties, including the treatment of fever, diabetes, dyspepsia, jaundice, and various skin diseases. This plant has garnered significant attention in recent years due to its potential in modern medicine, supported by extensive phytochemical, pharmacological, and clinical research. Studies have highlighted its immunomodulatory, anticancer, hypoglycemic, anti-inflammatory, and antiallergic effects. The active phytochemical constituents of T. cordifolia, particularly alkaloids such as palmatine, have shown promising therapeutic potentials, including significant antitumor activity. In addition, its anticancer properties are believed to be mediated by dietary phytochemicals that may inhibit or delay carcinogenesis. T. cordifolia is native to India, and its medicinal applications span across various cultures and languages, underscoring its widespread use. The present review aims to summarize the medicinal properties, therapeutic potential, and the need for further scientific exploration of T. cordifolia to validate its role in modern medicine. The plant's rich pharmacological profile makes it a promising candidate for future research and development in the field of natural therapeutics*

Keywords: Tinosporacordifolia, Guduchi, Amrita, medicinal plant, Ayurvedic medicine, phytochemicals, palmatine, anticancer, immunomodulation, hypoglycemic, anti-inflammatory, antiallergic.

I. INTRODUCTION

Tinospora cordifolia commonly known as Guduchi or Amrita (Menispermaceae), a traditional herbal medicine, is used as a remedy for fever, diabetes, dyspepsia, jaundice, and skin diseases [1]. It has been subjected to extensive phytochemical, pharmacological, and clinical investigation with many interesting findings in the area of immunomodulation, anticancer, hypoglycemic, antiallergic, and anti-inflammatory [2]. Naturally occurring phytochemicals display an active cancer preventive strategy to inhibit, delay, or reverse human carcinogenesis. Studies have indicated that certain daily consumed dietary phytochemicals have cancer protective effects mediated by carcinogens.

Tinospora cordifolia is a well known medicinal plant in traditional medicinal system and recent scientific studies have emphasized the possible use of Tinospora cordifolia in modern medicine. The present review aims to document the medicinal properties of Tinospora cordifolia and its potential prospects for the further scientific investigation for

Palmatine is a quaternary protoberberine alkaloid. It is typically yellow in color and reported as the most important pharmacological active constituents of a number of plants, such as Tinospora cordifolia [3]. Palmatine is a close structural analog of berberine that has been shown to exhibit significant antitumor activity against HL-60 leukemic cells [4].

Tinospora cordifolia is one of the noncontroversial and extensively used herbs in Ayurvedic medicine. It belongs to family Menispermaceae. It is a glabrous, succulent, woody climbing shrub native to India. It is also found in Burma and Sri Lanka. It thrives well in the tropical region, often attains a great height, and climbs up the trunks of large trees. The stem is gray or creamy white, deeply cleft spirally and longitudinally, with the space between spotted with large rosette-like lenticels. The wood is white, soft, and porous, and the freshly cut surface quickly assumes a yellow tint when exposed to air. Leaves are simple, alternate, exstipulate, long petiolate, chordate in shape showing multicoated reticulate venation. Long threadlike aerial roots come up from the branches. Flowers are small and Unisexual. Male flowers are in clusters female flower are solitary

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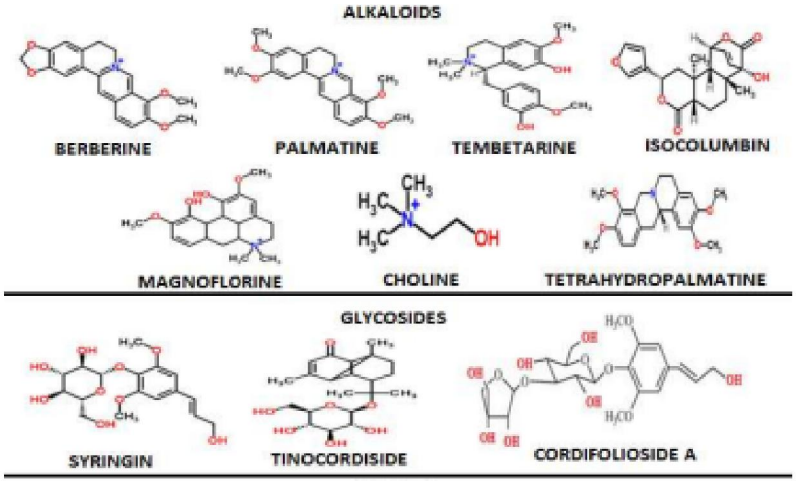
Fig.1& 2 . tulsi plant.

Tinospora cordifolia is known by different name in various different languages in India viz, Tippa-teega (Telugu), Shindilakodi (Tamil), Amruthu, Chittamruthu (Malayalam), Amruthaballi (Kannada), Rasakinda (Sinhala), gurcha (Hindi), garo (Gujarati), Amritavalli (Sanskrit), Guduchi (Marathi), Guluchi (Oriya). [6]

Fig 3 giloy powder

CHEMICAL CONSTITUENTS:

Tinospora cordifolia belong to different classes of constituents such as alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds and polysaccharides etc. Structures of some phytoactive compounds from Tinospora cordifolia are illustrate in figure 4 [7]



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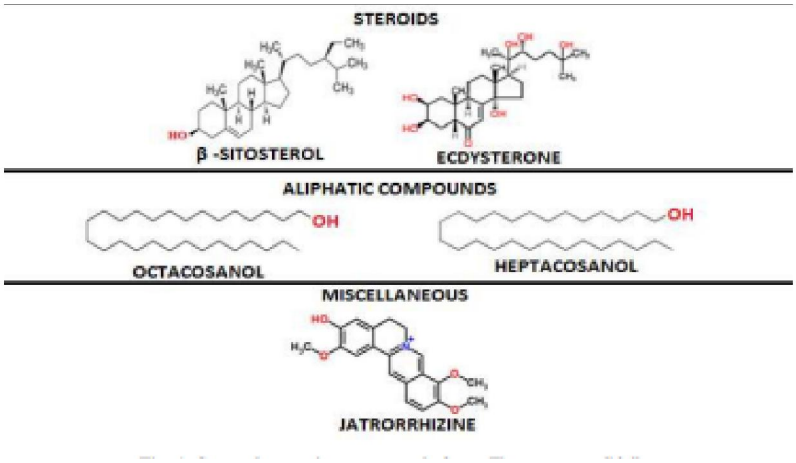

Fig.4 Chemical constituents of tinosporacordifolia

SCIENTIFIC CLASSIFICATION:
Scientific name: Tinospora Cordifolia
Family: Menispermaceae
Genus: Tinospora; Miers (1851)
Order: Ranunculales
Kingdom: Plantae

CULTIVATION:
Tinospora cordifolia, commonly known as Guduchi or Amrita, is a tropical climbing shrub that thrives in warm, humid climates. It prefers well-drained, loamy soils with a slightly acidic to neutral pH, and requires full sunlight or partial shade for optimal growth. While the plant can be propagated from seeds, vegetative propagation through stem cuttings is the most common method due to its higher success rate. The cuttings, typically 10-15 cm long, are planted in moist soil or a rooting medium and generally take 3-4 weeks to root. Once established, the plant requires support to climb, which can be provided by trellises, bamboo poles, or tall trees. Regular watering is essential, but overwatering should be avoided to prevent root rot. Organic fertilizers and compost can be used to enrich the soil, while balanced fertilizers like NPK (10:10:10) may be applied every 2-3 months to promote healthy growth. Pruning is important to maintain the plant's shape and encourage new growth, while regular weeding helps prevent competition for nutrients. Though generally resistant to pests, T. cordifolia may occasionally be affected by aphids, mealybugs, and fungal infections, which can be managed with natural remedies or organic treatments. The plant's stems, which are harvested after 1-2 years of growth, are the main medicinal part, with the bark being used for various preparations. Given its growing demand in herbal medicine markets, cultivating T. cordifolia can be a lucrative endeavor, though it requires patience due to its slow growth, space for climbing, and careful water management. Proper care and attention to these factors can yield a successful harvest and ensure a steady supply of this valuable medicinal herb.

EXTRACTION:
MATERIAL AND METHOD:
Plant materials: The stems of Tinospora cordifolia were collected from herbal garden of the Maharshi Dayanand University, Rohtak and identified by Dr. Surender Yadav, Department of botany of the university. Voucher specimen of the plant having No. MDU/Phcog/111 was kept in the department for future reference.
Chemicals: HPLC grade Methanol , Ethanol and Glacial acetic acid were used in the present study. Standard berberine was obtained from Sigma Chemicals
Material/Instruments Used: The materials/instruments used for this work were round bottom flask, Basket heater, distillation unit, thermometer, measuring cylinder, conical flask, separating funnel, soxhlet apperatus.

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Extraction by Maceration: Extraction was carried out by placing 20 g of coarsely powered sample drug in a closed vessel at room temperature. Added 200 mL of ethanol and allowed for extraction for 7 days with occasional stirring at regular intervals. The liquid was filtered and the percentage yield of extract was calculated, after completion of the extraction process.

Extrction by Soxhlet apparatus: The 20 g powder of dried stems of Tinospora cordifolia was placed in thimble holder. About 300 mL of ethanol was filled in the flask. The thimble was clogged with cotton in order to avoid transfer of sample particles to the distillation flask. The drug was extracted with ethanol in soxhlet apparatus for 3 h. The ethanolic extract was filtered and concentrated on rotaevaporator to give the ethanolic extract. Percentage yield of extract was calculated.

IDENTIFICATION TEST:

Alkaloids:

Mayer's test:

Add a few drops (2-3 drops) of Mayer's reagent to the solution of the sample in a test tube.

After adding the reagent, gently shake the test tube and observe the formation of any precipitate.

The presence of a **creamy white precipitate** indicates the presence of alkaloids.

Glycosides:

Extract was hydrolyzed with HCl solution and neutralized with NaOH solution.

Few drops of fehling's solution A & B were added.

Brick red precipitate showed the presence of glycosides.

Reducing sugar:

Extract was shaken with distilled water and filtered.

Filtrate was boiled with fehling's solution A&B for 10 min.

Orange & red precipitate indicates the presence of reducing sugar.

Steroids:

To the extract, add **concentrated sulfuric acid (H_2SO_4)** carefully along the sides of the test tube to avoid mixing. You should see a clear separation between the extract and the sulfuric acid.

After allowing the mixture to stand for a few minutes, observe any color change

A **red or orange** color at the interface between the acid and the extract indicates the presence of steroids.

Phenolic compound:

Take 2 ml of sampleand add 2-3 ml of ferric chloride

Greenish black colour indicates presence of phenolic compund .

PHARMACOLOGICAL ACTIVITY

Anticancer:

Chemicals. 7,12-Dimethylbenz(a)anthracene (DMBA), croton oil, NADH, glutathione reduced (GSH), 5,5-dithiobis-(2-nitrobenzoic acid) (DTNB), and 2-thiobarbituric acid (TBA) were obtained from Sigma-Aldrich, USA. All other chemicals were commercially available and analytical grade.

Tinospora cordifolia has demonstrated significant anti-cancer potential in various studies, particularly in animal models and human cancer cell lines. The alkaloid palmatine, extracted from the plant, showed anticancer effects in a DMBA-induced skin cancer model in mice, preventing micronucleus formation in bone marrow in a dose-dependent manner. In C57 Bl mice, a 50% methanolic extract of Tinospora cordifoliaat 750 mg/kg for 30 days increased lifespan and reduced tumor size. Studies on brain cancer using C6 glioma cells revealed that an ethanolic extract reduced cell proliferation and induced differentiation in a dose-dependent manner. Further investigations of secondary metabolites showed that

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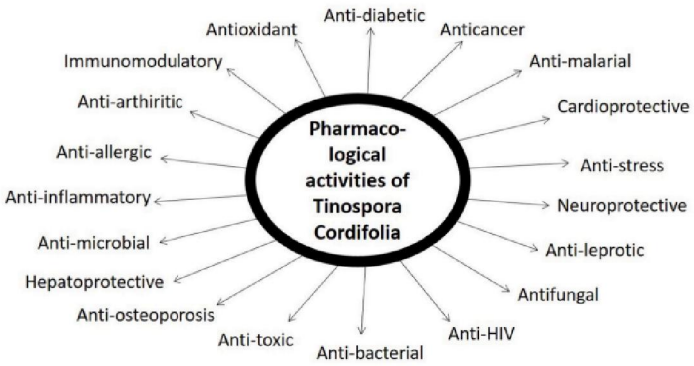
palmatine was active against KB (oral squamous carcinoma) and HT-29 (colon cancer) cells, while tinocordiside and yangambin were effective against other cancer cell lines. In **MCF-7 breast cancer cells, compounds from the hexane and methanol fractions suppressed cell proliferation, migration, and invasion, and influenced epithelial-mesenchymal transition (EMT) genes, suggesting a potential to inhibit cancer metastasis. These findings highlight the anticancer properties of *Tinospora cordifolia* and its bioactive compounds, especially in the context of skin, brain, and breast cancers.[7]



Antimicrobial activity:

Tinospora cordifolia exhibits strong antibacterial activity against a wide range of bacterial pathogens, including Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, and Salmonella species. Aqueous, ethanol, and acetone extracts from its leaves and stems show maximum inhibitory effects against Klebsiella pneumoniae and Pseudomonas aeruginosa, which are common urinary pathogens. Additionally, silver nanoparticles synthesized from its stem possess antibacterial activity against multidrug-resistant Pseudomonas aeruginosa from burn patients. A specific compound isolated from the stem extract showed strong antibacterial activity, particularly against Enterococcus faecalis and Bacillus subtilis, and antifungal effects against Trichophyton species. Furthermore, constituents of Tinospora cordifolia demonstrated high inhibitory activity against methicillin-resistant Staphylococcus aureus (MRSA) and carbapenemase-producing Klebsiellapneumoniae, indicating its potential as a source for new therapies targeting infectious diseases.

Immunomodulatory Activity: [7]

Tinospora cordifolia is renowned for its immunomodulatory properties, attributed to active compounds like 11-hydroxymustakone, magnoflorine, and cordifolioside A. Studies show that its ethanolic extract(100 mg/kg) enhances immune function by increasing T and B cells, antibody production, and cytokine levels (IL-2, IL-10, TNF-α). It stimulates polymorphonuclear leucocytes (PMN) for phagocytosis and boosts WBC counts and bone marrow cells, indicating strong immune stimulation. Additionally, a clinical trial with a Tinospora lotion demonstrated its ability to downregulate Interleukins (1, 6, and 8), reducing inflammation and supporting its anti-scabies activity.

Anti-diabetic activity:

Tinospora cordifolia exhibits significant antidiabetic potential through various bioactive compounds such as alkaloids, tannins, flavonoids, saponins, and steroids. Studies have shown that its extracts, including Sedimental extract (SETc) and ethanolic leaf extract, effectively lower blood glucose in diabetic animals, with efficacy comparable to insulin. The plant's compounds, like palmatine and jatrorrhizine, mimic insulin and enhance insulin sensitivity. Additionally, T. cordifolia helps mitigate diabetes-associated oxidative stress, promoting insulin secretion, inhibiting gluconeogenesis, and increasing antioxidant levels in tissues. These findings support its therapeutic potential for diabetes management in experimental and clinical settings.

Anti-OxidantActivity:

Tinospora cordifolia demonstrates significant antioxidant activity, with methanolic, ethanolic, and water extracts showing strong free radical scavenging, metal chelation, and reducing power. Studies reveal that its stem methanol extract increases erythrocyte membrane lipid peroxide and catalase activity while decreasing superoxide dismutase and

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glutathione peroxidase in diabetic rats. The plant also protects against aflatoxin-induced nephrotoxicity and liver cancer by reducing lipid peroxidation and restoring antioxidant levels. Additionally, Tinospora cordifolia leaf essential oil exhibits strong DPPH radical scavenging activity, and its extracts show the highest antioxidant potential in methanol.

II. CONCLUSION

In conclusion, Tinosporacordifolia (Guduchi or Amrita) is a highly valuable medicinal plant with a rich history in traditional medicine and growing recognition in modern healthcare due to its wide range of therapeutic benefits. Its cultivation, though requiring specific tropical conditions, is feasible and can be economically viable, especially for farmers in regions with suitable climates. The plant thrives in well-drained, loamy soils with adequate sunlight and humidity, and propagation through stem cuttings is the most effective method for growing it. Careful attention to irrigation, fertilization, and pest management ensures healthy plant development. Given its demand in herbal medicine markets, cultivating T. cordifolia presents an opportunity for sustainable agriculture, contributing to both local economies and global health industries. While the slow growth and space requirements pose challenges, the benefits of this plant—ranging from its immunomodulatory and anticancer properties to its use in treating various diseases—make it a promising candidate for further scientific research and widespread cultivation. With proper management and continued research into its cultivation methods, T. cordifolia can play a significant role in both traditional and modern medicinal practices.

III. AKNOWLEDGEMENT

We would like to acknowledge and give my warmest thanks to Ms. Prachi. N. Padwal. who made the work possible. Her guidance and advice carried me through all the stages of writing my paper. We would also like to thank you our institute who gave us this opportunity to do this review paper .

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