

Review Article

Biological Potential of *Elephantopus scaber* Linn.Sudip Kumar Mandal^{1*}, Haraprasad Pal², Ishan Pal³, Sankhadip Bose⁴^{1, 2, 3}Dr. B. C. Roy College of Pharmacy & Allied Health Sciences, Durgapur - 713206, India.⁴NSHM Knowledge Campus, Kolkata - Group of Institutions, BL Saha Road, Kolkata - 700053, India.*Corresponding author's E-mail: gotosudip79@gmail.com

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ABSTRACT

Elephantopus scaber Linn., belonging to the family Asteraceae, is a small herb found in Asia, Africa, Australia and Europe. The most common name in english for *Elephantopus scaber* is Elephant's Foot, but often it is called more precisely Prickly-leaves Elephant's Foot or Rough-leaved Elephant's Foot. The parts of this plant have been used traditionally for the treatment of number of diseases in many countries. The plant has been extensively screened and proved for anticancer activity, which is mainly for its deoxyelephantopin containing. Many other biological activities such as antimicrobial, hepatoprotective, antioxidant, antidiabetic, anti-inflammatory, analgesic, antiasthmatic, antiplatelet and wound healing ability have been reported in various research articles.

Keywords: *Elephantopus scaber*, phytochemicals, traditional medicine, pharmacological actions.

INTRODUCTION

In recent decades, research has shown that plants produce a diverse range of bioactive molecules for industrial interest, making them a rich source of different types of medicines and have shown a promising effect in therapeutics¹. The lectotype species of *Elephantopus* genus, family Asteraceae, consists of 32 species of centered in Asia, Africa, Australia and Europe²⁻⁵. The plant vigorously grows in tropical deciduous forest areas. Traditionally the plant is used as folk medicine by tribal communities across India. *Elephantopus scaber* Linn. is one of the medicinally important species of this genus. Hiradeve and Rangari⁶ have recently reviewed the ethnomedical history of *E. scaber*. The whole plant, its various parts and the extracts of *E. scaber* have been used for the treatment of a number of diseases.

*Elephantopus scaber*

PHYTOCHEMICALS

Flavonoids have been shown to be good taxonomic markers for Asteraceae. More than 800 compounds comprising 4700 flavonoid were occurred with some implications of flavonols, flavones and other types of the family Asteraceae⁷ apart from that *Elephantopus scaber* has been explored for a large amount of salt such as

potassium chloride and minerals especially calcium, magnesium, iron and zinc. The organic solvent like acetone extract of air-dried powdered seeds is reported to contain terpenoids, flavonoids, steroids, glycosides, alkaloid, quinones, phenols⁸. A number of phytochemical studies have demonstrated the presence of several classes of chemical compounds, the main ones being Phenolic acids, flavonoids, terpenoids, coumarines, quinones, essential oils.

Traditional Uses

E. scaber has been used as traditional medicine in many countries. In Thailand, it has been used as traditional medicine. In Brazil, the decoction of whole plant is used to stimulate diuresis, reduce fever and eliminate bladder stones, febrifuge, and diaphoretic against cough, bronchitis, and asthma⁹. In Malaysia, decoction of *E. scaber* root has been used to accelerate contraction of abdominal area and prevent inflammation after childbirth. Besides, whole *E. scaber* was also boiled with red bean to remove flatulence¹⁰. In Thailand people have used *E. scaber* to treat cough, as a tonic (root decoction)¹¹, chapped lips and galactagogue (whole plant decoction)¹⁰. It has also been used in Madagascar as an antipyretic agent (decoction of aerial part)¹²; in Taiwan (whole plant decoction) to treat hepatitis; in Nigeria (hot water extract of leaves) to cure arthritis and in Mauritius to treat diarrhoea, urinary problems and pimples (root paste)¹³. In India whole plant of *E. scaber* are used for the treatment of toothache as a toothbrush¹⁴. Also, the whole plant has been reported to be useful for curing insomnia, diabetes, bronchitis, viral or bacterial infection, leukaemia, rheumatism, snake bite, diuresis, antipyresis, to eliminate bladder stones and for filariasis. The leaf crushed and mixed with salt is used to treat dysentery, while the water extract of the leaves is applied externally



to treat eczema and ulcers^{15, 16}. In Southern China, Hong Kong and Taiwan, the whole plant of *E. scaber*, is widely used in the treatment of nephritis, edema, dampness, pain in the chest, fever, scabies, arthralgia due to wound and cough of Pneumonia¹⁷. The Murut people of Sabah Malaysia used the roots of the *Elephantopus* specie to treat bloody stool¹⁸.

Pharmacological Effects

Anticancer & antitumor activity

Cancer is the 2nd leading cause of death worldwide¹⁹. Deoxyelephantopin (DET) is one of the major sesquiterpene lactone derived from *E. scaber*. *In vitro* and *in vivo* experiments have demonstrated that deoxyelephantopin possesses cytotoxic activity against a variety of cancer cell lines and malignant tumors. Deoxyelephantopin has shown significant cytotoxicity against human breast cancer cell lines²⁰. Deoxyelephantopin in nasopharyngeal carcinoma (CNE) cells triggered Akt and Mitogen-activated protein kinase (MAPK) signalling pathways²¹ and showed pronounced activity against melanoma derived cell line MEXF 394NL and mammary cancer cell line MEXF 401NL with IC₅₀ value of 1.1 µg mL⁻¹.²² Very recently one literature has shown that DET could kill cancer cells selectively inducing apoptosis through multiple signaling pathways¹⁹. The antitumor activity of the leaves of *E. scaber* has been evaluated against Dalton's ascitic lymphoma (DAL) in Swiss albino mice²³. Deoxyelephantopin from *elephantopus scaber* inhibits HCT116 human colorectal carcinoma cell growth through apoptosis²⁴. Ethanol extract of *E. scaber* may be a potential anti-cancer agent for human breast cancer cells by the induction of p53-dependent apoptosis²⁵. Study of *E. scaber* on skin papillomas induced by DMBA and croton oil in mice showed tumor inhibitory activity of the active fraction against chemically induced tumors and an ability to inhibit the development of solid tumors²⁶.

Antimicrobial activity

There is a vital need to develop new classes of antibiotics as the currently used antibiotics developing a dangerous microbial resistance²⁷. Different study showed that *Elephantopus scaber* is a herb with good antimicrobial activity. The methanolic leaf extract of *E. scaber* showed significant antibacterial activity against *S. aureus*, *E. coli*, *P. aeruginosa*, *B. subtilis* and *P. vulgaris*²⁸. Ethyl acetate extract of the plant showed growth inhibitory effect at 4 mg/ml concentration in all the bacterial isolates tested except *Klebsiella pneumonia* where it showed ~75% inhibition. Lower concentration of the extract showed concentration-dependent inhibition effect. At 2 mg/ml 50% inhibition in all the cultures²⁹. Further research into the antimicrobial activity was done by the use of different strains of pathogenic bacteria and fungi. The result was analysed using well diffusion method³⁰. The acetone fraction of *E. scaber* demonstrated remarkable antibacterial effect against methicillin resistant

Staphylococcus aureus and methicillin sensitive *Staphylococcus aureus*³¹. A novel terpenoid from *Elephantopus scaber* showed antibacterial activity against *Staphylococcus aureus* and suggests that it can act as a drug for bacterial infections³². Study showed strong *in vitro* antibacterial activity of terpenoid derivatives against ES beta-lactamase-producing methicillin resistant *Staphylococcus aureus*³³.

Anti-diabetic activity

The effect of the crude extract and acetone fractions from *Elephantopus scaber* (Asteraceae) on glycemia was investigated in streptozotocin (STZ) diabetic rats. Oral administration of crude extract significantly reduced serum glucose levels and increased the lowered insulin concentrations in diabetic animals at 150 mg kg⁻¹. Nevertheless, the hypoglycemic effect of the acetone fractions (mg kg⁻¹) of *Elephantopus scaber* in diabetic rats was evident at 2 h after treatment, where the sugar lowering effect of the most effective fraction was more than 69%. Phytochemical analysis revealed the compound to be a terpenoid³⁴. Effect of *E. scaber* leaf extract on STZ-induced diabetic rats showed the methanol extract exhibited better hyperglycemic action than the hexane and ethyl acetate extracts. An acetone extract exhibited significant anti-diabetic activity by reducing blood glucose and restoring the insulin levels in STZ-induced diabetic rats³⁵. Oral administration of aqueous extract of leaves and roots into alloxan induced diabetic rats significantly reduced serum glucose, glycosylated hemoglobin and the activity of gluconeogenic enzyme glucose-6-phosphatase, but increased serum insulin, liver and skeletal muscle glycogen content and the activity of glycolytic enzyme glucokinase³⁶. Report reveals that Terpenoid and 2,6,23-trienolide isolated from whole plant act as anti diabetic agent³⁷.

Anti-inflammatory activity

Search for the novel natural anti-inflammatory substances are still necessary due to intolerable side effects of the synthetic anti-inflammatory drugs³⁸⁻⁴⁰. A compound isolated from the hydroalcoholic extract of aerial part of *E. scaber* was studied for the *in vivo* anti-inflammatory activity in albino rats and showed that higher dose of the compound is highly effective in inhibiting carragenan induced edema⁴¹. A study to investigate protective mechanism of *E. scaber* using lipopolysaccharide (LPS) induced inflammation of BV-2 microglial cells and acute liver injury in Sprague-Dawley rats. *E. scaber* reduced LPS induced nitric oxide (NO), interleukin (IL)-1, IL-6, reactive oxygen species and prostaglandin (PG) production in BV-2 cells. It significantly decreased serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) levels in LPS-treated rats⁴². Ethyl acetate fraction from the leaves of *E. scaber* exhibited anti-neuroinflammatory effect in lipopolysaccharide (LPS)-induced microglia cells (BV-2) by blocking nuclear factor κB (NF-κB) via the significant reduction of NO, inducible nitric oxide synthase (iNOS), cyclooxygenase(COX)-2,



Prostaglandin-E₂ (PGE₂), IL-1b, and Tumor necrosis factor(TNF)- α production⁴³.

Hepatoprotective activity

E. scaber was observed for its hepatoprotective effect in mice; the plant extract was able to reverse the liver damage induced by ethanol administration. This action buttressed the traditional use of the plant as a liver tonic⁴⁴. The water extract of *E. scaber* was observed to have a hepatoprotective effect on SD rats (LPS-induced liver damage). The mechanism of *E. scaber* protection involves an antioxidant effect and inhibition of p38 MAP kinase and COX-2 expressions in LPS-stressed acute hepatic injury in SD rats⁴². The hepatoprotective activity of *E. scaber* was evaluated using the methanolic extract. Administration of the extract to rats in which liver damage was previously induced by carbon tetrachloride was found to reverse the damage⁴⁵.

Anti-parasitic activity

Twenty three extracts derived from eleven plant species including *Elephantopus scaber* (leaf) showed promising antiplasmodial activities against the blood stage chloroquine resistant *P. falciparum* (EC₅₀ < 10 μ g/ml) with negligible toxicity effect to MDBK cells *in-vitro* [46]. *In vitro* antitrypanosomal (parasitic) activity of *Elephantopus scaber* was also reported⁴⁷.

Anti-HIV activity

Potent HIV-1 RT inhibitory actions were obtained from the water extract of *Elephantopus scaber* L. leaves and root. IC₅₀ of leaves and root were 69.9 and 107.57 μ g/ml, respectively [48]. The hot aqueous extract of *Elephantopus scaber* L. Leaves shown 48% inhibition against HIV-1 protease at the dose of 250 microgram/ml⁴⁹.

Anti-asthmatic activity

Ethanol extract of *Elephantopus scaber* leaves was evaluated for preliminary phytochemical screening and antiasthmatic activity using histamine and acetylcholine-induced bronchospasm, mast cell degranulation and histamine induced constriction on isolated guinea pig tracheal chain at different dose levels⁵⁰.

Memory power

Ethanol extract of *Elephantopus scaber* (Linn.) leaves may exhibit memory enhancing activity in aged mice and this enhancement of memory may be due to increase anticholinesterase and caspase activity in mice brain⁵¹.

Nephroprotective Activity

The nephroprotective effect of *Elephantopus scaber* could be due to flavonoid content and the inherent antioxidant moieties in the extract. The ethanolic extract of *Elephantopus scaber* leaves could constitute a lead to discovery of a novel drug for the treatment of drug-induced Nephrotoxicity⁵².

Wound healing activity

Deoxyelephantopin, may be due to the presence of active moiety, α methylene γ lactone showed more significant effect than ethanolic extract towards wound healing activity by increasing cellular proliferation, formation of granulation tissue, synthesis of collagen and increase in the rate of wound contraction⁵³. Aqueous extract of *E. scaber* is taken orally to heal wounds⁵⁴.

Anti-pest activity

Elephantopus scaber leaf extract was found to be toxic against pests like Red Flour Beetle (*Tribolium castaneum*), Cotton Stainer (*Dysdercus cingulatus*) and Maize Weevil (*Sitophilus zeamais*), therefore it can be used as a natural pesticide against those bugs, and the plant is worth further investigation for its anti-pest potential⁵⁵.

CONCLUSION AND FUTURE PROSPECTIVE

The use of plants as a source of medicine is as old as the existence of man, renewed interest into the use of herbal medicines is not unrelated to the emergence of new diseases, ineffectiveness of existing drugs and adverse effects of synthetic drugs. The present review tried to look at *Elephantopus scaber* on a broad perspective, with a knowledge that a lot of research has already been done on the plant. This paper tried to expose the different traditional uses of *Elephantopus scaber* such as its use for hepatitis, insomnia, diabetes, bronchitis, viral or bacterial infection, leukaemia, rheumatism, pain relief, snake bite, diuresis, antipyresis, etc. Different biological activities of the plant have been investigated, such as anticancer, antimicrobial, anti-inflammatory, anti-parasitic, anti-HIV, anti-diabetic, anti-asthmatic, hepatoprotective, nephroprotective, anti-asthmatic wound healing, memory power and anti-pest activities. Further investigations are necessary to validate its many other traditional uses. This plant may be a source to bring the new lead as anticancer and antimicrobial in near future. As evidenced from the barrage of reports regarding the biological activity and chemical composition of *Elephantopus scaber* the plant could be a potential source of income for the regions where it is found. Also, further synthesis is required to produce drugs from the isolated compound in large scale; this will reduce dependence on the natural source.

REFERENCES

1. Aidi WW, Mhamdi B, Sriti J, Ben JM, Ouchikh O, Hamdaoui G, Antioxidant activities of the essential oils and methanol extracts from myrtle (*Myrtus communis* var. *italica* L.) leaf, stem and flower, Food Chem Toxicol, 48, 2010, 1362-1370.
2. Kurokawa T, Nakanishi K, Deoxyelephantopin and its interrelation with elephantopin. Tetrahedron Letters, 33, 1970, 2863-2866.
3. Taylor RS, Manandhar NP, Towers GHN, Screening of selected medicinal plants of Nepal for antimicrobial activities, J Ethnopharmacol 46, 1995, 153-159.
4. Singh SD, Krishna V, Mankani KL, Manjunatha BK, Vidya SM, Manohara YN, Wound healing activity of the leaf extracts



- and deoxyelephantopin isolated from *Elephantopus scaber* Linn, Indian J Pharmacol 37, 2005, 238-242.
5. Wright CI, Buren LV, Kroner CI, Koning MM, Herbal medicines as diuretics: A review of the scientific evidence, J Ethnopharmacol, 114, 2007, 1-31.
 6. Hiradeve SM, Rangari VD, *Elephantopus scaber* Linn.: A review on its ethnomedical, phytochemical and pharmacological profile, J applied biomed, 12, 2014, 49–61.
 7. Emerenciano VP, Militão JS, Campos CC, Romoff P, Kaplan MAC, Zambon M, Flavonoids as chemotaxonomic markers for Asteraceae, Biochem. Syst Ecol, 29, 2001, 947-957.
 8. Jasmine R, Selvakumar BN, Synergistic action of two Indian medicinal plants of clinical isolates of vancomycin resistant *Enterococci* species, Pharmacologyonline, 3, 2011, 1192-1198.
 9. Wiwat C, Kwantrairat S, HIV- 1 Reverse Transcriptase Inhibitors from Thai Medicinal Plants and *Elephantopus scaber* Linn, J Phar Sci, 40, 2013, 35-44.
 10. M.L.A. Hammer MLA, Johns EA, Tapping an Amazonian plethora: four medicinal plants of Marajo Island, Para (Brazil), J Ethnopharmacol, 40, 1993, 53-75.
 11. Inta A, Shengji P, Balslev H, Wangpakapattanawong P, Trisonthi C, A comparative study on medicinal plants used in Akha's traditional medicine in China and Thailand, cultural coherence or ecological divergence, J Ethnopharmacol, 116, 2008, 508-517.
 12. Rasoanaivo P, Petitjean A, Ratsimamanga-Urverg S, Rakoto-Ratsimamanga A, Medicinal plants used to treat malaria in Madagascar, J Ethnopharmacol 37, 1992 117-127.
 13. Gurib-Fakim A, Sewraj M, Guehoh J, Dulloo E, Medical ethnobotany of some weeds of Mauritius and Rodrigues. J Ethnopharmacol, 39, 1993, 175-185.
 14. Achuta N, Shukla SS, Rawat AKS. An ethnobotanical study of medicinal plants of Rewa district Madhya Pradesh. Indian J traditional knowledge, 9, 2010, 191-202.
 15. Daniel M. Medicinal plants: chemistry and properties, Science Publishers Enfield, New Hampshire, 2006, 85-86.
 16. Jasmine R, Daisy P, Role of *Elephantopus scaber* on the glucose oxidation in liver and skeletal muscles of streptozotocin (STZ) induced diabetic adult male rats, Res J Med Plants. 2, 2008, 22-27.
 17. Peer LM, Metzger J, medicinal plants of east and Southeast Asia attributed properties and uses, The MIT Press, London, 1980, 620.
 18. Julius K, An ethnobotanical survey of medicinal and other useful plants of Muruts in Sabah, Malaysia. Ethnobotany Section, Forest Research Centre, Forestry Department Sabah, Sandakan, Sabah, Malaysia. Telopea, 10, 2003, 81–98.
 19. Mehmood T, Maryam A, Ghramh HA, Khan M, Ma T, Deoxyelephantopin and isodeoxyelephantopin as potential anticancer agents with effects on multiple signaling pathways, Molecules, 22, 2017, 10-13
 20. Su M, Wu X, Chung HY, Li Y, Ye W, Antiproliferative activities of five Chinese medicinal herbs and active compounds in *Elephantopus scaber*, Nat Prod Commu, 4, 2009, 1025-1030.
 21. Su M, Chung HY, Li Y, Deoxyelephantopin from *Elephantopus scaber* L. induces cell-cycle arrest and apoptosis in the human nasopharyngeal cancer CNE cells, Biochem Biophys Res Commun, 411, 2011, 342-347.
 22. Thana NN, Fotso S, Sevvana M, Sheldrickc GM, Fiebigd HH, Kelterd G, Laatsch H, Sesquiterpene lactones from *elephantopus scaber*, Naturforsch 60, 2005, 200-204.
 23. Rajkapoor B, Jayakar B, Anandan R, Antitumor activity of *Elephantopus scaber* Linn against dalton's ascitis lymphoma, Indian J Pharm Sci, 64, 2002, 71-73.
 24. Chan CK, Chan G, Awang K, Abdul KH, Deoxyelephantopin from *elephantopus scaber* inhibits hct116 human colorectal carcinoma cell growth through apoptosis and cell cycle arrest, Molecules, 21, 2016, 385.
 25. Ho WY, Yeap SK, Ho CL, Raha AR, Suraini AA, Alitheen NB, *Elephantopus scaber* induces cytotoxicity in MCF-7 human breast cancer cells via p53-induced apoptosis. J Med Plants Res, 5, 2011, 5741-5749.
 26. Xu G, Liang Q, Gong Z, Yu W, He S, Xi L, Antitumor activities of the four sesquiterpene lactones f from m *Elepephantopus scaber* L. Exp Oncol, 28, 2006, 106–109.
 27. Mandal SK, Indanyl Analogs as Potential Antimicrobial Agents, Asian J Pharm Clin Res 11, 2018, 278-280.
 28. Suresh KS, Perumal P, Suresh B, Antibacterial Studies on Leaf Extract of *Elephantopus Scaber* Linn, Ancient Sci Life, 23, 2004, 6-8.
 29. Avani, K. Neeta S, A study of the antimicrobial activity of *Elephantopus scaber*, Ind J Pharm, 37, 2005, 126-127.
 30. Kamalakannan P, Kavitha R, Elamathi R, Deepa T, Sridhar S, Study of Phytochemical and antimicrobial potential of methanol and aqueous extracts of aerial parts of *elephantopus scaber* linn, Int J Curr Phar Res, 4, 2012, 18-21.
 31. Jasmine R, Daisy P, Selvakumar BN. A novel terpenoid from *Elephantopus scaber* with antibacterial activity against beta lactamase producing clinical isolates, Res J Microbiol, 2, 2007, 770-775.
 32. P. Daisy, S. Mathew, Suveena S, Rayan NA, A novel terpenoid from *Elephantopus scaber*-antibacterial activity on *Staphylococcus aureus*: a substantiate computational approach, Int J Biomed Sci, 4, 2008, 196.
 33. Jasmine R, Daisy P, Selvakumar BN, Evaluating the antibacterial activity of *elephantopus scaber* extracts on clinical isolates of β -lactamase producing methicillin resistant *Staphylococcus aureus* from UTI patients, Int J Pharmacol, 3, 2007, 165-169.
 34. Jasmine R, Daisy P, Effect of crude extract and fractions from *Elephantopus scaber* on hyperglycemia in streptozotocin-diabetic rats. Int J Biol Chem, 1, 2007, 111-116.
 35. Daisy P, Vargese L, Priya CE, *Comparative studies on the different leaf extracts of Elephantopus scaber.L* on STZ-induced diabetic rats. Eur J Scientific Res, 32, 2009, 304-313.



36. Modilal MRD, Daisy P, Hypoglycemic effects of *Elephantopus scaber* in alloxan-induced diabetic rats, Ind J Novel Drug Delivery 3, 2011, 98-103.
37. Rao MU, Sreenivasulu M, Chengaiah B, Reddy KJ, Herbal medicines for diabetes mellitus: a review. Int J Pharm Tech Res, 2, 2010, 1883-1892.
38. Mandal SK, Ray SM, Synthesis and biological evaluation of (5,6-dialkoxy-3-oxo-2,3-dihydro-1*H*-inden-1-yl)acetic acid esters as anti-inflammatory agents with much reduced gastrointestinal ulcerogenic potential. Indo Am J Pharm Res, 4, 2014, 3796-807.
39. Vishwanathan B, gurupadayya BM, sairam KV, Inturi BK, Design, synthesis, *in vitro* antioxidant and *in vivo* anti-inflammatory activities of novel oxadiazole derivatives, Int J Pharm Pharm Sci, 6, 2014, 514-520.
40. Mandal SK, Ray SM, Synthesis and biological evaluation of (6-chloro-3-oxo-2,3-dihydro-1*H*-inden-1-yl)acetic acid esters as anti-inflammatory agents devoid of ulcerogenic potential at the tested dose level, Indo Am J Pharm Res, 4, 2014, 343-50.
41. Sankar V, Kalirajan R, Sweetlin F, Sales V, Raghuraman S, Antiinflammatory activity of *Elephantopus scaber* in albino rats, Indian J Pharm Sci. 63, 2001, 523-525.
42. Hung HF, Hou CW, Chen YL, Lin CC, Fu HW, Wang JS, Jeng KC, *Elephantopus scaber* inhibits lipopolysaccharide-induced liver injury by suppression of signaling pathways in rats, The Am J Chi Med, 39, 2011, 705-717.
43. Chan CK, Tan LTH, Andy SN, Kamarudin MNA, Goh BH, Kadir HA, Anti-neuroinflammatory Activity of *Elephantopus scaber* L. via Activation of Nrf2/HO-1 Signaling and Inhibition of p38 MAPK Pathway in LPS-Induced Microglia BV-2 Cells, 8, 2017, 397.
44. Wan YH, Swee KY, Ho CL, Raha AR, Alitheen NB, Hepatoprotective activity of *Elephantopus scaber* on alcohol-induced liver damage in mice, Evidence-Based Com Alt Med, 2012, 2012, 1-20.
45. Sheeba KO, Wills PJ, Latha BK, Rajalekshmy R, latha Ms, Antioxidant and antihepatotoxic efficacy of methanolic extract of *Elephantopus scaber* Linn in Wistar rats, Asian Pacific J Trop Dis, 2, 2012, 904-908
46. Razak MA, Effect of selected local medicinal plants on the asexual blood stage of chloroquine resistant *Plasmodium falciparum*, BMC Comp Alt Med, 14, 2014, 492
47. Norhayati I, *In vitro* antitrypanosomal activity of malaysian plants, J Trop Forest Sci, 25, 2013, 52-59.
48. Wiwat C, Kwantrairat S, HIV- 1 reverse transcriptase inhibitors from Thai medicinal plants and *Elephantopus scaber* Linn, J Phar Sci, 40, 2013, 35-44.
49. Xu HX, Wan M, Loh BN, Kon OL, Chow PW, Sim KY, Screening of traditional medicines for their inhibitory activity against HIV-1 protease. Phytother Res, 10, 1996, 207-210.
50. Sagar R, Sahoo HB, Evaluation of Antiasthmatic activity of ethanolic extract of *Elephantopus scaber* L. leaves, Indian J Pharmacol 44, 2012, 398-401.
51. Sahoo HB, Mandal PK, Bhattamisra SK, Bhaiji A, Sagar R, A new weapon for memory power: *Elephantopus scaber* (Linn.). Int J Nutr Pharmacol Neurol Dis, 4, 2014, 64-8.
52. Sahoo HB, Swain SR, Nandy S, Bhaiji A, Nephroprotective activity of ehanolic extract of *Elephantophus scaber* leaves on Albio rats, Int Res J Pharm, 3, 2012, 246-250.
53. Singh AP, promising phytochemicals from indian medicinal plants, Ethnobot Leaflets, 9, 2005, 15-23.
54. Basha SK, Anjaneyulu E, Sudarsanam G, Herbal plants for wound healing among Sugali tribes of Yerramalai forest of Kurnool District, Andhra Pradesh, India, Ind J Applied Pure Biol, 28, 2013, 19-25.
55. <http://herbsfromdistantlands.blogspot.in/2016/07/elephantopus-scaber-elephantopus-mollis.html> (Visited: April 2018)

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