

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, anti-arthritic, activities. Biologically active substance of in this plant is lactone cyanopicrin, 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. heterophyllum*, *J. dolomiaea*, *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, Skimmialaureola, Taxus wallichiana* and *Aesculusindica* 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*).



Figure 2. Distribution of *S. lappa* in world. (Red circles indicated distribution of plant).

gions. 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 Compositte, 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-ol)-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 cynanopicrin, 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].

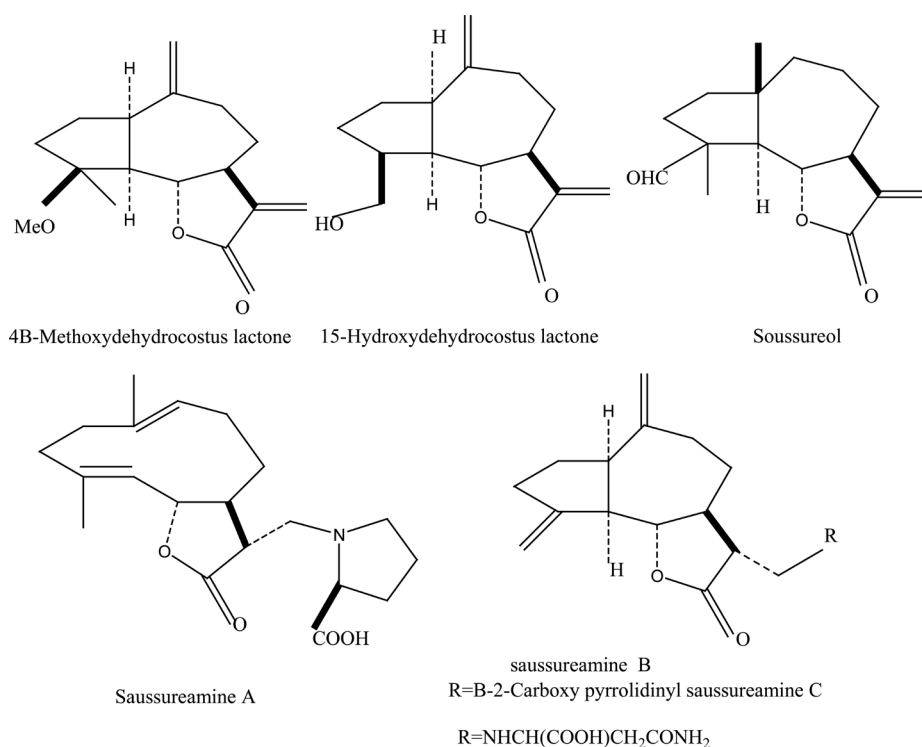


Figure 3. Chemical constituents of *Saussurea lappa*.



Figure 4. *Saussurea lappa* root.



Figure 5. Root powder 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 costunolide 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.

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

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

Plant	Chemical Constituents	Activities	References
<i>S. lappa</i>	volatile oils	anti-bacterial activity	[32]
<i>S. lappa</i>	costus oil	hair oil and in high quality perfumes	[33]
<i>S. lappa</i>	costus oil	treating leprosy	[33]
<i>S. lappa</i>	Bioactive compounds	Antiulcer	[34]
<i>S. lappa</i>	----	Antitumor	[35]
<i>S. lappa</i>	active compounds	Antifungal	[36]
<i>S. lappa</i>	sesquiterpene lactone like costunolide and dehydrocostus lactone	Antidiabetic	[37]
<i>S. lappa</i>	-	anthelmintic	[38]
<i>S. lappa</i>	Plant extract	anti- ulcer, anti-inflammatory, anti-cancer, hepatoprotective and pesticidal activities.	[39]
<i>S. lappa</i>	water extract	inhibits spread of intestinal cancer due to Costunolide. Mokkolactone, an alkaloid isolated from <i>S. lappa</i> induces apoptosis in leukaemic cells	[40]

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 micro propagation 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 μ M). 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/1BAP in MS media. Rooting was achieved on MS half strength medium with 1 mg/1NAA. 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 μ M 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. lappa*:

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 overgrazing, 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 impost 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

Saussurea 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 allopathic and herbal system of medicine such as chronic skin diseases, cholera, rheumatism, cold, cough and persistent hiccups, toothache, stomachache, typhoid fever, quartan malaria, rheumatism and 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-ulcertive, 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.

References

- [1] Halliwell, B. and Gutteridge, J.M.C. (1994) Free Radicals in Biology and Medicine.

- Nutrition Reviews*, **8**, 253-265.
- [2] Adnan, M. and Holscher, D. (2012) Diversity of Medicinal Plants among Different Forest Used Type of Pakistani Himalayan. *Economic Botany*, **66**, 344-356. <https://doi.org/10.1007/s12231-012-9213-4>
 - [3] Shinwari, Z.K. and Qaisar, M. (2011) Efforts on Conservation and Sustainable Use of Medicinal Plants of Pakistan. *Pakistan Journal of Botany*, **43**, 5-10.
 - [4] Ahmad, S.S. and Javed, S. (2007) Exploring the Economic Value of Underutilized Plant Species in Ayubia National Park. *Pakistan Journal of Botany*, **39**, 1435-1442.
 - [5] Hamayun, M., Khan, S.A., Kim, H.Y. and Leechee, I.J. (2006) Traditional Knowledge and *Ex-Situ* Conservation of Some Threatened Medicinal Plants of Swat Kohistan. *Pakistan Journal of Botany*, **38**, 205-209.
 - [6] Muhammad, S. (2003) Resource Management Plan. Hillan-Battagram Forests, Azad Kashmir, Pakistan, 1-32.
 - [7] Chaudhary, M.S.A., Ali, A. Sher, H. and Malik, S. (2000) Technical Report on Market Study of Medicinal Plants of Malakand, Peshawar, Lahore and Krachi. SDC-Interco Operation, Peshawar, Pakistan.
 - [8] Khan, M.A. (2008) Biodiversity and Ethnobotany of Himalayan Region Poonch Valley Azad Kashmir Pakistan. Ph.D. Thesis, Department of Botany, Quaid-i-Azam University, Islamabad, 1-292.
 - [9] Alam, J. and Ali, S.I. (2009) Conservation Status of *Astragalus gilgitensis* Ali (Fabaceae): A Critically Endangered Species in the Gilgit District, Pakistan. *Phyton*, **48**, 211-225.
 - [10] Rao, R.N., Raju, S.S., Babu, K.S. and Vadaparthy, P.R.R. (2013) HPLC Determination of Costunolide as a Marker of *Saussurea lappa* and Its Herbal Formulations. *International Journal of Biochemistry*, **3**, 99-107.
 - [11] Kokate, C.K., Purohit, A.P. and Gohkale, S.B. (2002) Pharmacognosy. In: *Terpenoids*, 21st Edition, Nirali Prakashan, Pune, 377-378.
 - [12] Shah, N.C. (1982) Herbal Folk Medicines in Northern. *Indian Journal of Ethnopharmacology*, **6**, 293-301. [https://doi.org/10.1016/0378-8741\(82\)90052-6](https://doi.org/10.1016/0378-8741(82)90052-6)
 - [13] Shah, R. (2006) Nature's Medicinal Plants of Uttaranchal: Herbs, Grasses and Ferns. Gyanodaya Prakashan, Kanpur.
 - [14] Hajra, P.K., Rao, R.R., Singh, D.K. and Uniyal, B.P. (1995) Flora of India. Vols. 12 & 13, Asteraceae. Botanical Survey of India, Calcutta.
 - [15] Madhavi, M., Mallika, G., Lokanath, N., Vishnu, M., Madhusudhana, N., Chetty, C. and Mohamed Saleem, T.S. (2001) A Review on Phytochemical and Pharmacological Aspects of *Saussurea lappa*. *International Journal of Review Life Science*, **2**, 24-31.
 - [16] Pandey, M.M., Rastogi, S. and Rawat, A.K. (2007) *Saussurea Costus*: Botanical, Chemical and Pharmacological Review of an Ayurvedic Plant. *Journal of Ethnopharmacology*, **110**, 379-390. <https://doi.org/10.1016/j.jep.2006.12.033>
 - [17] Indian Drug Manufacturers Association (2002) The Indian Herbal Pharmacopoeia. Revised New Edition, Indian Drug Manufacturers Association, Mumbai, 376-383.
 - [18] Taniguchi, M., Kataoka, T., Suzuk, H., Uramoto, M., Ando, M., Arao, K., Magae, J., Nishimura, T., Otake, N. and Nagai, K. (1995) Costunolide and Dehydrocostus Lactone as Inhibitors of Killing Function of Cytotoxic T Lymphocytes. *Bioscience Biotechnology and Biochemistry*, **59**, 2064-2067. <https://doi.org/10.1271/bbb.59.2064>
 - [19] De Kraker, J.W., Franssen, M.C., de Groot, A., Shibata, T. and Bouwmeester, H.J.

- (2001) Germacrenes from Fresh Costus Roots. *Phytochemistry*, **58**, 481-487. [https://doi.org/10.1016/S0031-9422\(01\)00291-6](https://doi.org/10.1016/S0031-9422(01)00291-6)
- [20] Singh, I.P., Talwar, K.K., Arora, J.K., Chhabra, B.R. and Kalsi, P.S. (1992) A Biologically Active Guaianolide from *Saussurea Lappa*. *Phytochemistry*, **31**, 2529-2531. [https://doi.org/10.1016/0031-9422\(92\)83317-R](https://doi.org/10.1016/0031-9422(92)83317-R)
- [21] Talwar, K.K., Sing, I.P. and Kalsi, P.S. (1992) A Sesquiterpenoid with Plant Growth Regulatory Activity from *Saussurea Lappa*. *Phytochemistry*, **31**, 336-338. [https://doi.org/10.1016/0031-9422\(91\)83069-W](https://doi.org/10.1016/0031-9422(91)83069-W)
- [22] Kritikar, K.R. and Basu, B.D. (1987) Indian Medicinal Plants. In: *Compositae*, Vol. 2, International Book Distributors, Dehradun, 1420-1423.
- [23] Saumeet, K., Seema, S. and Kaloo, A. (2015) Conservation Strategies of *Saussurea costus*, Critically Endangered Medicinal Herb Growing in Kashmir Himalaya. *International Journal of Science and Research*, **4**, 257-260.
- [24] Akhtar, M.S. and Farah, N. (1987) Phytochemical Screening of the Fruit of *Caesalpinia crista* (Kranjwa), *Melia azedarach* (Bakain) and Roots of *Saussurea lappa* (Qusti-Shireen). *Pakistan Journal of Agriculture Sciences*, **24**, 235-240.
- [25] Brodie, C.A., Torodai, J., Saloga, J., Domenico, J. and Gelfand, E.W. (1995) Ouabain Induces Inhibition of the Progression Phase in Human T-Cell Proliferation. *Journal of Cell Physiology*, **165**, 246-253. <https://doi.org/10.1002/jcp.1041650205>
- [26] Nadkarni, K.M. (2004) Medicinal Plants of India. Reprint Publication, Dehradun, 352-353.
- [27] Chen, H.C., Chou, C.K., Dee, L.S., Wang, J.C. and Yeh, S.F. (1995) Active Compounds from *Saussurea lappa* Clarke That Suppress Hepatitis B Virus Surface Antigen Gene Expression in Human Hepatoma Cells. *Antiviral Research*, **27**, 99-109. [https://doi.org/10.1016/0166-3542\(94\)00083-K](https://doi.org/10.1016/0166-3542(94)00083-K)
- [28] Khalid, A., Uzair-ur-Rehman, S.A., Khilji, S., Fatima, U. and Khan, M.I. (2010) Antimicrobial Activity Analysis of Extracts of *Acacia modesta*, *Artemisia absinthium*, *Nigella sativa* and *Saussurea lappa* against Gram Positive and Gram Negative Microorganisms. *African Journal of Biotechnology*, **10**, 4574-4580.
- [29] Hamilton, A.C. (2004) Medicinal Plants, Conservation and Livelihoods. *Biodiversity and Conservation*, **13**, 1477-1517. <https://doi.org/10.1023/B:BIOC.0000021333.23413.42>
- [30] Yashvanth, S., Robinson, A., Babu, K.S., Naidu, V.G.M., Vishnuvardhan, M.V.P.S. and Ramakrishna, S. (2010) Anti-Inflammatory and Cytotoxic Activity of Chloroform Extract of Roots of *Saussurea lappa* Clarke. *Journal of Pharmacy Research*, **3**, 1775-1778.
- [31] Yaeesh, S., Jamal, Q., Shah, A.J. and Gilani, A.H. (2010) Antihepatotoxic Activity of *Saussurea lappa* Extract on D-Galactosamine and Lipopolysaccharide-Induced Hepatitis in Mice. *Phytotherapy Research*, **2**, S229-S232. <https://doi.org/10.1002/ptr.3089>
- [32] Li, Y., Xu, C., Zhang, Q., Liu, J.Y. and Tan, R.X. (2005) *In Vitro* Anti-Helicobacter Pylori Action of 30 Chinese Herbal Medicines Used to Treat Ulcer Diseases. *Journal of Ethnopharmacology*, **98**, 329-333. <https://doi.org/10.1016/j.jep.2005.01.020>
- [33] Marotti, M., Piccaglia, R., Giovanelli, E., Deans, S.G. and Eaglesham, E. (1994) Effects of Planting Time and Mineral Fertilization on Peppermint Essential Oil Composition and Its Biological Activity. *Flavor and Fragrance Journal*, **9**, 125-129. <https://doi.org/10.1002/ffj.2730090307>
- [34] Sutar, N., Garai, R., Sharma, U.S., Singh, N. and Roy, S.D. (2011) Antiulcerogenic Activity of *Saussurea lappa* Root *International Journal of Pharmaceutical and Life*

Science, **2**, 516-520.

- [35] Ko, S.G., Kim, H.P., Jin, B.H.S., Kim, S.H., Park, C.H. and Lee, J.W. (2005) *Saussurea lappa* Induces G2-Growth Arrest and Apoptosis in AGS Gastric Cancer Cells. *Cancer Letters*, **220**, 11-19. <https://doi.org/10.1016/j.canlet.2004.06.026>
- [36] Barrero, A.F., Oltra, J.E., Alvarez, M., Raslan, D.S., Saude, D.A. and Akssira, M. (2000) New Sources and Antifungal Activity of Sesquiterpene Lactones. *Fitoterapia*, **71**, 60-64. [https://doi.org/10.1016/S0367-326X\(99\)00122-7](https://doi.org/10.1016/S0367-326X(99)00122-7)
- [37] Upadhyay, O.P., Singh, R.H. and Dutta, S.K. (1996) Studies on Antidiabetic Medicinal Plants Used in Indian Folklore. *Aryavaidyan*, **9**, 159-167.
- [38] Seki, K., Hashimoto, A., Kobayashi, H., Kawahara, Y. and Yamahara, J. (1991) Motility Inhibitory Effect on Anchusan and Jintan and Its Active Components in Anisakis Type Larvae. *Yakuri to Chiryō*, **19**, 265-289.
- [39] Dutta, N.K., Sastry, M.S. and Tamhane, R.G. (1960) Pharmacological Actions on an Alkaloidal Fraction Isolated from *Saussurea lappa* (Clarke). *Indian Journal of Pharmacy*, **22**, 6-7.
- [40] Umadevi, M., Sampath, K.P., Bhowmik, D. and Duraivel, S. (2013) Traditionally Used Anticancer Herbs in India. *Journal of Medicinal Plants Studies*, **1**, 56-74.
- [41] Ibrar, M. (2003) Conservation of Indigenous Medicinal Plants and Their Traditional Knowledge Found in Moist Temperate Himalaya Pakistan. Department of Biological Sciences/Quaid-I-Azam University, Islamabad.
- [42] Qureshi, R.A., Ghafar, S.A. and Ghufuran, M.A. (2007) Ethnobotanical Studies of Economically Important Plants of Gilgit and Surrounding Areas, Pakistan. *Pakistan Journal of Scientific and Industrial Research*, **50**, 60-67.
- [43] Zahara, K., Tabassum, S., Sabir, S., Arshad, M., Qureshi, R., Amjad, M.S. and Chaudhari, S.K. (2014) A Review of Therapeutic Potential of *Saussurea lappa*—An Endangered Plant from Himalaya. *Asian Pacific Journal of Tropical Medicine*, **S1**, S60-S69. [https://doi.org/10.1016/s1995-7645\(14\)60204-2](https://doi.org/10.1016/s1995-7645(14)60204-2)
- [44] Haq, F., Ahmad, H. and Alam, M. (2010) Master of Philosophy Thesis, Species Diversity of Vascular Plants, Battagram.
- [45] Kuniyal, C.P., Rawat, Y.S., Oinam, S.S., Kuniyal, J.C. and Vishvakarma, S.C.R. (2005) *Kuth (Saussurea lappa)* Cultivation in the Cold Desert Environment of the Lahaul Valley, Northwestern Himalaya, India: Arising Threats and Need to Revive Socio-Economic Values. *Biodiversity and Conservation*, **14**, 1035-1045. <https://doi.org/10.1007/s10531-004-4365-x>
- [46] Johnson, T.S., Badari, S., Naryan, B. and Narayana, D.B.A. (1997) Rapid *in Vitro* Propagation of *Saussurea lappa*, an Endangered Medicinal Plant, through Multiple Shoot Cultures. *In Vitro Cellular and Developmental Biology Plant*, **33**, 128-130. <https://doi.org/10.1007/s11627-997-0010-1>
- [47] Snehlata, H.S. and Payal, D.R. (2012) Fenugreek (*Trigonella foenum graecum* L.): An Overview. *Journal of Current Pharmaceutical Review and Research*, **2**, 169-187.
- [48] Arora, R. and Bhojwani, S.S. (1989) *In Vitro* Propagation and Low Temperature Storage of *Saussurea lappa* C.B. Clarke—An Endangered Medicinal Plant. *Plant Cell Reports*, **8**, 44-47. <https://doi.org/10.1007/BF00735776>
- [49] Sher, H. and Hussain, F. (2010) *Ex Situ* Management Study of Some High Value Medicinal Plant Species in Swat, Pakistan. *A Journal of Plants, People and Applied Research*, **8**, 17-24.
- [50] Parmar, M.P., Negi, S.L. and Ramola, S. (2012) Seeds Germination and Seedlings Analysis of *Saussurea costus* Royle Ex Benth. In High and Low Altitudinal Villages of District Uttarkashi (Uttarakhand). *IOSR Journal of Pharmacy*, **2**, 25-30.

- [51] Chang, M.S., Wan, J.S., Ming, J.D., Jang, J. and Gum, H.L. (2003) Cytotoxic Sesquiterpenes Lactones from the Root of *Saussurea lappa*. *Journal of National Products*, **66**, 1175-1180. <https://doi.org/10.1021/np030147e>
- [52] Siddique, M.A.A., Wafai, B.A., Riya, A.M. and Sheikh, S.A. (2001) Conservation of Kuth (*Saussurea costus*). A Threatened Medicinal Plant of Kashmir Himalaya. In: Samant, S.S., Dhar, U. and Palni, L.M.S., Eds., *Himalayan Medicinal Plants: Potential and Prospects*, Gyanodaya Prakashan, Kanpur, 197-204.
- [53] Nayar, M.P. and Shastry, A.R.K. (1987) Red Data Book of Indian Plants. Botanical Survey of India, Calcutta.
- [54] Kulkarni, S. and Desai, S. (2001) Immunostimulant Activity of Inulin Isolated from *Saussurea lappa* Roots. *Indian Journal of Pharmaceutical Sciences*, **63**, 292-294.
- [55] Shinwari, M.I. and Khan, M.A. (2000) Folk Use of Medicinal Herbs of Margalla Hills of National Park, Islamabad. *Journal of Ethnopharmacology*, **69**, 45-56. [https://doi.org/10.1016/S0378-8741\(99\)00135-X](https://doi.org/10.1016/S0378-8741(99)00135-X)
- [56] Chang, K.-M., Choi, S.-I. and Kim, G.-H. (2012) Anti-Oxidant Activity of *Saussurea lappa* C.B. Clarke Roots. *Preventive Nutrition and Food Science*, **17**, 306-330. <https://doi.org/10.3746/pnf.2012.17.4.306>



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