

# *Biophytum sensitivum*: Ancient medicine, modern targets

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## ABSTRACT

Research on medicinal plants began to focus on discovery of natural products as potential active principles against various diseases. Medicinal plants are very interesting, have the ability to produce remarkable chemical structures with diverse biological activities. *Biophytum sensitivum* is used as traditional medicine to cure variety of diseases. During the last few decades, extensive research has been carried out to elucidate the chemistry, biological activities, and medicinal applications of *B. sensitivum*. Phytochemical analysis have shown that the plant parts are rich in various beneficial compounds which include amentoflavone, cupressuflavone, and isoorientin. Extracts and its bioactive compounds have been known to possess antibacterial, anti-inflammatory, antioxidant, antitumor, radioprotective, chemoprotective, antimetastatic, antiangiogenesis, wound-healing, immunomodulation, anti-diabetic, and cardioprotective activity. The present review has been carried out to shed light on the diverse role of this plant in the management of various ailments facing us.

**Key words:** *Biophytum sensitivum*, medicinal plants, natural products

## INTRODUCTION

Plants are naturally gifted. In recent times, research on plants has increased across the globe owing to their immense potential to heal life-threatening diseases. A number of medicinal plants have been evaluated for their therapeutic potentials; most of them have shown their protective effects against various diseases. The secondary metabolites, especially the bioactive compounds present in the plants, provided the basis for several sophisticated traditional medicine systems like Ayurveda, Unani, Folk, and Chinese.<sup>[1]</sup>

Due to the alarming increase in the rate of advancement of illnesses and their diagnosis, drug discovery from active constituents of the plants is gaining more importance. Drug discovery from medicinal plants involves a multifaceted approach combining botanical, phytochemical, biological, and molecular techniques. Effectiveness of the natural products, mainly the herbal extracts with their proven potential and negligible side effects in therapeutics, has already replaced the synthetically derived chemical substances as in modern allopathic medication system which is regarded as unsafe to human and environment.<sup>[2]</sup>

Herbal medicines contains one or more herbal substances as active ingredients which is derived from the aerial and non-aerial parts, juices, resins, and oils of the plant either in crude state or as pharmaceutical formulation.<sup>[3,4]</sup> The chemical constituents of plant may help as cofactors for already available biologically active compounds.<sup>[5]</sup> Recently, there has been awareness on the understanding of the herbal knowledge for gaining insights into the socioeconomic and cultural components of the society. Advances in quantification and detection of herbal drug molecules provided us the better understanding of the relation between the specific component(s) and its efficacy.<sup>[6]</sup> Just like conventional molecular drugs, the phytopharmaceuticals are involved in the development and marketing of modern herbal drugs which is clinically effective, inexpensive, and

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globally competitive.<sup>[7]</sup> Phytomedicines (can be plants, parts of plants, and isolated bioactive compounds) have been used to treat or prevent various disorders.<sup>[6,8]</sup> Innumerable drugs from plants found worldwide have been documented in literatures, yet there continues to be untapped knowledge on the curative potential of several plants.

## OCCURRENCE AND BOTANICAL DESCRIPTION

*Biophytum sensitivum* (L: Linnaeus) DC belonging to Division: Magnoliophyta, Class: Magnoliopsida, Order: Oxalidales, Family: Oxalidaceae, found in wet lands of tropical India, South Asia and Africa. Normally, it is present in the shades of trees and shrubs, in grass lands at low and medium altitudes. It is commonly known as Life plant (English). In India, it is also known by various vernacular names, Jhalai (Bengali), Laajjaalu, Lakshmana (Hindi), Hara muni, Jalapushpa (Kannada), Mukkutti (Malayalam), Lajwanti (Marathi), Vipareetalajjaalu, Jhulapushpa (Sanskrit), Nilaccurunki, Tintaanaalee (Tamil), Attapatti, chumi, Jalapuspa, (Telugu). It has been used in traditional medicine for various ailments, especially in Indian medicine.<sup>[9,10]</sup> The flower of this plant is considered as one of the ten sacred plants which are called as Dasapushpam in tradition and culture of Kerala state in India.<sup>[11]</sup> Due to seeds remaining dormant, the cultivation of this plant has become very difficult. Shivanna *et al.* (2008) established a protocol to regenerate *B. sensitivum* through indirect and direct and somatic embryogenesis from its various explants.<sup>[12]</sup>

Various crude extract of this plant have shown multifarious activities which includes antioxidants, anti-inflammatory, and antitumor activity. Medicinal plants become the main source for cancer drug development.<sup>[13]</sup> Pharmacological screening from leaves of the *B. sensitivum* showed significant antitumor activity in Dalton's Lymphoma Ascites (DLA)-bearing mice<sup>[14]</sup> and this represents *B. sensitivum* as a valuable medicinal plant with therapeutic effects. Continued research to elucidate the molecular mechanisms behind the role of antitumor activity is worthwhile. The present article aims to provide a comprehensive review on its state of knowledge about morphology, phytoconstituents, and its various biological activity of *B. sensitivum* as a revolutionary

therapeutic agent to combat life-threatening diseases flourished during the last decade.

## PLANT MORPHOLOGY

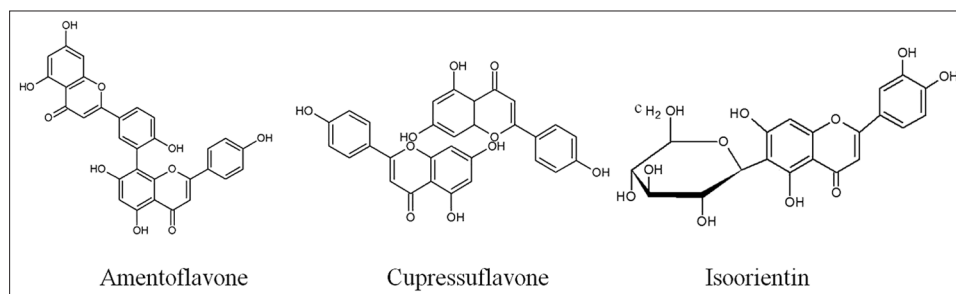
The little plant grows up to maximum of 20 cm and possess unbranched woody erect stem. Leaves: Leaves abruptly pinnate, leaflets opposite, 6 to 12 pairs, and each leaflet is up to 1.5 cm long, the terminal pair is the largest. Flower: The flowers are many and crowded at the apices of the numerous peduncles, normally yellow, white, or orange with red streak in the center of each of the five petals. The sepals are subulate-lanceolate, striate, and about 7 mm long. Fruits: Fruits are ellipsoid capsules which are shorter than the persistent calyx.<sup>[15]</sup>

## PHYTOCHEMISTRY

The phytochemistry of *B. sensitivum* showed a wide range of chemical compounds including two biflavones: cupressuflavone and amentoflavone; three flavonoids: luteolin 7- methyl ether, isoorientin and 3'-methoxyluteolin 7-O-glucoside; two acids: 4-Caffeoylquinic acid and 5-Caffeoylquinic acid which were isolated from the aerial parts of *B. sensitivum*.<sup>[16]</sup> It also contains 3', 8''-biapigenin,<sup>[17]</sup> proanthocyanidins (also known as condensed form of tannins),<sup>[18]</sup> and some phenolic compounds.<sup>[19]</sup> These compounds were isolated from the aerial part of this plant [Figure 1].<sup>[11]</sup>

## TRADITIONAL THERAPY

Tracing the history of traditional practice of *B. sensitivum* reveals its key action; the plant is bitter, expectorant, stimulant, and tonic in Ayurveda. It has been used as traditional medicine for several purposes. It is recommended to be used in the treatment of stomach ache, asthma, treating insomnia, convulsions, cramps, chest complaints, inflammations, tumors, and remedying chronic skin diseases. Commonly, the whole plant decoction is used for asthma and phthisis and the decoction of root is used for gonorrhoea and lithiasis.<sup>[9]</sup> Specifically, the leaves are diuretic and relieve strangury and commonly known as "Nagbeli," a folk medicine against "Madhumeha" (Diabetes mellitus),



**Figure 1:** Structures of phytoconstituents isolated from *B. sensitivum*

particularly in Eastern Nepal.<sup>[20,21]</sup> The powdered leaves and seeds were used to apply on wounds.<sup>[22]</sup> *B. sensitivum* is one of the plants used against snake envenomation. The whole part of plant is used to counteract the snake venom activity.<sup>[23]</sup> The major ethnopharmacological uses of *B. sensitivum* have been depicted in Table 1.

## PHARMACOLOGICAL POTENTIAL OF *B. SENSITIVUM*

Focusing on the review of research works with various crude extract and its compounds with radioprotection, immunomodulation, antitumor, antioxidant, antibacterial, hypoglycemic, antimetastatic, antiangiogenesis, chemoprevention, anti-diabetic, anti-inflammatory are covered. The widest spectra of pharmacological activities exhibited by *B. sensitivum* are represented in the Figure 2.

### Radioprotective Action

Over the past 50 years, research in the development of radioprotective agents attained an area of great significance due to its applications in planned radiotherapy and unplanned radiation exposure. Free-radical-induced reproductive cell death is the basis of radiotherapy, and it is clear that the main problem of this approach to fight

cancer is to target the ionizing radiation to the tumor cells in order to prevent damage to healthy tissue.<sup>[24]</sup> The use of *B. sensitivum* as a radioprotective agent in Swiss albino mice is evaluated. The results of this study showed that *B. sensitivum* treatment could scavenge the free radicals generated during whole-body radiation exposure and may protect the mice from radiation-induced hemopoietic damage which is mediated through immunomodulation as well as sequential induction of IL-1 $\beta$ , Granulocyte colony stimulating factor (GM-CSF), and IFN- $\gamma$ .<sup>[25]</sup>

### Induction of apoptosis in B16F-10 melanoma cells

The precisely controlled cellular event apoptosis, also known as programmed cell death, is a well-recognized process essential for normal human embryogenesis as well as to maintain tissue homeostasis and protective processes.<sup>[26]</sup> The methanolic extract of *B. sensitivum* and amentoflavone, a biflavonoid present in this plant, were able to inhibit the production of proinflammatory cytokines such as Interleukins (IL-1 $\beta$  and IL-6), GM-CSF, Tumor necrosis factor (TNF- $\alpha$ ), and Nitric oxide (NO) by Tumor-associated macrophages.<sup>[27,28]</sup>

### Effect of *B. sensitivum* on cell-mediated immune response

Guruvayoorappan and Kuttan evaluated the effect of *B. sensitivum* on mitogen-induced proliferative response of lymphocytes and on Natural Killer (NK) cell-mediated, Antibody-dependent cellular cytotoxicity (ADCC), and Antibody-dependent complement-mediated cytotoxicity (ACC) in Ehrlich ascites carcinoma (EAC)-bearing mice. The administration of *B. sensitivum* stimulates the immune system, leading to enhanced immune cell proliferation of splenocytes, thymocytes, and bone marrow cells by stimulating the mitogenic potential of various mitogens such as Lipopolysaccharide (LPS), Concanavalin A (Con A), Phytohemagglutinin, and Poke Weed Mitogen. NK cell activity, ADCC, and ACC were found to be enhanced in tumor-bearing animals that suggest the immunomodulatory property of *B. sensitivum*.<sup>[29]</sup>

### Immunostimulation and Antitumor Activity

The agents that activate the host-defense mechanisms or modulate the immune response by stimulation or

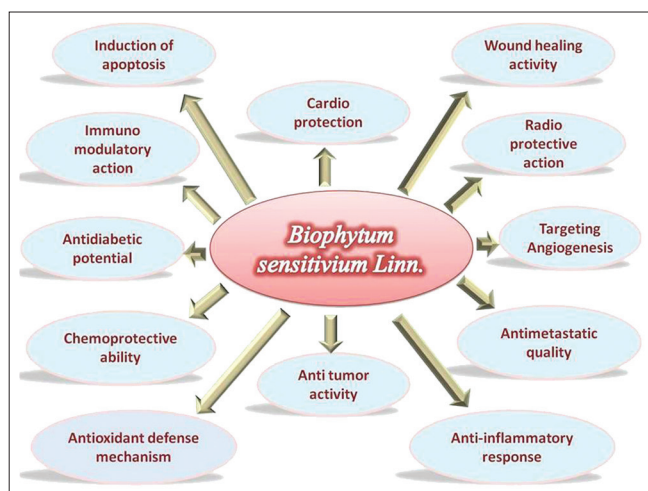


Figure 2: Pharmacological dimensions of *B. sensitivum*

Table 1: Ethnopharmacological uses of *B. sensitivum*

Part of the plant	Ailment	Group / Country	References
Whole plant decoction as a tonic (Oral)	Stomach ache, asthma, insomnia, convulsions, chest complaints, tumors	Ayurveda, Foot hills of Himalayas, India	9
Whole plant (Topical)	Inflammations, chronic skin diseases	Ayurveda, India	9
Root (Oral)	Gonorrhoea and Lithiasis	Ayurveda, India	9
Leaves (Oral)	Diabetes	"Nagbeli" a folk medicine, Nepal, Foot hills of Himalayas, India	51,80,81
Powdered leaves and seeds (Topical)	Wound healing	Mali, Africa	18
Whole plant decoction (Oral)	Snake envenomation	Both in Ayurveda and Siddha, India	19

suppression are referred as Immunomodulators. The methanolic extract of *B. sensitivum* was screened for its immunomodulatory and antitumor activity in BALB/c mice. The administration of methanolic extract of *B. sensitivum* increase the total WBC count and stimulate the hematopoietic system by increasing the count of bone marrow cells and also enhanced the differentiation of stem cells by increasing the presence of  $\gamma$ -esterase-positive bone marrow cells. Increase in circulatory antibody titer and antibody-forming cells indicates its stimulatory effect on the humoral arm of the immune system and production of immune cells by increasing weight of spleen and thymus. The antitumor activities of *B. sensitivum* extract was determined by both *in vitro* and *in vivo* methods. Administration of *B. sensitivum* inhibited the growth of solid tumor induced by DLA cells and ascites tumor induced by EAC cells. It also decreased cellular Glutathione (GSH), Serum Gamma Glutamyl Transpeptidase (GGT), and NO levels.<sup>[30]</sup> This was congruent to the report that the aqueous extract of *B. sensitivum* leaves showed significant antitumor activity against the transplantable murine tumor.<sup>[14]</sup>

#### Natural antioxidant defense mechanism

Antioxidative action plays a major role in protection of human beings against oxidative damage caused by the highly reactive unpaired electrons referred as free radicals, which attracted a great deal of attention in recent years. The increased flux of free radicals can react with number of biomolecules including DNA, lipids, and proteins and produce toxic effects.<sup>[31]</sup> Flavonoids can able to scavenge free radicals by means of directly donating the hydrogen atoms and also by various mechanisms.<sup>[32]</sup> The possible mechanism by which flavonoids can act is through interaction with various antioxidant enzymes.<sup>[33]</sup>

The antioxidant potential of *B. sensitivum* was evaluated in both by *in vitro* and *in vivo*. *B. sensitivum* was found to inhibit *in vitro* lipid peroxidation and also scavenge superoxide radicals and NO *in vitro*. Intraperitoneal administration of *B. sensitivum* in BALB/c mice inhibited Phorbol-12-myristate-13-acetate-induced superoxide radical generation in macrophages *in vivo*. The extract also produced a significant increase in catalase activity, Glutathione-S-transferase, GSH, Glutathione reductase and decrease in Glutathione peroxidase.<sup>[34]</sup> This result strongly supports its usefulness as a natural antioxidant to combat the free radical chain propagation effect. *B. sensitivum* was reportedly rich in flavonoids which includes Isoorientin, two biflavones: Amentoflavone and Cupressuflavone,<sup>[16]</sup> and Phenolic compounds;<sup>[19]</sup> Amentoflavone inhibits the cyclooxygenase-1- and cyclooxygenase-2-catalyzed prostaglandin biosynthesis.<sup>[35]</sup> A polysaccharide isolated from *B. sensitivum* was found to be enhancing the complement fixation.<sup>[10]</sup> These phytochemicals may be responsible for the antioxidant potential of *B. sensitivum* and further research works need to be initiated to understand the

precise mechanism behind the possible role and to find out which active ingredient is responsible for antioxidant action.

#### Antibacterial property

The use of *B. sensitivum* as an anti-infective agent was demonstrated recently. The leaves extracts of *B. sensitivum* (methanol, chloroform, acetone, and petroleum ether) was evaluated for its antibacterial activity by them against several human pathogenic bacterial strains (*Bacillus subtilis*, *Staphylococcus aureus*, *Streptococcus pneumonia*, *Klebsiella pneumoniae*, *Salmonella typhi*, *Proteus vulgaris*, and *Escherichia coli*). All the extracts showed various remarkable levels of activity on different test organisms and their activity is quite comparable with the standard antibiotics. This discovery indicates a potent remedy from *B. sensitivum* that will be a great advancement in bacterial infection therapies.<sup>[36]</sup>

#### Cardioprotection

Coronary heart disease is characterized by the presence of high blood cholesterol which is the main risk factor for this major life-threatening disease.<sup>[37]</sup> The possible hypocholesterolemic effect of *B. sensitivum* leaf water extract in inbred male albino rabbits was assessed. Simultaneous administration of *B. sensitivum* produced a beneficial effect by improving all the parameters of lipid profile which include Very low-density lipoprotein and Low-density lipoprotein, except High-density lipoprotein, and also it causes slight lowering of plasma glucose, but without any risk of causing severe hypoglycemia.<sup>[38]</sup>

#### Antimetastatic quality

The eradication or prevention of highly complex metastatic process, the major cause of mortality in various cancer patients, remains current clinical challenge in the investigation of cancer research. This multistep process involves up and down regulations in the expression of specific genes and various cytophysiological changes. Cancer cells from the primary neoplasm enter into the blood vessels or lymphatics and circulate in the body fluids, then form a new colony at a distant site.<sup>[39,40]</sup> The treatment with *B. sensitivum* in B16F-10 melanoma-induced experimental lung metastasis in C57BL/6 mice significantly reduced lung collagen hydroxyproline, hexosamine, uronic acid levels, serum sialic acid, and gamma glutamyl transpeptidase. It inhibits the expression level of several proinflammatory cytokines (IL-1, IL-6, GM-CSF, and TNF) and the proteolytic enzymes matrix metalloproteinases. It also inhibits the activation and nuclear translocation of p65, p50, c-Rel subunits of nuclear factors such as c-fos, activated transcription factor-2, and cyclic adenosine monophosphate response element binding protein in B16F-10 melanoma cells.<sup>[41]</sup>

#### Targeting angiogenesis

Understanding the key molecular pathways and signaling molecules involved in the formation of new capillaries from preexisting vasculature by the tumor cells has been a highly



active area in the investigation of cancer therapy over the past two decades.<sup>[42]</sup> Angiogenesis is one of the essential hallmarks required for the transformation of normal cell to a cancer cell. Targeting of angiogenesis has become a promising strategy for cancer treatment by developing angiogenesis inhibitors. Inhibition of angiogenesis suppresses the growth of tumor by switching off the supply of oxygen and nutrients.<sup>[43]</sup>

*B. sensitivum* displayed antiangiogenic activity in both *in vitro* and *in vivo* models. Intraperitoneal administration of methanol extract of *B. sensitivum* at a concentration of 50 mg/kg inhibited the tumor-directed capillary formation induced by B16-F10 melanoma cells and increased the level of proinflammatory cytokines such as IL-1 $\beta$ , IL-6, TNF- $\alpha$ , GM-CSF, and VEGF (Vascular Endothelial Growth Factor), the direct endothelial cell-proliferating agent. It also increased production of IL-2 and tissue inhibitor of metalloprotease-1 in B16-F10-injected and treated C57BL/6 animal models. The extract at concentrations of 1  $\mu$ g/ml, 5  $\mu$ g/ml, and 10  $\mu$ g/ml inhibited the VEGF-induced vessel sprouting in rat aortic ring assay and inhibited the VEGF-induced proliferation, cell migration, and capillary-like tube formation of primary cultured human endothelial cells and VEGF mRNA levels in B16-F10 melanoma cells. Antiangiogenic activity of *B. sensitivum* was supported by its significant modulation of inflammatory cytokines and inhibition of VEGF expression levels.<sup>[44]</sup>

#### Chemoprotective ability

The potential and powerful approach of modern chemotherapy uses natural, synthetic, or biological chemical agents to reverse, control, or prevent the multistep process of carcinogenesis by altering its molecular and cellular events.<sup>[45,46]</sup> The ethanolic extract of *B. sensitivum* was studied against cyclophosphamide (CTX)-induced toxicity in mice. Intraperitoneal administration of the extract with CTX significantly increased the total WBC count, bone marrow cellularity, alpha-esterase-positive cells, and weight of lymphoid organs. Reduction of GSH in liver and in intestinal mucosa of CTX-treated controls was significantly reversed by *B. sensitivum* administration with amelioration of changes in serum and liver Alkaline Phosphatase, Glutamic pyruvate transaminase, and lipid peroxidation. The level of the proinflammatory cytokine, TNF-alpha, which was elevated during CTX administration, was significantly reduced by the administration of *B. sensitivum* extract. The lowered levels of cytokines IFN-gamma, IL-2, and GM-CSF after CTX treatment were also found to be increased by *B. sensitivum* extract administration. Even though it did not compromise the antineoplastic activity of CTX, there is a synergistic action of CTX and *B. sensitivum* in reducing the solid tumors in mice was found.<sup>[47]</sup>

#### Antidiabetic potential

The inherited or acquired deficiency in production of insulin leads to hyperglycemic condition or Diabetes

mellitus, as a result of high blood sugar which in turn damage many of body systems. The prevalence of diabetes mellitus is alarmingly increasing worldwide from 2.8% in 2000 to 4.4% in 2030.<sup>[48]</sup> The administration of *B. sensitivum* reduced the activities of gluconeogenic enzymes present in glucose homeostasis and increased the level of plasma insulin which enhances the glycogenesis in streptozotocin and nicotinamide-induced diabetic rats have recently been reported.<sup>[49]</sup> The insulinotropic effect was investigated in alloxan-induced diabetic rabbits and the results showed significant hypoglycemic effect possibly due to stimulating action of synthesis of insulin from beta cells of islets of Langerhans of pancreas.<sup>[50,51]</sup>

#### Anti-inflammatory response

Inflammation is the important cause known to be responsible for association with several diseases like Cancer, Diabetes, Arthritis, Parkinson's disease, Alzheimer's disease, and Ulcerative colitis.<sup>[52-56]</sup> The anti-inflammatory action of *B. sensitivum* was investigated in aqueous and methanol extracts of the aerial parts and roots in the carrageenin-induced rat paw edema. The inhibition of edema was found to be maximum in aqueous extract of aerial parts and roots and methanol fraction of roots than the methanol fraction of aerial parts.<sup>[57]</sup> *B. sensitivum* inhibits the production of NO, proinflammatory cytokines like IL-1 $\beta$ , IL-6, and TNF- $\alpha$ , the important targets for treatment of inflammatory disorders in LPS or Con A-stimulated primary macrophages. The gene expression profile showed that *B. sensitivum* downregulate the expression of Inducible NO synthase and COX-2 and acts as potential inhibitor in inflammatory conditions.<sup>[58]</sup>

#### Amentoflavone—A potent biflavonoid in *B. sensitivum*

Amentoflavone is a potent biflavonoid present in *B. sensitivum* and other numerous plant species which include *Putranjiva roxburghii* Wall. (family: Euphorbiaceae), *Mangifera indica* Linn. (family: Anacardiaceae), *Ginkgo biloba* Linn. (family: Ginkgoaceae), *Selaginella sinensis*, *Selaginella willdenowii*, *Selaginella tamariscina* (family: Slaginellaceae)<sup>[59,66,71]</sup> *Antidesma laciniatum* (family: Euphorbiaceae),<sup>[60]</sup> *Trattinickia rhoifolia* (family: Burseraceae),<sup>[61]</sup> *Thuja orientalis* (family: Cupressaceae),<sup>[62]</sup> *Nandina domestica* (family: Berberidaceae),<sup>[63]</sup> *Cycas rumphii* (family: Cycadaceae), and *Trifolium alexandrinum* (family: Fabaceae).<sup>[64]</sup>

Amentoflavone, the active ingredient of *B. sensitivum* and other plants, has been shown to exhibit various pharmacological activities such as antiviral,<sup>[65,66]</sup> anti-inflammatory,<sup>[67]</sup> antidepressant,<sup>[68]</sup> antioxidant,<sup>[69]</sup> analgesic activities,<sup>[70]</sup> Inhibitor of phospholipase C $\gamma$ 1,<sup>[71]</sup> irreversible inhibitor of lymphocyte proliferation,<sup>[72]</sup> inhibitor of NO synthase in macrophages,<sup>[73]</sup> inhibitor of cAMP phosphodiesterase in rat adipose tissues,<sup>[74]</sup> inhibits nonenzymatic lipid peroxidation,<sup>[75]</sup> a potent caffeine-like Ca<sup>2+</sup> releaser in skeletal muscle sarcoplasmic

reticulum,<sup>[58]</sup> inhibits the papain super family member of cysteine proteases—Cathepsin B,<sup>[76]</sup> a potent scavenger of superoxide,<sup>[77]</sup> and inhibitory effect on the degradation of IκBα and NF-κB translocation into the nucleus.<sup>[78]</sup> It has potential to activate the proliferation of lymphoid cells and effector cell functions by increasing the production of IL-2 and IFN-γ and could impede the level of markers of proliferating tumor cells, serum sialic acid and serum γ-GGT.<sup>[79]</sup> It also has the ability to inhibit the production of proinflammatory cytokines such as IL-1β, IL-6, GM-CSF, and TNF-α in B16F-10 cells and peritoneal macrophages;<sup>[80]</sup> antiangiogenic qualities by distracting the integrity of endothelial cells and by modulating the endogenous factors required for the neovascularization process.<sup>[81]</sup> In view of the above interpretations, Amentoflavone become the potent bioactive principle from *B. sensitivum* and other several plants; it is evident to accept its worthwhile contribution to healthcare.

### Other active ingredients

Isoorientin is one of the main biologically active phytochemical components of *B. sensitivum*. It is also reported to be present in different plants species such as *Gentiana olivieri* (family: Gentianaceae),<sup>[82]</sup> *Cucumis sativus*, *Cucumis metuliferus*, *Cucumis myriocarpus* (family: Cucurbitaceae),<sup>[83]</sup> *Cymbopogon citrates* (family: Poaceae),<sup>[84]</sup> *Centaurea gigantean* (family: Asteraceae),<sup>[85]</sup> *Clematis rehderiana* (family: Ranunculaceae),<sup>[86]</sup> *Commelina communis* (family: Commelinaceae),<sup>[87]</sup> *Sasa borealis* (family: Poaceae),<sup>[88]</sup> *Daphne gnidium*,<sup>[89]</sup> *Passiflora edulis* (family: Passifloraceae),<sup>[90]</sup> *Caraipa densifolia*,<sup>[91]</sup> *Cecropia pachystachya* (family: Cecropiaceae),<sup>[92]</sup> *Patrinia villosa* <sup>[93]</sup>, *Arum palaestinum* (family: Araceae),<sup>[94]</sup> and *Zea Mays* (family: Poaceae).<sup>[95]</sup> Isoorientin can also synthesized from commercially available Phloroacetophenone.<sup>[96]</sup> Literatures on biological activities of isoorientin shows Hypoglycemic and antihyperlipidemic effects,<sup>[82]</sup> Antinociceptive, anti-inflammatory and gastroprotective activities,<sup>[97]</sup> antioxidant potential,<sup>[98]</sup> and myolytic activity on uterine smooth muscle of rats and guinea pigs.<sup>[94]</sup> Another component present in *B. sensitivum* is luteolin 7-methyl ether. It is also present in *Blumea balsamifera* (family: Asteraceae) and exhibited strong cytotoxicity against human lung cancer cell lines (NCI-H187).<sup>[99]</sup> As documented by several workers, further work on clinical investigations of these biologically active phytocomponents seems to be highly essential.

### CONCLUSION

Medicinal plants still remains as thriving source of life-saving drugs for the large majority of people treating health problems. During the past two decades, remarkable progress in medicinal plants research such as chemical characterization, biological, pharmacological, and toxicological activity of the plants has been witnessed. In the present review, the proven scientific validation for

the plant *B. sensitivum* reported in the last decade was highlighted. The bioactivity of the various extracts of *B. sensitivum* corresponding to its traditional application can validate the traditional folk medicinal usage of the plant. Furthermore, the theories, beliefs, and experimental studies will hopefully broaden our knowledge base needed for designing beneficial multi-target therapeutic agents from the *B. sensitivum* in near future directions. Studies in the recent past indicate its potential effectiveness of pure chemical compounds attributed to it and its diverse medicinal activities. From this, it is confirmed that *B. sensitivum* with its active ingredients can be implicated in the maintenance of health as well as in prevention, treatment, or improvement of several disease areas. However, further exploration for development of new drug molecules and to elucidate the mechanism responsible for its therapeutic action is of paramount importance. Further research works need to be initiated to look for the possible role of this plant extract and its chemical constituents to variety of diseases in human models.

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