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TENOSPORA CORDIFOLIA: PHYTOCHEMICAL & PHARMACOLOGICAL REVIEW

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ABSTRACT:

Tinospora cordifolia is a climbing deciduous shrub. It can be found all over the tropical region of India, as well as in China, Bangladesh, Myanmar, and Sri Lanka. This plant is a member of the Menispermaceae family. It is a well-known medicinal plant that is used in many traditional remedies to treat a wide range of illnesses. Amrita and Guduchi are the common names. It has been used to cure a variety of illnesses, including diabetes, leprosy, skin conditions, diarrhoea, and fever, and is regarded as an essential medicinal plant in the Indian system of medicine (ISM). Alkaloids, Terpenoids, Lignans, Steroids, and other chemical compounds have been documented to be present in the plant, establishing the phytochemistry and pharmacological action of Tinospora cordifolia. Additionally, it exhibits hepatoprotective, antioxidant, anti-hyperglycemic, and anti-neoplastic properties.

Introduction:

Herbal preparations are medicines that contain one or more plants in precise amounts to provide benefits for treating, diagnosing, and preventing illnesses in humans and animals ^[1]. Botanical medicine or phytomedicine are other names for it. Due to the lack of antibiotics or analgesics in the early 20th century, herbal medicine was the main form of treatment. Herbal therapy gradually lost its appeal among the populace due to the rising use of the allopathic medical system and its quick therapeutic results. For instance, curcuma is a potent antioxidant and anti-inflammatory that has been used in Traditional Chinese Medicine for

more than two thousand years ^[2, 3]. About 70–80% of people are still using herbal medicine for their primary health because of the less side effect and better compatibility with the human body ^[4]. The use of herbal medicine has increased, and it is more efficient than synthetic medications. Guduchi/Amrita and its Latin names, *Tinospora cordifolia* and *Tinospora sinensis* (Lour.) Merr., are other names for *T. cordifolia* (Wild) Hindi: Giloya; Hook. f. & Thomson, English: Tinospora Gulancha/Indian Tinospora. It is found in China, Myanmar, and Sri Lanka and is a member of the Menispermaceae family ^[5]. The plant is commonly used as traditional ayurvedic medicine and

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has several therapeutic properties^[6,7] such as jaundice, rheumatism, urinary disorder, skin diseases, diabetes, anemia, inflammation, allergic condition, anti-periodic, radioprotective properties, etc.^[8,9] The root of Giloya (*T. cordifolia*) is used as potent emetic and for bowel obstruction. The starch of this plant serves a beneficial household remedy for chronic fever, relieves burning sensation, increases energy and appetite. Giloya is useful in the treatment of helminthiasis, heart diseases, leprosy, rheumatoid arthritis, support the immune system, the body's resistance to infections, supports standard white blood cell structure, function, and levels^[10]. It also helps in digestive ailments such as hyperacidity, colitis, worm infestations, loss of appetite, abdominal pain, excessive thirst, and vomiting, and even liver disorders like hepatitis^[11, 12]. The plant's pharmacological effects are caused by its chemical components, which are found in various parts of the body of the plant, including the root, stem, and entire part, including sesquiterpenoids, phenolics, aliphatic compounds, essential oils, a combination of fatty acids, and polysaccharides^[13].

Pharmacognostic Description

The chemical constituents of the plant, such as sesquiterpenoids, phenolics, aliphatic compounds, essential oils, a mixture of fatty acids, and polysaccharides, can be found in many portions of the plant, including the root, stem, and complete part.^[14] The stem's powder is creamish brown or dark brown, has a distinctive odour and bitter taste, and is used to treat fever, urinary disorders, and dyspepsia [15]. the "Guduchi-satva" starch derived from the stem. It is very nutritious and aids with digestion. This plant has round, pulvinate, heart-shaped, simple, alternating, long-petioled (15 cm), somewhat twisted, and halfway around leaves. Oval, 10–20 cm long, seven nerved, profoundly cordate at the base, and membranous are the characteristics of the lamina^[16]. Flowers are unisexual, axillary, greenish-yellow in colour, and have 2 to 9 cm long leaflet branches. Male flowers are grouped, while female flowers are typically solitary.^[17] Its fruits are single-seeded, fruits during the winter and flowers grow during the summer^[18]The root is thread-like, aerial, squairshin, sometimes continuously lengthening touch the ground^[19], aerial roots are characterized by tetra to penta arch primary structure^[21]The seeds are curved

shape^[21], and endocarp is variously ornamented, which provides critical taxonomic characters, morphology of the plants has been depicted in (Fig. 1).

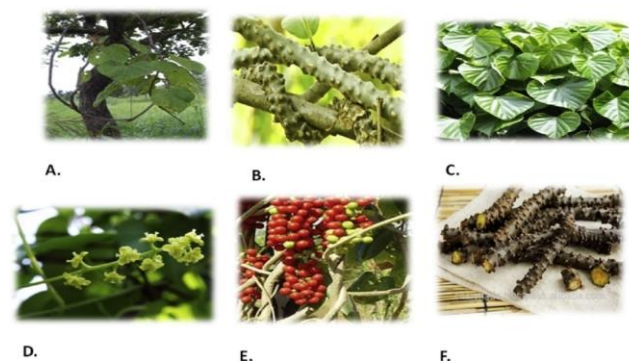


Figure 1:- Morphology of *Tinospora cordifolia*
A) stem B) root C) leaves
D) flower E) fruit F) seed

Chemical constituent:-

The chemical constituents of *T. cordifolia* belong to different classes such as alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharides, leaves are rich in protein (11.2%), calcium and phosphorus^[22]. The stem contains clerodane furano diterpene glucoside (amritoside A, B, C, and D) and the structure has been established by different spectroscopic studies^[23,24,25] Some of the essential constituents reported whereas the structure of the active chemical constituent for *Tinospora cordifolia*.

Alkaloids, glycosides, steroids, sesquiterpenoid, aliphatic molecule, essential oils, combination of fatty acids, and polysaccharides are the principal components of the plant. Berberine, bitter gilonin, non-glycoside gilonin, and gilsterol are among the alkaloids.

Tinosporine, tinosporide, tinosporaside, cordifolide, cordifol, heptacosanol, clerodane furano diterpene, diterpenoid furanolactone tinosporidine, columbin, and b-sitosterol are the primary phytoconstituents found in *Tinospora cordifolia*. Its stem contains berberine, palmatine, tembertarine, magniflorine, choline, and tinosporin.

Table 1: Major and sub groups of natural products present in different parts of *Tinospora cordifolia* and their biological activities^[26-46]

Active Component	Compound	Plant Part	Biological Activity (In Human being)
Alkaloids	Berberine, Choline, Tembetarine, Magnoflorine, Tinosporin, Palmetine, Isocolumbin, Aporphine alkaloids, Jatrorrhizine, Tetrahydropalmatine,	Stem, Root	Anti-viral infections, Anti-cancer, anti-diabetes, inflammation, Neurological, immunomodulatory, psychiatric conditions
Diterpenoid Lactones	Furanolactone, Clerodane derivatives [(5R,10R)-4R-8R-dihydroxy-2S-3R:15,16-diepoxy-cleroda-13 (16), 14-dieno-17,12S:18,1S-dilactone], Tinosporon, Tinosporides, Jateorine, Columbin	Whole Plant	Vasorelaxant: relaxes norepinephrine induced contractions, inhibits Ca ⁺⁺ influx, anti-inflammatory, antimicrobial, anti-hypertensive, anti-viral. Induce apoptosis in leukemia by activating caspase-3 and bax, inhibits bcl-2.

Glycosides	18-norclerodane glucoside, Furanoid diterpene glucoside, Tinocordiside, Tinocordifoliosid, Cordioside, Cordifolioside Syringin, Syringin-apiosylglycoside, Pregnane glycoside, Palmatosides, Cordifolioside A, B, C, D and E	Stem	Treats neurological disorders like ALS, Parkinsons, Dementia, motor and cognitive deficits and neuron loss in spine and hypothalamus, Immunomodulation, Inhibits NF-kB and act as nitric oxide scavenger to show anticancer activities.
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Steroids	β -sitosterol, δ -sitosterol, 20 β -hydroxyecdysone, Ecdysterone, Makisterone A, Giloinsterol	Shoot	IgA neuropathy, glucocorticoid induced osteoporosis in early inflammatory arthritis, induce cell cycle arrest in G2/M phase and apoptosis through c-Myc suppression. Inhibits TNF- α , IL-1 β , IL-6 and COX-2.
Sesquiterpenoid	Tinocordifolin	Stem	Antiseptic

Pharmacological activities

1. Anti-Diabetic Activity

The stem of this plant is generally used to cure diabetes by regulating level of blood glucose [47]. It has been reported to act as anti-diabetic drug through explanatory oxidative stress, promoting insulin secretion by inhibiting gluconeogenesis and glycogenolysis. The anti-diabetic properties exhibited by this plant species are attributed due

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to the presence of alkaloids (Magnoflorine, Palmetine, Jatrorrhizine) ^[48], tannins, cardiac glycosides, flavonoids, saponins, steroids etc. ^[49]. The crude extract of stem in ethyl acetate, dichloromethane, chloroform and hexane inhibits the enzymes like salivary, amylase and glucosidase resulting increase in post-prandial glucose level and show potential activities against Diabetes mellitus disease ^[50]. The root extract of this plant has also been reported to have anti-diabetic properties which decrease the level of glycosylated haemoglobin, hydroperoxidase and vitamin E ^[51].

2. Anti-Stress Activity

Sarma et al., reported ethanolic extract of *T. cordifolia* at the dose of 100 mg/kg gives significant anti-stress activity in all parameters compared with standard drug diazepam (dose of 2.5 mg/kg) ^[52]. The plant extract gives a moderate degree of behavior disorders and mental deficit response. The clinical research showed the improved I. Q level of patients. In Ayurveda, it acts as Medhya Rasayana or brain tonic by increasing mind power like memory and recollection ^[53]

3. Anti-HIV Activity

This plant's root extract has been demonstrated to reduce the body's natural resistance to HIV. Reduction in eosinophil count, activation of B lymphocytes, macrophages, haemoglobin level, and polymorphonuclear leucocytes were indicators of this anti-HIV action ^[54,55].

4. Anti-Cancer Activity

T. cordifolia shows anti-cancer activity, this activity is mostly shown in animal models. Root extract of *T. cordifolia* has been shown radio protective role due to extensively increase in body weight, tissue weight, tubular diameter. Dichloromethane extracts of TC shows cytotoxic effects owing to lipid peroxidation and release of LDH and decline in GST ^[56]In pre-irradiating mice, root extract has widely affected radiation, induced rise in lipid peroxidation and resulted in the decline of GSH in testes ^[57]Most of the synthetic chemotherapeutic agents laid toxic side effects on

the living organisms ^[58]The effect of Giloy has been reported better than doxorubicin treatment ^[59].

5. Anti-microbial activity

Thatte UM et. al. (1992), suggested *Tinospora cordifolia* methanol extracts have been shown to be effective against microbiological infections. *Tinospora cordifolia* extracts were tested for antibacterial activity against *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Salmonella typhi*, *Shigella flexneri*, *Salmonella paratyphi*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Enterobacter aerogene*, and *Serratia marcescens* (Gram-positive bacteria). TCE has been shown to aid bacterial clearance and improve phagocytic and intracellular bacteria in mice models. ^[60-61]

RESEARCH:-

Leaf extract of *T. cordifolia* reported to have an alpha-glucosidase inhibitor, characterized as saponarin was found to be also significant anti-oxidant and hydroxyl radical scavenging activity ^[53]. Due to the presence of alkaloids it shows protection against aflatoxin-induced nephrotoxicity. *T. cordifolia* aqueous extract has a radio protective activity, enhancing the survival of mice against a sub-lethal dose of gamma radiation ^[60-61]. Keeping in view the above mentioned medicinal properties, this plant has been listed an important plant amongst the 32 prioritized plants by NMPB, New Delhi, Government of India. Various funding agencies have been sanctioned the large amount to research on this important

Table -2: Various research projects sanctioned on *Tinospora cordifolia* by different funding agencies[60]

S.N.	Title	Area	Funding Agencies	Year	Amount
1	Studies on Reproductive biology and genetic diversity of <i>Rauwolfia serpentina</i> , <i>Tinospora cordifolia</i> and <i>Asparagus racemosus</i>	Reproductive Biology	Department of Science and Technology, Govt. of India, New Delhi	2006-2009	9,30,000.00
2.	Prevention of Radiation induced reproductive dysfunctions by <i>Tinospora cordifolia</i> (an Indian medicinal plant) extract.	Biochemistry and Pharmacology	Indian Council of Medical Research, Govt. of India, New Delhi	2007-2010	NA
3.	Studies on Modulation of Redox Status and Anti-Inflammatory Effects of <i>Eugenia caryophyllata</i> Linn, <i>Tinospora cordifolia</i> and <i>Rubia cordifolia</i>	Pharmacology	Department of Science and Technology, Govt. of India, New Delhi	2009-2012	NA
4.	In vitro studies on inhibition of eicosanoid metabolism for control of arthritis by extracts of stem of <i>Tinospora cordifolia</i>	Biochemistry and Pharmacology	Department of Science and Technology, Govt. of India, New Delhi	2011-2012	21,17,008.00
5.	Yield Enhancement Strategies for Production of Therapeutic Compounds by Cell and Tissue Cultures of <i>Tinospora cordifolia</i>	Plant Tissue Culture and Pharmacology	Department of Biotechnology, Govt. of India, New Delhi	2011-2014	21,15,000.00

Conclusion

The scientific research on *Tinospora cordifolia* suggests a huge biological potential of this plant. It is strongly believed that detailed information as presented in this review on the phytochemical and various biological properties of the extracts might provide detailed evidence for the use of this plant in different medicines. The phytochemical variations and efficacy of the medicinal values of *Tinospora cordifolia* is dependent on geographical locations and seasons. At the same time, the organic and aqueous extract of *Tinospora cordifolia* could be further exploited in the future as a source of useful phytochemical compounds for the pharmaceutical industry. Even though, there are many herbal plants in the world, Guduchi is considered to be having greater medicinal value. The pharmacological actions attributed to *Tinospora cordifolia* in Ayurvedic texts have evidences suggesting that this drug has immense potential in modern pharmacotherapeutics. Various crude extracts from various parts of guduchi have medicinal applications from time immemorial. *Tinospora cordifolia* can be a potential dietary

component which can help in prevention of different diseases. The utility of Guduchi leaves in diet is advisable and is highly beneficial. The presented review summarizes the information concerning the botany, Ethnopharmacology, phytochemistry and biological activity of the *Tinospora cordifolia* plant. Future directions will entail studies on its pharmacology using animal models and isolated bioactive compounds. Further studies on this plant must be carried out to explore some other important, necessary and unknown benefits.

REFERENCE

1. A.S. Olabiyi, F.E. Nkemehule, O.A. Odukoya, T.A. Samuel, S.O. Ogbonna, Inhibition of glycosylation as an index of activity in plants with antidiabetic potentials, *Biochem. Pharmacol.* 2 (2013) 181.
2. K. Singletary, Turmeric: an overview of potential health benefits, *Nutr. Today* 45 (2010) 216–225.
3. R. Wilken, M.S. Veena, M.B. Wang, E.S. Srivatsan, Curcumin: a review of anticancer properties and therapeutic activity in head and neck squamous cell carcinoma, *Mol. Cancer* 10 (2011) 1–19.
4. A. Pooja, L. Nagesh, Murlikrishnan, Evaluation of the antimicrobial activity of various concentrations of tulsi (*Ocimum sanctum*) extracts against *Streptococcus mutans*: an in-vitro study, *Indian J. Dent. Res.* 21 (2010) 357–359.
5. S. Saha, S. Ghosh, *Tinospora cordifolia*: one plant, many roles, *Ancient Sci. Life* 31 (2012) 151–159.
6. A.K. Meena, A. Singh, P. Panda, S. Mishra, M.M. Rao, *Tinospora cordifolia*: its bioactivities & evaluation of physicochemical properties, *IJPPR* 2 (2010) 50–55.
7. U. Sharma, M. Bala, N. Kumar, B. Singh, R.K. Munshi, S. Bhalerao, Immunomodulatory active compounds from *Tinospora cordifolia*, *J. Ethnopharmacol.* 141 (2012) 918–926.
8. H.C. Goel, J. Prasad, S. Singh, R.K. Sagar, P.K. Agrawala, M. Bala, A.K. Sinha, R. Dogra, Radioprotective potential of an herbal extract of *Tinospora cordifolia*, *J. Radiat. Res.* 45 (2004) 61–68.
9. V.V. Sonkamble, L.H. Kamble, Antidiabetic potential and identification of phytochemicals from *Tinospora cordifolia*, *Am. J. Phytomed. Clin. Ther.* 3 (2015) 97–110.

10. K. Sinha, N.P. Mishra, J. Singh, S.P.S. Khanuja, *Tinospora cordifolia* (Guduchi) a reservoir plant for therapeutic applications, *Indian J. Tradit. Knowle.* 3 (2004) 257–270.
11. K. Salkar, C. Chotalia, R. Salvi, *Tinospora cordifolia*: an antimicrobial and immunity enhancer plant, *Int. J. Sci. Res.* 6 (2017) 1603–1607.
12. P. Upreti, R.S. Chauhan, Effect of leaf powder of giloy (*Tinospora cordifolia*) in fish feed on survival and growth of post larvae of *Catla catla*, *J. Appl. Nat. Sci.* 10 (2018) 144–148.
13. M.M. Khan, M.S. dul Haque, M.S. Chowdhury, Medicinal use of the unique plant *Tinospora cordifolia*: evidence from the traditional medicine and recent research, *Asian J. Med. Biol. Res.* 2 (2016) 508–512.
14. A.K. Upadhyay, K. Kumar, A. Kumar, H.S. Mishra, *Tinospora cordifolia* (Willd.) Hook. f. and Thoms. (Guduchi)–Validation of the ayurvedic pharmacology through experimental and clinical studies, *Int. J. Ayurveda Res.* 1 (2010) 112–121.
15. P. Tiwari, P. Nayak, S.K. Prusty, P.K. Sahu, Phytochemistry and pharmacology of *Tinospora cordifolia*, *Syst. Rev. Pharm.* 9 (2018) 70–78.
16. A.K. Gupta, Anonymous: Quality Standards of Indian Medicinal Plants, New Delhi, 1st ed, 1, 2003, pp. 212–218.
17. V. Arul, S. Miyazaki, R. Dhananjayan, Studies on the anti-inflammatory, antipyretic and analgesic properties of the leaves of *Aegle marmelos* Corr, *J. Ethnopharmacol.* 96 (2005) 159–163.
18. U. Spandana, S.L. Liakhat Ali, T. Nirmala, M. Santhi, S.D. Babu, A review on *Tinospora cordifolia*, *IJCPR* 4 (2013) 61–68.
19. A. Sinha, H.P. Sharma, A medicinal plant: micropropagation and phytochemical screening of *Tinospora cordifolia* (Willd.) Miers ex Hook F & Thoms, *IJAPBC.* 4 (2015) 114–121.
20. S.S. Singh, S.C. Pandey, S. Srivastava, V.S. Gupta, B. Patro, A.C. Ghosh, Chemistry moreover, medicinal properties of *Tinospora cordifolia* (Guduchi), *Indian J. Pharmacol.* 35 (2003) 83–91.
21. B. Misra, B. Prakash, Study of Medicinal Plant and Drug, Bhava Prakash Nighantu, 1, 1969, p. 26
22. N. Chaudhary, M.B. Siddiqui, S. Khatoon, Pharmacognostical evaluation of *Tinospora cordifolia* (Willd) Meirs and identification of biomarkers, *J. Res. Indian Med.* 13 (2014) 543–550.
23. R. Maurya, L.R. Manhas, P. Gupta, P.K. Mishra, G. Singh, P.P. Yadav, Amritosides A, B, C and D: clerodane furano diterpene glucosides from *Tinospora cordifolia*, *Phytochemistry* 5 (2004) 2051–2055.
24. R. Abhijeet, D. Mokhat, On vegetative propagation through stem cuttings in medicinally lucrative *Tinospora* species, *J. Pharmacogn. Phytochem.* 2 (2018) 2313–2318.
25. G. Sumran, A. Aggarwal, Prospect of Indian herbs as sources of antioxidants in combating oxidative stress, *Chem. Biol. Interface* 9 (2019) 1–20.
26. Upadhaya AK, Kumar K, Kumar A, Mishra HS. *Tinospora cordifolia* (Willd.) Hook. F. and Thoms. (Guduchi)–Validation of the Ayurvedic pharmacology through experimental and clinical studies. *Int J Ayurveda Res* 2010; 1:112-121.
27. Rout GR. Identification of *Tinospora cordifolia* (Willd.) Miers ex Hook F & Thoms using RAPD markers. *Z Naturforsch C* 2006; 61:118-22.
28. Patel SS, Shah RS, Goyal RK. Antihyperglycemic, anti-hyperlipidemic and antioxidant effects of Dihar, a poly herbal ayurvedic formulation in streptozotocin induced diabetic rats. *Indian J Exp Biology* 2009; 47:564-570.
29. Gupta R, Sharma V. Ameliorative effects of *Tinospora cordifolia* root extract on histopathological and biochemical changes induced by aflatoxin-b (1) in mice kidney. *Toxicol Int* 2011; 18:94-98.
30. Jagetia GC, Rao SK. Evaluation of the antineoplastic activity of guduchi (*Tinospora cordifolia*) in ehrlich ascites carcinoma bearing mice. *Biol Pharm Bull* 2006; 29:460-466 .
31. Patel MB, Mishra S. Hypoglycemic activity of alkaloidal fraction of *Tinospora cordifolia*. *Phytomedicine* 2011; 18:1045- 1052.
32. Sriramaneni RN, Omar AZ, Ibrahim SM, Amirin S, Mohd ZA. Vasorelaxant effect of diterpenoid lactones from and *rographis paniculata* chloroform extract on rat aortic rings. *Pharmacognosy Res* 2010; 2:242-246.
33. Yang S, Evens AM, Prachands, Singh AT, Bhalla S, Devid K et al. Diterpenoid lactone and rographolide, the active component of and

- rographis paniculata. Clin Cancer Res 2010; 16:4755-4768.
34. Zhao F, He EQ, Wang L, Liu K. Anti-tumor activities of and rographolide, a diterpene from *Andrographis paniculata*, by inducing apoptosis and inhibiting VEGF level. J Asian Nat Prod Res 2008; 10:467-473.
 35. Kohno H, Maeda M, Tanino M, Tsukio Y, Ueda N, Wada K et al. A bitter diterpenoid furano lactone columbine from *calumbae Radix* inhibits azoxy methane-induced rat colon carcinogenesis. Cancer Lett 2002; 183:131-139.
 36. Dhanasekaran M, Baskar AA, Ignacimuthu S, Agastian P, Duraipandiyan V. Chemopreventive potential of Epoxy clerodane diterpene from *Tinospora cordifolia* against diethyl nitrosamine-induced hepatocellular carcinoma. Invest New Drugs 2009; 27:347-355.
 37. Ly PT, Singh S, Shaw CA. Novel environmental toxins: Steryl glycosides as a potential etiological factor for age-related neurodegenerative diseases. J Neurosci Res 2007; 85:231-237.
 38. Karpova EA, Voznyi YV, Dudukina TV, Tsvetkva IV. 4-Trifluoromethylumbelliferyl glycosides as new substrates for revealing diseases connected with hereditary deficiency of lysosome glycosidases. Biochem Int. 1991; 24:1135-1144.
 39. Kapil A and Sharma S. Immunopotentiating compounds from *Tinospora cordifolia*. J Ethnopharmacol 1997; 58:89-95. 26. Chen S, Wu K, Knox R. Structure-function studies of DT-diaphorase (NQO1) and NRH: Quinone oxidoreductase (NQO2). Free Radic Biol Med. 2001; 29: 276-284.
 40. Badwin AS. Control of oncogenesis and cancer therapy resistance by the transcription factor NF-kappa B. J of Clin Invest 2001; 107:241-246.
 41. Yang JH, Kondratyuk TP, Marler LE, Qiu X, Choi Y, Cao H et al. Isolation and evaluation of kaempferol glycosides from the fern *neochlopteris palmatopedata*. Phytochemistry 2010; 71:641-647.
 42. Kim SK, Kim HJ, Choi SE, Park KH, Choi HK, Lee MW. Antioxidative and inhibitory activities on nitric oxide (NO) and prostaglandin E2 (COX-2) production of flavonoids from seeds of *prunostomentosa* Thunberg. Arch Pharm Res 2008; 31:424-428.
 43. Lv J, Xu D, Perkovic V, Ma X, Johnson DW, Woodward M et al. Corticosteroid therapy in IgA nephropathy. J Am Soc Nephrol 2012; 23:1108-16.
 44. McKeown E, Bykerk VP, DeLeon F, Binner A, Thorne C, Hitchon CA et al. Quality assurance study of the use of preventative therapies in glucocorticoid-induced osteoporosis in early inflammatory arthritis: Result from the CATCH cohort. Rheumatology (Oxford) 2012; 51:1662-1669.
 45. Sundarraj S, Thangam R, Sreevani V, Kaveri K, Gunasekaran P, Achiraman S et al. γ -Sitosterol from *acacia nilotica* L. induces G2/M cell cycle arrest and apoptosis through c-Myc suppression in MCF-7 and A549 cells. J Ethnopharmacol 2012; 141:803-809.
 46. Maurya R, Handa SS. Tinocordifolin, a sesquiterpene from *Tinospora cordifolia*. Phytochem 1998; 49:1343-1346.
 47. Sangeetha MK, Balaji HR, Gayathri V, Vasanthi HR. *Tinospora cordifolia* attenuates oxidative stress and distorted carbohydrate metabolism in experimentally induced type 2 diabetes in rats. J Nat Med 2011; 65:544-550.
 48. Zinjarde SS, Bhargava SY, Kumar AR. Potent α -amylase inhibitory activity of Indian Ayurvedic medicinal plants. BMC Complement Altern Med 2011; 11:1.
 49. Chougale AD, Ghadyale VA, Panaskar SN, Arvindekar AU. Alpha glycosidase inhibition by stem extract of *Tinospora cordifolia*. J Enzyme Inhib Med Chem 2009; 24:998-1001.
 50. Umamaheswari S, Mainzen PPS. Antihyperglycaemic effects of 'IlogenExcel' an ayurvedic herbal formulation in streptozotocin induced diabetes mellitus. Acta Pol Pharm 2007; 64:53-61.
 51. D.N.K. Sarma, R.L. Khosa, J.P.N. Chaurasia, M. Sahai, Antistress activity of *Tinospora cordifolia* and *Centella asiatica* extracts, Phytoter Res. 10 (1996) 181-184.
 52. P. Baghel, Plant of versatile properties of *Tinospora cordifolia* (Guduchi), IJAIR 5 (2017) 751-753.
 53. Kalikae MV, Thawani VR, Varadpande UK, Santakke SD, Singh RP, Khiyani RK. Immunomodulatory effect of *T. cordifolia* extract

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- in HIV positive patients. *Ind J pharmacol* 2008; 40:107-110.
54. Akhtar S. Use of *T. cordifolia* in HIV infection. *Ind J pharmacol*. 2010; 42:57-63.
55. H. Ali, S. Dixit, Extraction optimization of *Tinospora cordifolia* and assessment of the anticancer activity of its alkaloid palmatine, *Sci. World J* 28 (2013) 1–10.
56. R. Verma, H.S. Chaudhary, R.C. Agrawal, Evaluation of antcarcinogenic and antmutagenic effect of *Tinospora cordifolia* in experimental animals, *J. Chem. Pharm. Res.* 3 (2011) 877–881.
57. R. Mishra, G. Kaur, Aqueous ethanolic extract of *Tinospora cordifolia* as a potential candidate for differentiation based therapy of glioblastomas, *PLoS One* 8 (2013), e78764.
58. Sharma V, Pandey D. Beneficial effects of *Tinospora cordifolia* on blood profiles in male mice exposed to lead *Toxic Int* 2010; 17:12-17.
59. Kapur P, Wuttke W, Jarry H. Beneficial effects of beta-ecdysone on the joint epiphyseal cartilage tissue and trabecular bone in ovariectomized rats. *phytomedecine* 2010; 17:350-355.
60. Thatte UM, Kulkarni MR, Dahanukar SA. Immunotherapeutic modification of *Escherichia coli* peritonitis and bacteremia by *Tinospora cordifolia*. *J Postgrad Med*. 1992; 38: 13–5.