International Journal of Pharmacognosy and Chemistry

Open Access Review Article

A current study on pharmacology and phytochemistry of *biophytum sensitivum*

Roopa D*, Bharathi D.R, Rupesh Kumar Mani, Gurusidda, V. Siva Ganesh

Department of Pharmacology, Sri Adichunchanagiri college of Pharmacy

Article History

Received on: 06-04-2022
Revised on: 13-04-2022
Accepted on: 18-05-2022

***Keywords*:** Biophytum sensitivum, little tree plant, Daspushpum, Oxalidaceae.

DOI:
https://doi.org/10.46796/ijpc.v3i2.319

Abstract

Biophytum sensitivum (L.) DC, a highly valuable medicinal herb from the Daspushpam category of Ayurvedic essential plants in the Oxalidaceae family. It is also called as, little tree plant, life plant and sensitive plant growing in Africa, South Asia and Madagascar's tropical region. It has an intriguing characteristic that is similar to that of the touch-me-not plant. This article describes the synonyms, biological source, phytoconstituents and various pharmacological activities of *Biophytum sensitivum* (L.) DC, which include Anti-inflammatory, Anti diabetic, Anti urolithiatic, Antibacterial, Immunomodulatory and anti tumor activity, Nephroprotective activity, Antifertility, Radioprotective, Hypocholesterolemic effect, Wound healing, Anti-fungal activity, Antihypertensive, Analgesic activity, Antipyretic activity, Chemoprotective activity, Anti-fungal activity ,Anti-angiogenic activity, Anti-metastatic activity, Larvicidal activity and Diuretic activity.

***Corresponding Author**

Roopa D

Introduction

Researchers have increased their interest in plants over the past couple of years because they have the potential to heal a wide range of infections. There have been many studies on medicinal plants for their therapeutic potential; most of them have shown defensive mechanism against a wide variety of ailments. Some folk medicine systems, such as Ayurveda, Unani, and Chinese, rely on secondary metabolites, particularly bioactive compounds in plants [1]. Traditionally, the plant has been used to treat joint pain, inflammation, fever, malaria, wounds, stomach ache, diabetes, gonorrhoea, tuberculosis, cough, and convulsions [2] The highly valuable medicinal herb *Biophytum sensitivum* (L.) DC, which belongs to the Daspushpam category of ayurvedically essential plants in the Oxalidaceae family, is widely used in Ayurveda [3]. This plant grows in the tropical regions of South Asia, Africa, and Madagascar, and is also recognized as the life plant, little tree plant, and sensitive plant. As with the touch-me-not plant, this little tree can be admired for its attractive quality [4, 5]. Kerala's tradition and culture claimed that it is one of ten sacred plants [6]. It's known as Jalapushpa or Attapatti in Andhra Pradesh, India, and is utilised as a folk remedy for diabetes. During the rainy season, it thrives in shaded spots in dry portions of India. It's a common ingredient in traditional Oriental herbal treatments. It is also widely used as a traditional medicinal plant in diabetic rabbits in Nepal [7]. *B.sensitivum* is frequently utilised in the Indian traditional medicine systems of Ayurveda and Siddha to treat a variety of diseases [8]. It has radio-protective, immune-modulatory, cardio-protective, anticancer, and wound-healing properties, analgesic, antipyretic, anti-inflammatory, antihyperglycemic, antibacterial, antihypertensive, antioxidant, chemoprotective, antifertility, apoptotic , cell mediated immune response , repetitive action potentials, effects on

prostaglandin biosynthesis, and other biological properties and therapeutic potentials have been widely explored [9,10,11].

Taxonomy [12]

Botanical name	*Biophytum sensitivum*
Kingdom:	Plantae
Division:	Magnoliophyta
Class:	Magnoliopsida
Order	Oxalidates
Family:	Oxalidaceae
Genus:	Biophytum
Species:	Sensitivum
Botanical name	*Biophytum sensitivum*

Synonyms [12, 13]

Common names	**Life plant, little tree plant, sensitive plant**
Kannada	Jalapushpa Haramuni
Telugu	Chumi, Jala pupa, Pulichinta, Attapatti
Marathi	Jharera, Lahanmulaka, Lajwanti
Sanskrit	Jalapuspa, Krichhraha,Lajjaluka, Panktipatra, Pitapushpa, Lajjalu, Laghuvrikshaka
Bengali	Jhalai
Gujrathi	Jharera
Malayalam	Nilaccurunki, Tintanali ,Mukkuti
Tamil	Tintaanaalee Nilaccurunki
Hindi	Lajalu, Lakshmana, Lajjaalu Zarer

Botanical description

Typically, it grows to a height of 2.5-20 cm and has an unbranched woody erect stem. There are green leaves on top of the stem, which are peripinnate and crowded into a rosette, Leaflets of this plant measure between 6 and 12 mm long, are oblong, and have six to 15 pairs. Leaflets can fold together as an extreme form of "sleep movement," which is common to many members of this family. Flowers are dimorphic, measuring 8 mm in diameter, yellow, and clustered at the peduncle apices. There are five imbricate, sharp sepals, lanceolate with parallel nerves. There are five yellow petals with red markings, and a large corolla shaped like a slaver, and rounded lobes. The corolla is substantially larger than the sepals, with rounded lobes and a glabrous style. The fruit is an oval, apiculate capsule that slightly exceeds the sepals. The seeds have prominent ridges and are striated transversely. From September to December, the plant has been seen fruiting and flowering [2, 14].

Phytoconstituents

In the phytochemistry of *B. sensitivum*, phenolic and polyphenolic compounds, saponin, essential oil, polysaccharides, and pectin were determined. The major bioactive constituents discovered are a trace of cupressoflavone, bioflavonoid, and amentoflavone [15].

In methanolic extracts of roots, stems, and leaves, mentoflavone levels were estimated using reverse phase high performance liquid chromatography (HPLC). These levels were 0.26 percent in roots, 0.33 percent in stems, and 0.012 percent in leaves. Flavonoids like luteolin-7-methyl ether, isoorientin, and 3'-methoxy-uteolin 7-O-glycoside; and two acids like 4-caffeoilinic acid and 5-caffeoilinic acid were isolated from the aerial parts of *B. sensitivum*. Further isolation and quantification of C-glycosyl flavones and proanthocynidins from the plant revealed the presence of isoorientin, orientin, isovitexin, isoorientin 7-O-glucoside, and isoorientin 2″-O-rhamnoside in the leaves' methanolic extract. Roots and leaves contained the highest amounts of (–)-epicatechin and epicatechin-(4-8)-epicatechin (proanthocynidin B2) [16]. 69 components were discovered using gas chromatographic-spectroscopic techniques.

Reported Pharmacological activities

Anti-inflammatory

S.M. Jachak *et.al* have studied the inflammatory activity of aerial parts of *B. sensitivum* by using a carrageenan induced rat paw edema model. For the treatment of inflammation, the aqueous and methanolic extract of roots and aerial parts of plants were used. Among the both extracts except for the methanol extract of aerial parts, all fractions prevented the formation of carrageenin-induced rat paw oedema [17].

Anti-diabetic:

Renuka Chitravel, *et.al.*, was carried out the effect of *Biophytum sensitivum* by using three different extracts like ethanol, aqueous and ethylacetate. By administration of STZ the diabetes was induced to the rats. These extracts were administered orally at a dose of 200 mg /kg.

The aqueous solution of *B. sensitivum* leaf extract shows the hypoglycaemic activity, to examine the effect of the extract on (STZ)-nicotinamide-induced diabetic rats. Standard drug STZ was administered intraperitoneally to

adult male Wistar rats (40 and 110 mg/kg b.w., respectively) to induce diabetes. Rats received BSEt 200 mg/kg for 28 days. The effect of the extract on blood glucose, plasma insulin, total haemoglobin, glycosylated haemoglobin, liver glycogen, and carbohydrate metabolism regulating enzymes was tested in diabetic rats. In diabetic rats, the leaf extract of the plant significantly reduced blood glucose and glycosylated hemoglobin levels and significantly increased plasma insulin levels, liver glycogen levels, hexokinase activities, and glucose-6-phosphatase, fructose-1, 6-biphosphatase activities [18].

Anti urolithiatic

Anil Tukaram Pawar *et.al.,* carried out this activity in standardised methanol extract of aerial parts of *B. sensitivum* in rats. The urolithiasis was induced by surgically implanting zinc discs in the urinary bladders. At a dose of 400 mg/kg body weight the activity was assessed by measuring the dimensions of stones and estimating levels of various biomarkers in serum and urine samples [19].

Antibacterial

This study demonstrates that methanol, chloroform, acetone, and petroleum ether extracts of B sensitivum have antibacterial activity that can be determined by agar well diffusion method on several human pathogenic bacteria (Bacillus subtillis, Staphylococcus aureus, Streptococcus pneumonia, Klebsiella pneumonia, Salmonella typhi, Proteus vulgaris, and Escherichia coli). All extracts werw inhibited in the range of 7-25 mm on selected bacteria. Acetone extract exhibited great activity against B subtillis and moderate activity against S aureus, S pneumoniae, and K pneumonia. The same extract had the least effect against Styphi, E coli, and Pvulgaris. The methanol extract was significantly active against Ecoli, P vulgaris, S pneumonia, and K pneumonia, followed by S aureus. There was the least amount of activity found for the remaining bacteria All selected bacterial pathogens were moderately inhibited by petroleum ether and chloroform extracts. The primary goal of this study was to show that *B. sensitivum* (chloroform, methanol, acetone, and petroleum ether) have been tested against a variety of people pathogenic bacteria. There were bacterial strains transmitted via diffusion (Klebsiella pneumoniae, Salmonella typhi, Proteus vulgaris, and Escherichia coli) including Bacillus subtilis, Staphylococcus aureus, Streptococcus pneumoniae, and Streptococcus pneumoniae. Various extracts showed different levels of activity against different test organisms, and their effectiveness was found to be quite comparable to that of standard antibiotics. Antibacterial activity of acetone extracts was found to be outstanding. The results of these tests confirm that methanol and chloroform extracts have stronger antibacterial activity compared to petroleum ether extracts. Plant extracts can also be used as antifungal agents based on their results [20].

Antioxidant

C. Guruvayoorappan et.al., investigated the antioxidant capacity of *Biophytum sensitivum* (L.) DC (Oxalidaceae) in vitro and in vivo. At concentrations of 50, 95, and 20 g mL-1 (IC50) inhibited in vitro lipid peroxidation as well as scavenged superoxide radicals generated by photoreduction of riboflavin and hydroxyl radicals generated by the Fenton reaction. By administering BSE extract intraperitoneally to macrophages, superoxide production is inhibited. The catalase activity was increased by the administration of B. *sensitivum* to mice. By the administration of extract Glutathione levels was significantly increased in the blood and liver. After applying biological plant extracts, the level of glutathione peroxidase decreased and the levels of glutathione transferase and glutathione reductase increased. In vitro as well as in vivo, B sensitivum exhibited significant antioxidant activity [21].

Immunomodulatory and anti tumor activity

C Guruvayoorappan et al., studied the immunomodulatory and anti-cancer activity of alcoholic extract of *Biophytum sensitivum*. The extract is completely toxic to the ascites from Ehrlich's carcinoma and Dalton's lymphoma at a dose of 0.5 mg/ml. In cultured L929 cells, B sensitivum extract was found to be cytotoxic at 0.1 mg/ml. In mice induced with DLA cells, *B. sensitivum* extract (500g/dose/animal) inhibited solid tumour growth and increased life expectancy of Ehrlich ascites carcinoma-bearing mice by 93.3%. Ascites tumor bearing animals treated with B sensitivum showed significant reductions in glutathione (GSH), gamma glutamyl transpeptidase (GGT), and nitric oxide (NO) levels in tumour cells. After 12 days in BALB/c mice, the total WBC count reached 14,087 cells/mm3. It was found that *B. sensitivum* extract significantly increased bone marrow cellularity, as well as the growth of plaque-forming cells (p0.001) [22]

Nephroprotective activity

Sachin Chandravakar et.al. examined the nephroprotective effects of a whole plant extract to be obtained from the plant, *Biophytum sensitivum* after extracting it with pe-

troleum ether, choloroform, methanol and water. Animals were randomly selected and divided into five groups of 6 animal in each group. The 200mg/kg test extracts were administered orally. The rats were given 40 mg/kg of Gentamicin intraperitoneally for 7 days. All the animals were sacrificed on the eighth day, and their blood was collected. As an indicator of nephrotoxicity, urea and creatinine levels in serum were elevated. The kidneys of all group animals were histopathologically examined. *Biophytum sensitivum* extracts in methanol and aqueous form were shown to have nephroprotective effects [23].

Antifertility

Johnson DB etal., studied the antifertility activity of whole plant of *B. sensitivum*. The effects of infertility on female Wistar albino rats were evaluated using whole plant extracts of B sensitivum in the following ways: ethanol, ethyl acetate, chloroform, and n-butanol at a dose of 400 mg/kg. All extracts inhibited pregnancy compared with control animals, resulting in a significant reduction in implants. The ethanol extract had the highest fertility activity (100 percent). When the extracts were discarded, the activity was reversible [24].

Radioprotective

In vivo mouse models were used to study the radioprotective effects of methanolic extracts of Biophytum sensitivum. After treatment with B sensitivum (50 mg / kg body weight) and systemic gamma irradiation (6 Gy / animal), samples were collected for cellular enzymes, antioxidant levels, hematological parameters, cytology bone marrow, serum cytokine level, and spleen hematopoietic colonies. Irradiated animals receiving B sensitivum may experience a reduction in ALP, GPT, and LPO levels. B sensitivum can significantly raise the level of glutathione (GSH) in the liver and mucosa of irradiated animals. Treatment with *B. sensitivum* can improve total white blood cell counts, bone marrow cells, alphaesterase positive cells, and relative organ weight in the spleen and thymus. The number of hematopoietic colonies on the surface of the spleen was increased after the treatment of *B. sensitivum*. Treatment with *B. sensitivum* was also able to stimulate the production of cytokines such as IL1β, IFNγ and GMCSF in the whole body of animals irradiated with gamma rays. The present investigation shows that the protective effect of *Biophytum sensitivum* on radiation-induced damage of the hematopoietic system is mediated by immunoregulatory as well as the sequential induction of IL1β, GMCSF and IFNγ [25].

Hypocholesterolemic effect

Dinesh puri has investigated the possible hypocholesterolemic effect of water extract of *Biophytum Sensitivum* leaves on male albino rabbits in three groups (six in each group): group I healthy controls, group II untreated rabbits with hypercholesterolemia and group III rabbits with hypercholesterolemia treated with an aqueous extract. Hypercholesterolemia was initially induced in rabbits of groups II and III by feeding cholesterol at a dose of 100 mg / kg b.w / day for 1 week. subsequently, for 4 weeks, the group II rabbits continued to receive the previous dose of cholesterol, while the group III rabbits received plant extracts (200 mg / kg bw / day) at the same dose, higher cholesterol in four weeks. Group I rabbit received only peanut oil at a dose of 1 ml / kg body weight. In group II, serum total cholesterol (TC) showed an almost 5-fold increase from baseline of 53.6 ± 7 mg / dl to 286.3 ± 22 mg / dl. In group III, there was only an increase of until the third week from 52.6 ± 7 mg / dl to 170.8 ± 12 mg / dl, then TC started to decrease and at 146.3 ± 13 mg / dl at the end of the fifth week.The treatment not only prevented elevations of serum triglycerides and it also lowers the values of very low density lipoprotein plus low density lipoprotein cholesterol (VLDLc + LDLc), and the ratios of total cholesterol to high density lipoprotein cholesterol (TC/HDLc).This study concluded that leaves of has a hypocholesterolemic effect [26].

Wound healing

Biophytum sensitivum (L.) DC (syn. Biophytum petersianum Klotzsch) is a medicinal plant with a long history of use in Mali and other countries, including as a wound healing remedy [27].

Antihypertensive:

In the guinea pig and rat models, all B. sensitivum plant extracts appear to have antihypertensive activity. The extract antagonises calcium chloride in a non-competitive manner, and the isolated rat aortic K + fertility activity induces contraction in a concentration-dependent manner. Noradrenaline-induced aortic contraction is also inhibited by the extract. These studies clearly indicate that B. sensitivum antihypertensive effect is due to the inhibition of calcium entry, which is also found in voltage-gated and calcium-driven calcium channels [28].

Analgesic activity

The tail flick method and acetic acid induced writhing method were used to assess the analgesic activity of a

methanolic extract of the whole plant of B. sensitivum at doses of 100 and 200 mg/kg in mice. Results recorded analgesic activity in these two models. The acetic acid induced writhing method stronger than the tail flick method.The maximum pain tolerance is shown at the higher dose (200mg\kg) in tail flick method. In the instance of the acetic acid writhing method, the analgesic activity was determined to be 67.91 and 54.93 percent in 200 and 100 mg/kg doses, respectively. The methanolic extract was shown to have strong analgesic efficacy [29].

Antipyretic activity

The antipyretic activity of a methanolic extract of the whole plant of B. sensitivum was investigated in rats using yeast-induced pyrexia at doses of 100 and 200 mg/kg. The body temperature of yeast-treated rats was significantly reduced after administration of plant extract. The higher dose (200 mg/kg) is more active than the lower dose (100 mg/kg). It was discovered that the extract has a strong antipyretic effect and significantly reduces the febrile response in rats [29].

Chemoprotective activity

C.Guruvayoorappan et.al has been investigated the chemoprotective effect by using a alcoholic extract of biophytum sensitivum in cyclophosphamide (CTX) induced toxicity in swiss albino mice. The extract was administered with cyclophosphamide in intraperitoneal route and it significantly increase the bone marrow cellularity (15.6 ± 0.42 cells/femur), total WBC count (3,356 ± 236 cells/cm2), and α-esterase positive cells (846 ± 30 cells) when compared to control mice treated with only CTX. When comapared to control grouped mices the relative organs like spleen and thymus are increased in the mices administered with B. sensitivum extract. The administration of B. sensitivum significantly reversed the reduction of GSH in the liver (4.9 ± 0.22 nmol/mg protein) and the intestinal mucosa (10.6 ± 1.02 nmol/mg protein) of CTX-treated controls. (Liver: 6.5 ± 0.18 nmol/mg protein; intestinal mucosa: 16.5±0.88 nmol/mg protein), with improvements in serum ALP, GPT, and lipid peroxidation. A histopathological examination of the small intestine suggests that B. sensitivum may reduce CTX-induced intestinal damage. TNF-, a pro-inflammatory cytokine that was elevated during CTX administration, was significantly reduced by the administration of B. sensitivum extract. The lowered levels of cytokines IFN-, IL-2, and GM-CSF after CTX treatment were found to be increased by B. sensitivum extract administration [30].

Anti-fungal activity

The acetone extract of B. sensitivum leaves demonstrated strong antifungal activity. In disc method, B. sensitivum leaf extract inhibited the growth of fungal pathogens A. fumigatus, A. niger, C. neoformans, and Norcardia sp [31].

Anti-angiogenic activity

Amentoflavone extracted from B. sensitivum has been shown to prevent tumor-directed angiogenesis by compromising endothelial cell integrity and changing endogenous factors such IL-1, IL-6, TNF-, GM-CSF, and VEGF, which are necessary for the neovascularization process. Amentoflavone's antiangiogenic action is responsible for tumour development and metastasis suppression [32, 33].

Anti-metastatic activity

Chandrasekaran Guruvayoorappan et.al studied the inhibition of tumor metastasis. At a dose of 50 mg/kg for 10 days, amentoflavone extracted from B. sensitivum inhibited experimental tumour metastasis in C57BL/6 mice injected with B16F-10 melanoma cells. Amentoflavone was discovered to have an antimetastatic effect in B16F-10 melanoma cells by altering proinflammatory cytokine production and inhibiting the activation and nuclear translocation of p6, p50, c-Rel subunits of nuclear factor-kappaB, and other transcription factors such as c-fos, activated transcription factor-2, and cyclic adenosine monophosphate response element binding protein [34, 35].

Larvicidal activity

Acetone extract of B. sensitivum leaves was found to be effective larvicidal, pupicidal, and also interfered with the normal development and emergence of adult mosquitos on Aedes aegypti mosquitos at concentrations of 10, 15, and 25 mg/L in a dose dependent manner. It has been concluded that B. sensitivum has a high potential as a larvicidal agent against aedes aegypti strains [36].

Diuretic activity

Sachin K. Chandavarkar et.al has been investigated the diuretic activity in different extracts (chloroform,methanol and aqueous) of whole plant of *Biophytum sensitivum* (Linn.) DC. in Wistar strain albino rats. The extract at a dose of 200mg/kg B.W was given orally in which the methanol and ethanol shows a significant increased urinary output and excreation of electrolyte, where the chloroform shows an insignificant effect [37].

Traditional uses of *Biophytum sensitivum*:

Biophytum sensitivum Dc., which are used in Ayurvedic practice for several ailments.It is having a good antioxidant and free radicle scavenging.[38] It is used in the treatment of cancer[39], roots decoction is used for gonorrhoea ,fever, & urinary disorders[40],the leaf part is used for antiexcitement, antifertility, antiseptic, bilious fever, burns, convolusion, cramps, cuts, wounds as haemostat, fever, decreases sexual vigour, diarrhoea, giddiness, headache, malaria, muscular and rheumatic pain[41] ,the herb of the plant is used for insomnia, convulsions, cramps, strangury & asthma[42],in the form of juice the entire plant is used for the treatment of epilepsy it is also used against poisonous bite it is also used for treatment of diuretic in pregnant women ,bleeding and for migraine [43-46].

Conclusion

In the present study, it is scientifically proven that the plant *Biophytum sensitivum* and its active ingredients can be used in the maintenance of health as well as the prevention, treatment, or improvement of a variety of diseases. B. sensitivum's pharmacological potential has been established, and it has been determined to be generally safe in research thus far. Further investigation into the potential involvement of this plant extract and its chemical ingredients in a range of disorders in human models is required.

References

1. Sakthivel KM, Guruvayoorappan C. Biophytum sensitivum: Ancient medicine, modern targets. Journal of advanced pharmaceutical technology & research. 2012 Apr;3(2):83.
2. Babas SY, Luka CD, Istifanus G, Mayel MH. DETERMINATION OF THE ANTIDIABETIC PROPERTY OF THE AQUEOUS EXTRACT OF BIOPHYTUM SENSITIVUM ON STREPTOZOTOCIN INDUCED DIABETIC RATS. GSJ. 2020 Aug;8(8).
3. George MA, Urumbil SK, Anilkumar M. Isolation, Identification and Characterisation of Endophytic Bacteria in Biophytum sensifivum (L.) DC. J. Pure Appl. Microbiol. 2020;14(1):647
4. Kala SC, Mallikarjuna K. A short review on callus studies of *Biophytum sensitivum* Linn. World Journal of Microbiology Research. 2015 Jan 23;4(4):985-91.
5. Bharati AC, Sahu AN. Ethnobotany, phytochemistry and pharmacology of *Biophytum sensitivum* DC. Pharmacognosy reviews. 2012 Jan;6(11):68.
6. Chandavarkar SK, Desai SM. Diuretic activity of different extracts of Biophytum sensitivum (Linn.) DC. Ayu. 2015 Jul;36(3):356.
7. Mishra M, Bandyopadhyay D, Pramanik KC, Chatterjee TK. Antihyperglycemic activity of Biophytum sensitivum (L.) DC in alloxan diabetic rats. Oriental Pharmacy and Experimental Medicine. 2007;7(4):418-25.
8. Kala SC, Vijayalakshmi M, Khalivulla SI, Mallikarjuna K. Phytochemical and Antimicrobial Analysis of Callus Extracts of Biophytum sensitivum (Linn) DC. Microbiology Research Journal International. 2014 May 6:869-84.
9. Subramanian A, Kumar SS, Suja SK, Sudarshanand M, Chakraborty A. Antioxidant and free radical scavenging activity of annular and seasonal ayurvedic medicinal plants Elephantopus scaber L. and Biophytum sensitivum DC. Int. J. Pharm. Bio. Chem. Sci. 2014;1:06-17.
10. Pawar AT, Vyawahare NS. Protective effect of standardized extract of Biophytum sensitivum against calcium oxalate urolithiasis in rats. Bulletin of Faculty of Pharmacy, Cairo University. 2015 Dec 1;53(2):161-72.
11. Kumar PT, Kalita P, Burman TK, Chatterjee TK, Maity S. FORMULATION AND EVALUATION OF ANTIDIABETIC TABLET CONTAINING WHOLE PLANT EXTRACT OF BIOPHYTUM SENSITIVUM ON THE BASIS OF TOTAL FLAVONOID CONTENT. World Journal of Pharmaceutical Research. 2013 Apr 20;2(4):986-1007.
12. Sajith Kumar PN, Rajagopal PL, Arthi I, Anjana AK, Yamuna CV. AN UPDATED REVIEW ON VARIOUS PHARMACOLOGICAL ACTIVITY OF BIOPHYTUM SENSITIVUM.
13. Zade D, Pathak S, Khobragade P, Wairagade S, Fadanvis P. Review of Viparit lajjalu (Biophytum sensitivum Linn.) and its Effect on Sperms. Int J Cur Res Rev| Vol. 2021 Apr;13(07):64.
14. Mathew George, Lincy Joesph and Umesh Kumar. 2016. *Biophytum sensitivum* Chemical Constituents and Medicinal Properties: A Review*Int.J.Curr.Res.Aca.Rev.* 4(7): 57-67

15. PK L, Sajith Kumar PN, Rajagopal PL, Arthi I, Anjana AK, Yamuna CV. AN UPDATED REVIEW ON VARIOUS PHARMACOLOGICAL ACTIVITY OF BIOPHYTUM SENSITIVUM.
16. Bharati AC, Sahu AN. Ethnobotany, phytochemistry and pharmacology of Biophytum sensitivum DC. Pharmacognosy reviews. 2012 Jan;6(11):68.
17. Jachak SM, Bucar F, Kartnig T. Antiinflammatory activity of extracts of Biophytum sensitivum in carrageenin-induced rat paw oedema. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives. 1999 Feb;13(1):73-4.
18. Ananda PK, Kumarappan CT, Christudas S, Kalaichelvan VK. Effect of Biophytum sensitivum on streptozotocin and nicotinamide-induced diabetic rats. Asian Pacific Journal of Tropical Biomedicine. 2012 Jan 1;2(1):31-5.
19. Pawar AT, Vyawahare NS. Anti-urolithiatic activity of standardized extract of Biophytum sensitivum against zinc disc implantation induced urolithiasis in rats. Journal of advanced pharmaceutical technology & research. 2015 Oct;6(4):176.
20. Natarajan D, Shivakumar MS, Srinivasan R. Antibacterial activity of leaf extracts of Biophytum sensitivum (L.) DC. Journal of pharmaceutical sciences and Research. 2010 Nov 1;2(11):717
21. Guruvayoorappan C, Afira AH, Kuttan G. Antioxidant potential of Biophytum sensitivum extract in vitro and in vivo. Journal of basic and clinical physiology and pharmacology. 2006 Dec 1;17(4):255-68.
22. Guruvayoorappan C, Kuttan G. Immunomodulatory and antitumor activity of Biophytum sensitivum extract. Asian Pacific Journal of cancer prevention. 2007 Jan 1;8(1):27.
23. Chandavarkar S, Desai M, Gautam G. Nephroprotective activity of different extracts of Biophytum sensitivum (Linn.) DC. Int J Herb Med. 2017;5(1):31-4.
24. Johnson DB, Dinesh Kumar C, Arunkanth KR, Giles D, Gopal M, Hubert VG. Antifertility activity of Biophytum sensitivum. Indian drugs. 2003;40(9):523-5.
25. Guruvayoorappan C, Kuttan G. Protective effect of Biophytum sensitivum (L.) DC on radiation-induced damage in mice. Immunopharmacology and immunotoxicology. 2008 Jan 1;30(4):815-35.
26. Puri D. Hypocholesterolemic effect of Biophytum sensitivum leaf water extract. Pharmaceutical biology. 2003 Jan 1;41(4):253-8.
27. Inngjerdingen KT, Coulibaly A, Diallo D, Michaelsen TE, Paulsen BS. A complement fixing polysaccharide from Biophytum p etersianum Klotzsch, a medicinal plant from Mali, west Africa. Biomacromolecules. 2006 Jan 9;7(1):48-53.
28. Titrikou S, Eklu-Gadegbeku K, Mouzou A, Aklikokou K, Gbeassor M. Calcium antagonistic activity of Biophytum petersianum on vascular smooth muscles of wistar rat. Iranian Journal of Pharmacology & Therapeutics. 2008 May 24;6(2):185-9.
29. Chatterjee TK, Mishra M, Pramanik K, Bandyopadhyay D. Evaluation of Anti-inflammatory, Antipyretic and Analgesic properties of Biophytum sensitivum (L.) DC. Indian Drugs. 2008 Feb 1;45(2):123-31.
30. Guruvayoorappan C, Kuttan G. Evaluation of the chemoprotective effect of Biophytum sensitivum (L.) DC extract against cyclophosphamide induced toxicity in Swiss albino mice. Drug metabolism and drug interactions. 2007 Jun 1;22(2-3):131-50.
31. Ida B, Seema D, Shital D, Riva S, Astrida R. Antimicrobial activity of ten common herbs, commonly known as Dashapushpam from Kerala, India. African Journal of microbiology research. 2010 Nov 18;4(22):2357-62.
32. Guruvayoorappan C, Kuttan G. Anti-angiogenic effect of Biophytum sensitivum is exerted through its cytokine modulation activity and inhibitory activity against VEGF mRNA expression, endothelial cell migration and capillary tube formation. Journal of experimental therapeutics & oncology. 2007 Jun 1;6(3).
33. Guruvayoorappan C, Kuttan G. Inhibition of tumor specific angiogenesis by amentoflavone. Biochemistry (Moscow). 2008 Feb;73(2):209-18.
34. Guruvayoorappan C, Kuttan G. Amentoflavone inhibits experimental tumor metastasis through a regulatory mechanism involving MMP-2, MMP-9, prolyl hydroxylase, lysyl oxidase, VEGF, ERK-1, ERK-2, STAT-1, NM23 and cyto-

kines in lung tissues of C57BL/6 mice. Immunopharmacology and immunotoxicology. 2008 Jan 1;30(4):711-27.
35. Guruvayoorappan C, Kuttan G. Anti-metastatic effect of Biophytum sensitivumis exerted through its cytokine and immunomodulatory activity and its regulatory effect on the activation and nuclear translocation of transcription factors in B16F-10 melanoma cells. Journal of experimental therapeutics & oncology. 2008 Mar 1;7(1).
36. Shivakumar MS, Srinivasan R, Natarajan D. Bioefficacy of Biophytum sensitivum (L.) leaf extracts against dengue mosquito vector Aedes aegypti (L.). Res J Pharmaceut Biol Chem Sci. 2012;3(3):885-92.
37. Chandavarkar SK, Desai SM. Diuretic activity of different extracts of Biophytum sensitivum (Linn.) DC. Ayu. 2015 Jul;36(3):356.
38. Subramanian A, Kumar SS, Suja SK, Sudarshanand M, Chakraborty A. Antioxidant and free radical scavenging activity of annular and seasonal ayurvedic medicinal plants Elephantopus scaber L. and Biophytum sensitivum DC. Int. J. Pharm. Bio. Chem. Sci. 2014;1:06-17.
39. Xavier TF, Kannan M, Lija L, Auxillia A, Rose AK. Ethnobotanical study of Kani tribes in Thoduhills of Kerala, South India. Journal of Ethnopharmacology. 2014 Feb 27;152(1):78-90.
40. Poonam K, Singh GS. Ethnobotanical study of medicinal plants used by the Taungya community in Terai Arc Landscape, India. Journal of ethnopharmacology. 2009 May 4;123(1):167-76.
41. Singh A, Dubey NK. An ethnobotanical study of medicinal plants in Sonebhadra District of Uttar, Pradesh, India with reference to their infection by foliar fungi. Journal of Medicinal Plants Research. 2012 Apr 16;6(14):2727-46.
42. Sivasankari B, Anandharaj M, Gunasekaran P. An ethnobotanical study of indigenous knowledge on medicinal plants used by the village peoples of Thoppampatti, Dindigul district, Tamilnadu, India. Journal of Ethnopharmacology. 2014 Apr 28;153(2):408-23.
43. Kuvar SD, Shinde RD. ETHNOBOTANICAL STUDIES ON KOKNI TRIBE OF MAHARASHTRA. Journal of Global Biosciences. 2019;8(3):6034-42.
44. Rajith NP, Ramachandran VS. Ethnomedicines of Kurichyas, Kannur district, Western Ghats, Kerala.
45. Kamble SY, Patil SR, Sawant PS, Sawant S, Pawar SG, Singh EA. Studies on plants used in traditional medicine by Bhilla tribe of Maharashtra.
46. Silja VP, Varma KS, Mohanan KV. Ethnomedicinal plant knowledge of the Mullu kuruma tribe of Wayanad district, Kerala.