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A brief review of remedial uses of *Saussurea lappa*

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Abstract

Plants are being used by human beings for treating various ailments since time immemorial. Plants are used for numerous pharmacological activities and 25000 various products in the support of this are obtained from different plant species by various scientists. Since time *Saussurea lappa* immemorial and endures till date. Research work is being carried out extensively on various herbal drugs to validate their use in medicine. One such potent herb *Saussurea lappa* Clarke is the member of family Compositae. These plants are well known for its medicinal value and have been proved to be anticancerous, anti-inflammatory and anti-fungal.

Chemical constituents extracted from this plant are lactone cynaropicrin, dehydrocostus, germacrene, lappadilactone due to which it show useful pharmacological and medical characters. Despite the modern day pharmacological uses it is famous for numerous traditional uses such as insecticide, pesticide, to treat diseases and in perfumery. In past days it was used to treat more than 40 diseases. This review has been summarized to aware people about the various remedial and traditional uses of this plant.

Keywords: Active compounds, drug, medicinal, pharmacological, remedial

Introduction

Saussurea lappa is a potential herb belonging to family Asteraceae. It is a well identified medicinal plant and used in many medicines all over the world. Different types of chemical compounds are isolated from the plant body and mainly the roots, these chemicals form many bioactive substances. Their population size is continuously diminishing due to the high demand and consumption rate. *Saussurea lappa* is near to extinction because of careless handling, harvesting and wastage of plant material by the locals (Ahmad et al., 2007) [1]. The roots and root stalks are used for toothache, asthma, dysentery, skin diseases and rheumatism and asincense (Shah, 1982) [2]. In Ayurveda the root is used particularly for improving complexion, cures leucoderma, itching, ringworm, vomiting, scabies, headache, epilepsy (Madhuri et al., 2012) [3]. It is also used in Unani system of medicine as it stimulates the brain, used in diseases of liver, kidney and blood. It is also used for treating deaf, headache, paralysis, asthma, Cough, old fever, inflammation, and ophthalmic condition (Kritikar et al., 1987) [4]. In China, Japan and Nepal, the root is used to cure abdominal pain and tenesmus (Choi YK, 2013) [5]. *Saussurea lappa* roots are being used traditionally for its therapeutic purposes as folklore medicine. Hence, this review is directed towards exploring the various pharmacological activities of *Saussurea lappa*. It is commonly known as kutha.

Taxonomic classification

Saussurea lappa is member of family asteracea/ compositae. Asteracea is one of the largest angiosperm families, with more than 1,620 genera and about 23,600 species of plants including herbs, shrubs and trees. The genus *Saussurea* consists of about 300 species.

Geographical distribution

Saussurea lappa is indigenous to India, Pakistan and China, where it grows in the Himalaya region at 2500 - 3500 m altitude (Rao RN et al., 2013) [7]. It is found in cool temperature and arctic regions of Asia, Europe and North America. The plant is cosmopolitan in conveyance additionally among the districts of Himalayas, Kashmir, Jammu, Kishengange valley, Western Ghats and developed in Tamil Nadu, Uttar Pradesh, wild in India at an elevation of 2500 to 3000 m and in Kashmir to take care of the business demand of the market due to over misuse of the wild (Kokate, CK et al., 2002) [8]. In India it is found in Kashmir, Jammu, and Western Ghats and is cultivated in Tamil Nadu, Uttar Pradesh and Kashmir to meet commercial demand.

Table 1: Taxonomic classification of *S. lappa* C.B. Clarke (Source Zahara K *et al.*, 2014) [6]

Kingdom	Plantae
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta
Division	Tracheophyta
Subdivision	Spermatophytina
Infradivision	Angiospermae
Class	Magnoliopsida
Superorder	Asterales
Order	Asterales
Family	Asteraceae
Genus	<i>Saussurea</i>
Species	<i>S. lappa</i> C.B. Clarke

Vernacular Names

Saussurea lappa is known by many names in different parts of world. Common names include saw-wort and snow lotus. In different Indian languages *S. lappa* is known by following given names (Khan M *et al.*, 2013) [9].

Arabic: Quist

Assamese: Kud, kur

Bengali: Kudo, Pachak, Kur, Kut

Chinese: Mu Xiang;

English: Costus;

French: Costus elegant;

German: Practigekostwurz;

Gujarati: Upaleta, Kath, Kur

Hindi: Kot, Kur, Kut, Kust, Pachak

Kannad: Changalkustha;

Kannada: Changal, Koshtha

Kashmiri: Kuth, Chob-i-Kud, Post khai

Malayalam: Kottam, Sepuddy

Bengali: Kudo

Marathi: Upleta, Kushtha

Oriya: Kudha

Persian: Qust

Punjabi: Kuth

Sanskrit: Kushta, Kashmirja, UtpalamAmayam;

Tamil: Goshtam, Kostam, Kottam

Telegu: Changala, Kustam

Urdu: Qust

Morphological Description

Saussurea lappa is an erect, robust, pubescent, perennial herb, with a stout simple stem 1–2m high.

Root: Root is about 60cm long and produce strong characteristic odour. Both root and stem of the plant body are stout and fibrous. The dried root tastes slightly bitter. It is dirty grey to yellow in color and generally wrinkled and ridged. Roots are dark brown to grayish in colour, hard and attain length upto 40 cm.

Leaf: Leaf length is about 1m long. Leaves are lobate, membranous, scaberulous above, glabrate beneath, auricled at base, irregularly toothed with characteristic odour. Upper leaves are smaller, sessile or shortly petioled; two small lobes at the base of these leaves almost clasping the stem.

Flower: bluish-purple, stalkless flowers are present in clusters of 2-5. Flowers are borne either terminally or in axils of leaves. (Chadha YR, 1972) [10]

**Fig 1:** (roots and sapling of *S. lappa*)

Inflorescence: The inflorescence of *Saussurea lappa* is arranged in terminal and axillary clusters, with dark bluish purple to black flowers (Pandey MM *et al.* 2007) [11].

Fruits: Fruits of *S. lappa* are curved and cupped and about 3mm long. Fruits contain hairs on them.

Chemical constituents

The chemical constituents were isolated from the roots of *Saussurea lappa* such as hexane extract, methanolic extract

and petroleum extract (Amara U *et al.*, 2017) [12]. The chemical constituents from the fresh roots are included like lappadilactone, lactone cynaropicrin, dehydrocostus, germacrene such as (+)-germacrene A germacra1(10), 4,11(13)-trien-12al,germacra-1(10),4,11(13)-trien-12-oland germacra-1(10) 4,11(13)trien-12-oic acid were isolated and studied (Taniguchi M *et al.*, 1995) [13].

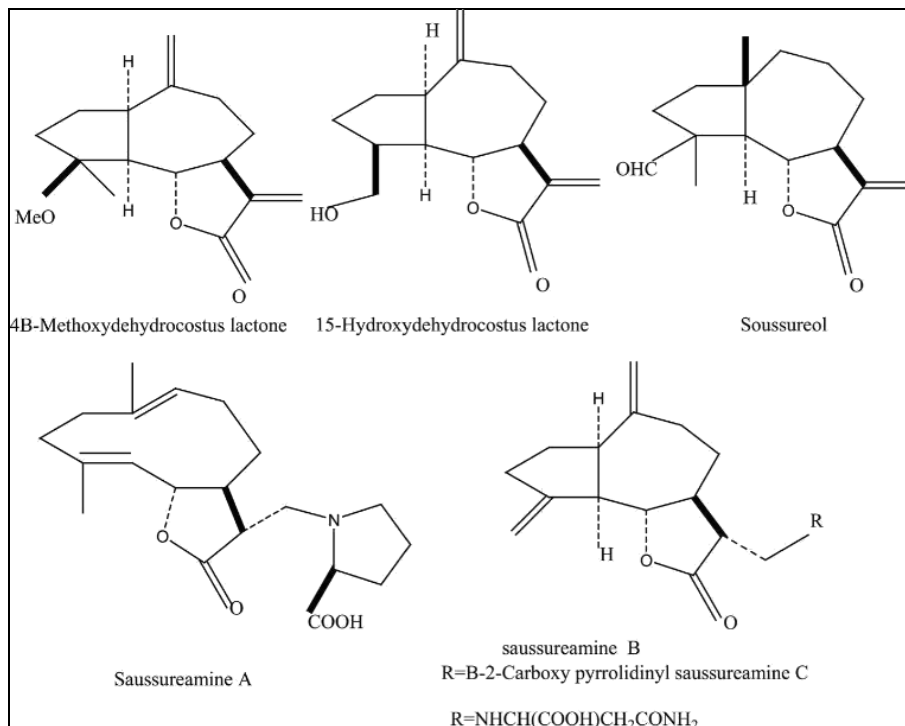


Fig 2: Chemical constituents of *Saussurea lappa*. Source: Taniguchi M *et al*, 1995^[13]

Pharmacological Properties

S. lappa has been screened as medicinally important plant. The various chemical compounds isolated from SL possess medicinal properties. Many workers have reported several very important pharmacological uses and bioactive substances.

Anticancerous: The extract of *S. lappa* roots has been found to have anticancerous effects on different types of cancers. Such as lung cancer (Hung JY *et al.*, 2010)^[14], prostate cancer (Kim EJ *et al.*, 2008)^[15], (Tian X *et al.*, 2017)^[16], oral cancer (Moon SM *et al.*, 2013)^[17], gastric cancer (Ko SG *et al.*, 2005)^[18].

- **Prostate Cancer:** In androgen-insensitive human prostate cells the apoptosis was persuaded by the hexane extracts of *S. lappa* roots (Kim E *et al.*, 2008)^[15]. It stops the migration of prostate cancer cells (Kim EJ *et al.*, 2012)^[19]. The experiments were performed to check the relationship between apoptosis and autophagy in SLE mediated prostate cells. To study the anticancerous effects of SLE, LNCaP prostate cancer cells were cultivated with 6.3, 12.5, 25, 50, and 100mg/mL SLE for 24 hours, and the cytotoxicity was checked using the MTT assay. In a dose dependent manner the viability of LNCaP cells was reduced, SLE showed the significant effect against prostate cancer cell by suppressing AR and PSA at the transcriptional and translational level. The results of this experiment demonstrated that the anticancer effect of SLE is mediated through the regulation of apoptosis and autophagy in prostate cancer cells (Tian X *et al.*, 2017)^[16].
- **Oral Cancer:** The dried roots of *S. lappa* have shown inhibition of cancerous cell propagation in human oral cancer. The experiments were carried out by performing DNA fragmentation assay and western blotting. (Moon SM *et al.*, 2013)^[17].
- **Gastric Cancer:** The ethanolic extract of roots of this plant, either in traditional or in combination with modern chemical therapy works on the gastric cancerous cells

and possess healing properties to the same. Specific dosage and particular time is required for the proper results, or in other words it is dosage and time dependent method such as 80 µg/ mL and 48hours are required for the treatment of gastric cancer cells (Ko SG *et al.*, 2005)^[18].

- **Breast Cancer:** Costunolide obtained from SLE showed an inhibitory effect on the metastasis of breast cancer cells. The experiments were performed on mice and the results were checked after few days of observation, which showed the significant inhibition of growth and metastasis of breast cancer cells. Thus, it is concluded that *Saussurea lappa*-derived costunolide have inhibitory effect migration, growth and metastasis of breast cancer cells (Choi YK *et al.*, 2013)^[5].
- **Anti-inflammatory properties:** The different bioactive compounds isolated from *Saussurea lappa* have inhibitory effect on inflammation in human and animals. They all inhibit inflammation in dose dependent manner. The acute inflammation shows symptoms such as redness, heat, pain, swelling. The increased movement of plasma and leukocytes from the blood causes inflammation. To treat this serious problem the various approaches can be and must be In androgen-insensitive human prostate cells the apoptosis was persuaded by the hexane extracts of *S. lappa* roots (Kim E *et al.*, 2008)^[15]. It stops the migration of prostate cancer cells (Kim EJ *et al.*, 2012)^[19]. The experiments were performed to check the relationship between apoptosis and autophagy in SLE mediated prostate cells. To study the anticancerous effects of SLE, LNCaP prostate cancer cells were cultivated with 6.3, 12.5, 25, 50, and 100mg/mL SLE for 24 hours, and the cytotoxicity was checked using the MTT assay. In a dose dependent manner the viability of LNCaP cells was reduced, SLE showed the significant effect against prostate cancer cell by suppressing AR and PSA at the transcriptional and translational level. The results of this experiment demonstrated that the anticancer effect of SLE is mediated through the

regulation of apoptosis and autophagy in prostate cancer cells (Tian X *et al.*, 2017) ^[16] properties to treat acute inflammation (Tejaswi JK D *et al.*, 2018) ^[20]. Skin inflammation is very common dermatological ailment and *S. lappa* have various compounds present in it which have ability to support the pharmacological industry in formation of medicines to treat this such as allantolactone, costic acid, costunolide. This is demonstrated by carrying out experiments treating infection cells with these compounds (Lim HS *et al.*, 2015) ^[21]. The SLE-isolated sesquiterpene lactone was demonstrated using the cotton pellet granuloma assay in rats and was found to be having effect on different phases of inflammation. (Damre AA *et al.*, 2003) ^[22]. The ethanolic extracts from SL were experimented to check their effect on acute and chronic inflammation. The experiments were performed on rats and mice and given dose of 50 to 200mg/kg. It was found that this extract have inhibitory effect on inflammation. The anti-inflammatory effect was proved through carrageenan induces paw edema (Gokhale AB *et al.*, 2002) ^[23]. *Saussurea lappa* is frequently used in Korean traditional method of medication for inflammatory diseases. The methanolic extracts were also found to possess anti-inflammatory effects. It was observed that 0.1 mg/ml concentration inhibits about 50% of the inflammation induction factor (Lee GI *et al.*, 1995) ^[24]. It was confirmed by means of an electrophoretic mobility shift assay, that the costunolide derived from SLE also have antiinflammatory properties (Kang JS *et al.*, 2003) ^[25].

- **Antimicrobial property:** The methanolic extracts from *Saussurea lappa* have significant antibacterial properties (Parekh J *et al.*, 2007) ^[26]. It has been concluded from that this plant have a strong spectrum of antimicrobial effect against various food borne bacteria and can play important role in discovery of future drugs to treat the bacterial diseases (Khalid A *et al.*, 2011) ^[27]. *Helicobacter pylori* is an important disease-causing pathogen and causes many diseases including functional diseases of the digestive tract (e.g., gastric cancer, gastritis and dyspepsia) and can also cause endocrine disorders (Furuta T *et al.*, 2009) ^[28]. The ethanol extracts of *Saussurea lappa* was tested against five different strains of *H. pylori* and was found to be strongly inhibitory to all test strains (Li Y *et al.*, 2005) ^[29]. The ethanolic extracts from *S. lappa* inhibits the growth, acid production and adhesion of the water in-soluble glucan of *Streptococcus mutans*. It works in dose dependent manner, which is about 0.5mg/ml to 4mg/ml (Yu H *et al.*, 2006) ^[30]. The roots of this plant possess antifungal properties especially against pathogenic fungi. It was tested along with 105 Indian plant species and was found to have considerable antifungal effects (Ray P *et al.*, 1976) ^[31]. Various compounds were isolated from the roots and tested against the nine fungal strains *i.e.* *Aspergillus flavus*, *Aspergillusniger*, *Aspergillus ochraceus*, *Aspergillus versicolor*, *Aspergillus flavus*, *Penicillium ochrochloron*, *Penicillium funiculosum*, *Trichodermaviride*, *Cladosporium cladosporioides* and *Alternaria*. The compound showed antifungal effects which were moderate too high (Rao KS *et al.*, 2007) ^[32].
- **Gastric function:** Decoction of *S. lappa* was used to check for difference in factors such as serum gastrin, gastric acidity and plasma somatostatin in the patients with such disorders. SLD was also given to five healthy volunteers through oral route. It sped up the gastric emptying time and discharge of endogenous motilin. The plasma somatostatim, acidity output and serum gastrin levels where unchanged (Chen SF *et al.*, 1994) ^[33].
- **Gastro-protective effect:** The costunolide and dehydrocostus from methanol extract of the dried roots of the plant showed the gastro-protective effect in rats on acidified ethanol induced gastric mucosal, dose dependent method(5 and 10mg/ kg). *Saussurea amines* A inhibits water-immersion induced gastric mucosal lesions in mice (Matsuda H *et al.*, 2000) ^[34].
- **Hepaprotective:** Costunolide and dehydrocostus are the active compounds which are identified for showing strong suppression of hepatitis B surface antigen. Results showed that, Both costunolide and dehydrocostus lactone can be used in future anti HBV drugs (Chen H C *et al.*, 1995) ^[35].
- **Antiulcer:** The acetone and costunolide from SLE showed inhibitory effect on the formation of gastric ulcer induced by restrain of water in mice. To test this property the experiments on wistar rats were performed by giving the test compound orally in dose dependent manner (Yamahara Jet *et al.*, 1984) ^[36]. *Saussurea lappa* is the one of the major components in UL-409, a herbal formulation activity (Mitra SK *et al.*, 1998) ^[37] and is known for antiulcer property. To check this, the dosage of 600mg/kg was given orally to wistar rats and male pigs. The results showed the healing effect on alcohol and aspirin induced gastric ulceration, cold resistant induced ulceration. It also enhances the gastric mucus secretion in all different types of ulcers. From the experiment, UL-409 was proved to be antiulcer remedy (Mitra SK *et al.*, 1996) ^[38].
- **Spasmolytic:** *Saussurea lappa* was traditional used to cure spasms and constipation. The scientific basis of this property was tested by carrying out several experiments which concluded that the aqueous-methanol crude extract of *S. Lappa* have spasmolytic effect and can cure spasms. In concentration dependent dose it cause declining effect on spasms, the results demonstrated that it contains spasmolytic constituents (Gilani AH *et al.*, 2007) ^[39]. This effect was mediated by blocking calcium channel, this method is mostly used for testing spasmolytic effect in plant extracts (Gilani AH *et al.*, 2007) ^[39]. This demonstrated the scientific evidence in the support of traditional spasmolytic use of SL.
- **Anti-hepatotoxic activity:** Extracts of *S. lappa* roots were found to have antiviral activity against hepatitis B virus (Chen *et al.*, 1995) ^[35]. On the basis of this antihepatotoxic activity was checked and demonstrated by treating the mice with the extracts. It worked against the lipopolysaccharide and D-galactosamine induced hepatitis. It was used in dose dependent manner and at the dose as high as 5g/kg, it doesnot produce any behavioral changes or mortality (Yaesh S *et al.*, 2010) ^[40].
- **Hypoglycaemic:** A detailed clinical study on hypoglycaemic plants from different region of India was done and SL was found to be most effective for obese, diabetes (Upadhaya OP *et al.*, 1993) ^[41].
- **Immunomodular:** The hydroalcoholic extracts from roots of SL show immunomodulatory activity. The experiments were performed by using SLE at two doses - 100mg/kg and 200mg/kg. It does not show significant effect on humoral immunity when short term treatment of lower dose is provided, whereas the higher dose of SLE

has shown immunomodulatory activity on both humoral as well as cellular arms of the immune system (Pandey RS *et al.*, 2012) ^[42].

- **Anticonvulsant activity:** The roots of SL were used in the treatment of epilepsy in ayurveda. To find the scientific basis of the anticonvulsant activity the experiments were performed on mice using various extracts of SL roots (Ambavade SD *et al.*, 2009) ^[43], (Gupta *et al.*, 2009) ^[44]. The results demonstrated that the petroleum ether extracts of SL possess significant anticonvulsant activity, it was concluded by elevating seizure threshold by GABAergic mechanism (Ambavade SD *et al.*, 2009) ^[43]. The ethanolic extract inhibits the seizures induced by both maximal electric shock and pentylenetetrazol (PTZ). The experiments are done by various method (Gupta *et al.*, 2009) ^[44]. These experiments and studies showed that *Saussurea lappa* possess anticonvulsant activity.

Miscellaneous

1. **Antifeedant:** On testing seven different plants against the insects of stored food grain, the rhizomes of SL was found to be most powerful repellents of *Tribolium castaneum* (herbst) and possess antifeedant activity against *Rhyzopertha dominica* F. (Malik MM *et al.*, 1984) ^[45].
2. **CNS depressant:** Dehydrocostus lactone and costunolide from *Saussurea lappa* increased hexobarbital induced sleeping time and decreased body temperature and were isolated as CNS active constituents (Okugawa H *et al.*, 1996) ^[46]. The inhalation of essential oils by the women in labour cause mild sedation and relieves the labour pain and anxiety. The sedation is mild and causes no harm to mother or foetus.
3. **Antiparasitic:** The activity of SLE against nematodal infections was determined by giving oral dose to *Clonorchis sinensis* infected rabbits and was found to be effective (Rhee JK *et al.*, 1985) ^[47]. In the children infected naturally with the respective worms, the anti nematodal efficiency of SL was studied on the basis of percentage of faecal eggs per gram, which reduced significantly (Akhtar and Riffat, 1991) ^[48].
4. **Hypolipidaemic:** Aqueous extract of SL showed hypolipidemic effect by reducing serum cholesterol and serum triglycerides in rabbits at a dose of 2mg/kg when given orally.
5. **Antidiarrheal:** The methanolic extract inhibited the diarrhea evoked by castor oil in wistar rats in dose dependant manner. Applied the doses of 100, 300, 500 mg/kg inhibited the diarrhea by 26.33, 32.28 and 66.77% (Negi *et al.*, 2013) ^[49].

Ethnobotanical Properties

Backache and chest pain: Root powder when taken with milk/decoction helps in relieving pains. Root powder heated in Oil is massaged on the affected area for quick relief.

Cold: Decoction of root is taken.

Cough: Root powder taken with warm water (Mahmood A *et al.*, 2011) ^[50], (Kumar M *et al.*, 2009) ^[51].

Toothache: Powder of root is used to relieve toothache (Mahmood A *et al.*, 2011) ^[50]

Epilepsy: The roots powder is used with honey.

Exhaustion: Root pieces are burnt in hookah and the smoke inhaled.

General weakness: Root powder taken with cow's milk or ghee.

Headache: Root powder heated with root and use for headache.

Headache: Paste of the root is applied.

Leprosy: Root powder is ingested.

Lustre and growth of hair: Mustard oil is heated with root powder and that oil used on hair.

Piles: Root powder also used for piles

Pustules: Fine root powder is wiped on the wound.

Rheumatism: Juice of roots is used with sweetener to cure rheumatism (Mahmood A *et al.*, 2011) ^[50].

Painful joints: 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.

Respiratory Disorder: It is quite beneficial for the management of bronchitis, asthma and cough. The essential oil present in the plant helps in relaxing the bronchial muscle (Qureshi RA *et al.*, 2007) ^[52].

Relieving Power and reliever Properties: The root has a distinguishing fragrance. It helps to strengthen the stomach and captures the secretion of bleeding. It helps to remove phlegm from bronchial tubes. The essential oil has antiseptic and disinfectant properties.

Cholera: This herb helps to relieve cholera, fresh *Saussurea*, cardamom and water can be consumed for every half an hour in order to relieve the condition. The drug gives out a depressant action which helps brain in relieving the spasm.

Throat infection: Root is chewed.

Typhoid: Extraction from root is used for the treatment of typhoid fever (U. Amara *et al.* 2017) ^[12].

Ulcers: It was traditionally used to cure ulcers (Kala CP, 2006) ^[53].

Dysentery: Is used to treat dysentery (Kala CP, 2006) ^[53].

Scabies: Root paste is consumed with milk to treat scabies (Mala F *et al.*, 2012) ^[54].

Ethnoveterinary Properties

Infertility: Paste prepared from *Phyllanthus emblica* L. fruit, *Saussurea lappa* L. root and *Withania somnifera* (L.) is given orally to cow once a day to cure infertility.

Cardiac Diseases: It is also used against the heart diseases in bovine (Sharma S. *et al.*, 2010) ^[55].

Other Properties

- Perfumery: The oil from SL is widely used in perfumes due to its pleasant fragrance. It is mixed with other perfumes (Butola JS *et al.*, 2010) ^[56].
- Pesticidal: It acts as insect repellent. In china and India the sticks covered with powder are made and are burnt at homes and temples to repel insects.
- Insecticide: The powered form is used as insecticide by sprinkling on the crop plants (Sharma S *et al.*, 2010) ^[55] and to protect shawls and other fabrics from insects (Butola JS *et al.*, 2010) ^[56].
- The upper parts of plant is used as fuel and fodder (Butola JS *et al.* 2010) ^[56].
- Dried leaves are smoked as tobacco (Butola JS *et al.*, 2010) ^[56].
- Used to improve complexion (Zahara K *et al.*, 2014) ^[6].
- To kill lice.
- To turn grey hair to black (Zahara K *et al.*, 2014) ^[6].

Status and Trade

In the Himalaya along with the dominant high-altitude genera for high number of endemic species, *Saussurea* is the second largest genera with 35 species. It is number one in seizures of illegally traded endangered plants. Due to its high market demand and exploitation of wild, naturally growing *Saussurea* the species are found to be extinct. In order to meet the demand rate commercial cultivation is practised at high scale now. It is cultivated in the forested area with similar conditions to where it occurs naturally. For exportation to Arabia and red sea ports, the roots are transported to Bombay and Calcutta to perfumery and medicine industries. China is the largest exporter of *Saussurea lappa*, it has exported 1024 tons since 1983 to 2009 and India being second largest exporter has shipped out 266 tons in the same period of time. France is the largest importer. The product is imported or marketed under the name of costus root and costus root oil. In India, it is easily available in the markets of Calcutta, Delhi Mumbai, Amritsar and Haridwar.

Conclusion and Future Scope

S. lappa possesses numerous significant medicinal and traditional properties. It is used to cure various diseases and disorders in ethnobotany such as headache, stomach ache, epilepsy, leprosy, typhoid and chemicals extracted from the roots of the plant show several pharmacological activities like anticancerous, Anti-inflammatory and antimicrobial etc. The examination of literature on this plant concluded that it is medicinally important and is endangered due to high demand and consumption and illegal exploitation. From various evidences it is revealed that *S. lappa* is safe and effective when used in traditional dosage. It also shows some other properties except medicinal one, such as perfumery and antiparasite. Due to its significant pharmacological and ethnobotanical uses from long time and presence of many significant bioactive substances which can lead to extraction and identification of some new chemical compounds, it is concluded that *S. lappa* can help in future clinical and chemical researches.

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