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Tinospora cordifolia (Giloy): A Review of the Various Pharmacological Pathways of a Highly Potential Medicinal Ayurveda Plant

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ABSTRACT

Tinospora cordifolia, often known as "Amrita" or "Guduchi," is a medication that played a significant role in Indian systems of medicine (ISM) and has been utilised in the treatment of many ailments since the beginning of time. The term "guduchi" comes from the Sanskrit language and translates to "which protects the body from diseases." There is another name for this herb, and that name is "Amrita," which is a reference to the celestial elixir that is described in Hindu mythology. The medication is a well-known Indian bitter that is used for a variety of conditions, including fevers, diabetes, dyspepsia, jaundice, urinary issues, skin illnesses, and frequent diarrhoea and dysentery. Furthermore, it has been demonstrated to be effective in the treatment of cardiovascular disorders, leprosy, helminthiasis, and rheumatoid arthritis syndrome. In addition to being a significant medicine, it is utilised in a variety of preparations, including Satva, Ghrita, Tail, Swarasa, and all of these. An examination of the Charaka Samhita, the Sushruta Samhita, the Ashtanga Hridaya, the Ashtanga Sangraha, the Bhavprakash Nighantu, the Raj Nighantu, the Dhanvantari Nighantu, the Shaligrama Nighantu, the Priya Nighantu, the Kaiydev Nighantu, the Madanpal Nighantu, and the Shodhal Nighantu, as well as the internet and contemporary medical literature, have all been examined for this review article. There was a widespread recognition that the Tinospora cordifolia plant possessed high degrees of medicinal, therapeutic, curative, healing, and alleviating properties. By virtue of its anti-toxic, anti-inflammatory, anti-pyretic, and anti-oxidant qualities, guduchi possesses a significant potential for therapeutic application. Moreover, there is no evidence to suggest that Guduchi contains any hazardous substances or has any adverse effects, which further demonstrates that it is safe to use. Concluding remarks: The medicinal characteristics of the plant Tinospora cordifolia (Giloy) have been confirmed by the studies that were presented in this review. These studies focus on the therapeutic and safety features of the herb, and they demonstrate that it can prevent a variety of diseases or abnormalities by naturally boosting immunity in human bodies.

Keywords- Giloy, pharmacological, phytochemical, Herbal plants.

I. INTRODUCTION

The World Health Organization defines traditional medicine as "the knowledge, skills, and practices that are based on the theories, beliefs, and experiences that are indigenous to different cultures, and that are used in the maintenance of health as well as in the prevention, diagnosis, improvement, or treatment of physical and mental illness." The philosophy and practices of traditional medicine are influenced by the conditions, environment, and geographic area in which it was initially developed. However, a common philosophy is a holistic approach to life, equilibrium of the mind, body, and environment, and an emphasis on health rather than disease. There are many different systems of traditional medicine, and each one has its own unique

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philosophy and practices. Generally speaking, the focus is on the overall condition of the individual, rather than on the specific illness or disease from which the patient is suffering, and the utilisation of herbs is an essential component of all traditional medical practices. Tinospora plant has a significant potential to diagnose and treat a variety of diseases. It is one of the medicinal plants that has been studied and utilised extensively for the treatment of a wide range of conditions, including but not limited to heart disease, diabetes, leprosy, rheumatoid arthritis, and allergy [1]. There is a widespread belief that it is a cure-all for virtually all ailments and conditions. Tinospora has been gaining a lot of attention from researchers all over the world ever since the Covid-19 pandemic. This is due to the fact that it is used as a herbal medicine in primary healthcare and as a home remedy for preventing a variety of diseases and disorders. Tinospora and other medicinal plants have a wide variety of applications, ranging from use in clinical settings to research in phytochemistry and pharmacology[2]. The reverse strategy, on the other hand, confirms scientific output by employing a contemporary research method that is referred to as "reverse pharmacology. There were a total of 34 scientific plant species belonging to the genus Tinopora that were documented, and thirteen of those species names were approved as actual species. The Tinospora genus contains three distinct species of medicinal plants: Cordifolia, Crispa, and Sinensis[3]. These species are very prevalent in India. Each of these Tinospora species is a member of the family Menispermaceae, which is a member of the Angiosperm organisation. The visual identification and phytochemical properties of plant parts such as stems, flowers, roots, and leaves are very similar to those of these plant species. These plant species are very similar to one another. Both in Asia and Africa, as well as in Australia, they are utilised extensively for therapeutic purposes. A previous study found that Tinospora species were clinically investigated for a variety of conditions, including diabetes, urinary infections, fever, cold, skin inflammation, fungal infections, and bacterial infections[4]. Tinospora species contain a wide variety of phytochemicals and different therapeutic approaches that can be used to treat a variety of diseases. There are a number of phytochemical elements that are present in the Tinospora plant that are responsible for its therapeutic approach [3,4]. These constituents include alkaloids, flavonoids, glycosides, aliphatic compounds, diterpenoid, vitamins, tannins, lactones, steroids, coumarins, lignans, triterpenes, and nucleosides. Although there are three different species of Tinospora plants, Cordifolia is the most important of the three because of the medicinal properties and therapeutic activities that it possesses.[5]. T. cordifolia has also been shown to have immunomodulatory properties, making it useful for relieving stress and anxiety. T. cordifolia plant has the potential to inhibit free radical generation and thus protect membranes from radical-induced membrane damage. It is also effective in Dengue since it helps to improve the platelet count. Besides, it has many unknown health benefits and uses. T. cordifolia extracts have been used to combat autoimmune illness. It lowers pro-inflammatory cytokines, i.e., interleukin-6 (IL-6), and tumor necrosis factor-α (TNF-α) production in a rheumatoid arthritis rat model [6]. In addition, antitumor activities have been demonstrated by a variety of extract fractions and components of T. cordifolia [7].

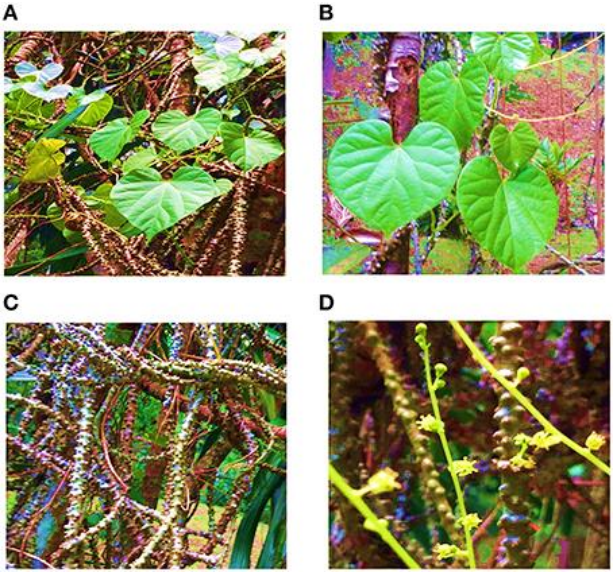

Fig: 1 T. Cordifolia plant parts

While there are a number of other ayurvedic medicinal plants, T. cordifolia has a significant potential to be demonstrated as a highly valued plant that possesses medicinal, ethnopharmacological, phytochemical, and an infinite number of other capabilities (Supplement material). Previous research has demonstrated that T. cordifolia possesses a wide range of therapeutic medicinal qualities, including anti-diabetic, anti-inflammatory, anti-arthritic, antioxidant, hepatoprotective, cardioprotective, anti-allergic, and anti-stress capabilities, amongst many others [[6], [7], [8]. In order to validate the therapeutic potential of T. cordifolia, however, additional extensive investigations are required to be conducted in order to provide an understanding of the regulatory mechanisms. The purpose of this in-depth review is to provide an overview of the various pharmacological activities that T. cordifolia possesses.[9][10] These activities, in turn, contribute to the advancement of science, healthcare, and public knowledge of the potential medical advantages of the plant.

II. MATERIAL & METHOD

We searching from different sources like google scholar, PubMed, publon, research gate etc. Study timing aug 2024 to oct 2024. keywords - phytochemicals, pharmacological.

Plant description

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Tinospora is a huge deciduous, glabrous perennial plant that may be found all over India, particularly in the tropical regions that are located up to 1.2 km above sea level. It can be found in nations that are geographically close to it, including China, Sri Lanka, Bangladesh, Pakistan, and Burma [11]. The majority of places where tinospora plants are grown are in warm temperatures. For its cultivation, Tinospora favours soil that is either medium-black or red in colour. It is also possible to cultivate it successfully in a wide range of soils, from sandy to clay loam, amongst others. On the other hand, in order for it to thrive, the soil needs to be well-drained, have an adequate amount of moisture, and be abundant in organic matter. Guduchi, Giloy, Amrita, and heart-leaved moonseed are all names that are often used to refer to the plant that is T. cordifolia [12]. It is sometimes referred to as a holy drink because it is believed to be the ambrosia of the god Indra. An additional species of Tinospora, T. crispa, is a tiny herb that is called as Faridbel in the local area. It is a climber that is woody, high, and completely glabrous. Both the temperate and tropical regions of India are home to the plant that is spread out and grows widely. T. sinensis/malabarica, also known as Malabar gulbel, is the third species under consideration. It is characterised by a huge deciduous climber, a dazzling light coloured stem, long orbicular-cordate leaves that are longer than those of T. cordifolia, dioecious blooms, and aerial roots that originate from branches [13].

Ayurvedic Significance

This plant is being consumed traditionally and each part of it have significant role in improvement of human health. It has been utilized as a constituent of a few people and Ayurvedic arrangements as juices, decoctions, glue, powders and pills to serve general weakness, fever, illnesses of skin, persistent the runs, jaundice, asthma and bone-crack, which were portrayed in old texts like Ras Ayana, Sangrahi, Balya, Agnideepana, Tridoshshamaka, Dahnashaka, Mehnashaka, Kasa-swasahara, Pandunashaka, Kamla-Kushta Vataraktanashaka, Jwarhara, Krimihara, Prameha, Arshnashaka, and KricchHridroganashak [14]. Amrita used as a blood purifier, eliminating flawed and harmed red platelets from fringe blood flow. Due to its high alkaloidal substance, the Ayurvedic Pharmacopeia of India has recognized the stem of amrita as a medicine [15].

Leaves: Powder of leaves and their decoction, joined with cow's milk, have been utilized to fix gout, ulcers, jaundice, fever, and wounds, just as to oversee blood sugar [16]. Bark: for disease its underlying foundations and stem are utilized in North Gujrat (India) [17]. Stem extricate is utilized as mystical pill in jaundice fever, derma problems and fever while stem-starch (satva) is utilized as a tonic. As a remedy to wind chomp and scorpion sting, a mixture of root + stem is suggested [18]. Roots are recommended as an emetic in the treatment of visceral blockages, leprosy, diarrhoea, and dysentery [19, 20].

Chemical Constituents

A variety of active constituents were isolated from T. cordifolia plant. All components belong to different drug categories such as glycosides, alkaloids, aliphatic compounds, steroids, sesquiterpenoid, polysaccharides, diterpenoid lactones, and phenolics.[21] T. cordifolia plants leaves are fully rich with protein, and good for phosphorus and calcium. Different constituents reported include glycoside, alkaloids, bitter principles, crystalline components, etc. The bitter principles have been identified as columbin, chasmanthin, and palmarin. The alkaloid tinosporin, borapetoside F, borapetoside B, syringin, polypodine B [20,22]-acetonide, angelicoidenol2-O-β-D-apiofuranosyl-(1→6)-βD-glucopyranoside, secoisolariciresinol-9'-O-Dglucopyranoside, and pinoresinol-di-O-glycoside also have been isolated from T. cordifolia.

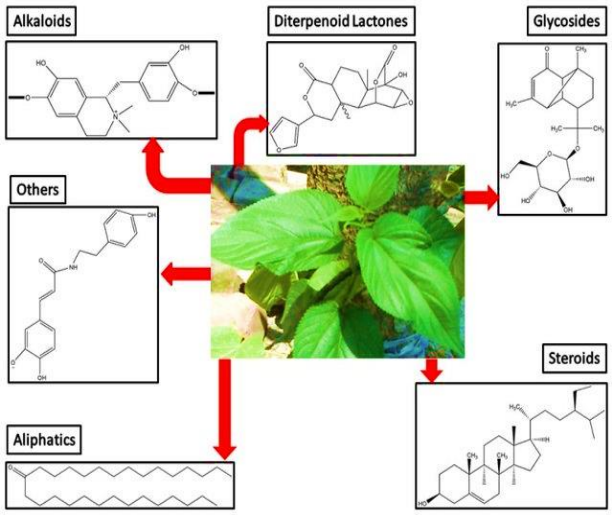

Fig 2: List of chemical compound

Table 1: List of chemical compound and its chemical constituents

Class of Chemical	Constituent	Reference
Terpenoides	Tinosporide,Furanolactone diterpene, Furanolactone clerodane diterpene, furanoid diterpene, Tinosporaside, ecdysteronemakisterone 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	[21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31]

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Alkaloid	Tinosporine, (S), Magnoflorine, (S), Berberine, (S), Choline, (S), Jatrorrhizine, (S), 1,2-Substituted pyrrolidine(S), Alkaloids, viz. jatrorrhizine, palmatine, beberine, tembeterine, choline.	[32, 33, 34, 35, 36]
Diterpenoid lactones	Diterpenoid (S), tinosporoncolumbin (S), clerodane derivatives (W), tinosporon (W), tinosporisides (W), jateorine (W), columbin (W), tinosporal, tinosporide.	
Glycoside	18 Nonderodane glycoside (S), furanoid diterpene glycoside (S), tinocordiside (S), tinocordifoliside (S),	
Class of Chemical	**Constituent**	**Reference**
	cordioside (S), cordifolioside A, B, C, D (S), syringin (S), syringinapiosylglycoside (S), palmatosides	
Lignans	3 (a, 4-dihydroxy-3-methoxybenzyl)-4-(4- hydroxy-3-methoxybenzyl), (S)	[37]
Steroids	Giloinsterol, (S), ß-Sitosterol, (S), 20a-Hydroxy ecdysone, (S)	[38, 39, 40, 41]
Others	Giloin, Tinosporan acetate, Tinosporal acetate, Tinosporidine, Heptacosanol, Octacosanol, sinapic acid, Tinosponone, two phytoecdysones, an immunologically active arabinogalactan	[42,43,44,45,46,]

Qualitative Analysis: In accordance with the Indian Pharmacopoeia, researchers had carried out a physicochemical analysis of the stem of the Guduchi plant and submitted their findings. Foreign matter, total ash, acid insoluble ash, water soluble ash,[23][24] loss on drying, and extractive values were all values that were determined to be present in the stem. An investigation on the physicochemical properties of the leaf, stem, and aerial root of Guduchi was initiated. It was recorded that the ash and extractive levels, in addition to the physicochemical parameters, of powdered air-dried leaf, stem, and aerial root.[25]

Physicochemical Analysis: TLC Analysis: An strategy that involved simple reflux was utilised by the researchers in order to produce methanolic extracts of the leaf, stem, and aerial root of the plant. In all three fractions of the mobile phase extract, the biomarkers berberine and tinosporaside were found to be present. These biomarkers were identified at UV 254 nm and 366 nm.[26] TLC was performed on the Guduchi stem extracts that were extracted using the Soxhlet method. The solvents that were used were hexane, chloroform, ethyl acetate, and methanol. Both visible light and derivatising chemicals, such as the Natural Product (NP) reagent, which is active at 366 nm, were utilised in order to achieve the detection of spots with both methods. According to the findings, the Rf values that are created by the extracts of hexane, chloroform, and ethyl acetate are in the ranges of 0.14 to 0.51, 0.19 to 0.78, 0.06-0.81, and 0.05-0.87, respectively.[27] On the other hand, the Rf values that are produced by methanol are in the range of 8 to 1. The technique of thin-layer chromatography (TLC) was utilised to examine four different powdered extracts of Guduchi stem. These extracts were fresh aqueous extract, freeze-drying powder, aqueous freeze-drying powder, and dried powder. Using anisaldehyde as the spray reagent and two separate solvent solutions as the mobile phase, bands were observed at a wavelength of 366 nanometres in ultraviolet light. [28]The first three samples in both solvent systems contain a number of bands that have Rf values that are comparable to one another. The fourth and final sample contains a single band that has an Rf value that is distinct from the others. Every single Rf value was recorded, and in this particular study 17, it was found that tinosporaside, which is a key component, had an Rf value of 0.58.[29].

HPTLC Analysis: By utilising an HPTLC technique, the process of determining the amount of tinosporaside present in Guduchi was simplified and made more accurate. For the purpose of separating tinosporaside by the use of TLC, plates made of pre-coated silica gel 60F 254 were utilised.[30] The plates were then scanned using a densitometric scanner operating in UV reflectance photomode at a wavelength of infinity. The ratio of toluene, acetone, and water in the solvent solution was 5:15:1. The solvent solution was composed of water. Utilising the HPTLC method that was suggested, the Rf of tinosporaside was discovered to be 0.58, and the concentration of tinosporaside in the test sample was found to be 0.40% weight-to-weight composition. [31][32]

Using the Soxhlet extraction method, a methanolic stem extract of Guduchi was generated, and the primary objective of the research was to identify the presence of berberine in this extract. Compounds were separated by TLC on pre-coated silica gel 60F 254 plates using a solvent solution consisting of butanol, ethyl acetate, acetic acid, and water in the proportions of 3: 5: 1: 1.[33][34] These plates were then scanned with a densitometric scanner in the UV reflectance photo mode at 366 nm. There was a 0.23% (w/w) concentration of berberine in the methanolic stem extract of Guduchi, and the relative frequency was 0.23. [35][36] The fingerprinting of the Soxhlet methanolic extract of

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Guduchi stem was performed with the help of a CAMAG HPTLC system equipped with a Linomat-V spotting and scanner 3, as well as the solvent system consisting of Toluene, ethyl acetate, and formic acid in the proportions of 5:4: 1, respectively. Analyses were performed on chromatograms that were obtained at 254 nm and 366 nm. [37] Guduchi was found to have seven fingerprint spots at a wavelength of 254 nm and 10 at a wavelength of 366 nm. Maceration, soxhlation, and MAE were the extraction methods that were utilised in the HPTLC analysis of the methanolic extract of Guduchi.[38] This was done in order to determine the concentration of berberine that was present in the test sample. In this particular experiment, the mobile phase consisted of a combination of methanol, acetic acid, and water in the proportions of 8:1:1. The density scans were obtained by use a CAMAG TLC scanner 3 with the absorbance mode and 366nm preset accordingly. Berberine's maximum absorption was found at a wavelength of 348 nm. With regard to the acquisition of berberine, researchers demonstrated that MAE was significantly more efficient than other methods. A CAMAG HPTLC equipment was utilised by the researchers in order to conduct an analysis of four distinct powdered extracts of Guduchi stem that were extracted using a variety of solvent systems.[39][40][41] These solvent systems included chloroform, methanol, and ethyl acetate in the proportions of 9.5: 0.5: 0.1 v/v/v. After derivatisation with anisaldehyde, the Rf value of many compounds was recorded at 254 nm, and this was done again after the derivatisation process.[42][43]

Total Phenolic Content: A total phenolic content analysis was performed on Guduchi stem extracts that were prepared with hexane, chloroform, ethyl acetate, and methanol respective solvents.[44][45] The findings of a modified Folin-Ciocalteu test were determined with the help of tannic acid, which served as a reference. A reading of 765 nm was obtained from the UV-VIS spectrophotometer as the absorption reading. It has been demonstrated by the data that the phenolic content of Guduchi is highest in the ethyl acetate extract, which has a concentration of 9.8 µg/g, while the hexane extract has a concentration of 4.8 µg/g.[46][47][48]

Total Flavonoid Content: Using quercetin as a point of reference, the total flavonoid concentration in extracts of Guduchi stem that were prepared in hexane, chloroform, ethyl acetate, and methanol was determined by measuring the absorbance at 415 nm. [49][50] The flavonoid content of Guduchi stem extract that was generated using methanol was found to be significantly greater than the flavonoid concentration obtained using hexane, which was 11.08 µg/g, instead of 3.62 µg/g, as indicated by the findings of the current study.[51][52]

III. PHARMACOLOGICAL ACTIVITY

Immunomodulatory activity:

A study was conducted to explore the immunomodulatory activity of T. cordifolia, which has been utilised as an adjuvant in the immunotherapy treatment of tumours. Palmatine is an active component of T. cordifolia, and it has the ability to inhibit the development of B-cell lymphoma-2 and promote distinctive apoptotic features that are associated with the constitutive expression of caspase-activated deoxyribonucleic acid in both the nucleus and the cytoplasm. There is a pharmacophore group of octacosanol, which is an aliphatic alcohol, that is present in palmatine. This group has been shown to have angio-inhibiting and antimetastatic actions[53], Through the inhibition of nuclear factor-kB (NF-κB), T. cordifolia was able to decrease the expression of the vascular endothelial growth factor gene, which in turn had the effect of suppressing the sprouting of new blood vessels and providing protection against neuroblastoma.[54] Through the modulation of the expression of proliferating cell nuclear antigen and cyclin D1, stem aqueous ethanolic extract (AEC) of T. cordifolia has the potential to inhibit the proliferation of neuroblastoma cells. Through the introduction of T. cordifolia, the expression of mortalin and the RelA subunit of NF-κB was induced.[55]

Antiarrhythmic Activity

T. cordifolia contains a number of essential components, including tembetarine and berberine. The body's resilience to physiochemical and biological stress is increased by these ingredients, which are referred to as adaptogens. Additionally, they contribute to the production of energy. CaCl2 is responsible for producing arrhythmias that are severe and resistant to manipulation. In order to create a meaningful effect, it is necessary to administer high dosages of antiarrhythmic drugs during treatment.[56] The presence of calcium causes a hyperpolarisation of the resting potential in the cells of the sinoatrial node, which in turn lowers the excitability of Purkinje cells. This is because the threshold potential has a less negative value when calcium concentration is present.[57] The impact was enhanced by T. cordifolia extract, as seen by a gradual reduction in plasma calcium and sodium levels, as well as an improvement in potassium levels at larger doses.[58] T. cordifolia was able to normalise the arrhythmogenic calcium excess, decrease the sodium levels that were produced by calcium, and increase the potassium levels that were anti-arrhythmic.As indicated by the percentage of protection, the stem extract of T. cordifolia demonstrated powerful antiarrhythmic activity. This was demonstrated by the normalisation of PQRST waves.[59][60]

Neuroprotective Activity

Kosaraju et al.,[61] who evaluated the neuroprotective action of T. cordifolia ethanolic extract (TCEE), found that it was effective against Parkinsonism that was induced by 6-hydroxy dopamine.[62] The elevated levels of dopamine that are a result of the treatment of TCEE are either the result of a decreased metabolism of dopamine or an increased manufacture of

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dopamine by dopaminergic neurones in the substantia nigra.The anti-stress and anti-depression action of T. cordifolia root extract, in which dopamine levels were normalised following treatment, further supports the high levels of dopamine that were achieved by the use of transcranial electrical stimulation (TCEE). The reduction of iron-induced damage is one of the ways that TCEE helps to avoid dopaminergic neurodegeneration. There is a possibility that a decrease in glutathione could hinder the clearance of H2O2, enhance the production of OH radicals, and result in oxidative stress. TCEE exhibits considerable neuroprotection in Parkinson's disease that is produced by 6-hydroxydopamine. This is accomplished by protecting dopaminergic neurones and lowering the development of iron buildup.

Antidiabetic Activity

T. cordifolia is well explored in most available diabetes models in animals which were also substantiated in clinical subjects.[63] T. cordifolia constituents (berberine, palmatosides and palmetine) have highly anti-diabetic activity. T. cordifolia suppressed the glucose consumption efficiency which concludes the anti-diabetic activity is mediated through an insulin- reliant pathway through the activation of insulin reuptake tyrosine kinase and phosphatidyl inositol-OH- kinase. However, these inhibitors did not completely arrest the glucose consumption efficiency. T. cordifolia mediated its action majorly through insulin pathway and to some extent by other pathways like activated protein kinase, Ras-Raf-MEK-ERK, c-Jun N-terminal kinase, or peroxisome proliferator-activated receptors (Figure 3).[64] T. cordifolia constituents (alkaloids) are considered to share similar activity in mediating anti- diabetic properties. Palmatine and T. cordifolia improved Glut-4 expression, suppressed PPARγ (lipogenic gene) and simultaneously up-regulated PPARα expression.

Anti-microbial Activity

T. cordifolia exhibits efficacy at a lower concentration and higher volume, with the highest antibacterial activity (40 µL at 2% concentration) being achieved during the experiment. Extracts of T. cordifolia that are diluted in water have been shown to possess potent antibacterial properties against several pathogens.There are secondary metabolites and phytochemicals that are present in the stem extract of T. cordifolia. These include quinones, polyphenols, alkaloids (such as berberine and palmatine), flavonoids, tannins, coumarins, terpenoids, polypeptides, and polypeptides.[65], Constituents of T. cordifolia, such as quinones and flavonoids, bind to adhesins and create complexes with the cell wall. Terpenoids, polyphenols, and tannins cause membrane disruption and form metal ion complexes, which inactivate the enzymes that are produced by bacteria.[66]

Anti-viral Activity

Berberine is the primary component of T. cordifolia, and it was utilised as a colouring agent in the natural world. It is possible to dye mast cells with heparin with the use of this ingredient. [67]While berberine is relatively hazardous when administered parenterally, it is commonly used orally for the treatment of a wide variety of fungal and parasite illnesses. Berberine, β-sitosterol, tetrahydropalmatine, octacosanol, and coline possess anti-viral properties that are effective against the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).30.31 minutes.[68] In order to reduce the levels of cholesterol, berberine was utilised, and β-sitosterol was utilised to treat inflammation. The term "straight-chain aliphatic 28-carbon primary fatty alcohol" refers to the alcohol category that ocacosanol belongs to. This alcohol is utilised in the health business for the purpose of producing nutritional supplements. Choline provides assistance for a wide variety of essential biological functions, including the proliferation of cells and the metabolism. The effectiveness of T. cordifolia (giloy) as an inhibitor for SARS CoV-2 has been demonstrated through the use of molecular docking.[69], For the purpose of targeting 3CLpro targets I and II of key protease enzymes, berberine, β-sitosterol, octacosanol, tetrahydropalmatine, and choline have been individually chosen. The primary chemical components of T. cordifolia, such as berberine and β-sitosterol, have the potential to be employed as an anti-viral medication against SARS-CoV-2. These constituents exhibit a high level of effectiveness in inhibiting the protein of SARS-CoV-2, in comparison to other anti-viral agents. The stem extract of T. cordifolia contains compounds that are considered to be effective inhibitors in the regulation of 3CL protease activity.[70] These constituents also give beneficial effects in inhibiting the reproduction and growth of viruses. It has been demonstrated that hyponidd can lower glucose-mediated haemoglobin count, despite the fact that it can maintain oxidative load by decrease reactive species. An evaluation of "Dihar" was conducted over the period of one and a half months in an animal model that was induced by streptozotocin. The results showed that it decreased levels of urea and systemic creatinine while simultaneously enhancing enzyme activity.[71]

Anti-Anxiety: In comparison to the standard dose of diazepam, which is 2.5 mg/kg, the anti-anxiety effects of an ethanolic extract of T. cordifolia, which was administered at a dose of 100 mg/kg, were shown to be significantly more remarkable. The intelligence quotients of patients have been higher, according to clinical study. [72][73][74] In the practice of Ayurvedic medicine, T. cordifolia has been utilised for centuries as a brain tonic, with the assumption that it may improve cognitive processes such as memory and recall.

Antihyperlipidemic: In a study that investigated the hypolipidemic effect of an aqueous extract of the root on rats weighing 2.5 and 5.0 g/kg body weight on the sixth week, the researchers found that the rats' tissue cholesterol, serum, phospholipids, and free fatty acid levels all fell as a result of consumption of the extract. It was shown that the root extract had the greatest

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hypolipidemic impact when it was administered at a dosage of 5.0 grammes per kilogramme of body weight.[75][76] Researchers have never before investigated whether or not the root extract of T. cordifolia has the ability to lower the fat levels in the blood or tissues of diabetic rats.

Hepatic Disorder: The effects of *T. cordifolia* water extract (TCE) on hepatic and gastrointestinal toxicity were studied, who discovered elevated levels of gamma-glutamyl transferase, aspartate transaminase, alanine transaminase, triglyceride, cholesterol, HDL and LDL in alcohol samples, though these markers were reduced following TCE mediation [77][78]

Anti-Proliferative: In order to determine whether or not *T. cordifolia* extract is effective against cancer, scientists employed a response surface methodology. The extract inhibited tumor growth in a DMBA-induced animal model of skin cancer. C57 BI mice were administered a 50% methanolic extract of *T. cordifolia* for 30 days at a concentration of 750 mg/kg body weight, and the results were similar to those shown when the extract was made at 200, 400, and 600 mg/kg dry weight. As the size of the tumor increased, so did the likelihood of dying [78]

Anti-HIV: An extract from *T. cordifolia*'s roots may help HIV-positive individuals feel more at ease in their living situations. *T. cordifolia* stem concentrate may have strong anti-HIV potential due to its ability to reduce eosinophil count, B lymphocyte incitement, macrophage incitement, hemoglobin level, and polymorphonuclear leucocytes [79]

Wound Healing: Based on their analysis, studies concluded that dexamethasone inhibited the wound healing profile of alcoholic extract of *T. cordifolia* and its effect on wound healing. Increased flexibility in the *T. cordifolia* extract, which may be attributable to the maturation of collagen combination, contributed to the plant's wound- healing efficacy. *T. cordifolia* extract did not counteract the negative effects of dexamethasone on wound healing[80].

Parkinson's Disease: *T. cordifolia* concentrate is quite appealing in the treatment of parkinosis. In a parkinsonian mouse model where 1-methyl-4- phenyl-1, 2, 3, 6-tetra hydropyridine (MPTP) was injected, they observed that watery concentrate had an anti-inflammatory effect. The results suggested that *T. cordifolia* protected dopaminergic neurons by reversing neuroinflammation in MPTP-induced parkinsonism, and the concentrate reversed the behavioral abnormalities seen in objective MPTP- inebriated rats. The plant's varied bioactivities may be attributed to the wide range of compounds it contains. Parts of the *T. cordifolia* plant containing diverse organically dynamic substances were used historically by persons suffering from a wide range of ailments.[81][82][83]

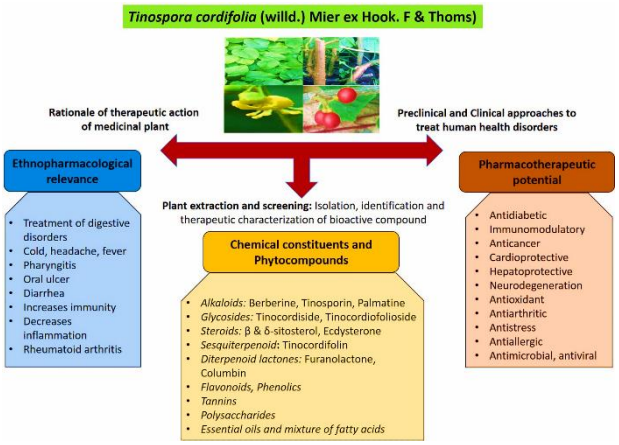

Fig: 3 Pharmacological activities of T. cordifolia

Market Products Based on *T. cordifolia*: In order to promote wellness and avoid sickness, there are a number of products on the market that are based on T. cordifolia, and each of these items plays an important role in the process. [84][85]You can acquire Giloy in a wide variety of forms, such as syrup, powder, tablets, juice, and a great deal of other available options. With the help of these products, the immune system is strengthened, and a wide variety of ailments can be treated. It is normal practice to use products that include giloy to ease the symptoms of a variety of conditions, including diarrhoea, asthma, bronchitis, eczema, viral fever, and the common cold.[86][87] These products are sold by well-known brands like as Dabur and Patanjali. [88-90]

Table 2: T. cordifolia marketed product with their brand name

Product names	Brands	Roles
Brave heart capsule	Brave Heart	Regulates heart function, strengthens heart, lowers blood pressure, lipid levels especially cholesterol and LDL cholesterol
Cirrholiv-ds syrup	Paul Medicos	Used as a hepatoprotector and immunomodulator Treats liver related diseases
Giloy capsules	Zandu	Helps in maintaining healthy liver, balances blood sugar level, strengthens digestive system
Giloy ghanvati	Dabur	Helps in building immunity and protects against various infections, improves Digestion
Giloy ghan vati	Patanjali	Helps in gastroenteritis, Provides immunity against infectious diseases, chronic fever, cough and cold

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Guduchi churna	Baidyanath	Contains antioxidants that fight free radicals, treats dengue, swine flu, malaria, acts as a hypoglycemic agent and helps in treating diabetes, has anti- ageing properties that helps in improving skin health
Guduchi ghrita	Guduchi	Treats gout and skin disorders
Guduchi sattva	DAV Pharmacy	Soothes burning sensation, Effective in liver diseases, Fever, cough, diabetes
Giloy juice	Kapiva	Effective in fever, gout, jaundice, anemia, Works as good detoxifier by flushing out toxins, Improves skin health and controls respiratory problems as well
Immuniveda Chyawanprash	Saffola	Acts as a bioavailability enhancer, improves respiratory health and immunity, provides strength, energy and stamina
Madhumehari	Baidyanath	Reduces blood and urine sugar levels, helps in beating fatigue
Panchanimbadi Churna	Prakruti Remedies	Leukoderma, eczema, dermatitis, skin disorders, diabetes, poison, ascites, arthritis

IV. CONCLUSION

T. cordifolia's chemical diversity has been reviewed here. Antioxidant, antibacterial, anti-HIV, analgesic, anti-fungal, antiproliferative, and anti-epileptic are a few of the many possible effects. Its curative qualities have been well recognized. Potential future treatments for a variety of clinical disorders may include isolating pure lead compounds from the plant portion or from endophytic fungi separated from various areas of the plant. As a result, this evaluation serves both a scientific and clinical function in the quest for new therapeutics.

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