

## GUDUCHI: A POTENTIAL PLANT FOR IMMUNITY AND THERAPEUTIC EFFICACY

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### ABSTRACT

Guduchi (*Tinospora cordifolia*) is a common medicinal plant distributed throughout the tropics. Its therapeutic efficacy is well recognised worldwide. Its dietary benefits are lesser known. Guduchi is used by various Indian tribal people in diet, and is also a part of traditional Indian cuisine. Ayurveda also notes its importance for dieting. The different benefits acquired through Guduchi's use as a dilatory component, its phytochemicals and pharmacology have been reviewed and discussed in this article.

**KEYWORDS:** Guduchi, *Tinospora cordifolia*, Diet, Ayurveda, Ethnomedicine.

### INTRODUCTION

*Tinospora cordifolia* which belongs to the Menispermaceae family is well known as Guduchi in Ayurveda. It is an effective medicine that is used by Ayurveda practitioners in different diseased conditions and also for health maintenance. Most Ayurvedic lexicons admire the possible health benefits of this drug and compare it to the heavenly nectar that results in immortality. Hence this is due to the name Amruta. It is a well-known rejuvenator and nootropic, sometimes used in the treatment of illnesses such as fever, diabetes and skin disorders.<sup>[1]</sup> Although its effectiveness in food and nutrition is quite well-known, less well-known. The classification of food products in Ayurveda is found to be dependent on the form of food, in different vargas or classes. Shaka varga is one such group dealing with vegetables.

Herbal medicines are one of the most significant fields of herbal medicine in the world. In order to encourage the use of herbal medicine and to evaluate their potential as a source of

new medicines, more intensive study of medicinal plants with a reputation for folklore is important. For millennia human beings used herbs for medicinal purposes. Traditional types of medicine have existed and continue to exist in many countries around the world including Indian subcontinent countries such as India, Pakistan and Bangladesh.<sup>[2]</sup> The writings note that plant therapy use is as old as 4000–5000 B.C. And the Chinese used the natural herbal preparations first as medicines.<sup>[3]</sup> Plants are one of the most significant medicinal sources. Today the vast number of plant-derived drugs, such as *Papaver somniferum* morphine, *Withania somnifera* aswagandha, Ephedrine from *Ephedra vulgaris*, Atropine from *Atropa belladonna*, *Rauwolfia serpentina* reserpine, etc. The medicinal plants are abundant in secondary metabolites (which are possible drug sources) and essential substances. The major advantages reported in various ailments for the therapeutic uses of medicinal plants are their protection in addition to being economical, efficient and their easy availability.<sup>[4,5]</sup> Because of these benefits, the conventional medical practitioners used the medicinal plants extensively in their day-to-day practise. Also very exciting is the future of higher plants as sources of medicinal agents for use in the study, prevention and treatment of diseases. Of the essential life-saving drugs used in the armamentarium of modern medicine, natural products have provided us with some. Of the approximate 250,000 to 400,000 plant species, however, only 6 per cent were studied for biological activity. This indicates a need for direct phyto-pharmacological evaluation of herbal drugs<sup>[6]</sup> for planned action. This article aims to provide an overview of and pharmacological behaviour of the chemical constituents found in different parts of *Tinospora cordifolia*.

### **Vernacular Names**

Sanskrit: Guduchi, Amrita

Bengali : Golanca

English : *Tinospora*

Gujarati : Gulvel

Hindi : Gulancha

Kannada: Amrutaballi, Madhuparni

Malayalam : Amrytu, Chittamritam

Oriya : Gulochi

Tamil : Amudam, Chindil

Telugu : Tippateege, Guricha

Urdu : Gilo, Satgilo

**Taxonomic Classification**

Kingdom : Plantae – Plants;

Subkingdom : Tracheophyta – Vascular Plants;

Super-division: Spermatophyta – Seed bearing plants;

Division: Magnoliophyta – Flowering;

Class : Magnoliopsida – Dicotyledons;

Subclass: Polypetalae – Petals are free;

Series : Thalamiflorae – Many stamens and flower

**Hypogynous**

Order : Ranales

Family : Menispermaceae – The Moonseed family;

Tribe : Tinosporeae

Genus : Tinospora

Species : cordifolia

Synonyms of Guduchi

Guduchi - That which protects.

Amruta - That which can act similar to the celestial nectar which can make the person immortal.

Chakrangi, Chakralakshanika - Referring to the radiating medullary rays visible on transverse section.

Chinnaruha, Chinnodbhava - Referring to its propagation by stem cuttings.<sup>[5]</sup>



**Figure 1:** *Tinospora cordifolia* (Willd.) Miers.



**Figure 2:** The stem pieces of *Tinospora cordifolia*.

### Botanical Description of Guduchi

*Tinospora cordifolia* is a popular traditional medicine spread throughout India's tropical region from Kumaon to Assam, north through West Bengal, Bihar, Deccan, Konkan, Karnataka and Kerala, India. It is a fairly common plant of dry and deciduous forests, spreading over hedges and small trees.<sup>[6]</sup> It is a glabrous, succulent, climbing shrub that sometimes reaches a great height and sends down long threads like roots in the air. Specially the plant seems to be found climbing up the trunks of large Neem trees. The aerial roots emerging from the mature branches or cut bits of stems expand downward and often enter the ground by continuously lengthening. They gradually thicken and resemble stems. The new or tender stems are greenish ribbed with longitudinal striae. The bark is creamy-white grey in colour, deeply cleft with spiral and longitudinal clefts, the space between the clefts is typically dotted like lenticels with broad rosette. The branches bear smooth heart shaped leaves.<sup>7</sup> Leaves are simple, alternate, exstipulate, long, reticular venation. Flowers are small and unisexual, where male flowers are solitary in clusters, and female flowers. The aggregate fruit is red, fleshy, with many drupelets on thick stalk with scars in the sub-terminal style, coloured in scarlet. In summer flowers grow and in winter fruits.<sup>[8]</sup>

### Guduchi - Patra Shaka

Ayurveda is the science and art of life which encompasses every aspect that leads to a healthy and a long life. The fruitful practice of Ayurveda in the present era, though an ancient system, vows to the credibility and validity of this science. Alongwith medicines and treatment theorems for diseased conditions, Ayurveda emphasises on prevention of occurrence of the diseases. In this regard, there is a mention of dietary regimens to be followed by an individual so as to keep him healthy and unaffected by external factors such as weather changes, etc. A mention of various dietary articles is found in all the texts of Ayurveda classified into different vargas (Groups) based on the type of food. Guduchi, under the name Vatsadani, is mentioned as one among the Patra Shakas indicating the use of *Tinospora cordifolia* leaves as vegetable. Sushruta mentions the properties of leaves of Guduchi as that which is having Ushna veerya (producing a catabolic effect), tasting sweet and bitter and pacifying Vata (A bio-force mentioned in Ayurveda which is responsible for the movement of every macro and micro component of the body)<sup>[4]</sup> Charaka includes guduchi in 8 different ganas (groups of drugs with similar action) vowing to its multifaceted action. Sandhaniya (binds the excreta), Triptighna (Removes disgust towards food), Stanyashodhana (purifies breast milk), Snehopaga (supports oleation), Trsnanigrahana (pacifies thirst), Dahaprashamana (reduces

burning sensation), Prajasthapana (supports conception and pregnancy), Vayahsthapana (Anti-ageing, rejuvenating).<sup>[9]</sup>

A careful consideration of the above reveals that it has its action on different systems of the body such as the gastro-intestinal (Truptighna, Sandhaniya), immuno modulatory (Vayahsthapana), reproductive (Stanyashodhana, Prajasthapana), fluid metabolism (Trushna nigrhana, Dahaprashamana) etc. Hence Guduchi can be utilized in both treatment and dietetics in the above said diseases.

### Phytochemistry

The plant mainly contains alkaloids, glycosides, steroids, sesquiterpenoid, aliphatic compound, essential oils, mixture of fatty acids and polysaccharides. The alkaloids include berberine, bitter gilonin and non-glycoside gilonin gilsterol. The major phytoconstituent in *Tinospora cordifolia* includes tinosporine, tinosporide, tinosporaside, cordifolide, cordifol, heptacosanol, clerodane furano diterpene, diterpenoid furanolactone tinosporidine, columbin and  $\beta$ -sitosterol. Berberine, palmatine, tembertarine, magniflorine, choline and tinosporin are reported from its stem. A rearranged cadinane sesquiterpene glycoside named tinocordiside, consisting of a tricyclic skeleton with a cyclobutane ring, has been isolated from the immunomodulatory aqueous fraction of the plant. The new clerodane furano-diterpene<sup>[2]</sup> with the molecular formula C<sub>20</sub>H<sub>20</sub>O<sub>8</sub> has been isolated from the stems of *Tinospora cordifolia*<sup>[10]</sup> *T. cordifolia* contains high fibre (15.9 %), sufficient protein (4.5 %-11.2 %), sufficient carbohydrate (61.66 %) and low fat (3.1 %). It has high potassium (0.845 %), high chromium (0.006 %), sufficient iron (0.28 %) and sufficient calcium (0.131 %) and important in various regulatory functions.<sup>[11]</sup>

### Ethno-medico-botanical and Tribal uses

Guduchi is used as an ingredient of different compound- herbal-preparations. It is also used in the traditional medicinal system of Thailand for treatment of diarrhoea and has been reported to inhibit the in vitro growth of the intestinal protozoan parasite, *Blastocystis hominis*. *T. cordifolia* is highly valued in 'Sri Lankan' traditional medications too. Shade-dried-leaves are ground into powder and mixed with hot water and the mixture is taken orally in the treatment of diabetes by the people living in sacred-groves in Cuddalore district of Tamilnadu, India. Another interesting use is, the smashed leaf and root is added to brown sugar and taken orally at night after normal dinner as a potent aphrodisiac by the village-folk of Natore and Rajshahi districts of Bangladesh<sup>12</sup>. In tribal medicine, whole plant, powdered

root and stem bark, decoction of root and stem, juice of the root, juice or paste of the leaves and stem of the *T. cordifolia* are being used to treat various ailments viz. fever, jaundice, diarrhoea, dysentery, general debility, cough, asthma, leucorrhoea, skin diseases, fractures, eye disorders, bites of poisonous insects, venomous snake etc.<sup>[10]</sup> National Ayurveda Dietetics Research Institute (NADRI, CCRAS, Bangalore, India) conducts local health tradition survey tours in different districts of Karnataka and the following uses of Guduchi were collected during such tours. In Davanagere District of Karnataka, India some folk healers claim to use Guduchi decoction orally in cases of Amlapitta (Hyperacidity), Indigestion and also, oral intake of Guduchi is said to alleviate leucorrhoea. The drug is considered a potent treatment against Hikka (Hiccups) by traditional healers in Bagalkot District of Karnataka, India.

**Table 1: Pharmacological Activities Reported From *Tinospora Cordifolia*.**

Sr.No	Activity	Part/Extract	Animal Model/Cell Lines
1.	Neuroprotective effect	Aerial parts/Ethanol extract	6-hydroxy dopamine lesion rat models of Parkinson's disease. <sup>[24]</sup>
2.	Antiulcer activity	Whole plant/ Ethanol & aqueous extracts	Albino rats using pylorus ligation induced ulcer. <sup>[25]</sup>
3.	Antidiarrhoeal activity	Whole plant/Ethanol & aqueous extract	Castor oil & Magnesium sulphate induced diarrhea in Albino rats. <sup>[26]</sup>
4.	Analgesic activity	Whole plant/Ethanol extract	Hot plate & abdominal writhing method in albino rats. <sup>[27]</sup>
5.	Aphrodisiac property	Aqueous & hydroalcoholic extract	Adult Albino rats of wistar strain. <sup>[28]</sup>
6.	Immunomodulatory activity	Whole plant/Aqueous extract	Swiss male albino mice. <sup>[29]</sup>
7.	Antidyslipidemic activity	Stem Extract	Alloxan induced diabetic male adult rats of Charles Foster strain. <sup>[30]</sup>
8.	Antioxidant activity	Whole plant/Ethanol extract	n-nitrosodiethylamine induced liver cancer in male wistar albino rats. <sup>[31]</sup>
9.	Anti-inflammatory activity	Stem/Aqueous extract	Carrageenan induced paw edema model in rats. <sup>[32]</sup>
10.	Gastroprotective activity	Whole plant	Indomethacin induced gastric ulcer in rats. <sup>[33]</sup>
11.	Nootropic effect	Whole plant/Ethanol extract	Amnesic rats using radial arm maze task performance & barnes maze test. <sup>[34]</sup>
12.	Radioprotective & cytoprotective activity	Stem/Ethanol extract	4 Gy- $\gamma$ radiation in albino mice & cyclophosphamide induced genotoxicity. <sup>[35]</sup>
13.	Antifeedant activity	Whole plant/ Chloroform extract	Microorganism used: <i>Earias vitella</i> , <i>Plutella xylostella</i> , <i>Spodoptera litura</i> . <sup>[36]</sup>

14.	Ameliorative effect	Root/Ethanol extract	Male Swiss albino mice exposed to aflatoxin B1. <sup>[37]</sup>
15.	Cardioprotective effect	Whole plant/ Alcohol extract	Calcium chloride administrated by intravenous infusion to produce arrhythmia in rats. <sup>[38]</sup>
16.	Hepatoprotective activity	Whole plant/ Aq. extract	Bile duct ligation induced jaundice in rats. <sup>[40]</sup>
17.	Hypoglycemic activity	Stem/ Aq. extract	Insulin released effect was detected in vitro using rat pancreatic $\beta$ -cell lines. <sup>[41]</sup>
18.	Antipsychotic activity	Aqueous & ethanol extract	Amphetamine challenged mice model. <sup>[42]</sup>
19.	Antidepressant activity	Pet.ether extract	Swiss albino mice & activity was evaluated using tail suspension test & forced swim test. <sup>[43]</sup>
20.	Antiosteoporotic activity	Stem/ethanol extract	Female Sprague-Dawley rats. <sup>[44]</sup>
21.	Antineoplastic activity	Aerial parts/DCM extract	Mice transplanted with Ehrlich ascites carcinoma. <sup>[45]</sup>
22.	Antifertility effect	Stem/Methanol extract	Male rats. <sup>[46]</sup>
23.	Antiasthmatic activity	Stem/hydroalcoholic extract	Mice were sensitized with intraperitoneal ovalbumin followed by intranasal ovalbumin in vivo asthma model. <sup>[47]</sup>
24.	Antitumor activity	Aqueous alcoholic extract	C6 glioma cells were used, extract reduced the cell proliferation in dose dependant manner. <sup>[48]</sup>
25.	Diabetic neuropathy	Stem/aqueous extract	Streptozotocin induced wistar albino diabetic rats & in vitro aldose reductase inhibition assay & in vivo results were analysed with Mann whitney Test. <sup>[49]</sup>
26.	Hepatocellular carcinoma	Aerial parts/ Ether extract	Diethyl nitrosamine induced hepatocellular carcinoma in male wistar rats. <sup>[50]</sup>
27.	Antimalarial activity	Stem/ Ethanolic extract	Microorganism used Plasmodium berghei on white swiss mice models. <sup>[50]</sup>
28.	Antibacterial activity	Stem/ Aqueous & ethanolicExtract	Microorganisms used: <i>E.coli</i> , <i>P.vulgaris</i> , <i>E.faecalis</i> , <i>S.typhi</i> , <i>S.aureus</i> , <i>S.marcesenses</i> . <sup>[52]</sup>
29.	Anticancer activity	Aqueous & ethanolic extract	IMR 32 human neuroblastoma cell lines as a model system. <sup>[53]</sup>
30.	Antipyretic activity	Formulation guduchi ghrita	Albino rats against yeast induced pyrexia. <sup>[54]</sup>
31.	Allergic rhinitis	Aq.extract	Double blind placebo controlled trial. <sup>[55]</sup>

Guduchi is one drug which has undergone numerous experimentations for its therapeutic utility. It has shown positive activity over different systems thus encompassing the entire body. It is a Rasayana as mentioned in Ayurveda which speaks of its in-toto action. It has been proved to possess Anti-inflammatory, antioxidant, anti-cancerous, cognition and memory enhancing aphrodisiac immunomodulatory and management of vatarakta (Gouty arthritis) effects. Preventive and Curative Potential of Guduchi as Food The potential benefits of guduchi as a therapeutic agent are well known whereas its dietary utility is not very renowned. Nutritional aspects of Guduchi are of a great importance in health and disease. The practice of using the leaves as a food article promotes health, serving both preventive and curative purposes. High carbohydrate and protein contents present in Guduchi helps in providing the essential energy component yielding 292.54 Cal/100g.<sup>[10]</sup> Trace element presence in guduchi makes it a potential chromium and potassium supplement. The inadequate dietary intake of Chromium causes several metabolic abnormalities including impaired glucose and lipid metabolism, elevated circulating insulin levels and decreased insulin receptor numbers.<sup>[54]</sup> Chromium repletion improves glucose tolerance and reverses abnormal elevations in circulating insulin and glucagon.<sup>[13]</sup> Intake of Chromium has also shown to improve glycemic control and cholesterol levels in patients with Type II diabetes. The common intake of guduchi leaves as an anti-diabetic by people in diet is benefiting them by the action of the chromium component. Chromium supplementation also helps in relieving ataxia and peripheral nerve conduction defects. Potassium supplementation can reduce cardiac arrhythmias and also prevent the occurrence of the same, thus supporting the cardiac functioning. Ayurveda mentions the utility of guduchi in Hriddourbalya- as it enhances cardiac wellness. Guduchi also provides sufficient iron and calcium in accordance with the daily requirement thus preventing conditions such as Iron deficiency anaemia, dizziness, weakness, fatigue, dyspnoea and neuropsychiatric manifestations of chronic hypocalcaemia. The neurological manifestations are clubbed under the name of Vatavyadhis (Diseases caused due to vitiated Vata) in Ayurveda and the authors have clearly stated about the properties of Guduchi shaka which can pacify vata<sup>[3,4]</sup> and hence prevent occurrence of the Vatavyadhis. Along with the particular components acting towards prevention of diseases, it can be noted that the drug is also a potent medicament for a number of diseased conditions, as understood by the pharmacological experimentation done on Guduchi. Hence it can be noted that the drug in-toto is considered a rejuvenator, replenishing the health of the person who consumes it.<sup>[55]</sup>

## CONCLUSION

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 pharmaco-therapeutics. 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. Also it is strong immunomodulator.

## REFERENCES

1. Pandey G. *Dravyaguna Vijnana* - Varanasi: Choukambha Krishnadas Academy, 2004; I: 697-710.
2. Bhavamishra. *Bhavaprakasha Nighantu - Hindi Commentary* by KC Chunekar. Ed.I; Varanasi: Chaukhumbha Bharathi Academy, 2002; 663.
3. Agnivesha, *Charaka samhita, Sutra sthana, 27/104*, refined and annotated by Charaka, redacted by Dridhabala with *Ayurveda Deepika* commentary by Chakrapanidatta; edited by Yadavji Trikamji Acharya; Varanasi: Chaukhamba Press; reprint, 2011; 234.
4. Sushruta, *Sushruta Samhita, Sutrasthana 46/254*, with *Nibandhasangraha* commentary by Shri Dalhanacharya; edited by Yadavji Trikamji Acharya; 6th ed. Varanasi: Chaukhamba Orientalia; 1997. p. 232. Kavya B et al / *Int. J. Res. Ayurveda Pharm.*, Mar– Apr, 2015; 6(2): 198.
5. Sharma PriyaVrat, *Namarupajnana*, Varanasi, Chaukambha Vishvabharati, Ed: I, Re., 2001; 75.
6. Kirti S, Mishra NP, Singh J, Khanuja SPS. *Tinospora cordifolia* (Guduchi), a reservoir plant for therapeutic applications: A Review. *Indian J Traditional Knowledge*, 2004; 3(3): 257-270.
7. Sharma M, Kumar A. Pharmacognostical characterization of some selected medicinal plants of semi-arid regions. *Journal of Pharmacognosy and Phytochemistry* 2013; 1(6): 216-228.
8. Neeraja PV, Margaret E. Amruthavalli (*Tinospora cordifolia*) multipurpose rejuvenator. *International Journal of Pharmaceutical, Chemical and Biological Sciences*, 2013; 3(2): 233-241.

9. Agnivesha, Charaka samhita, Sutra sthana, 4/13, refined and annotated by Charaka, redacted by Dridhabala with Ayurveda Deepika commentary by Chakrapanidatta; edited by Yadavji Trikamji Acharya; Varanasi: Chaukhamba Press; reprint, 2011; 36-40.
10. Devprakash, Srinivasan KK, Subburaju T, Gurav S and Singh S. *Tinospora cordifolia*: A Review on its Ethnobotany, Phytochemical and Pharmacological Profile. *Asian Journal of Biochemical and Pharmaceutical Research*, 2011; 4(1): 291-302.
11. Choudary N, Siddiqui MB, Azmat S and Khatoon S. *Tinospora cordifolia*: Ethnobotany, Phytopharmacology and Phytochemistry Aspects. *Int J Pharm Sci Res.*, 2013; 4(3): 891-899.
12. Bhattacharyya C and Bhattacharyya G. Therapeutic potential of Giloe, *Tinospora cordifolia* (Willd.) Hook. f. and Thomson (Menispermaceae): The Magical Herb of Ayurveda. *International Journal of Pharmaceutical and Biological Archives*, 2013; 4(4): 558- 584.
13. Porter DJ, Raymond LW. Chromium: Friend or Foe? *Arch Fam Med.*, 1999; 8: 386. <http://dx.doi.org/10.1001/archfami.8.5.386>
14. Jeejeebhoy KN. Chromium deficiency, glucose intolerance and neuropathy reversed by chromium supplementation, in a patient receiving long-term total parenteral nutrition. *Am. J. Clin. Nutr.*, 1977; 531-538.
15. Whelton PK, He J. Potassium in preventing and treating high blood pressure. *Semin Nephrol*, 1999; 19(5): 494-499.
16. Maiti A, Chatterjee S. Neuropsychiatric manifestations and their outcomes in chronic hypocalcaemia. *J Indian Med Assoc*, 2013; 111(3): 174-177.
17. Tiwari M, Dwivedi UN, Kakkar P. *Tinospora cordifolia* extract modulates COX-2, iNOS, ICAM-1, pro-inflammatory cytokines and redox status in murine model of asthma. *J Ethnopharmacol*, 2014; 153(2): 326-337. <http://dx.doi.org/10.1016/j.jep.2014.01.031>
18. Pushp P, Sharma N, Joseph GS, Singh RP. Antioxidant activity and detection of (-) epicatechin in the methanolic extract of stem of *Tinospora cordifolia*. *J Food Sci Technol.*, 2013; 50(3): 567-72. <http://dx.doi.org/10.1007/s13197-011-0354-8>
19. Ali H, Dixit S. Extraction optimization of *Tinospora cordifolia* and assessment of the anticancer activity of its alkaloid palmatine. *Scientific World Journal*, 2013; 376216.
20. Gupta A, Raj H, Karchuli MS, Upmanyu N. Comparative evaluation of ethanolic extracts of *Bacopa monnieri*, *Evolvulus alsinoides*, *Tinospora cordifolia* and their combinations on cognitive functions in rats. *Curr Aging Sci.*, 2013; 6(3): 239-43. <http://dx.doi.org/10.2174/18746098112059990036>

21. Jayaganthan P, Perumal P, Balamurugan TC, Verma RP, Singh LP, Pattanaik AK, Kataria M. Effects of *Tinospora cordifolia* supplementation on semen quality and hormonal profile in rams. *Anim Reprod Sci.*, 2013; 140(1-2): 47-53. <http://dx.doi.org/10.1016/j.anireprosci.2013.05.003>
22. Sachdeva H, Sehgal R, Kaur S. *Tinospora cordifolia* as a protective and immunomodulatory agent in combination with cisplatin against murine visceral leishmaniasis. *Exp Parasitol*, 2014; 137: 53-65. <http://dx.doi.org/10.1016/j.exppara.2013.12.006>
23. Huded S, Gummadi SV, Sankh K, Asha HN, Ashwini HS, Lingadore K. Evaluation of Guduchi yoga in the management of Vatarakta (Gouty arthritis): A clinical study. *Int. J. Res. Ayurveda Pharm.*, 2013; 4(5): 688-692. <http://dx.doi.org/10.7897/2277-4343.04512>
24. Kavya B, Kavya N, Ramarao V and Venkateshwarlu G. *Tinosporacordifolia* (Willd.) Miers.: Nutritional, ethnomedical and therapeutic utility. *Int. J. Res. Ayurveda Pharm.*
25. Kaur M., Singh A, Kumar B. Comparative antidiarrhoeal & antiulcer effect of aqueous & ethanolic extracts of *Tinospora cordifolia* in rats. *International Journal of Pharmaceutical Technology & Research*, 2014; 5: 122-8.
26. Goel B., Pathak N. Clinical evaluation of analgesic activity of Guduchi, *Tinospora cordifolia* using animal model. *Journal of Clinical Diagnosis & Research*, 2014; 8: 1-4.
27. Wani JA., Neema RK. Phytochemical screening & aphrodisiac activity of *Tinospora cordifolia*. *International Journal of Pharmaceutical & Clinical Research*, 2011; 3: 21-26.
28. Gupta MS, Sharma GD, Chakraborty B. Effect of aqueous extract of *Tinospora cordifolia* on functions of peritoneal macrophages isolated from CCl<sub>4</sub> intoxicated male albino mice. *BMC Complementary & Alternate Medicine*, 2011; 119102.
29. Kumar V., Mahdi F., Chander R, Hussain I. *Tinospora cordifolia* regulates lipid metabolism in alloxan induced diabetes in rats. *International journal of Pharmacy & Life Sciences*, 2013; 4: 3010-17.
30. Ramesh V., Jayaprakash R., Sridhar MP. Antioxidant activity of ethanol extract of *Tinospora cordifolia* on N-nitrosodiethylamine induced liver cancer in male wistar albino rats. *Journal of Pharmaceutical & Bioallied Sciences*, 2015; 1: 45-50.
31. Patgiri B., Umretia BL., Prajapati PK., Shukla VJ. Anti-inflammatory activity of aqueous extract of *Tinospora cordifolia*. *Ayurveda*, 2014; 35: 108-10.
32. Antonisamy P., Dhanasekaran M., Balthazar JD. Gastroprotective effect of epoxy clerodane diterpene isolated from *Tinospora cordifolia* on indomethacin induced gastric ulcers in rats. *Phytomedicine*, 2014; 21: 966-9.

33. Gupta A., Raj H., Upmanyu N. Evaluation of *B. monnieri*, *cordifolia*, *E. alsinoides* & their combinations on cognitive functions in rats. *Current Agriculture Sciences*, 2013; 6: 239-43.
34. Patel A., Singh CS., Patel NS. Radioprotective & cytoprotective activity of *Tinospora cordifolia* stem enriched extract containing Cordifolioside. *Indian Journal of Pharmacology*, 2013; 45: 237-43.
35. Ratnasamy R., Compos AM. A new antifeedant clerodane diterpenoid from *Tinospora cordifolia*. *Natural Product Review*, 2013; 27: 1431-6.
36. Gupta R., Sharma V. Ameliorative effect of *Tinospora cordifolia* root extract on histopathological & biochemical changes induced by aflatoxin b1 in mice kidney. *Toxicol. Int.*, 2011; 18: 94-8.
37. Sharma AK., K Kishore K, Sharma D., Agarwal SS., Singh SK. Cardioprotective activity of alcoholic extract of *Tinospora cordifolia* in CaCl<sub>2</sub> induced cardiac arrhythmia in rats. *Journal of Biomedical Research*, 2011; 25: 280-6.
38. Stance MH., A Nagy A., Tosa M., Vlad L. Hepatoprotective effect of orally administered melatonin & *Tinospora cordifolia* in experimental jaundice. *Chirurgia (bucur)*, 2011; 106(2): 205-10.
39. Patel MB., Mishra S. Hypoglycaemic activity of alkaloidal fraction of *Tinospora cordifolia*. *Phytomedicine*, 2011; 18: 1045-52.
40. Jain BN., Jain VK., Shete A. *Journal Advanced Pharmaceutical Technology Research*, 2010; 1: 30-3.
41. Dhingra D., Goyal PK. Evidence for the involvement of monoaminergic & GABAergic systems in antidepressant like activity of *Tinospora cordifolia* in mice. *Indian journal of Pharmaceutical Sciences*, 2008; 70: 761-7.
42. Kapoor P., Jarry H., Wuttke W. Evaluation of antiosteopotential of *Tinospora cordifolia* in female rats. *Maturitas*, 2008; 59: 329-38.
43. Jagetia GC, Rao SK. Evaluation of antineoplastic activity of Guduchi, *Tinospora cordifolia* in Ehrlich ascites carcinoma bearing mice. *Biological Pharmaceutical Bulletin*, 2006; 29: 460-6.
44. Gupta RS., Sharma A. Antifertility effect of *Tinospora cordifolia* stem extract in male rats. *Indian Journal of Experimental Biology*, 2003; 41: 8859-64.
45. Tiwari M., Kakkar P., Dwivedi UN. *Tinospora cordifolia* extract modulates COX-2, iNOS, ICAM 1, pro-inflammatory cytokines & redox status in murine model of asthma. *Journal of Ethnopharmacology*, 2014; 28: 326-37.

46. Mishra R., Kaur G. Aqueous ethanolic extract of *Tinospora cordifolia* as a potential candidate for differentiation based therapy of glioblastomas. PLOS One, 2013; 8.
47. Nadig PD., Dethe SM., Revankar RR., Aliyar MA. Effect of *Tinospora cordifolia* on experiental diabetic neuropathy. Indian Journal of Pharmacology, 2012; 44: 580-3.
48. Baskar A., Agastian P., Dhanasekaran M. Chemopreventive potential of epoxy Clerodane diterpene from *Tinospora cordifolia* against diethylnitrosamine induced hepatocellular carcinoma. Invest New Drugs, 2009; 27: 347-55.
49. Singh V., Banyal HS. Antimalarial effect of *Tinospora cordifolia* & *Cissampelos pareira* on Plasmodium berghei. Current Science, 2011; 110: 1356-8.
50. Xavier TF., Anand SP. Antibacterial activity of stem extracts of *Tinospora cordifolia*. Ancient science Life, 2003; 23: 40-3.
51. Mishra R, G Kaur. *Tinospora cordifolia* induces differentiation & senescence pathways in neuroblastoma cells. Molecular Neurobiology, 2015; 52: 719-33.
52. Ashok BK., Ravishankar B., Bhat SD. Antipyretic activity of Guduchi ghrita formulations in albino rats. Ayu, 2010; 31: 367-70.
53. Badar VA., Thawani VR., Wakode PT. Efficacy of *Tinospora cordifolia* in allergic rhinitis. Journal of Ethnopharmacology, 2005; 96: 445-9.
54. Sharm MM., Batra A., Mittal J. *Tinospora cordifolia*: A multipurpose medicinal plant- A review. Journal of Medicinal Plant Studies, 2014; 2: 32-47.
55. Spandana U., Ali SL., Nirmala T. A review on *Tinospora cordifolia*. International Journal of current Pharmaceutical review & Research, 2013; 4: 61-68.