

Tinospora cordifolia: Its Bioactivities and Evaluation of Physicochemical Properties

*¹AK Meena, ¹Arjun Singh, ¹P Panda, ¹Sudip Mishra, ¹MM Rao

¹National Institute of Ayurvedic Pharmaceutical Research, Patiala – 147001 (Punjab)

²School of Pharmaceutical Sciences, Shobhit University, Meerut, UP, (India)

ABSTRACT

The medicinal plants are widely used by the traditional medical practitioners for curing various diseases in their day to day practice. In traditional systems of medicine, different parts (leaves, stem, flower, root, seeds and even whole plant) of *tinospora cardifolia* (Menispermaceae), commonly known as Guduchi are used. *T. cordifolia* is a glabrous, succulent, climbing shrub native to India. The plant is well known for several medicinal uses like immunostimulant, anti-bacterial, analgesic, antipyretic and also for the treatment of jaundice, skin diseases, diabetes, anemia etc. As there is no detailed on the standardisation work reported on stem, the physicochemical parameters, brief study on pharmacological activities and microbial contamination analysis are carried out. The study revealed specific identities for the particular crude drug which will be useful in identification and control to adulterations of the raw drug.

Key words: *Tinospora cordifolia*, physicochemical parameters, pharmacological activities.

INTRODUCTION

The medicinal use of plants is very old. The writings indicate that therapeutic use of plants is as old as 4000–5000 B.C. and Chinese used first the natural herbal preparations as medicines. Plants are one of the most important sources of medicines. Today the large number of drugs derived from plants, like morphine from *Papaver somniferum*, Aswagandha from *Withania somnifera*, Ephedrine from *Ephedra vulgaris*, Atropine from *Atropa belladonna*, Reserpine from *Roulphia serpentina* etc. The medicinal plants are rich in secondary metabolites (which are potential sources of drugs) and essential oils of therapeutic importance. The important advantages claimed for therapeutic uses of medicinal plants in various ailments are their safety besides being economical, effective and their easy availability [1, 2]. Because of these advantages the medicinal plants have been widely used by the traditional medical practitioners in their day to day practice. According to a survey (1993) of World Health Organization (WHO), the practitioners of traditional system of medicine treat about 80% of patients in India, 85% in Burma and 90% in Bangladesh [3]. In traditional systems of medicine the Indian medicinal plants have been used as a immunostimulant and in successful management of various disease conditions like bronchial asthma, chronic fever, cold, cough, malaria, dysentery, convulsions, diabetes, diarrhoea, arthritis, emetic syndrome, skin diseases, insect bite etc. and in treatment of gastric, hepatic, cardiovascular & immunological disorders [1,4-8].

Tinospora cordifolia (Menispermaceae), is also known as Guduchi (Hindi), Gulancha/palo (Bengal), Galo (Gujarati), Giloya, Shindilakodi (Tamil), Guduchi, Madhuparni, Amrita, Chinnaruha, Vatsadanni, Tantrika,

Kuundalini, Chakralakshanika (Sanskrita), Tippaatigo (Telugu), Gulavel (Marathi), Amrita Balli (kannada), Ambrithu (Malayalam), Gilo (Punjabi).

The plant is a glabrous climbing shrub found throughout India, typically growing in deciduous and dry forests. The leaves are simple, alternate, entire, cordate, 7-9 nerved and heart shaped. The succulent bark is creamy white to grey in color, with deep clefts spirally or longitudinally, spotted with rosette-like lenticels. It puts out long, slender aerial roots, often growing on mango or neem trees [9]. Flowers are yellow generally grows in clusters, female flowers usually solitary, growing in lax racemes from nodes on old wood. Fruits are drupes, turn red when ripe. It thrives easily in the tropical region, often attains a great height, and climbs up the trunks of large neem trees. The surface of the stems appears to be closely studded with warty tubercles and the surface skin is longitudinally fissured. The wood is white, soft, and porous, and the freshly cut surface quickly assumes a yellow tint when exposed to air. Long thread-like aerial roots come up from the branches [10].

Tinospora cordifolia has anti-cancer [11,12], immune stimulating [13], nerve cell protecting [14], anti-diabetic [15-18], cholesterol-lowering and liver-protective actions [17].

Tinospora cordifolia is also responsible for decreasing the tissue damage caused by radiation [19-21], the side effects of some forms of chemotherapy [22] and speeding healing of diabetic foot ulcers [23]. The plant is also used as anti-bacterial, analgesic, antipyretic and also for the treatment of jaundice, skin diseases, diabetes, anemia etc [9-13].

Tinospora cordifolia stem has some chemical constituents like Alkaloid (berberine (I) , Palmatine (II), Giloin, crude Giloininand) & Glucoside (18-norclerodane glucoside

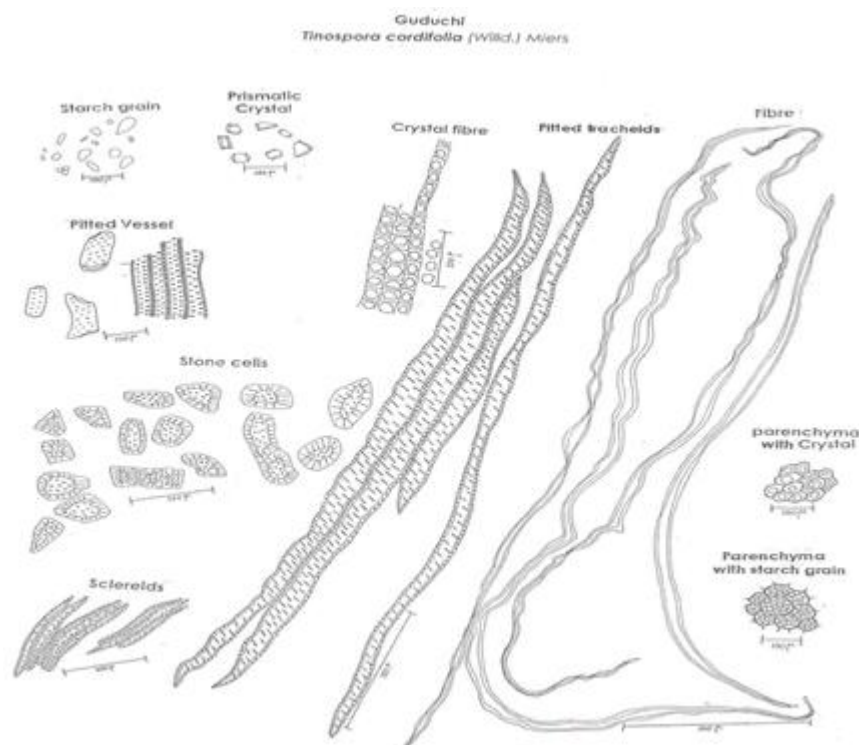


Figure 1. Macroscopic characters of *Tinospora cordifolia*

(VII) glycosides, Furanoid diterpene glucoside (VIII and IX), Tinocordiside (X), Tinocordifolioside (XI), cordioside, Cordifolioside A, Cordifolioside B, Syringin (XII), Syringin-apiosylglycoside, Palmatosides C, Palmatosides F, Cordifolioside A (XIII), Cordifolioside B, Cordifolioside C, Cordifolioside D, Cordifolioside E, arabinogalactan polysaccharide (TSP), steroids (Ecdysterone (XXIV), Makisterone A (XXV), Giloinsterol), Sesquiterpenoid (Tinocordifolin), Diterpenoid (Furanolactone XIV, Lactones, Clerodane derivatives XV, XVI and XVII [(5R,10R)-4R-8R-dihydroxy-2S-3R:15,16-diepoxy-cleroda-13 (16), 14-dieno-17,12S: 18,1S-dilactone] and Tinosporon, Tinosporides XVIII, and XIX, Jateorine (XX), Columbin (XXI), tinosporic acid, cordifolisides A to E, syringe) etc.

Ayurvedic literature quotes different parts of guduchi as a constituent of several compound preparations, like stem is a bitter stomachic; stimulates bile secretion; causes constipation; tonic; allays thirst, fever, burning sensation, prevents vomiting; diuretic; enriches the blood; cures jaundice; useful in skin diseases; the juice is useful in diabetes, vaginal and urethral discharges, low fevers, and enlarged spleen. The root and stem are prescribed in combination with other drugs as an antidote to snake bite and scorpion sting. An infusion of the powdered stem is used as an alternative and tonic and has enjoyed the reputation among ancient Hindu writers of being an aphrodisiac [24,25].

Bioactivities: *Tinospora cordifolia* is regarded as useful medicinal plant and used in folk medicines, such as –
Immunomodulator Activity: Remarkable research work has been done on its immunomodulatory activity using its various extracts of different parts. Guduchi's

immunomodulatory property as an adjuvant therapy in diabetic patients with foot ulcers has been reported. Its prospective double blind randomized controlled study showed significant improvement in wound healing [26]. The extract have potential use as an immunoprophylactic to prevent diseases in finfish aquaculture [27]. The total extract, polar and non-polar extracts and the formulations containing guduchi exhibit promising immunomodulatory effect in cyclophosphamide treated mouse ascitic sarcoma [28]. The whole and aqueous extracts of *Tinospora cordifolia* are having significant adaptogenic activity on a variety of biological, physical and chemical stressors on different animal models [29].

Phagocytic Action: *Tinospora cordifolia* have phagocytic action and normalize the killing capacities of neutrophils when tested on patients suffering from obstructive jaundice [30,31].

Hypoglycemic Action: *Tinospora cordifolia* has been extensively studied for its hypoglycemic, hypolipidemic and anticataract activity, so it can be used in the treatment of diabetes mellitus as monoherbal or polyherbal formulation [32]. A herbomineral formulation "Hyponid" is reported for its possible hypoglycemic as well as antioxidant activity [33]. The alcoholic extract significantly reduces the blood and urine glucose and body weight, and lipids in serum and tissues in alloxan induced diabetic rats [15,17,34]. Hyperglycemia and hyperlipidaemia coexists in diabetes. *Tinospora cordifolia* also decreased hepatic glucose-6-phosphatase and serum acid phosphatase, alkaline phosphates and lactate dehydrogenase [15]. The aqueous, alcoholic and chloroform extracts of the *Tinospora cordifolia* has significant hypoglycemic activity, which is postulated to be an insulin like action and it has no significant hypolipidaemic activity [35].

Table 1: Physico-chemical parameters of stem of *T. cordifolia*

S.No.	Parameters	Results
	Loss on drying at 105°C (%)	4.2
	Total ash	11.3
	Water soluble ash	0.77
	Acid- insoluble ash	0.93
	Water soluble extractive	85.3
	Alcohol soluble extractive	34.8
	pH	5.4
	Presence of microbes	Below permissible limit

Table. 2 TLC of *Tinospora cordifolia* Willd. Miers

S.No	366 nm		After Derivatisation in visible light	
	Colour	R _f	Colour	R _f
	-	-	Bluish grey	0.42
	Pink	0.47	Bluish grey	0.47
	Pink	0.50	Bluish grey	0.56
	Pink	0.58	-	-
	Blue	0.63	Bluish grey	0.62
	-	-	Bluish grey	0.71
	-	-	Bluish grey	0.92

Hepatoprotective Action: Many monoherbal as well as polyherbal formulation(s) of *Tinospora cordifolia* are used in various liver diseases. Protective effect of *Tinospora cordifolia* crude extract on drug induced liver injury and immunosuppression by isoniazid, rifampicin and pyrazinamide is documented recently. Crude extracts of *Tinospora cordifolia* aerial roots has protective action against liver injury induced by the anti-tubercular drugs and it prevents immunosuppression. Hepatoprotective herbs like *Tinospora cordifolia* can minimize the liver toxicity^[36].

Anti-Ulcer Activity: Antioxidant mechanism of *Tinospora cordifolia* is responsible for the possible anti-ulcer activity^[37]. The herb has strong free radical scavenging properties against reactive oxygen and nitrogen species as revealed by electron paramagnetic resonance spectroscopy, diminishing the expression of iNOS gene, therefore attenuating oxidative stress mediated cell injury during oxygen glucose deprivation and exerting the above effects at both the cytosolic as well as at gene expression levels. Hence *Tinospora cordifolia* may be an effective therapeutic tool against ischemic brain damage^[38-40].

Anti Tumor Activity: The anti tumor activity of *Tinospora cordifolia* may be due to decreased lipid peroxidation, glutathione-S-transferase activity or due to the release of lactate dehydrogenase. The hydroalcoholic extract of aerial parts has potent chemopreventive effect against cancer, in which oxidative stress plays an important causative role. Methylene chloride extract is more potent than the methanol and aqueous extracts in preventing the cell killing in cultured HeLa cells^[41].

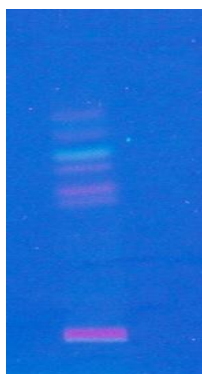
Cardioprotective Action: *Tinospora cordifolia* having antioxidative activity are shown to be cardioprotective in experimental models of myocardial ischemia reperfusion injury. The ethanolic extract of *Tinospora cordifolia* is responsible for the reduction in infarct size and in lipid

peroxide levels of serum and heart tissue at various doses^[42]. The cardioprotective activity of an herbal formulation "Caps HT2", which contains methanol extract of *tinospora cordifolia* as a component, has antioxidant, anticoagulant, platelet antiaggregatory, lipoprotein lipase releasing, anti-inflammatory and hypolipidaemic activity in rats^[43]. It contains potent in-vitro acetylcholinesterase inhibitory activity. Methanolic and successive water extracts have been investigated, whereby, methanolic extract was found to be more active than water extract which decreases IgM and increase in Hb^[44].

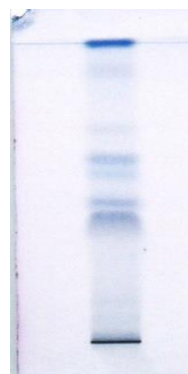
Antifertility Action: Methanolic (70%) stem extract has significant male antifertility activity. In male rats, it has no effect on body weight loss but decreases the weight of testes, epididymis, seminal vesicle and ventral prostate in a significant manner. It reduces the sperm motility as well as sperm density significantly, which result in reduction of male fertility by 100%^[45].

Antiamoebic Action: A crude extract formulation containing *Tinospora cordifolia* produces cure rate of 73% at a dose of 800 mg/kg/day in hepatic amoebiasis. The ethanolic extract alone and in combination as a polyherbal crude extract has activity against *Entamoeba histolytica*. The result of the crude polyherbal formulation is significant as that of metronidazole. The *Tinospora cordifolia* stem's hexane and chloroform soluble portions showed insignificant antipyretic activity in rabbits receiving subcutaneous yeast injections^[46].

Others: Studies on induced oedema and arthritis and on human arthritis proved anti-inflammatory potency of the water extract of plant. It also has antipyretic action. This drug relaxes the intestinal and uterine smooth muscles. It is proved effective in prevention of fibrosis and in stimulating regeneration in hepatic tissue. Aqueous extract of stem and root of the plant has been used therapeutically because of immunomodulation property as well as antimalarial and antileprotic activities^[47,48].



λ 366 nm



After derivatization in visible light

Figure . 2 TLC of *Tinospora cordifolia* Willd. Miers (Toluene: Ethyl acetate :: 9:2 v/v)

Macroscopical characters: Light brown coloured powder with bitter taste and odour nil.

Microscopical characters: The powder shows characters like simple to 3-compound starch grains measuring about 20-60 μ in length, prismatic crystals of calcium oxalate about 50 μ in length, crystal fibres, pitted tracheids upto 450 μ in length, thin walled long fibres upto 600 μ in length, simple pitted vessels, stone cells with narrow and wide lumen with pitted wall measuring about 50-80 μ in length, groups of sclereids about 15 μ in length, fragments of parenchyma with prismatic crystals of calcium oxalate and round parenchyma of the cortex with starch grains.

Physicochemical Parameters: Physico-chemical parameters of the stem extract of Guduchi (*T. cordifolia*) are tabulated in Table 2. Deterioration time of the plant material depends upon the amount of water present in plant material. If the water content is high, the plant can be easily deteriorated due to fungus. The loss on drying at 105°C in stem was found to be 4.2%. Total ash value of plant material indicated the amount of minerals and earthy materials attached to the plant material. Analytical results showed total ash value and water-soluble ash content were 0.77 % and 0.93% respectively. The amount of acid-insoluble siliceous matter present in the plant was 0.93%. Water soluble and alcohol soluble extractives are 85.3 and 34.8 respectively. pH of the stem extract was found to be 5.4.

TLC of *Tinospora cordifolia* Willd. Miers Stem

TLC Methodology: 4g of the sample was soaked in 40 ml of rectified spirit (90%) with occasional shaking for 18 hrs, boiled for 10 minutes and filtered. The filtrate was evaporated and extracted with Chloroform. The soluble portion was filtered, concentrated and made upto 10 ml in standard flask. The solution was applied on (E.Merck) Aluminium plate pre-coated with Silica gel 60 F₂₅₄ of 0.2 mm thickness using Linomat IV applicator. The plate was developed in Toluene: Ethyl acetate (9 : 2 v/v). After air drying the plate was visualized in UV 366 nm. The plate was then dipped in Vanillin -Sulphuric acid and heated in air oven at 105°C till the spots appeared.

REFERENCE

- Atal CK, Kapoor BM. 1989, Cultivation and utilization of medicinal plants (Eds. PID CSIR),.
- Siddiqui HH. 1993, Safety of herbal drugs-an overview. *Drugs News & Views* 1(2): 7-10.
- WHO survey. In medicinal plants (Eds. Haq. I.) Hamdard Foundation Press, Karachi, 13, 1993.
- Chopra RN, Chopra IC, Handa KL, Kapoor LD. *Indigenous drugs of India* (Published by UN Dhar, Pvt. Ltd., Calcutta), 1993.
- Chopra RN, Nayar SI, Chopra IC. *Glossary of Indian Medicinal Plants* (Published by CSIR, New Delhi), 1956.
- Satyavati GV, Raina MK, Sharma M. *Medicinal Plants of India* (Published by ICMR, New Delhi), 1976.
- Nadkarni AK, Nadkarni KM. *Indian MateriaMedica* (Published by Popular Prakashan Pvt. Ltd., Bombay), 1976.
- Sirkar NN. *Pharmacological basis of Ayurvedic therapeutics*. In: *Cultivation and utilization of medicinal plants*.
- Wagner, Hildebert (1999). *Immunomodulatory agents from plants*. Birkhäuser. pp.294. ISBN 9783764358488.
- Warrier, P. K.; V. P. K. Nambiar, C. Ramankutty, R. Vasudevan Nair (1996). *Indian medicinal plants: a compendium of 500 species*, 5, 283.
- Singh N, Singh SM, Shrivastava P, et al. Effect of *Tinospora cordifolia* on the antitumor activity of tumor-associated macrophages-derived dendritic cells. *Immunopharmacol Immunotoxicol*. 2005; 27:1-14.
- Singh N, Singh SM, Shrivastava P, et al. Immunomodulatory and antitumor actions of medicinal plant *Tinosporacordifolia* are mediated through activation of tumor-associated macrophages. *Immunopharmacol Immunotoxicol*. 2004;26:145-162.
- Nair PK, Rodriguez S, Ramachandran R, et al. Immune stimulating properties of a novel polysaccharide from the medicinal plant *Tinospora cordifolia*. *Int Immunopharmacol*. 2004; 4:1645-1659.
- Y. R. Chadha, *The Wealth of India*, Publication and information directorate, CSIR, New Delhi, 1976, 10, pp.251.

15. Stanely M, Prince P, Menon VP. Hypoglycaemic and hypolipidaemic action of alcohol extract of *Tinospora cordifolia* roots in chemical induced diabetes in rats. *Phytother Res.* 2003; 17 (4): 410-413
16. Stanely P, Prince M, Menon VP. Hypoglycaemic and other related actions of *Tinospora cordifolia* roots in alloxan-induced diabetic rats. *J Ethnopharmacol.* 2000; 70(1): 9-15.
17. Rathi SS, Grover JK, Vikrant V, Bisis NR. Prevention of experimental diabetic cataract by Indian Ayurvedic plant extracts. *Phytother Res.* 2002; 16(8): 774-777.
18. B. Bishayi, S. Roychowdherry, S. Ghosh, M. Sengupta, *J. Toxicol. Sci.* **2002**, 27, 139-146.
19. Subramanian M, Chintalwar GJ, Chattopadhyay S, et al. Antioxidant properties of a *Tinospora cordifolia* polysaccharide against iron-mediated lipid damage and gamma-ray induced protein damage. *Redox Rep.* 2002;7:137-143.
20. Goel HC, Prasad J, Singh S, et al. Radioprotective potential of an herbal extract of *Tinospora cordifolia*. *JRadiat Res (Tokyo).* 2004; 45:61-68.
21. Pahadiya S, Sharma J. Alteration of lethal effects of gamma rays in Swiss albino mice by *Tinospora cordifolia*. *Phytother Res.* 2003; 17:552-554.
22. Mathew S, Kuttan G. Antioxidant activity of *Tinospora cordifolia* and its usefulness in the amelioration of cyclophosphamide induced toxicity. *J Exp Clin Cancer Res.* 1998; 16:407-411.
23. Purandare H, Supe A. Immunomodulatory role of *Tinospora cordifolia* as an adjuvant in surgical treatment of diabetic foot ulcers: A prospective randomized controlled study. *Indian J Med Sci.* 2007; 61:347-355.
24. Anonymous. (1989). The Wealth of India, Raw materials. Vol-X, Revised (sP. S. Prince, V. P. Menon, *J. Ethnopharmacol.* **1999**, 65, 277-281.
25. Kirtikar KR, Basu BD. Indian Medicinal Plants, Vol-I, 2005, International Book Distributors, India, pp 76-80.
26. Purandare H, Supe A. Immunomodulatory role of *Tinospora cordifolia* as an adjuvant in surgical treatment of diabetic foot ulcers: A prospective randomized controlled study. *Indian J Med Sci.* 2007; 61; (6): 347-355
27. Sudhakaran DS, Sreirekha P, Devasree LD, Premsingh S, Michael RD. Immunostimulatory effect of *Tinospora cordifolia* Miers leaf extract in *Oreochromis mossambicus*, *Indian J Exp Biol.* 2006; 44(9):726-732.
28. Diwanay S, Chitre D, Patwardhan B. Immunoprotection by botanical drugs in cancer chemotherapy. *J Ethnopharmacol.* 2004; 90(1): 49-55.
29. Rege NN, Thatte UM, Dahanukar SA. Adaptogenic properties of six rasayana herbs used in Ayurvedic medicine. *Phytother Res.* 1999; 13(4): 275-291.
30. Rege NN, Nazareth HM, Bapat RD, Dahanukar SA. Modulation of immunosuppression in obstructive jaundice by *Tinospora cordifolia*. *Indian J Med Res.* 1989; 90: 478-483.
31. Rege N, Bapat RD, Koti R, Desai NK, Dahanukar S. Immunotherapy with *Tinospora cordifolia*: a new lead in the management of obstructive jaundice. *Indian J Gastroenterology.* 1993; 12(1): 5-8.
32. Umamaheswari S, Prince PS. Antihyperglycaemic effect of 'Ilogen-Excel', an ayurvedic herbal formulation in streptozotocin-induced diabetes mellitus. *Acta Pol Pharm.* 2007; 64(1): 53-61.
33. Babu, PS, Stanely M, and Prince P. Antihyperglycaemic and antioxidant effect of hyponidd, an ayurvedic herbomineral formulation in streptozotocin-induced diabetic rats. *Journal of Pharmacy and Pharmacology.* 2004; 56: 1435-1442.
34. Rathi SS, Grover JK, Vikrant V, et al. Prevention of experimental diabetic cataract by Indian Ayurvedic plant extracts. *Phytother Res.* 2002; 16:774-777.
35. Wadood N, Wadood A, Shah SA. Effect of *Tinospora cordifolia* on blood glucose and total lipid levels of normal and alloxan-diabetic rabbits. *Planta Med.* 1992; 58(2): 131-136.
36. Adhvaryu MR, Reddy N, Parabia MH. Effects of four Indian medicinal herbs on Isoniazid-, Rifampicin- and Pyrazinamide-induced hepatic injury and immunosuppression in guinea pigs. *World J Gastroenterol.* 2007; 13(23): 3199-3205.
37. Bafna PA, Balaraman R. Anti-ulcer and anti-oxidant activity of pepticare, a herbomineral formulation. *Phytomedicine.* 2005; 12: 264-270.
38. Rawal AK, Muddeshwar MG, Bisis SK. Effect of *Rubia cordifolia*, *Fagonia cretica* linn, and *Tinospora cordifolia* on free radical generation and lipid peroxidation during oxygen-glucose deprivation in rat hippocampal slices. *Biochem Biophys Res Commun.* 2004; 324(2): 588-596.
39. Rawal AK, Muddeshwar MG, Bisis SK. *Rubia cordifolia*, *Fagonia cretica* linn and *Tinospora cordifolia* exert neuroprotection by modulating the antioxidant system in rat Hippocampal slices subjected to oxygen glucose deprivation. *BMC Complement Altern Med.* 2004; 4: 11.
40. Jagetia GC, Baliga MS. The evaluation of nitric oxide scavenging activity of certain Indian medicinal plants in vitro: a preliminary study. *J Med Food.* 2004; 7(3):343-348.
41. Singh RP, Banerjee S, Kumar PV, Raveesha KA, Rao AR. *Tinospora cordifolia* induces enzymes of carcinogen/drug metabolism and antioxidant system, and inhibits lipid peroxidation in mice. *Phytomedicine.* 2006; 13(1-2): 74-84.
42. Rao PR, Kumar VK, Viswanath RK, Subbaraju GV. Cardioprotective activity of alcoholic extract of *Tinospora cordifolia* in ischemia-reperfusion induced myocardial infarction in rats. *Biol Pharm Bull.* 2005; 28(12): 2319-2322.
43. Mary NK, Babu BH, Padikkala J. Antiatherogenic effect of Caps HT2, a herbal Ayurvedic medicine formulation. *Phytomedicine.* 2003; 10(6-7): 474-482.

44. Singh RK. *Tinospora cordifolia* as an adjuvant drug in the treatment of hyper-reactive malarious splenomegaly--case reports. *J Vector Borne Dis.* 2005; 42(1): 36-38.
45. Gupta RS, Sharma A. Antifertility effect of *Tinospora cordifolia* (Willd.) stem extract in male rats. *Indian J Exp Biol.* 2003; 41(8): 885-889.
46. Ikram M, Khattak SG, Gilani SN. Antipyretic studies on some indigenous Pakistani medicinal plants: II, *J Ethnopharmacol.* 1987; 19(2): 185-192.
47. Singh SS, Pandey SC, Shrivastava S, Gupta VS, Palio B. Chemistry and medicinal properties of *Tinospora cordifolia*. *Indian J Pharmacol* 2003; 35: 83-89.
48. Najib Nik A, Rahman N, Furuta T, Kojima S, Takane K, Ali Mohd M. Antimalarial activity of extracts of Malaysian medicinal plants. *J Ethnopharmacol* 1999; 64(3): 249-25