Conservation Status and Therapeutic Potential of *Saussurea lappa*: An Overview

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**Abstract**

Plants from the start are being used for the welfare of human and animals. About 25,000 biological active compounds are reported by different scientists. Plants itself are a complete treatment bioagent. People are still using plants and their decoction for different diseases. *Saussurea lappa* Clarke is the member of family Compositae. This plant is famous due to its high medical importance. The plant is commonly named as Kuth root or costus and has wide use for anticancer, antiulcer, hepatoprotective, anti-viral, anticonvulsant, antiarthritic, activities. Biologically active substance of in this plant is lactone cynaropicrin, dehydrocostus, germacrene, lappadilactone. This plant can be used to extract such bioactive compounds which can help the scientist to discover new and potential drugs. Due to such chemical composition and medicinal importance this review has been prepared for the awareness of the people to conserve their medicinal plants which can be used for potential drug discovery.

**Keywords**

*Saussurea lappa*, Biological Active Compounds, Medicinal Uses, Potential Drug Discovery

1. Introduction

Most of the people in Pakistan depend on agriculture. The rural community has knowledge about medicinal plants used against various diseases including rheumatism hence mainly living in proximity to vegetation [1]. But natural vegetation is adversely effected by rapid and haphazard collection of the plant species. Many plants are in risk of extinction and need many conservation strategies [2]. However, the medicinal plants carry high pathogens and vector burden and
more medicinal values; hence their diversity declines due to degraded and poor ecosystem [3]. In medicinal plants collection and processing, mostly children and women are involved; hence many species become endangered. They lose a major quantity of medicinal plants, because they usually do improper collection, carrying and processing [4] [5]. About 5700 medicinal plant species are estimated to exist in Pakistan [3]. Medicinal and aromatic plants are present in innumerable forms and play an important role in the life of people. In Indian societies, all the plants that are present on the earth are considered as medicinal [Jivak in Astanga Hriday (Sutra: 9-10)]. Due to some ecological factors, the number of the native plant species is decreased such as high consumption, invasive and introduced species, deforestation and attack of pathogens, loss of habitat, erosion [6]. It is reported that in Swat 5000 tons of medicinal plants are collected annually and local communities of 500 families are also involved in medicinal plant collection [7]. Medicinal plants like G. wallichianum, A. heterophyl lum, J. dolomiae, B. amplexicaule, A. bracteosa, and B. lyceum are on the edge of extinction due to the high rate of their consumption [8]. Similarly, population of Solanum surattense Burm. F and Withania somnifera (L.) Dunal is decreasing at an alarming rate. Taxa viz, Pistacea integerrima, Paeonia emodi, Skimmia laureola, Taxus wallichiana and Aesculus indica are extensively exploited by the local people community for their various ethnobotanical and medicinal uses. Special attention is required for the sustainable use of natural resources and also attention for the conservation of environment in the moist temperate Himalaya region of Pakistan [9]. Saussurea lappa (S. lappa) is indigenous to India, Pakistan and China, where it grows in the Himalaya region at 2500 - 3500 m altitude [10].

2. Distribution

The plant is cosmopolitan in distribution also among the regions of Himalayas, Kashmir, Jammu, Kishenganga valley, Western Ghats and cultivated in Tamilnadu, Uttar Pradesh, wild in India at an altitude of 2500 to 3000 m and in Kashmir to meet the commercial demand of the market due to over exploitation of the wild [11]. Living habitat of Saussurea lappa is in Kashmir, Himachal Pradesh and Garhwal at 25,003.000 m; cultivated in Kashmir and neighbouring re-

Figure 1. Saussurea lappa (S. lappa).
regions. In the southern part of Punjab, Himalaya and Kashmir regions [12]. In Pakistan, it is found in Forest, Kaghan, and Azad Kashmir. *S. lappa* is native to cool temperate and arctic regions of Asia, Europe, North America, Himalayas, and Central Asia [13] [14]. At a height of 8000 to 13,000 feet above the sea level it will grows on the moist slope northern Himalayas regions [15].

3. Description

*S. lappa* C.B. Clarke belonging to family Compositae, order: Asterales, class: Magnoliopsida, Genus: Saussurea DC, Species: *S. lappa* C.B. Clarke, commonly known as Costus. It grows to a height of 1 - 2 m which is a tall, perennial herb stout and fibrous, stem is upright, while root is a long stout of approximately 60 cm with a characteristic odour [14]; leaves are membranous, irregularly toothed, lobate, stalked, upper leaves are small while basal leaves are large with long lobately winged stalks. Flowers are stalkless arranged in terminal and axillary heads with dark purple to black in colour. Pappas is feathery giving an inquisitive appearance to the fruiting flower heads and is approximately 1.7 cm long, fluffy. Fruit of *S. lappa* is compressed, hairy and is cupped, curved [16].

The dried root of *S. lappa* is externally muddy grey to creamy in color its tastes are slightly bitter and about 8 - 12 cm long, 1 - 3 cm in diameter. Secondary roots are tubular it is generally ridged and wrinkled. Strong and characteristic aroma found in *S. lappa* roots. Section of the root is cut in two parts outer ring is light thinner and inner portion is dark brown [17].

Roots of *S. lappa* isolated the biologically active chemical constituents are: such as, hexane extract, petroleum extract, methanolic extract the chemical constituents like costunolide germacrenes like; lappadilactone, germacra-1(10), (+)-germacrene A. dehydrocostus lactone, cynaropicrin.), 4,11(13)-trien-12-ol 7,
germacra 14,11(13)-trien-12 al.-trien-12-oic acid (8) and germacra-1 were isolated and studied [18] [19] [20] [21]. Saussurea lappa roots have been widely used in chronic gastritis, rheumatoid arthritis, asthma and bronchitis in traditional medicine and in inflammation-related diseases [22]. Its roots are used especially in Siddha for the medicinal purposes [17].

**Chemical constituents:**

The chemical constituents were isolated from the roots of Saussurea lappa, such as hexane extract, methanolic extract and petroleum extract. The chemical constituents from the fresh roots are included like lappadilactone, lactone cynaropicrin, dehydrocostus, germacrenes such as (+)-germacrene A germacra1(10), 4,11(13)-trien-12al,germacra-1(10),4,11(13)-trien-12-ol and germacra-1(10),4,11(13)-trien-12-oic acid were isolated and studied [18] [19] [20] [21].

**Uses:**

Saussurea lappa roots have been widely suggested in inflammation-related diseases considered by chronic gastritis, rheumatoid arthritis, asthma and bronchitis in traditional medicine [22]. Generally the root powder and oil are used for the medicinal purposes particularly in Siddha [17]. The scientific proofs of their consequence are insufficient. (Akhtar and Farah) stated chemical substances exerting anthelmintic effects in animals. Costus oil, extracted from the roots, is used in the preparation of hair oil and in high feature perfumes [23]. Newly, a small number of In Vitro studies telling effects of the methanolic root extracts of Saussurea lappa on cell mediated immunity in rats. However, the toxicological effects of these preparations on individual’s general health remain yet to be discovered [24] [25].

**Figure 3.** Chemical constituents of Saussurea lappa.
It is claimed that *Saussurea lappa* roots have antiulcer activity but detailed scientific surveys have not been carried out to describe the antiulcer activities of *Saussurea lappa* roots [26]. It is specified that costinolide and dehydrocostus lactone revealed strong exploitive effect on the appearance of hepatitis B surface antigen in human hepatoma cells [27]. In the southern part of Kashmir, Himalaya and Punjab regions the roots and root stalks are used for asthma, dysentery, toothache, skin diseases, rheumatism, and as incense [12].

**Other uses of S. lappa:** *S. lappa* is a medically important plant. Several active compounds isolated from plant are informed to have medicinal properties e.g. the major components are sesquiterpene lactones such as dehydrocostus lactone and costunolide. *S. lappa* possesses various bioactivities such as antimicrobial [28], immunostimulant [29], anti-inflammatory and antihepatotoxic [30] [31] respectively.

**Status of Plant:**

*Saussurea lappa* is a well identified medicinal plant due to its medicinal values commonly this is used in numerous indigenous systems of medicine all over the world. Chemical constituents like Costunolide, dehydrocostus lactone and cyanopicrin isolated from costus have been documented to have more ability to be developed as bioactive molecules [41]. Due to high consumption of medicinal plants their population size is decreases day by day. Among them *Saussurea lappa* is most on the edge of extinction due to high rate of exploitation by local people. They usually do inappropriate carrying, handling and collection due to which they loss a major quantity of medicinal plants [4] [5].

According to IUCN *Saussurea lappa* (Falc.) Lipsch protection status is criti-
Table 1. Traditional uses of *Saussurea lappa* root.

<table>
<thead>
<tr>
<th>Medicinal uses</th>
<th>Part use</th>
<th>Methods of applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomachache</td>
<td>Powder of root</td>
<td>Root powder is taken with water. Root decoction is taken. Powder of root is heated in mustard oil and its paste is useful for stomach</td>
</tr>
<tr>
<td>Headache</td>
<td>Root</td>
<td>Root powder heated with root and use for headache</td>
</tr>
<tr>
<td>Cough and cold</td>
<td>Root powder</td>
<td>Root powder is taken with warm water</td>
</tr>
<tr>
<td>Throat infection</td>
<td>Root</td>
<td>Root is chewed</td>
</tr>
<tr>
<td>Backache and chest pain</td>
<td>Root powder</td>
<td>Root powder is taken with milk/decoction. Oil heated with powder of root and massaged on the affected area</td>
</tr>
<tr>
<td>Rheumatism and painful joints</td>
<td>Root</td>
<td>Root powder is heated in ghee/butter and taken with milk. The above mentioned ghee/butter is rubbed on the affected area and bandaged</td>
</tr>
<tr>
<td>Scanty urination</td>
<td>Root powder</td>
<td>Jaggery is mixed in the decoction of root powder which is then taken. Paste of root powder is applied on the stomach below the naval</td>
</tr>
<tr>
<td>Skin rashes formed after insect bite</td>
<td>Root powder</td>
<td>Root powder is roasted in ghee/butter then applied on the affected area</td>
</tr>
<tr>
<td>Exhaustion</td>
<td>Root</td>
<td>Root pieces are burnt in hookah and the smoke inhaled</td>
</tr>
<tr>
<td>Lustre and growth of hair</td>
<td>Root powder</td>
<td>Mustard oil is heated with root powder and that oil used on hair</td>
</tr>
<tr>
<td>Pustules</td>
<td>Root powder</td>
<td>Fine root powder is wiped on the wound.</td>
</tr>
<tr>
<td>General weakness</td>
<td>Root powder</td>
<td>Root powder taken with cow’s milk or ghee</td>
</tr>
<tr>
<td>Piles</td>
<td>Root</td>
<td>Root powder also used for piles</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>Root</td>
<td>The roots powder are used with honey</td>
</tr>
<tr>
<td>Headache</td>
<td>Root</td>
<td>Paste of the root is applied</td>
</tr>
<tr>
<td>Typhoid fever</td>
<td>Root</td>
<td>Decoction of root is taken</td>
</tr>
<tr>
<td>Leprosy</td>
<td>Root powder</td>
<td>Root powder is ingested</td>
</tr>
<tr>
<td>Cold</td>
<td>Root</td>
<td>Decoction of root is taken</td>
</tr>
</tbody>
</table>

Table 2. Other medicinal uses of *S. lappa* on basis of its bioactive compounds.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Chemical Constituents</th>
<th>Activities</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. lappa</em></td>
<td>volatile oils</td>
<td>anti-bacterial activity</td>
<td>[32]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>costus oil</td>
<td>hair oil and in high quality perfumes</td>
<td>[33]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>costus oil</td>
<td>treating leprosy</td>
<td>[33]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>Bioactive compounds</td>
<td>Antiulcer</td>
<td>[34]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>----</td>
<td>Antitumor</td>
<td>[35]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>active compounds</td>
<td>Antifungal</td>
<td>[36]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>sesquiterpene lactone like costunolide and dehydrocostus lactone</td>
<td>Antidiabetic</td>
<td>[37]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>-</td>
<td>antihelminthic</td>
<td>[38]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>Plant extract</td>
<td>anti-ulcer, anti-inflammatory, anti-cancer, hepatoprotective and pesticidal activities.</td>
<td>[39]</td>
</tr>
<tr>
<td><em>S. lappa</em></td>
<td>water extract</td>
<td>inhibits spread of intestinal cancer due to Costunolide. Mokkolactone, an alkaloid isolated from <em>S. lappa</em> induces apoptosis in leukaemic cells</td>
<td>[40]</td>
</tr>
</tbody>
</table>
cally Endangered. *Saussurea lappa* is a tremendously endangered species because of its high medicinal importance [42]. Decrease in the population number of the natural plant species is due to the some major ecological causes, such as deforestation, loss of habitat, invasive, high consumption, erosion and introduced species and attack of pathogens [6].

*S. lappa* status is critically endangered according to [43]. Due to of limited geographical ranges and precise territories endemic and erratic taxa of an area are at risk [44]. The plant communities in the study area have been largely exploited due to some these reasons like, excess intake of medicinal resources to cure the diseases, deforestation for fuel increased tourism, population explosion and lack of sentience [8].

**Conservation Strategies:**

Keeping in mind the critically endangered position and vast potential medicinal value the review aims to provide in depth comparative assessment of *in vitro* tactics used for the preservation of *S. costus*. *Saussurea lappa* is one of the 37 Himalayan endangered medicinal plants that have been ordered for its in situ and ex situ preservation [45]. Various preservation strategies have been suggested by different workers due to its excessive medicinal importance;

- **Micropropagation:** [46] achieved rapid micropropagation of *S. lappa* C. B. Clarke TO cultured the shoot apices (0.5 - 1 cm) old seedlings of 2 week on Skoog’s and Murashige medium (MS) accompanied with thidiazuron (0.45 µM). Callus free multiple shoots were attained on media supplemented with TDZ and N6-benzyladenine-(BA). TDZ was most active (90%) in inducing multiple shoots. Micropropagated plantlets after rooting were effectively shifted to the soil. Used different explants of *S. costus* on MS media for mass propagation. *In vitro* micropropagation was accomplished on MS medium supplemented with 2.0 mg/lBAP in MS media. Rooting was achieved on MS half strength medium with 1 mg/lNAA. The rooted plantlets were successfully moved to field [47].

- **In vitro multiplication:** In 1989 established the protocol for *in vitro* multiplication of *Saussurea lappa* MS medium having BAP and GA3. 5-fold shoot multiplication occurred every three weeks. Shoots rooted on MS containing 0.5 µM NAA survived with 90% effectiveness and Shoot cultures stored at 5°C in the dark for 12 months without an intervening subculture survived with 100% viability [48].

- **Ex situ strategy:** [49] conducted ex situ experiments in order to evaluate the growth routine of some medicinal plants including *S. costus* by planting small pieces of rhizomes collected from the natural habitat and observed very low sprouting percentage and survival of *S. costus*. [50] explored the effect of altitude on seed germination and survival percentage diversity in *S. costus*. High altitude favoured high survival and seed germination percentage the natural habitat and detected very low sprouting percentage and survival of *S. costus*.

- Hence, direct conservation processes were urgently required in order to pro-
tect the taxon from extinction. These include:

(i) appropriate documentation and preservation of indigenous knowledge need to be done, (ii) proper training of the local communities about the conservation and viable consumption of medicinally important flora needs to be given, (iii) overgrazing and deforestation should be reduced, (iv) permanent monitoring programs should be established, (v) natural gas should be introduced in the area as an alternate fuel source, (vi) promote forest management practices that benefit biodiversity conservation, (vii) proper health facilities to local people should be provided, (viii) responsiveness programs at local low level should be introduced.

**Challenges in conservation and sustainable use of S. lapa:**

Medicinal plants always consider as an important means for the development of drug. Locally the medicinal values of medicinal plants ignored and studies have been carried out in order to explore various active principles of the extracts and to create their exact mechanism of action. One of the most significant area in which compounds from plant sources have contributed successfully, is the cardiovascular research. *Saussurea lappa* is native to Pakistan has been mostly used for the treatment of various diseases [51].

*S. lappa* is an essential plant, used widely in traditional and herbal medicine, also used in modern medicine. Due to high demand, mostly the local populations of the some species are either have been extirpated or are under destructive harvesting, therefore accessibility of this vital plant is diminishing in the wild day by day. *S. lappa* is endemic to a geographically limited part of the Himalayas, and grows on moist slopes at altitudes of 2600 - 4000 m [13]. Apart from the limited dissemination, the harvesting of whole plant for local use is one of the causes for being threatened. This critically endangered species is enlisted in Appendix I of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). *S. lappa* is considered as one of the 37 Himalayan endangered medicinal plants that have been arranged for in situ and ex situ conservation process [47].

Because of a common species to the Himalaya, the dispersal of this species is fairly limited to extremely slight geographical range [52], which makes it more vulnerable to extinction. Being an endangered species (CSIR 1973, [53], it was enlisted in Appendix I of CITES. Trade of *S. lappa* is restricted under Foreign Trade Development Act -1992. It is first listed in Appendix II of CITES on 1.7.1975 as *S. lappa* and afterward up listed to Appendix I in 1985. Due to the several known uses, *S. lappa* is in high demand both internationally and at the local level. It is one of the most commercially used Appendix I CITES species for many complaints in several indigenous systems of medicine [17]-[54].

In the pharmaceutical industry there is high demand of *Saussurea costus*. During the last decades, the species has been even more stimulated due to its threatened status globally. Due to unrestrained exploitation of the species and high market demand, it was reported to be extinct in many pockets in the wild. In traditional medication and are adopting the allopathic medicines almost our
young generation is not interested [55]. However, some MPs are broadly used in the studied area. The area is under pressure of heavy deforestation and over-grazing, as there is no management of grazing land so overgrazing causes the fragmentation of the habitat. Medicinal plants are uprooted by the local people for marketing or for local use and may be heavily grazed. There is a time to create alertness to local occupants about the position of this precious lifeline. We expect that the root of *S. lappa* C.B. Clarke can be used as an alternative antioxidant agent in the medical and food industry provided that the toxicity associated with high concentrations be resolved in future study [56]. The present study, therefore is focused on the traditional knowledge of local communities, reinforcement of the local communities to increase and conserve the medicinal wealth, and impose the identification of the factors affecting the medicinal plants and their assessment of conservation status of medicinal plants. To investigate the therapeutic potential and conservation of *S. lappa* traditional knowledge of local people.

4. Conclusion

*Sassurea lappa* is a highly medicinal plant which is used in many indigenous systems of medicine from ages. *S. lappa* is often prescribed in various indigenous systems of medicines chiefly those of India, Korea, China and Tibet, because it is used for treatment of many diseases in allopatric and herbal system of medicine such as chronic skin diseases, cholera, rheumatism, cold, cough and persistent hiccups, toothache, stomachache, typhoid fever, quartan malaria, leprosy etc. Several active compounds isolated from *S. lappa* are described to have medicinal properties. The chemical constituents isolated from *S. lappa* showed numerous pharmacological activities including neuronal diseases, immune diseases, inflammatory and gastric protective effects, hepatotoxic activities etc. Evolving science explained the active phyto-ingredients present in this plant, which show anti-inflammatory, anticancer, gastro-protective activities and the several extracts of *Saussurea lappa* showed its anticonvulsant, anti-inflammatory, anti-ulcerative, hepatoprotective antimicrobial and antiviral activities. Experimental evidences and encouraging research results suggest that *Saussurea lappa* plant is safe and very active especially when used in traditional dosages on numerous indications. However, it exhibits several traditional uses which promise scope for modern and clinical uses of this plant for a new research progress. As already revealed, *Saussurea lappa* has a great demand in pharmaceutical industry. It is endemic to a geographically limited part of the Himalayas. Population size of this species decreases due to the high rate of consumption. However, a multi-branched approach including *in situ* and *ex situ* conservation and selection of better quality genotypes followed by their multiplication could well provide available solution to the problem.

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