
A CRITICAL REVIEW ON *BIOPHYTUM SENSITIVUM* (L.) DC.: INTEGRATING PHYTOCHEMISTRY AND PHARMACOLOGICAL POTENTIAL WITH MODERN STANDARDIZATION PARADIGMS

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ABSTRACT

Known as "Lajjalu" in Northern India, *Biophytum sensitivum* DC. (Family: Oxalidaceae) is an annual herb that grows in the Himalayan foothills. In addition to being used as a tonic, stimulant, and to cure stomachaches, asthma, sleeplessness, convulsions, cramps, chest complaints, inflammations, tumors, and chronic skin conditions, this indigenous medication is used to treat "Madhumeha," or diabetes mellitus. Numerous pharmacological properties, including anti-tumor, antipyretic, immunomodulatory, antidiabetic, antiulcer, radio-protective, larvicidal, antibacterial, and antioxidant properties, have been scientifically tested. Phytochemical investigations revealed that the main components were phenolic compounds and flavonoids. It contains antitumor, antioxidant, antibacterial, radio protective, anti-hypertensive, antiangiogenics, chemoprevention, anti-diabetic, and anti-inflammatory, according to a recent pharmacological study. The goal of this effort is to assemble a review of this plant's macroscopic features, chemical components, pharmacological reports, clinical trials, formulations.

KEYWORDS: *Biophytum sensitivum*, macroscopic features, chemical components, pharmacological reports, clinical trials.

INTRODUCTION

Plants are supplied by nature. The enormous potential of plants to treat life-threatening illnesses has led to a rise in plant research worldwide in recent years. The therapeutic potential of several medicinal plants has been assessed, and the majority of them have demonstrated their ability to prevent a variety of illnesses ^[1]. Drug discovery from the active components of plants is becoming increasingly important due to the concerning rise in the rate of disease progression and diagnosis ^[2]. Wet regions of tropical India, South Asia, and Africa are home to *Biophytum sensitivum* (L: Linnaeus) DC, a member of the Magnoliophyta Division, Class, Order, and Family. It is typically found in grasslands at low and medium elevations, under the shelter of trees and shrubs. Jhalai (Bengali), Laajjaalu, Lakshmana (Hindi), Haramuni, Jalapushpa (Kannada), Mukkutti (Malayalam), Lajwanti (Marathi), Vipareetalajjaalu, Jhulapushpa (Sanskrit), Nilaccurunki, Tintaanaalee (Tamil), Attapatti, chumi, Jalapuspa (Telugu) are some of the other colloquial names for it. ^[3,4]. The cultivation of this plant has become extremely challenging because the seeds are still dormant. A method for regenerating *Biophytum sensitivum* from its different explants via somatic, direct, and indirect embryogenesis was developed by Shivanna et al. (2008).^[5]

MORPHOLOGY

The small plant has an upright, unbranched, woody stem and can reach a maximum height of 20 cm.

- Leaves: Abruptly pinnate leaves with six to twelve pairs of opposing leaflets, each up to 1.5 cm long, with the terminal pair being the largest.
- Bloom: Usually yellow, white, or orange with a red streak in the middle of each of the five petals, the blooms are many and packed at the tips of the many peduncles. The sepals are striate, subulate-lanceolate, and roughly 7 mm long.
- Fruits: The ellipsoid capsules that make up fruits are shorter than the persistent calyx.^[6]

Taxonomical classification

Kingdom: Plantae

Phylum: Tracheophyta

Class: Magnoliposida

Order: Oxalidales

Family: Oxalidaceae

Genus: *Biophytum*

Species: *sensitivum*

Botanical name: *Biophytum sensitivum* (L.) DC [7]



Fig.1. Representing image of Biophytum sensitivum.

Phytochemistry

The phytochemistry of *B. sensitivum* revealed a variety of chemical compounds, such as two biflavones, cupressuflavone and amentoflavone; three flavonoids, luteolin 7-methyl ether, isoorientin, and 3'-methoxyluteolin 7-O-glucoside; and two acids, 4- and 5-caffeoylquinic acid, which were isolated from the aerial parts of *B. sensitivum* [16]. Additionally, it includes certain phenolic compounds, proanthocyanidins (also called condensed form of tannins), and 3', 8'-biapigenin [8, 9]. [10]

Pharmacological potential

Reviewing studies employing different crude extracts and their constituents with antitumor, antioxidant, antibacterial, radioprotective, anti-hypertensive, antiangiogenesis, chemoprevention, anti-diabetic, and anti-inflammatory properties is the main focus.

a. Chemoprotective

A *Biophytum sensitivum* alcoholic extract was used by C. Guruvayoorappan et al. to study the chemoprotective activity in cyclophosphamide (CTX)-induced toxicity in Swiss albino mice. When the extract was given intraperitoneally along with cyclophosphamide, the bone marrow cellularity (15.6 ± 0.42 cells/femur), total WBC count ($3,356 \pm 236$ cells/cm²), and α -esterase positive cells (846 ± 30 cells) were significantly higher than in control mice that received only CTX.

The mice given *Biophytum sensitivum* extract had higher relative organs like the spleen and

thymus when compared to the control group. The loss of GSH in the intestinal mucosa (10.6 ± 1.02 nmol/mg protein) and liver (4.9 ± 0.22 nmol/mg protein) of CTX-treated controls was considerably restored by the treatment of *Biophytum sensitivum*. (Intestinal mucosa: 16.5 ± 0.88 nmol/mg protein; liver: 6.5 ± 0.18 nmol/mg protein), with improvements in lipid peroxidation, GPT, and serum ALP. *Biophytum sensitivum* may lessen intestinal damage caused by CTX, according to a histological analysis of the small intestine. The treatment of *Biophytum sensitivum* extract considerably decreased TNF-, a pro-inflammatory cytokine that was increased after CTX administration. It was discovered that *Biophytum sensitivum* extract administration raised the decreased levels of cytokines IFN-, IL-2, and GMCSF following CTX treatment ^[11].

b. Antioxidant

The antioxidant potential of *Biophytum sensitivum* (L.) DC (Oxalidaceae) was studied in vitro and in vivo by C. Guruvayoorappan et al. In vitro lipid peroxidation was prevented at doses of 50, 95, and 20 g mL⁻¹ (IC₅₀), while superoxide radicals produced by photoreduction of riboflavin and hydroxyl radicals produced by the Fenton reaction were scavenged. Superoxide generation is suppressed when macrophages are given BSE extract intraperitoneally. When *Biophytum sensitivum* was given to mice, the catalase activity rose. Glutathione levels were considerably raised in the liver and blood after the extract was administered. Following the application of biological plant extracts, glutathione peroxidase levels dropped while glutathione reductase and transferase levels rose. *Biophytum sensitivum* showed notable antioxidant activity both in vivo and in vitro ^[12].

c. Antimicrobial

This study shows that *Biophytum sensitivum* extracts in methanol, chloroform, acetone, and petroleum ether have antibacterial activity against a number of human pathogenic bacteria (*Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus pneumonia*, *Klebsiella pneumonia*, *Salmonella typhi*, *Proteus vulgaris*, and *Escherichia coli*) using the agar well diffusion method.

Acetone extract showed modest action against *S. aureus*, *S. pneumoniae*, and *K. pneumonia*, but strong activity against *B. subtilis*. Petroleum ether and chloroform extracts moderately inhibited all of the chosen bacterial pathogens. This study's main objective was to demonstrate that *Biophytum sensitivum* (chloroform, methanol, acetone, and petroleum ether) has been tested against a range of human pathogenic microorganisms. Different extracts demonstrated varying degrees of activity against various test organisms, and it was discovered that their efficacy was quite comparable to that of conventional antibiotics.

Acetone extracts were shown to have exceptional antibacterial action. These studies' findings verify that extracts of methanol and chloroform have more potent antibacterial activity than extracts of petroleum ether. According to their findings, plant extracts may also be employed as antifungal agents [13].

d. Immunomodulatory, anti-tumour

The immunomodulatory and anti-cancer properties of an alcoholic extract of *Biophytum sensitivum* were investigated by C. Guruvayoorappan et al. At a concentration of 0.5 mg/ml, the extract is totally toxic to the ascites from Dalton's lymphoma and Ehrlich's carcinoma. *Biophytum sensitivum* extract was shown to be cytotoxic at 0.1 mg/ml in cultivated L929 cells. *B. sensitivum* extract (500g/dose/animal) prolonged the life expectancy of Ehrlich ascites carcinoma bearing mice by 93.3% and prevented solid tumor formation in mice generated by DLA cells. Animals with ascites tumors treated with *Biophytum sensitivum* had significantly lower levels of nitric oxide (NO), glutathione (GSH), and gamma glutamyl transpeptidase (GGT) in their tumor cells. The overall WBC count in BALB/c mice was 14,087 cells/mm³ after 12 days. *Biophytum sensitivum* extract was observed to significantly boost both the development of plaque-forming cells and bone marrow cellularity (p0.001). [14]

e. Radioprotective

The radioprotective effects of *Biophytum sensitivum* methanolic extracts were investigated using in vivo mouse models. Samples were taken for cellular enzymes, antioxidant levels, hematological parameters, cytology bone marrow, serum cytokine level, and spleen hematopoietic colonies following treatment with *Biophytum sensitivum* (50 mg/kg body weight) and systemic gamma irradiation (6 Gy/animal). ALP, GPT, and LPO levels may decrease in irradiated animals given *Biophytum sensitivum*. Alpha esterase positive cells, bone marrow cells, total white blood cell counts, and the relative organ weight of the thymus and spleen can all be improved with *Biophytum sensitivum* treatment. Following *Biophytum sensitivum* therapy, the number of hematopoietic colonies on the spleen's surface increased. Additionally, *Biophytum sensitivum* treatment was able to increase the body-wide production of cytokines such IL1 β , IFN γ , and GMCSF in mice exposed to gamma radiation. The current study demonstrates that immunoregulatory and the sequential production of IL1 β , GMCSF, and IFN γ regulate *Biophytum sensitivum*'s protective action against radiation-induced hematopoietic system damage [15].

f. Antihypertensive

All *Biophytum sensitivum* plant extracts seem to exhibit antihypertensive properties in the rat and guinea pig models. The isolated rat aortic K⁺ fertility activity causes contraction in a

concentration-dependent way, and the extract antagonists calcium chloride in a non-competitive way. The extract also prevents aortic contraction brought on by noradrenaline. These data unequivocally show that the antihypertensive impact of *Biophytum sensitivum* results from the suppression of calcium entry, which is also present in calcium-driven and voltage gated calcium channels [16].

g. Anti-angiogenic

By impairing endothelial cell integrity and altering endogenous molecules like IL-1, IL-6, TNF-, GM-CSF, and VEGF that are essential for the neovascularization process, amentoflavone isolated from *Biophytum sensitivum* has been demonstrated to suppress tumor-directed angiogenesis.

Tumor development and metastasis suppression are caused by the antiangiogenic effect of amentoflavone [17, 18].

h. Anti-diabetic

Renuka Chitravel et al. used three distinct extracts—ethanol, aqueous, and ethyl acetate—to investigate the effects of *Biophytum sensitivum*. Rats were given STZ to cause diabetes. The oral dosage of these extracts was 200 mg/kg. In order to investigate the extract's impact on (STZ)-nicotinamide-induced diabetic rats, the aqueous solution of *B. sensitivum* leaf extract exhibits hypoglycemic.

To induce diabetes in adult male Wistar rats, the standard medication STZ was given intraperitoneally at doses of 40 and 110 mg/kg b.w., respectively. For 28 days, rats were given 200 mg/kg of *Biophytum sensitivum*. Diabetic rats were used to examine the extract's effects on blood glucose, plasma insulin, total hemoglobin, glycosylated hemoglobin, liver glycogen, and enzymes that regulate carbohydrate metabolism. The plant's leaf extract dramatically raised plasma insulin levels, liver glycogen levels, hexokinase activities, glucose-6-phosphatase, fructose-1, and 6-biphosphatase activities, and decreased blood glucose and glycosylated hemoglobin levels in diabetic rats [19].

i. Anti-inflammatory

S.M. Jachak et al. used a rat paw edema model caused by carrageenan to investigate the inflammatory activities of aerial sections of *Biophytum sensitivum*. The aqueous and methanolic extracts of plant roots and aerial parts were utilized to treat inflammation. All fractions of both extracts, with the exception of the methanol extract of aerial portions, inhibited the development of rat paw edema caused by carrageenin [20].

QUALITY STANDARDIZATION AND PHARMACOGNOSY

MACRO-MICROSCOPIC EVALUATION

The small plant has an upright, unbranched, woody stem and can reach a maximum height of 20 cm.

Leaves: Abruptly pinnate leaves with six to twelve pairs of opposing leaflets, each up to 1.5 cm long, with the terminal pair being the largest.

Bloom: Usually yellow, white, or orange with a red streak in the middle of each of the five petals, the blooms are many and packed at the tips of the many peduncles. The sepals are striate, subulate-lanceolate

Fruits: The ellipsoid capsules that make up fruits are shorter than the persistent calyx ^[21].

A circle of collateral bundles makes up the basic vascular structure of both the stem and the petiole, and it is frequently complemented externally by a sclerenchymatous ring in the pericycle. As the family name suggests, oxalic acid is highly prevalent in tissue, where it is thought to exist as dissolved potassium oxalate crystals and be released as calcium oxalate, typically in the form of tiny, solitary cubical and crystal cells. In *B. sensitivum*, these cells accompany and create a sheath around the vein's vascular bundles [Fig.2]. Typically, dorsiventral, leaflets have unicellular heads, varying-length stalks, and glandular hair. At least one, and occasionally two, auxiliary cells run parallel to the hole in rubiacious stomata. The vein's vascular bundles have larger terminal tracheids. The stem's TS displays a pericycle surrounded by a ring of sclerenchyma that is more or less continuous ^[22].



Figure 2. Transverse section of stem of *Biophytum sensitivum*.

PHYSIOCHEMICAL PROFILE EVALUATION

By identifying adulteration using a variety of common physicochemical criteria, the purity of the plant can be assessed. As a result, a number of physicochemical characteristics of the entire *B. sensitivum* plant were determined, including foreign matter, moisture content, ash and extractive values, swelling index, foaming index, and crude fibre determination. The results are displayed as

1. Foreign Matter -NIL
2. Alcohol Soluble Extractive value -15.50 % w/w
3. Water soluble Extractive value- 13.75 % w/w
4. Total ash- 8.80 % w/w
5. Water soluble ash -5.26 % w/w
6. Acid-insoluble ash- 1.90 % w/w
7. Sulphated ash- 0.35 % w/w
8. Moisture content (Loss on drying)- 8.50 % w/w
9. Swelling index- NIL
10. Foaming Index- Less than 100 ml
11. Crude fibre content -10.0 l²³

CONCLUSION

The plant's parts have historically been known to have a wide range of therapeutic qualities, including antibacterial qualities that can help treat diabetes and a number of skin problems. Scientific study has demonstrated antibacterial, antifungal, and antidiabetic properties. In the Ayurvedic medical system, *Biophytum sensitivum* is frequently used to treat diabetes. Traditionally, the entire plant has been used to treat a number of illnesses. There hasn't been any methodical research done to identify the bioactive components that cause the aforementioned bioactivities. Only nineteen of the plant's phytoconstituents, including flavonoids, steroids, and phenolic compounds, have been identified thus far. Only flavonoids (amentoflavone) have been proposed to have the majority of pharmacological actions among these components. These findings imply that further thorough research is required in order to separate the plant's bioactive components and standardize it using the identified bioactive markers. There is just one patented formulation used to treat diabetes and its complications that includes *Biophytum sensitivum* as one of the components. According to toxicological studies, it is safe but the studies should be kept to be progressed.

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