



Review Article

Saussurea Obvallata (DC.) SCH.BIP. (*BRAHMAKAMAL*): A RICH SOURCE OF BIOACTIVE COMPOUNDS AND THERAPEUTIC APPLICATIONS

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ABSTRACT

Saussurea obvallata (DC.) Sch.Bip., commonly known as *Brahmakamal*, is native to the Indian Himalayan region, Tibet, north-eastern Myanmar, and Southwest China. It belongs to the Asteraceae family and grows perennially at high altitudes. This plant holds immense importance in Hindu and Buddhist traditions and has a rich history of being a revered state flower of Uttarakhand. In addition, it has been used for centuries as a remedy in traditional medicine for treatment of various ailments such as wounds, heart and mental diseases, cough, cold, stomach problems, paralysis and stroke. Modern phytochemical studies confirm that the plant is an excellent source of alkaloids, flavonoids, phenolics, tannins, saponins, terpenoids, proteins, and some trace elements. The crude extracts of the plant have been reported to possess antioxidant, antimicrobial, antifungal, anti-hypoxic, radioprotective, anti-urolithic, anti-cancerous, and healing properties against wounds, in-vitro and in-vivo models. Despite the great therapeutic potential, research on the plant has been limited, and its conservation status is threatened due to habitat loss, illegal collection, and grazing. Therefore, the current study aimed to summarize the existing information on various aspects of this species, as well as suggest future perspectives for research on *Brahmakamal*.

INTRODUCTION

The genus *Saussurea* DC belongs to largest tribe Cardueae in the family Asteraceae and represented by more than several hundred species. This genus prevails in high-altitude regions of the Northern Hemisphere, while the Indian subcontinent is recognized as a region of the greatest diversity. About sixty species of the genus *Saussurea* are reported from India, and some of them such as *Dolomiaea costus* (Falc.) Kasana & A.K.Pandey (kuth), *Dolomiaea costus* (Falc.) Kasana & A.K.Pandey and *Saussurea involucrata* (Kar. & Kir.) Sch.Bip. have been widely used in the Ayurvedic, Unani, Siddha, Tibetan, and Chinese medicine traditions for their diverse bioactivities. [1]

Among these, the herbaceous plant belonging to the species *Saussurea obvallata* (DC.) Sch.Bip is popularly known as *Brahmakamal*. Endowed with immense medicinal properties, the plant holds a special place in the cultural domain of the Himalayan people as it blooms rarely at an altitude of over 5000 meters. The word *Brahmakamal* itself means the lotus of Brahma and it is believed to have mystical powers. Moreover, it has the honor of being the state flower of Uttarakhand. However, this plant has remained mysterious as it flowers only on a full moon night and the reason behind this phenomenon is still unknown.[2] In addition to its cultural significance, local healers have used ground parts of this plant in traditional remedies for cardiac issues, mental and neurological conditions, coughs, colds, gastric problems, and bone pain for centuries. [3]

The recent preliminary pharmacological studies on the different parts of the plant have utilized modern and improved extraction and assay techniques to demonstrate antioxidant, antimicrobial, antifungal, anti-hypoxic, radioprotective, anti-urolithic, anticancer and wound healing activities. [4,5] At the same time, the

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species is recognized as endangered across much of its range owing to habitat degradation, overgrazing and unsustainable harvesting for the medicinal and ornamental trade.^[6] This review compiles the available information about botanical, ethnobotanical, phytochemical, pharmacological, phytogeographical, and conservation status of the plant species of *Saussurea obvallata* (DC.) Sch.Bip., in order to provide an updated reference for further research aiming at the development of this biogeographic entity as a remedy.

Taxonomy and Botanical Description

Taxonomic classification

Kingdom: Plantae; Clade: Angiosperms, Eudicots, Asterids; Order: Asterales; Family: Asteraceae (Compositae); Genus: *Saussurea*; Species: *Saussurea obvallata* (DC.) Sch.Bip. The species was originally described by de Candolle and later revised by Schultz Bipontinus; the synonym *Saussurea obvallata* (DC.) Edgew. is also encountered frequently in the ethnobotanical and pharmacological literature.^[2]

Morphology

Brahmakamal is a perennial herb rarely reaching more than 0.3m in height, usually with a rosette of leaves from which a hollow flowering stalk arises. The plant has one outstanding feature that makes it easy to recognize: the large, purple, translucent, papery bracts, which are arranged around the flower bud, like the petals of a flower. In fact, the whole inflorescence resembles a lotus flower and is sometimes called Indian lotus. However, the *Brahmakamal* is not related to the lotus, but rather to the daisy family. The actual flowers are small, tubular, and purple or lavender in color, located inside the large bracts. The plant blooms in July-September in the monsoon season, with flowers wilting quickly, hence its association with mystery.^[2] The species is hermaphroditic and insect pollinated, and it tolerates a range of soil textures and pH from mildly acid to mildly alkaline provided moisture is adequate.



Fig.1. *Saussurea obvallata* (DC.) Sch.Bip

Distribution, Habitat and Ecology

Saussurea Obvallata (DC.) Sch.Bip. is a perennial herb which is almost endemic to the Indian Himalayan Region and is sparsely distributed in Tibet, northern Myanmar and western China. It occurs only in the alpine zone of its range, growing commonly between elevations of 3800-4800m on rocky, scree slopes, alpine meadows and in the vicinity of glaciers where it is moistened by permanently melting snow.^[6] A narrow ecological amplitude due to cold temperatures, high levels of UV radiation, a short vegetation period, and specific soil requirements make it vulnerable to climate change and land use changes, which is indicated by the ecological-niche modeling analyses that predict it will likely experience a distribution reduction in the future.^[6]

Ethnobotanical and Cultural Significance

Brahmakamal grows in the higher reaches of the Himalayas and is considered sacred to Lord Brahma and appears at the shikharas of the Kedarnath and Badrinath temples during the summer season, being offered to the deity. The plant has an analogous position in the Tibetan Buddhist tradition.^[2,3] In addition to the medicinal uses mentioned before, people living in the Himalayas, particularly in the past centuries, have used different parts of the plant in folk medicine. Thus, the plant has been used in the local folk medicine of the Garhwal, Kumaon, and Tibetan regions for treatments of wounds, paralysis, cerebral ischemia, heart diseases, psychological and mental imbalances, cough, colds, and intestinal problems (the whole plant, flowers, leaves, and rhizome have different applications)., as summarized in Table 1.^[4]

Table 1: Traditional and reported therapeutic uses of different parts of *Saussurea obvallata* (DC.) Sch. Bip.

Plant part	Traditional / reported therapeutic use
Whole plant	Offered in worship; used in Tibetan and local Himalayan folk medicine as a general tonic
Flower	Applied to wounds; used for cardiac complaints and as an ornamental / ritual offering

Leaves	Used in preparations for cough, cold and intestinal ailments
Rhizome / root	Used for bone aches, urinary-tract complaints and general debility
Extracts (various solvents)	Investigated for antioxidant, antimicrobial, antifungal, anti-hypoxic, radioprotective, anti-urolithic and wound-healing activity

Phytochemistry

Qualitative and quantitative phytochemical screening of extracts obtained from whole plant, flower, leaves and rhizome of *Saussurea obvallata* (DC.) Sch.Bip. using different solvents with various polarity such as methanol, ethanol, aqueous, petroleum ether, chloroform and n-butanol fractions have been carried out. All the tested extracts showed the presence of various phytochemical constituents like proteins, alkaloids, flavonoids, phenolic compounds, saponins, tannins and terpenoids.^[8] In addition, various studies conducted using GC-MS and elemental profiling were able to identify a number of volatile components and trace elements such as calcium, iron, magnesium, zinc, copper, chromium, nickel, and lead, some of which are essential or have pharmacological significance.^[9] The polyphenolic and flavonoid fractions in particular are repeatedly implicated as the principal drivers of the plant's antioxidant capacity, while alkaloid and saponin fractions are more often associated with reported antimicrobial and immunomodulatory effects.^{[1][5]} A summary of major phytoconstituent classes and their proposed contribution to bioactivity is provided in Table 2.

Table 2. Major phytoconstituent classes reported in *Saussurea obvallata* (DC.) Sch.Bip.

Class of compound	Representative constituents / findings	Plant part / extract
Alkaloids	Detected in qualitative phytochemical screening; contribute to reported CNS and antimicrobial activity	Whole plant, flower, rhizome
Flavonoids	Major contributors to antioxidant and free-radical scavenging capacity	Flower, leaf extracts
Phenolic compounds	Correlate with DPPH radical-scavenging and total phenolic content assays	Methanolic and aqueous extracts
Tannins	Associated with astringent, wound-healing and antimicrobial properties	Rhizome, root
Saponins	Implicated in anti-inflammatory and immunomodulatory effects	Whole plant
Terpenoids	Linked to anti-hypoxic and radioprotective bioactivity in preliminary studies	Whole plant, essential fractions
Proteins and amino acids	Reported to contribute to wound-healing and tissue-protective effects	Whole plant extract
Trace minerals	Calcium, iron, magnesium, zinc, copper, chromium, nickel reported in elemental analyses	Whole plant ash / mineral profiling

Although this wide qualitative screening is impressive, it is hard to deny that the in-depth structural identification of individual marker compounds and their isolation from the species *Saussurea obvallata* is less studied than in its congeners *Dolomiaea costus* and *Saussurea involucrata*, which is noted several times in the scientific literature.^[1]

Pharmacological Activities

Antioxidant activity

Different solvent extracts of *S. obvallata* (DC.) Sch.Bip possess considerable free radical scavenging activity as revealed by in vitro assays using stable radicals such as DPPH, and the radical scavenging activity was related to their phenolic and flavonoid

content and hence its traditional use as a general restorative tonic.^{[9][5]}

Antimicrobial and antifungal activity

Extracts were active against a range of bacterial and fungal test organisms in disc diffusion assays and minimum inhibitory concentration determinations, supporting traditional use for wound healing and skin infections and suggesting potential for topical antimicrobial development after further strain surveys and mechanism-of-action investigations.^[9,3]

Wound-healing activity

In excision wound rat models, the ethanolic extract in the form of an ointment was found to enhance wound contraction and epithelization to a similar extent to a standard povidone-iodine ointment,

thus providing a rationale for the traditional ethnomedical use of this plant.^[7]

Anti-hypoxic and radioprotective activity

Preliminary *in vivo* studies revealed that *Saussurea obvallata* (DC.) Sch.Bip. extracts can increase resistance to experimentally induced hypoxia and reduce some of the radiation-induced damage markers, which could be associated with the plant's adaptation to life in conditions of low air pressure and high ultraviolet radiation, thus presenting pharmacological interest and pointing toward potential applications in high-altitude medicine and radioprotection.^{[10][4]}

Anti-urolithic activity

Extracts have been evaluated in experimental models of urolithiasis, with reported reductions in crystal deposition parameters, offering a pharmacological rationale for the plant's traditional use in urinary-tract complaints.^[10]

Anticancer activity

A smaller number of studies have demonstrated cytotoxic or antiproliferative effects of *Saussurea obvallata* (DC.) Sch.Bip. extracts *in vitro*, but this area of research is still only in its infancy and requires more thorough exploration in order to identify and characterize specific active agents and their mechanisms of action before these properties can be considered therapeutically relevant.^{[1][10]}

Effects on cardiac and mental disorders

Traditional applications of the plant in treating cardialgia and mental disorders are scarcely documented, and thus constitute one of the ethnobotanically documented therapeutic claims with low pharmaceutical validation, which is mentioned by several of the reviewed studies as an area requiring further exploration.^{[4][3]}

Conservation Status and Threats

Saussurea obvallata (DC.) Sch.Bip., an endangered Himalayan herb, is threatened by habitat fragmentation due to the development of tourism and pilgrimage routes in the high-altitude regions, grazing pressure by domestic animals, climate change leading to alteration of its habitat, and overexploitation for commercial purposes. The plant has an immense demand in the market, fetching a price of about Rs.800-1000 per kg, thereby making it an attractive commodity for illicit trade.^[6] In response, the species has been listed under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), included in the negative list of exports maintained by India's Ministry of Commerce, placed in Schedule VI of India's Wildlife Protection Act, and its trade is further restricted under

the Foreign Trade Development Act.^[6] Conservation biologists have proposed systematic population assessments using standardized ecological survey protocols, *in situ* protection of the alpine habitat, and the development of *ex situ* propagation and cultivation methods, such as tissue culture-based micropropagation, to take pressure off wild populations while allowing their continued use for research and traditional purposes.^[6,4]

Research Gaps and Future Directions

- Elucidate structures of individual bioactive molecules responsible for the observed activity, rather than testing the activity of crude extracts.
- Pharmacological and toxicological profiling of the most promising leads since there is yet limited information on the safety and optimal dosing in humans.
- Mechanistic pharmacology and controlled clinical trials of the most promising indications (wound healing, antimicrobial and anti-hypoxic activities).
- Development of protocols to allow efficient propagation of the plant for both scientific and traditional purposes.
- Long term demographic studies of the plant's populations and its habitat requirements to guide conservation efforts under predicted climate change scenarios.

CONCLUSION

The plant species *Saussurea obvallata* (DC.) Sch.Bip. is a part of a group of high-altitude medicinal plants that have accumulated recognition in local culture and ethnopharmacology long before their pharmacological activity was scientifically investigated. Some of the proposed uses of this plant have been supported by recent phytochemical and pharmacological research, while others, in particular the traditional claim regarding the cardiac and psychiatric activity, require additional studies. Considering the current trends of ecosystem destruction in high altitude regions and the corresponding decrease in biodiversity, the future of such a plant species is closely linked to the progress in conservation biology, sustainable cultivation and pharmacological study of its properties.

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