

Review Article

Vernonia Cinerea: A Review

Dipali Shelar*, Sucheta Tikole, Tejaswini Kakade

MSS, College of Pharmacy, Medha, Satara-415012, Maharashtra, India

Received 15 May 2014; received in revised form 26 May 2014; accepted 27 May 2014

Available online 23 June 2014

Abstract

The present review describes the morphological, phytochemical and pharmacology aspects of *Vernonia cinerea* (Lauraceae). This plant is commonly called as ash-colored fleabane belonging to the family Asteraceae. Regarding the history of the plant, it was mentioned in Sanskrit texts as being present in northern, western and southern India. The chief constituents are the triterpenes. Parts that were used include the flower (treatment of conjunctivitis), seeds (used as anthelmintic), root (dropsy), and juice (piles). The whole plant is also considered to promote perspiration in febrile condition. The plant is anthelmintic, antibacterial, antiviral, antifungal, anti-inflammatory, diuretic, and stomachic. The plant is used as anticancer, febrifuge, diaphoretic (infusion of herb, combined with quinine, is used against malaria). The Ayurvedic Pharmacopoeia of India recommends the plant in intermittent fever, filariasis, pityriasis versicolor (tinea versicolor), blisters, boils, vaginal discharges and in cases of psychoneurosis. So, the present paper enumerates an overview of phytochemical and pharmacological properties, which may help the researchers to set their minds for approaching the efficacy and potency of herb.

Keywords: *Vernonia cinerea*, Traditional uses, Pharmacological profile.**1. Introduction**

Sahadevi consists of dried whole plant of *Vernonia cinerea* Lees. (Fam. Asteraceae); an erect, rarely decumbent, branched herb, 12-75 cm high, found throughout India ascending to an altitude of 1800 m¹. As it can grow under different conditions of moisture and soil, the height of the plant and the size of leaves and flowers vary considerably. Each brush-like flower is really composed of a number of tiny flowers. When the seeds (really fruits) ripen, small powder-puff-like balls are seen on the plant. Everywhere we can see many species of this plant having white, pink, violet, reddish or purple flowers. Regarding the history of the plant, it was mentioned in Sanskrit texts as being present in northern, western and southern India. The chief constituents are the triterpenes. Aerial parts gave luteolin-monobeta-D-glucopyranoside.

Whole plant gave triterpene compounds- betaamyirin acetate, lupeol acetate, betaamyirinand lupeol; sterols- beta- sitosterol, stigmasterol and alpha-spinasterol; phenolic resin and potassium chloride. Parts that were used include the flower (treatment of conjunctivitis), seeds (used as anthelmintic), root (dropsy), and juice (piles). The whole plant is also considered to promote perspiration in febrile condition. The plant is anthelmintic, antibacterial, antiviral, antifungal, anti-inflammatory, diuretic, and stomachic. The roots are useful in diarrhoea, cough, inflammations, skin diseases, leprosy, renal and vesicle calculi. The leaves are useful in humid herpes, eczema, ring worm, guinea worms, and elephantiasis. The flowers are used in conjunctivitis, vitiated condition of vata and fever. The seeds are useful in roundworms, threadworms, cough, flatulence, leucoderma, psoriasis, chronic skin disease; the plant is used as anticancer, febrifuge, diaphoretic (infusion of herb, combined with quinine, is used against malaria). Used as a specific herb for leucorrhoea, dysuria, spasm

*Corresponding author.**E-mail address:* dipali.1386@rediffmail.com

(Dipali Shelar)

e-2230-7842 / © 2014 JCPR. All rights reserved.

of bladder, strangury and for hematological disorders, as a blood purifier and styptic, also used in asthma. Seeds used as antifatulent, antispasmodic; used in dysuria, decoction used for colic². The Ayurvedic Pharmacopoeia of India recommends the plant in intermittent fever, filariasis, pityriasis versicolor (tinea versicolor), blisters, boils, vaginal discharges and in cases of psychoneurosis. The water soluble fraction of the methanol extract of the defatted dried ground whole plant of *Vernonia cinerea* showed significant diuretic activity in rats comparable to lasix a known diuretic³

2. Source and Botanical Description

Botanical name	: <i>Vernonia cinerea</i>
Family	: Asteraceae
Common name	: Sahadevi
Part used	: Leaves, seed, roots etc Terpenoids.
Habitant	: It can grow under different conditions of moisture and soil. It is found in northern, western and southern India.

3. Morphology

Rootlets are external surface, dirty brown; fracture, short. Stem are Glabrous, cylindrical, hairy, slightly branched; 10-17 cm long, 1-8 mm thick, grooved and ribbed; basal region of branches greenish-brown, apical region dark green, bearing a number of flowers; fracture, short. Leafs are Simple, dark-green, smooth, alternate, opposite, exstipulate, 2.5-5 cm long, 1.8-3.6 cm broad, elliptical, lanceolate, obtuse or acutely toothed; shape and size variable; petiole short; odour, slightly characteristic⁴.



Fig. 1: *Vernonia cinerea*

4. Traditional Uses

Rasa :Tikta

Guna :Lakhu,Rooksha

Virya : Ushna Plant pacifies vitiated vata, pitta, tonsillitis, stomach pain, diarrhea, intermittent fever, eczema, herpes, ringworm, and elephantiasis. Leaves are useful in conjunctivitis, and in lacrimation. Seeds are useful in worm infestation, cough, psoriasis, leukoderma and in other skin diseases. Plant possess anti cancerous property⁵.

5. Phytochemistry

The major constituents of the seed of this species contain fats and saponin. The constituents are alpha-spinasterol (seed), arachidic (seed 1,140 - 11,400 ppm) behenic-acid (seed 1,520 - 15,200 ppm) beta-amyrin (seed) beta-amyrin-acetate(seed) beta-sitosterol (seed) fat (seed 38,000 - 380,000 ppm) plant: linoleic-acid (seed 8,360 - 83,600 ppm) lupeol (seed) lupeol-acetate (seed) luteolin-7-mono-beta-d-glucoside (seed) myristic-acid (seed 3,040 - 30,400 ppm) oleic-acid (seed 1,520 - 15,200 ppm) palmitic-acid(seed 1,520 - 15,200 ppm) pentaynene flower stigmasterol (seed) vernolic-acid (seed) 5 Also Ten compounds were identified to be (-)-clovane-2,9-diol , caryolane-1,9beta-diol , apigenin , chrysoeriol , luteolin , thermopsoside , luteolin-7-O-beta-D-glucoside , quercetin, apigenin-4'-O-beta-D-glucoside , hyperin , beta-amyrin aceate , lupeol acetate⁶.

6. Scientifically Validated Uses

6.1. Antipyretic activity

Antipyretic effect of petroleum ether and chloroform soluble fractions of ethanol extract of the roots of *Vernonia cinerea* was investigated. Intraperitoneal administration of boiled milk at a dose 0.5 ml/kg body weight in albino rabbit leads to pyrexia. Intraperitoneal (i.p. route) administration of petroleum ether and chloroform soluble fractions of ethanol extract of the roots of *Vernonia cinerea* at a dose 250 mg/kg body weight were shown significantly reduce the elevated body temperature of rabbit which was compared with standard aspirin (market product) and solvent used⁷.

6.2. Determination of β -sitosterol and lupeol

A simple, precise and accurate high-performance liquid chromatographic method has been developed for simultaneous determination of β -sitosterol and Lupeol in whole plant powder of *Vernonia cinerea* Linn. Chromatographic separation of the two compounds was performed on a waters symmetry shield C18 column (150 x 4.6, 5 μ m) as stationary phase with a mobile phase comprising of methanol : acetonitrile (30:70) v/v at a flow rate of 1.0 mL min⁻¹ and UV detection at 210nm with a run time of 12.0 min. The proposed method was validated for linearity, accuracy, precision and limit of quantitation. The validated HPLC method can be used for a routine quality control analysis and simultaneous quantitation of β -sitosterol and Lupeol from *Vernonia cinerea* Linn⁸.

6.3. Antimicrobial activity

The present study was designed to evaluate antimicrobial activities of pet ether extract and ethanol extract of whole plant of *Vernonia cinerea* (L) Less. We carried out the antimicrobial screening of the extracts of *Vernonia cinerea* (L) Less. against most prevalent microbes like *S. aureus*, *P. aeruginosa*, *S. aureus*, *B. cereus*, *K. pneumonia*, *E. coli*, *A. niger* and *C. albicans* by disc diffusion method. Both the petroleum ether and alcoholic extracts *Vernonia cinerea* (PEVC and EEVC) of at various concentrations produced significant antibacterial and antifungal activities against the selected microorganisms when compared to the standard drugs Ciprofloxacin and Ketoconazole for antibacterial and antifungal activity, respectively⁹.

6.4. Nephroprotective Activity

The alcoholic extract of *Vernonia cinerea* showed promising nephrocurative activity, where as ethyl acetate extract of *Vernonia cinerea* possessed significant nephroprotective activity in the rat model of cisplatin-induced renal toxicity. These results suggest the therapeutic utility of herbal *Vernonia cinerea* extracts in renal injury¹⁰.

6.5. Antimicrobial activity

Ten herbs which are widely used in Ayurvedic system of medicine and are collectively known as "Dashapushpam "in Kerala, (India), were screened for their antimicrobial properties against nine spp. of pathogenic fungi and seven spp. of pathogenic bacteria. In the preparation of extracts, the entire shoot systems were used for *Cardiospermum halicacabum* and *Evolvulus alsinoides* and only leaves for others. Crude plant extracts were prepared by cold extraction with acetone. Two sets of pathogenic fungi-Set-1 and Set- 2- were used with Nystatin and Amphotericin as standards, respectively. From Set- 1, all the extracts showed antimicrobial properties at least with two fungal species, the most commendable being the extract of *Vernonia cinerea* which was effective against all the fungal strains, outscoring the standard Nystatin. Only *Ipomoea sepiaria* and *V. cinerea* could inhibit the growth of *Rhodotorula* sp. Among the six extracts tested with Set- 2, only *I. sepiaria* and *V. cinerea* were effective which inhibited the growth of only one strain, in sharp contrast to the activity of the standard, Amphotericin which was highly effective against all other spp. The extracts of *Aerva lanata*, *C. halicacabum* and *V. cinerea* inhibited the growth of six, seven and four species of bacteria respectively. Results show that the herbal extracts involved are more effective against pathogenic fungi than pathogenic bacteria and throws light on the future prospects of plants as sources of potent antibiotics¹¹.

6.6. Antimicrobial activity

Chemical preservatives have been used in the food industry for many years. However, with increased health concerns, consumers prefer additive-free products or food preservatives based on natural products. This study evaluated antimicrobial activities of extracts from *Emilia sonchifolia* L. (Common name: lilac tassel flower), *Tridax procumbens* L. (Common name: tridax daisy) and *Vernonia cinerea* L. (Common name: Sahadevi), belonging to the *Asteracea* family, to explore their potential for use against general food spoilage and human pathogens so that new food preservatives may be developed. Three

methanol extracts of these plants were tested *in vitro* against 20 bacterial species, 3 yeast species, and 12 filamentous fungi by the agar diffusion and broth dilution methods. The *V. cinerea* extract was found to be most effective against all of the tested organisms and the methanol fraction showed the most significant ($p < 0.05$) antimicrobial activity among all the soluble fractions tested. The minimum inhibitory concentrations (MICs) of extracts determined by the broth dilution method ranged from 1.56 to 100.00mg/mL. The MIC of methanol fraction was the lowest in comparison to the other four extracts. The study findings indicate that bioactive natural products from these plants may be isolated for further testing as leads in the development of new pharmaceuticals in food preservation as well as natural plant-based medicine¹².

6.7. HPTLC Fingerprint

Part Used: Whole plant

Chemical constituents: Saponins, Sapogenins & Flavonoids

Mobile phase: Toluene: Ethyl acetate (9.5: 0.5)

Tank saturation: 20 minutes

Sample applied: 7 μ l

Solvent front: 80 mm

Drying: For 10 minutes

Detection/ Visualization: At 254 nm, 366 nm & after derivatization

Derivatisation: Derivatize the plate with anisaldehyde sulphuric acid and heat the plate at 105 0 C till the band develop¹³.

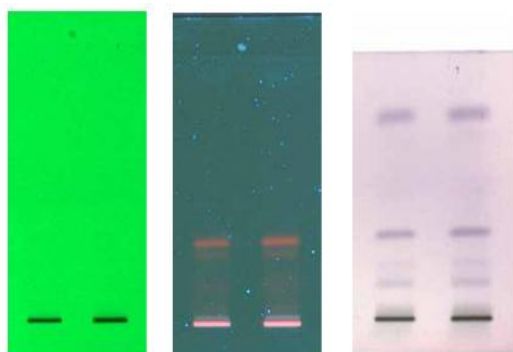


Fig. 2: HPTLC profiles of sample solution of *Vernonia cinerea* Whole plant.

Table 1: HPTLC details of sample solution of *Vernonia cinerea* whole plant.

S. No. of resolved bands	Visualization		After Derivatization
	UV 254 nm	UV 366 nm	
1	-	0.14	0.14
2	-	0.26	0.21
3	-	0.31	0.31
4	-	-	0.77

6.8. Anti-inflammatory activity

The methanol extract of the whole plant of *Vernonia cinerea* Less. was evaluated for its anti inflammatory activity in acute (carrageenin, histamine and serotonin induced rat paw edema) and a chronic model (cotton pouch induced granuloma). The methanol extract (250 and 500 mg/[kg.sup.-1] p.o.) exhibited significant activity ($p < 0.001$) against all phlogistic agents used in a dose dependant manner. In the chronic model (cotton pouch granuloma method) the methanol extract exhibited significant anti-inflammatory activity. All these effects were compared with standard drug phenylbutazone (100 mg/kg)¹⁴.

6.9. Analgesic & antipyretic activity

The chloroform, methanolic and ether extracts of *Vernonia cinerea* (Asteraceae; Less) leaf (100, 200 and 400 mg/kg intraperitoneally) were tested in: acetic acid-induced writhing in mice, carrageenin-induced oedema and brewer's yeast-induced pyrexia in rats to assess their analgesic, anti-inflammatory, antipyretic and behavioral activities, respectively. The changes in writhings and behavioural activities in mice, the pyrexia and paw volumes in rats were reduced significantly ($P < 0.05$) compared to the control. There was an increase in pain threshold on the oedematous right hind limb paw of the rats. These results indicate that the extracts could possess analgesic, antipyretic and anti-inflammatory properties. All these effects and the changes in the behavioural activities could be suggested as contributory effects to the use of *V. cinerea* leaf in the treatment of malaria¹⁵.

6.10. Herbal remedy

Plant name: Neichatti "An Excellent Siddha remedy for fever" Botanical name: *Vernonia cinerea* Family: Compositae Actions: Diaphoretic, Alterative, Anthelmintic, Antispasmodic, Antidote. The samoolam is crushed well, eight parts of water added and boiled to 1/4 parts. 23 to 30 ml of this decoction is good to cure fever. The juice of flowers is helpful in conditions like red eye as an external drop¹⁶.

6.11. Isolation of sesquiterpen lactone

Two new sesquiterpene lactones, vernolides C and D as well as six known ones were isolated from the dichloromethane fraction of an aqueous extract from *Vernonia cinerea*. Their structures were elucidated by spectroscopic methods. Among the known sesquiterpene lactones, three of them were described in this plant for the first time¹⁷.

6.12. Supplementation and exercise on oxidative stress biomarkers, beta-endorphin release, and the rate of cigarette smoking.

Volunteer smokers were randomly divided into four groups: group 1: VC supplement; group 2: exercise with VC supplement; group 3: exercise; and group 4: control. VC was prepared by wash and dry techniques and taken orally before smoking, matching the frequency of strenuous exercise (three times weekly). Before and after a two month period, exhaled carbon monoxide (CO), blood oxidative stress (malondialdehyde [MDA], nitric oxide [NOx], protein hydroperoxide [PrOOH] and total antioxidant capacity [TAC]), beta-endorphin and smoking rate were measured, and statistically analyzed. Supplementation with *Vernonia cinerea* Less and exercise provided benefit related to reduced smoking rate, which may be related to oxidative stress and beta-endorphine levels¹⁸.

6.13. Ameliorative activity

Cyclophosphamide (CTX) is a widely used antineoplastic drug, which could cause toxicity to normal cells due to its toxic metabolites. The use of CTX in treating cancer patients is limited due to its severe toxicity induced mainly by oxidative stress. The present study

reports the protective role of *Vernonia cinerea* L. against the CTX-induced toxicity in Balb/c mice. Intraperitoneal administration of the extract significantly increased the total WBC Count, bone marrow cellularity, α -esterase positive cells, and weights of lymphoid organs in CTX-treated animals, when compared with CTX control mice. Administration of *V. cinerea* was found to reduce the enhanced level of alkaline phosphatase, glutamate pyruvate transaminase, lipid peroxidation, and also significantly increased the reduced glutathione level in CTX-treated animals. Histopathological analysis of small intestine also suggests that extract could reduce the CTX-induced intestinal damage. The level of proinflammatory cytokine TNF- α , which was elevated during CTX administration, was significantly reduced by the *V. cinerea* extract administration. The lowered levels of other cytokines like IFN- γ , IL-2, GM-CSF, after CTX treatment were also found to be increased by extract administration. Administration of *V. cinerea* did not compromise the anti-neoplastic activity of CTX. Infact, there was a synergistic action of CTX and *V. cinerea* in reducing the solid tumors in mice. Methanolic extract of *V. cinerea* given intraperitoneally (i.p.) showed a significant chemoprotective activity without compromising the chemotherapeutic efficacy of CTX, indicating its possible use as an adjuvant during chemotherapy¹⁹.

6.14. Modulation of immune response

The effect of methanolic extract of *Vernonia cinerea* L. on the immune system was studied using BALB/c mice. Intraperitoneal (i.p.) administration of five doses of the extract (20mg/kg body weight) was found to enhance the total white blood cell (WBC) count (13,700 \pm 463 cells/mm³) on 6th day, bone marrow cellularity (27.9 \pm 2.1 \times 10⁶ cells/femur) and number of α -esterase positive cells (1184 \pm 56.29/4000 cells). Treatment with *V. cinerea* along with the antigen, sheep red blood cells (SRBC), produced an enhancement in the circulating antibody titre and the number of plaque forming cells (PFC) in the spleen. Maximum number of PFC (304.16 \pm 12.4) was obtained on the 6th day. It also enhanced the proliferation of splenocytes, thymocytes and bone marrow cells both in the

presence and absence of specific mitogens in vitro and in vivo. Administration of *V. cinerea* significantly reduced the lipopolysaccharide (LPS) induced elevated levels of nitric oxide (NO) and proinflammatory cytokines such as tumor necrosis factor- α , interleukin-1 (IL-1 β), and IL-6 in mice. Treatment of *V. cinerea* methanolic extract also showed an enhancement in the phagocytic activity of peritoneal macrophages. Moreover the extract down regulated the inducible NO synthase and cyclooxygenase-2 (COX-2) mRNA expression in LPS-stimulated macrophages. These results indicate the immunomodulatory activity of *V. cinerea*²⁰.

6.15. Protective activity

The radioprotective effect of *Vernonia cinerea* extract was studied in balb/c mice. Whole-body irradiation of γ -rays (6 Gy) given to animals reduced the white blood cell count, bone marrow cellularity and α -esterase positive cells in control animals, which were elevated by the administration of *V. cinerea* extract (20 mg/kg body weight [b.wt.], intraperitoneally [i.p.]). The elevated levels of serum enzymes alkaline phosphatase (ALP), glutamate pyruvate transferases (GPT) and lipid peroxidation (LPO) after irradiation were also reduced with *V. cineria* extract administration. *V. cinerea* treatment also significantly enhanced the animal's antioxidant status by enhancing the activities superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) and reduced glutathione (GSH) level in irradiated animals. Histopathological analysis of liver and small intestine also suggests that *V. cinerea* could reduce the tissue damages induced by radiation. The level of pro-inflammatory cytokines such as interleukin 1 β (IL-1 β), tumour necrosis factor α (TNF- α) and C-reactive protein (CRP) elevated after irradiation, which were significantly reduced by *V. cinerea* extract administration. On the other hand, the extract stimulated the production of other cytokines such as granulocyte monocyte-colony stimulating factor (GM-CSF) and interferon- γ (IFN- γ) in animals exposed to radiation. Agarose gel electrophoresis of DNA isolated from bone marrow of control animals showed heavy DNA damage, but a reduced

DNA damage was seen in animals treated with *V. cinerea* extract. Administration of *V. cinerea* did not compromise the anti-neoplastic efficiency of radiation. In fact, there was a synergistic action of radiation and *V. cinerea* in reducing the solid tumours in mice. Methanolic extract of *V. cinerea* given i.p. showed a significant radio protective activity without compromising the radio therapeutic efficacy of radiation, indicating its possible use as an adjuvant during radiotherapy²¹.

6.16. Arthritis activity

The anti-inflammatory effect of an alcoholic extract from the flower of *Vernonia cinerea* (Asteraceae; Less) was tested in adjuvant arthritic rats. Changes in paw volume, body and tissue weights and serum and tissue enzyme activities of ALT, AST, ACP and cathepsin-D in adjuvant rats were reversed by oral administration of 100 mg/kg body weight (BW) of the flower extract. The extract also reversed the major histopathological changes in the hind paws of the arthritic rats. Phytochemical studies revealed the presence of alkaloids, saponins, steroids and flavonoids. It was concluded that the extract contains as yet unidentified anti-inflammatory principle(s)²².

6.17 Antitumor activity

The effect of *Vernonia cinerea* Less. extract on the inhibition of lung metastasis induced by B16F-10 melanoma cells was studied in C57BL/6 mice. *V cinerea* extract significantly ($P < .001$) inhibited lung tumor formation (78.8%) and significantly increased the life span (72.5%). Moreover, lung collagen hydroxyproline, uronic acid, and hexosamine and also serum sialic acid, γ -glutamyltransferase (GGT), and vascular endothelial growth factor (VEGF) levels were found to be significantly ($P < .001$) lower in treated animals compared with untreated controls. Histopathological analysis of the lung tissues also correlated with these findings. *V cinerea* treatment significantly inhibited the invasion of B16F-10 melanoma cells across the collagen matrix of the Boyden chamber. *V cinerea* also inhibited the migration of B16F-10 melanoma cells across a polycarbonate filter in vitro. It down regulated the production and

expression of proinflammatory cytokines such as TNF (tumor necrosis factor)- α , IL (interleukin)-1 β , IL-6, and GM-CSF (granulocyte monocyte colony-stimulating factor). *V cinerea* extract administration could suppress or down regulate the expression of matrix metalloproteinase (MMP)-2, MMP-9, lysyl oxidase, prolyl hydroxylase, K-ras, extracellular signal-regulated kinase (ERK)-1, ERK-2, and VEGF and also upregulate the expression of nm-23, tissue inhibitor of metalloproteinase (TIMP-1), and TIMP-2 in the lung tissue of metastasis-induced animals. It also inhibited the protein expression of MMP-2 and MMP-9 in gelatin zymographic analysis of B16F-10 cells. These results indicate that *V cinerea* could inhibit the metastatic progression of B16F-10 melanoma cells in C57BL/6 mice by regulating MMPs, VEGF, prolyl hydroxylase, lysyl oxidase, ERK-1, ERK-2, TIMPs, nm23, and proinflammatory cytokine gene expression in metastatic lung tissue²³.

Conclusion

The wide spread use of *Vernonia cinerea* Less. As chemotherapeutic, antitumour and various other disorders has lead a scientific approach towards its use as medicinal plants. *Vernonia cinerea* Less. is an plant whose all parts are of medicinal value.

References

- [1] The Ayurvedic pharmacopoeia of India. Part I, Volume III, 170-172.
- [2] Anand et al. IJPSR, 2011, 2, 1 (2011) 127-131.
- [3] K.J. Varghese, et al. IJPSR, 1, 10 (2010) 50-59.
- [4] The Ayurvedic pharmacopoeia of India. Part I, Volume III. 170-172.
- [5] Dr. Duke's phytochemical and ethno botanical databases, www.ars-grin.gov/duke/.
- [6] Zhu h, tang y, min z, gong z. zhongguo zhong yao za zhi. 34, 21 (2009) 2765-7.
- [7] A.R. Sankar et al., IJPSR, 2, 1 (2011) 141-145.
- [8] W. Shah, M.B. kekare. International journal of Pharma and bio sciences, 1, 3 (2010).
- [9] A. Somasundaram. Pharmacology online, 2 (2010) 957-960.
- [10] S. Adikay, K. Bharathi. Pharmacology Online, 2 (2011) 548-555.
- [11] M.N. Vijayan et al. African Journal of microbiology research, 4, 22 (2010) 2357-2362.
- [12] D.I. Latha, S. sasidhajain, K Jain. j nutrition, 15, 2 (2009) 223 – 231.
- [13] Ayurvedic pharmacopoeia. HPTLC fingerprint atlas of ayurvedic single plant drug mentioned, volume III, IV, 93-94.
- [14] U.K. Mazumder, M. Gupta. The free library, (2003).
- [15] E.O. Iwalewa, O.J. Iwalewa, J.O. Adeboye. Journal of ethnopharmacology, 86, 2-3 (2003) 229-234.
- [16] Neichatti or vernonia cinerea: Herbal remedy for fever, swellings, skin infections and scorpion bite, Siddha medicine, (2010).
- [17] A. Chea et al. Chem. Pharm. Bull., 54, 10 (2010) 1437-9.
- [18] L. Donrawee, P. sainatee et al. Journal of the international society of sports nutrition, (2010) 7-21.
- [19] P. Pratheeshkumar, Girija kuttan. Immunopharmacology and Immunotoxicology, 18, 4, 197-207.
- [20] P. Pratheeshkumar, G. kuttan. Immunotoxicol and Immunotoxicology, (2010).
- [21] P. Pratheeshkumar. Exp toxicology, (2010).
- [22] M. Latha, T. Geetha et al. General Pharmacology, 31, 4 (1998) 601-60.
- [23] P. Pratheeshkumar et al. Integr. Cancer. Therapy, (2010).

Source of Support: Nil. Conflict of Interest: None declared
