Review Article

Tinospora cordifolia: A Multipurpose Miracle Plant Having Medicinal Importance: A Review

Santoshi Malla, Lal Bista
Institute of Agriculture and Animal Sciences, Tribhuwan University, Bharatpur, Nepal

Abstract

Medicinal plants are of great importance since the beginning of human civilizations. Popularity of medicinal plants is increasing year by year in plant-based medicines, health products, pharmaceuticals, cosmetics, food supplements, etc., due to its well-known properties along with its no side effects as compared to drugs. *Tinospora cordifolia is* commonly known as "Guduchi," "Gurjo," heart-leaved moonseed," or giloy. A chemical constituent present in various parts of *T. cordifolia*, their medicinal importance has risen up its popularity. Recently from the period of COVID-19 pandemics, it is widely used to boost up immunity to fight against the coronavirus. This miracle plant is a shrub of vast Ayurvedic importance and is widely used in clinical research. This article had compiled diverse information regarding the identifications, chemical components present, pharmacological as well as Ayurvedic importance of *T. cordifolia* with a focus of it on recent occurred COVID pandemic as well.

Keywords: Ayurvedic, clinical research, COVID-19, health products, immunity, miracle plant, pharmaceuticals

Introduction

Tinospora cordifolia which is commonly known as Guduchi, Amrita (Sanskrit), Gurjo (Nepali), Giloya (hindi), Gulancha, Giloe (Bengali), Galo (Gujrati), and Tepoatige (Telagu) is the herbaceous vine of medicinal importance belonging to family Menispermaceae. About 70%–80% of people are still using plant-based medicinesfor better health as it has no side effects and has better compatibility with the human body.[1] It is the natural products having the medicinal importance which is gaining popularity in clinical research due to its no side effects.[2] It is a deciduous, largely spreading, climbing shrub found at higher altitude, having elongated twinning branches, and typical greenish-yellow flowers. It has a racemose panicle where male flowers are clustered, and females are solitary. It has six sepals in two series having three in each where outer ones are smaller than inner and six petals, smaller than sepals, is membranous and obovate. Fruit are fleshy, single-seeded, ovoid smooth druplets on thick stalks with subterminal style scars, scarlet or orange-colored, aggregates in clusters. Seeds are white, bean-shaped, and curved, while embryo also turns into curve shape later. Leaves are simple, alternate, and exstipulate having long, roundish, and pulvinate petioles. Leaves were morphologically heart-shaped, hence known to be heart-leaved moonseed. Different kinds of active components such as alkaloids, steroids, diterpenoid lactones, aliphatics, and glyceroides are derived from the different parts of plants. The stem and the root is high in medicinal constituents. Leaf extract as well is found effective against microbial infections. It helps in cell repairment and rejuvenation process. It has great medicinal importance in case of diabetes, infection, toxicity, cancer, inflammation, spasmodic, arthritic, neoplastic, malaria, urinary disease, fever, ailments, COVID-19, etc., Recently occurred pandemic had risen up its popularity and importance as immunity booster had captured the focus of many researchers towards this miracle plant. In this review, we focus more on the active component present in its parts and its medicinal importance in today's world.

Types

The genus *Tinospora* is mainly found of two types of namely *T. cordifolia* and *Tinispora sinensis*. These two species are further elaborated below:

Access this article online

Quick Response Code:

Website: www.matrixscipharma.org

DOI: 10.4103/mtsp.mtsp_3_21

Address for correspondence: Dr. Santoshi Malla, Institute of Agriculture and Animal Sciences, Tribhuwan University, Bharatpur 44209, Nepal.
E-mail: mallasantoshi77@gmail.com

How to cite this article: Malla S, Bista L. *Tinospora cordifolia*: A multipurpose miracle plant having medicinal importance: A review. Matrix Sci Pharma 2021;5:54-9.

Received: 08-Apr-2021 **Accepted:** 05-Jul-2021 **Available Online:** 01-Feb-2022

Distruibution and Habitat

Tinospora is native medicinal plant of tropical and subtropical regions of Asia including Nepal, India, Sri Lanka, China, Philippines, Myanmar, Thailand, Indonesia, Malaysia, Vietnam, Bangladesh, and South Africa.[2] The species *T. sinensis* is wild one and found to be scattered, infrequently in deciduous forest areas, and the species *Tinospora cordfolia* is found wild mostly in deciduous forest as well as in cultivated form. It is usually found throughout Tropical Asia up to ascending height of 300 m. It is found mainly in the rainforest, tropical and subtropical regions of Asia. It has greater adaptability and grows well in a wide range of acidic to alkaline soil with a moderate amount of moisture. Since 2000 BC, it was used by practitioners of Ayurveda for the treatment of various diseases and found effecting in building up immunity to fight against many diseases. Classification, differentiation and some descriptions of Tinospora can be founded in the Tables 1-4.

Cultivation

Among these two species, *T. cordifolia* is found in cultivated form as well. Medicinal plants are cultivated using organic manures such as FYM, compost, Vermi-compost, green manuring, depending upon the need of the species. Chemical fertilizer and pesticides are not used in its cultivation as they aid in the accumulation of toxic residuals in the plant's parts. Bio-pesticides are used to control insects and pest over chemical pesticides. Irrigation is given weekly or at fortnight intervals depending upon the season. After maturation, the mature plants are harvested, and the plant parts are chopped in small places and dried.

Tinospora is cultivated for medicinal as well as for ornamental purposes. They are propagated through cutting where the twigs are cut down and are placed between the branches of the tree where they are able to establish themselves within some year as a climber.[3] Yield has been estimated around 9–10 quintal/ha.

Table 1: Binomial classification of *Tinospora cordifolia*

Binomial classification	
Kingdom	**Plantae**
Sub kingdom	*Traceophytes*
Super division	*Spermatophyta*
Division	*Magnoliophyta*
Sub division	*Angiosperms*
Class	*Magnoliopsia*
Sub class	*Polypeptalae*
Order	*Ranunculales*
Family	*Menispermaceae*
Genus	*Tinospora*
Species	*Cordifolia*
Binomial name	*T. cordifolia*

T. cordifolia: Tinospora cordifolia

Active Components

It is a plant having a wide range of chemical constituents such as alkaloids, glycosides, steroids, sesquiterpenoid, phenolics, aliphatic compounds, diterpenoid lactones, polysaccharides with leaves rich in Calcium and Phosphorus.[4] Stem contains clerodane furono diterpene glucoside and the structures has been created by different spectroscopic studies.[5]

Alkaloids

It is extracted from stem and root. It contains Berberine, Palmatine, Tembetarine, Magnoflorine, Choline, Tinosporin, Isocolumbin, Tetrahydropalmatine. It acts as antiviral infections, neurological, Immunomodulatory, anti-diabetes as well as anticancer.[6]

Glycosides

It is extracted from whole plant. It contains Tinocordiside, Tinocordifolioside, Cordioside, 18-norclerodane glucoside, Cordifolioside Syringin, Syringinapiosylglycoside, Furanoidditerpene, glucoside, palmatosides, Cordifolioside A, B, C, D and E, Pregane glycoside. It acts as anti-cancer, treats neurological disorders such as amyotrophic lateral sclerosis, Parkinsons, and Dementia.[7]

Table 2: Differentiation between the two species of *Tinospora* namely, *Tinospora cordifolia* and *Tinispora sinensis*

Character	*T. cordifolia*	*T. sinensis*
Nature	Profuse climber plant	Rambling shrub
Leaves	Broad as long, thin papery width , ovate reniform, nonhairy, dark green, more in number having size 5-8.5 cm	Long as broad, broader than long, thick leathery width, ovate of cordate hairy, yellowish green, less in number having size 8-12 cm
Stem	Stem having lenticels with T.S wheel like shape	Stem having lenticels with T.S wheel like shape
Bark	Green in color and corky	Dirty green and warty
Petiole	3-4 cm	9-11 cm
Branches	Long and wiry	Short and thick
Flowers	5-8 mm across, greenish-yellow having male fascicled and female solitary or in raceme	5-7 mm across, greenish yellow having female in raceme from bare branches
Drupe	5-6 mm across, globose, orange-red when ripen	0.9-1.2 cm across, ellipsoid, orange-red when ripen
Flowering and fruiting time	January - August	January - May
Distribution	Mostly in deciduous forests and planted	Scattered, infrequently in deciduous forest area

T. sinensis: Tinispora sinensis, T. cordifolia: Tinospora cordifolia

Table 3: Nutrient content per 100 g of *Tinospora cordifolia*

Nutrients	Amount present in 100 g of *T. cordifolia*
Protein	2.30 g
Carbohydrates	3.34 g
Fiber	11.321 g
Calcium	85.248 mg
Iron	5.87 mg
Vitamin A	303.7 mcg
Vitamin C	56 mg
Energy	292.54 calorie

T. cordifolia: Tinospora cordifolia

Table 4: Different parts of *Tinospora cordifolia* and its required dosage

Plant part	Requirement dosage
T. cordifolia Stem powder	1-3 g
T. cordifolia stem juice	1-5 ml
T. cordifolia stem extract	125-500 mg
T. cordifolia stem water	50-100 ml
T. cordifolia sativa	250-1000 mg
T. cordifolia leaves juice	2.5-10 ml
T. cordifolia leaves powder	1-3 g

T. cordifolia: Tinospora cordifolia

Steroids

It is extracted from the shoot parts. It contains 20$^{\delta}$-Hydroxyecdysone, $^{\delta}$-sitosterol, Giloinsterol Ecdysterone, Makisterone A. It inhibits Tumor necrosis factor-alpha, interleukin (IL)-1 $_{\beta}$, IL-6 and COX-2, inflammatory arthritis, IgA neuropathy.[8]

Sesquiterpenoid

It is extracted from stem. It contains Tinocordiofolin.[9]

Diterpenoid lactones

It is extracted from the whole plant. It contains Furanolacone, Tinosporon, Tinosporides, Columbin, Clerodane derivatives and Jateorine. It acts as anti-inflammatory, antimicrobial, antiviral, antihypertensive, Vasorelaxant, induces apoptosis in leukemia by activating caspase-3 and bax, and inhibits bcl-2 and antiseptic.[10]

Aliphatic compounds

It is extracted from whole compounds. It contains Heptacosanol, Octacosanol, Nonacosan-15-one dichloromethane. It acts as anti-inflammatory, protection against 6-hydroxydopamine induced parkinsonisns in rats.[11]

Other compounds

It is extracted from whole plant and the roots, see Figure 1. It contains 3 (ά-4-dihydroxyl-3-methoxy-benzyl)-4-(4-compounds hydroxyl-3-methoxy-benzyl)-tetrahydrofuran, Giloinin, Tinosporic acid, Tinosporidine, Cordifol, Cordifelone, Jatrorrhizine, N-trans-feruloyltyramine as diacetate. It acts as protease inhibitors for HIV and drug-resistant HIV.[12]

Figure 1: Morphology of *Tinospora cordifolia*

Medicinal Importance

Immunity booster

A study had found and characterized the various classes of active components noted for immunomodulatory action. It is an immunomodulator, and it is given mostly to children through vaccine as they were highly prone to infection.[13] In case of diarrhea, Mix ¼-1/2 teaspoon of *Tinospora* in 1 Glass of lukewarm water. Mix well and drink it after lunch and dinner. In recent occurred COVID-19 pandemic, many people consumed the extract of *T. cordifolia* to boos up energy to fight against coronavirus, and its popularity and effectiveness is widely spread as well as noticed.[14]

Anti-diabetes

Based on the recent study, the in-vivo studies of different extracts of plant on diabetic patients and the sedimental extract of T. cordifolia on subject at 30 days. Different doses (200 and 400 mg/kg b. w) and on 30 days in streptozotoci-diabetic albino rats and found that the *T. cordifolia* shows the antidiabetic activity in diabetic animals with 50%–70% efficiency than that of insulin.[15,16] In traditional medicines, the stems of *T. cordifolia* is used in the therapy of diabetes by regulation the blood glucose. Phyto-compounds such as Alkaloids, tannins, cardiac glycosides, saponins, flavonoids, Steroids act as antidiabetic by mitigating the oxidative stress, promoting insulin secretion, and through inhibiting gluconeogenesis and glycogenolysis, thereby regulating the blood glucose level.[17]

Antitoxicity

The plant extracts scavage free radicals generated during alfatoxicosis and have protective action by lowering thiobarbituric acid reactive substances levels as well as the activities of antioxidant enzymes through superoxide dismutase (SOD), catalase, glutathione peroxidase (GPx), Glutathione S-transferase as well as glutathione reductase in kidney.[18-20] Oral treatment of *T. cordifolia* extracts prevents the occurrence of lead induced liver damage. In case of alfatoxin-induced nephrotoxicity, alkaloids such as Choline, tinosporin, isocolumbin, palmatine, tetrahydropalmatine, and magnoflorine is found effective.

Anticancer action

Ali *et al*. reported its effect is mostly in animals.[21] *T. cordifolia* stem/Aqueous and ethanolic extract plays radioprotective role through increasing body weight, tissue weight, testes-body weight ratio and tubular diameter as well as inhibit the toxic effect of sub-lethal gamma radiation on testes in male swiss Albino mice. *T. cordifolia* extract Dihydrotestosterone stimulates the growth and proliferation of Human LNCap cells.[22]

Anti-hiv action

Some of the research found that the root extract of T. cordifolia affects the immune system of HIV positive patient. It improves the therapeutic results by reducing the recurrent resistance of HIV virus. *T. cordifolia* extract shows the anti-HIV action by reducing the eosinphil count, stimulating the B lymphocytes, macrophages, and polymorphonuclear leukocytes and hemoglobin percentage, hence disclosing its auspicious role of application in the management of the disease.[23-25]

Anti-oxidant action

The formulation of *T. cordifolia* and examined its antioxidant activity DPPH (1-diphenyl-2-picrylhydrazyl) free radical scavenging method.[26] The stem methanol extracts having antioxidant activity are given orally to increase the erythrocytes membrane lipid peroxide and catalase activity as well as also decrease the activities of SOD, GPx in alloxan-induced diabetic rats. Its extract also has possible inhibitors of aldose reductase and antioxidant agents, thus decreasing chemotoxicity induced by free radicals.[27]

Antimicrobial activity

Jeyachandran *et al*. found antibacterial activity of stem against gram-positive and negative bacteria through the *in-vitro* analysis and reveals good therapeutic action on infectious diseases. T. cordifolia extract have anti-microbial action against *Escherichia coli*, *Staphylococcus aureus, Klebsiella pneumonia*, *Proteus vulgaris*, *Salmonella typhi*, *Shigella flexneri, Salmonella paratyphi, Salmonella typhimurium, Pseudomonas aeruginosa, Serratia marcesene*s (Gram-positive bacteria). *T. cordifolia* extract has immune-stimulant properties towards macrophages.[28]

Anti-inflammatory and anti-depressant action

Sarma *et al*. reported that the ethanolic extract of *T. cordifolia* at dose of 100 mg/kg gives significant anti-depressant action in all parameters compared to standard drug Diazepam at dose of 2.5 mg/kg. The stem or the aqueous extract of *T. cordifolia* is effective against inflammation problems whereas pet. Ether action is effective against the depressions.[29]

Hepatic disordeer

T. cordifolia water extract has protective action on Hepatic and Gastrointestinal Toxicity increasing in the levels of gamma-glutamyl transferase, aspartate transaminase, alanine transaminase, Triglyceride, Cholestrol, HDL and LDL (0.05) significantly in the alcoholic sample whereas after *T. cordifolia* extract intervention, their level get downregulated and the patient starts showing normal liver function as *T. cordifolia* extract relives the symptoms.[30]

Hypolipidemic effect

Stanely *et al*. studied the hypolipidemic effect of aqueous extract of root on rat weighing 2.5–5 g/kg body weight in 6th week which leads to reduce cholesterol, decrease in serum, phospholipids as well as fatty acid in alloxan diabetic rats. The dose of root extract at rate 5 g/kg body weight exhibits highest hypolipidaemic effect. As the serum lipid level decreased, the risk of vascular disease.[31]

Wound healing

The recent examination was focused on evaluating the wound healing activity of *T. cordifolia* alcoholic extract and its activity on dexamenthasone suppressed healing. Incision, excision and the dead space of the wound models are used to examine the wound healing effect of plant increased the tensile strength extract of *T. cordifolia* might be assigned to promotion of collagen synthesis and the extract of *T. cordifolia* did not reverse the wound healing suppressed by dexamethasone.[32]

Anti-osteoporotic effects

A study reported that the *T. cordifolia* affect the proliferation, differentiation and mineralization of bone-like matrix on the osteoblast systems in *in vitro*, thus, shows potential application as an anti-osteoporotic factor. Alcoholic extract of *T. cordifolia* increases the differentiation of cells into oestoblastic lineage as well as increasing mineralization of bone-like matrix by stimulating the growth of osteoblasts.[33] *T. cordifolia* extract such as Beta Ecdysone (Ecd) has been found inducing an increase in the thickness of joint cartilage significantly, facilitate the osteogenic differentiation in mouse mesenchymal stem cells and further, 20-OH-Beta-Ecd extracted from *T. cordifolia* foreground the importance of *T. cordifolia* in treating osteoarthritis and osteoporosis.

Parkinson's disease

T. cordifolia extract is highly effective against Parkinsonism, and they observed the anti-inflammatory activity of aqueous extract in 1-methyl-4-phenyl-1,2,3,6-tetra hydropyridine (MPTP)-intoxicated parkinsonian mouse model. *T. cordifolia* extract protects the dopaminergic neurons by suppressing neuroinflammation in MPTP-induced parkinsonian mouse model.[34]

COVID-19

Rais *et al*. stated that management of mild COVID-19 infection is possible with the use of *T. cordifolia*. COVID-19 is a recent occurred pandemic highlighted the importance of Gurjo in medicinal field. According to Ayurved and Yog Guru Baba Ramdev, Consuming the *T. cordifolia* along with ginger, tulsi, pepper, and turmeric will help in boosting immune system and prevents the corona virus.[35,36] One study has stated that *T. cordifolia* is crucial in the prevention of attachment of virus to the host cells, which prevents the replication of severe acute respiratory syndrome coronavirus-2. It also has antipyretic effect that aids in maintaining body temperature.

The symptoms of COVID-19 such as cough, cold, and tonsil are prevented by this medicinal plant with its anti-inflammatory properties.[37] The shortness of breath, chest, tightness and wheezing are also improved by consuming the juice of *T. cordifolia* or chewing the stem of it. Not only that, it also boost the immune system and effective for fever management. Thus, it is highly recommended for preventing the coronavirus.

Conclusion and Recommendation

T. cordifolia is the miracle shrub containing a various number of active as well as miscellaneous compounds having medicinal importance in case of fever, jaundice, cancer, HIV, asthma, skin disease, inflammation, snake bite, fracture, pain, diarrhea, etc. Its cultivation is done around the Bagmati corridor of Kathmandu Valley after knowing the importance of *T. cordifolia* in recently occurred pandemic. It is a medicinal plant with easy and simple cultivation practices and grow even in a normal management practice. Whole plant including leaves, stem and roots are used to extract the active components present in respective parts and effective to treat various types of diseases with no side effects. It has been used as medicinal purpose since ancient times. Although it is a miracle plant of vast medicinal importance, it is rarely cultivated commercially. Even though the genetically diverse and the reports of the application of micro-propagation of *T. cordifolia* exist, effective conservation strategies of economically important medicinal plant's germplasm are yet to be completed. This plant has the capacity to treat many severe diseases with no side effects and harms. After corona, this medicinal plant had gained importance and people were aware about its beneficial aspects. It should be cultivated commercially to facilitate export and can earn money which leads to self as well as world's development as the plant-based medicines have no side effects as compared to synthetic chemical-based medicines. This miracle plant needs proper attention for commercial cultivation so that health problems could be minimized at high extent through the benefits of active constituents present in it which saves money as well as health. Government as well as private sectors have to focus on commercialization of *T. cordifolia* as it has the potential to prevent against wide range of disease including recent occurred COVID-19.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Saha S, Ghosh S. *Tinospora cordifolia*: One plant, many roles. Anc Sci Life 2012;31:151-9.
2. Khan M, Haque MS, Chowdhury SI. Medicinal use of the unique plant *Tinospora cordifolia*: Evidence from the traditional medicine and recent research. Asian J Med Biol Res 2017;2:508-12.
3. Abhijeet R, Mokat D. On vegetative propagation through stem cuttings in medicinally lucrative *Tinospora* species. J Pharmacogn Phytochem 2018;7:2313-8.
4. Choudhary N, Siddiqui MB, Khatoon S. Pharmacognostic evaluation of *Tinospora cordifolia* (Willd.) Miers and identification of biomarkers. Indian J Tradit Knowl 2014;13:543-0.
5. Maurya R, Manhas LR, Gupta P, Mishra PK, Singh G, Yadav PP. Amritosides A, B, C and D: Clerodane furano diterpene glucosides from *Tinospora cordifolia*. Phytochemistry 2004;65:2051-5.
6. Bhatt RK, Sabata BK. A furanoid diterpene glucoside from *Tinospora cordifolia*. Phytochemistry 1989;28:2419-22.
7. Maurya R, Handa SS. Tinocordifolin, a sesquiterpene from Tinospora cordifolia. Phytochemistry 1998;49:1343-5.
8. Bhardwaj M. Review on phytochemical and pharmacological activities of *Tinospora cordifolia* Linn. J Gujarat Res Soc 2019;21:1934-54.
9. Duraipandiyan, V.; Ignacimuthu, S.; Balakrishna, K.; Al-Harbi, N. A. Antimicrobial Activity of *Tinospora cordifolia*: An Ethnomedicinal Plant. Asian J. Tradit. Med. 2012, 7, 59–65.
10. Narayanan A, Raja S, Ponmurugan K, Kandekar S, Natarajaseenivasan K, Maripandi A, *et al*. Antibacterial activity of selected medicinal plants against multiple antibiotic resistant uropathogens: A study from Kolli Hills, Tamil Nadu, India. Benef Microbes 2011;2:235-43.
11. Prasad B, Chauhan A. Anti-oxidant and antimicrobial studies of *Tinospora cordifolia* (Guduchi/Giloy) stems and roots under *in-vitro* condition. Int J Adv Microbiol Health Res 2019;3:1-10.
12. Singh D, Chaudhuri PK. Chemistry and pharmacology of *Tinospora cordifolia*. Nat Prod Commun 2017;12:299-308.
13. Meena AK, Singh A, Panda P, Mishra S, Rao MM. *Tinospora cordifolia*: Its bioactivities and evaluation of physicochemical properties. Int J Pharmacogn Phytochem Res 2010;2:50-5.
14. Pandey MU, Chikara SK, Vyas MK, Sharma R, Thakur GS, Bisen PS. *Tinospora cordifolia*: A climbing shrub in health care management. Int J Pharm Bio Sci 2012;3:612-28.
15. Verma DK, Kumar P, El-Shazly M. Unmasking the many faces of giloy (*Tinospora cordifolia* L.): A fresh look on its phytochemical and medicinal properties. Curr Pharm Des 2021;27:2571-81.
16. Mittal J, Sharma MM, Batra A. *Tinospora cordifolia*: A multipurpose medicinal plant A. J Med Plants 2014;2:32-47.
17. Jabiullah SI, Battineni JK, Bakshi V, Boggula N. *Tinospora cordifolia*: A medicinal plant: A review. J Med Plants 2018;6:226-30.
18. Sharma U, Bala M, Kumar N, Singh B, Munshi RK, Bhalerao S. Immunomodulatory active compounds from *Tinospora cordifolia*. J Ethnopharmacol 2012;141:918-26.
19. Biswasroy P, Panda S, Das C, Das D, Kar DM, Ghosh G. *Tinospora cordifolia* a plant with spectacular natural immunobooster. Res J Pharm Technol 2020;13:1035-8.
20. Shamsuzzaman M, Hasan MR. A review of anticancer potential medicinal plants. J Sci Facts 2019;5:1-4.
21. Mathew S, Kuttan G. Antioxidant activity of *Tinospora cordifolia* and its usefulness in the amelioration of cyclophosphamide induced toxicity. J Exp Clin Cancer Res 1997;16:407-11.
22. Khan MI, Harsha PS, Giridhar P, Ravishankar GA. Pigment identification, antioxidant activity, and nutrient composition of *Tinospora cordifolia* (willd.) Miers ex Hook. f and Thoms fruit. Int J Food Sci Nutr 2011;62:239-49.
23. Sivakumar V, Rajan MD. Antioxidant effect of *Tinospora cordifolia* extract in alloxan-induced diabetic rats. Indian J Pharm Sci 2010;72:795.
24. Gupta GD, Sujatha N, Dhanik A, Rai NP. Clinical evaluation of Shilajatu Rasayana in patients with HIV infection. Ayu 2010;31:28.
25. Gupta R, Sharma V. Ameliorative effects of *Tinospora cordifolia* root extract on histopathological and biochemical changes induced by aflatoxin-B1 in mice kidney. Toxicol Int 2011;18:94.
26. Ali H, Dixit S. Extraction optimization of *Tinospora cordifolia* and assessment of the anticancer activity of its alkaloid palmatine. ScientificWorldJournal 2013;2013:376216.
27. Kalikar MV, Thawani VR, Varadpande UK, Sontakke SD, Singh RP, Khiyani RK. Immunomodulatory effect of *Tinospora cordifolia* extract in human immuno-deficiency virus positive patients. Indian J Pharmacol 2008;40:107.
28. Akhtar S. Use of *Tinospora cordifolia* in HIV infection. Indian J Pharmacol 2010;42:57.
29. Mehra TN, Arora M, Madan S. Standardization and evaluation of formulation parameters of *Tinospora cordifolia* tablet. J Adv Pharm

Educ Res 2013;3:440-9.
30. Jeyachandran R, Xavier TF, Anand SP. Antibacterial activity of stem extracts of *Tinospora cordifolia* (Willd) Hook. f and Thomson. Ancient Sci Life 2003;23:40.
31. Sarma DN, Khosa RL, Chansauria JP, Sahai M. Antistress activity of *Tinospora cordifolia* and *Centella asiatica* extracts. Phytother Res 1996;10:181-3.
32. Sharma P, Parmar J, Verma P, Goyal PK. Radiation-induced testicular injury and its amelioration by *Tinospora cordifolia* (an Indian medicinal plant) extract. Evid Based Complement Altern Med 2011;2011:643847.
33. Stanely P, Prince M, Menon VP. Hypoglycaemic and other related actions of *Tinospora cordifolia* roots in alloxan-induced diabetic rats. J Ethnopharmacol 2000;70:9-15.
34. Shanbhag T, Shenoy S, Rao MC. Wound healing profile of *Tinospora cordifolia*. Indian Drugs 2005;42:217-21.
35. Abiramasundari G, Sumalatha KR, Sreepriya M. Effects of *Tinospora cordifolia* (Menispermaceae) on the proliferation, osteogenic differentiation and mineralization of osteoblast model systems *in vitro*. J Ethnopharmacol 2012;141:474-80.
36. Birla H, Rai SN, Singh SS, Zahra W, Rawat A, Tiwari N, *et al*. *Tinospora cordifolia* suppresses neuroinflammation in parkinsonian mouse model. Neuromol Med 2019;21:42-53.
37. Rais A, Kumar T, Yadav A, Negi DS. Management of a mild COVID-19 infection through Ayurvedic intervention: A case report. J Ayurveda Case Rep 2020;3:91.