Phytochemical and Pharmacological Review of an Ethno Medicinal Plant: *Saussurea Lappa*

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**Abstract**

Indian Himalayan region is one of the richest sources of valuable medicinal plants and herbs since antiquity due to its unique climatic conditions. *Saussurea lappa* is one of the most common prescribed herbs in indigenous systems of medicines in China, Tibet and India for treatment of various types of human ailments such as fever, bronchitis, rheumatoid arthritis, typhoid fever and chronic skin diseases. *S. lappa* produces various secondary metabolites with extraordinary biological activities which has anti-inflammatory, antibacterial, hepatoprotective, anti-tumor, anti-viral, anti-ulcerogenic, anti-epileptic and cyto-toxic properties. Costunolide and dehydrocostus lactone are major constituents that exhibits anti-inflammatory and anti-tumor activities. The present review puts an insight on the phytochemical, pharmacological and therapeutic properties of the plant as well scope of the future research for medicinal application.

**Keywords:** *Saussurea lappa*, Indigenous medicine, Costunolide, Anti-inflammatory, Anti-tumor, Phytochemicals, Therapeutic uses.

**1. Introduction**

*Saussurea lappa* is a potential herb belonging to family Asteraceae (Table 1). It is a long erect herb found mostly in Northern mountainous regions of Pakistan and India (Gupta *et al.*, 1967). Its flowers are dark purple or black in color, occupying terminal and axillary heads. Pappas is long, fluffy, feathery and fruit is cupped, curved, compressed and hairy (Fig 1). Leaves are radical with long lobately winged stalks. Roots (Fig 2) are stout, carrot like, 60cm long, possessing a characteristic penetrating sweet aromatic odour along with bitter taste (Jain *et al.*, 1984; Nayar *et al.*, 1987, 1988, 1990; Stainton, 1988; Samant *et al.*, 1998; Pandey *et al.*, 2007). It is known in different languages with various names like saw-wort, snow lotus and in Hindi: Kuth; Urdu: Minal; English: Costus; Chinese: Mu Xiang; Tamil: Kostum; Sanskrit: Amayam, Puskara; Gujarati: Upleta; German: Pratigte kostwurz; French: Costus elegant; Marathi: Kastha; Kannad: Changal kustha; Malayalam: Kottam; Bengali: Kudo (Chadha, 1972). Medicinal properties of *S. lappa* plant are well documented in traditional Chinese medicine, Ayurvedic medicine and Tibetan system of medicine (Singh, 1999). In the Handbook of Traditional Tibetan Drugs, out of 175 formulations *S. lappa* to be amongst the main ingredients in 71 formulations (Tasrong *et al.*, 1986). Traditionally it has been used in the treatment of large number of ailments and diseases such as asthma, cough, throat infection, tuberculosis, leprosy, malaria, convulsions, fever, helminthic infestations, opthalmic conditions, paralysis, deaf, tridosa, hysteria, headache, rheumatism, intestinal carcinogenesis, oedema and as an antispasmodic (Nadkarni *et al.*, 1954; Basu *et al.*, 1987; Lee *et al.*, 2001; Malik *et al.*, 2011).

**Table 1:** Taxonomic classification of *Saussurea lappa*

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Plantae</th>
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<tr>
<td>Subphylum</td>
<td>Euphyllophytina</td>
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<tr>
<td>Infraphylum</td>
<td>Radiatopses</td>
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<tr>
<td>Subclass</td>
<td>Asteridae</td>
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<td>Superorder</td>
<td>Asteranae</td>
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<td>Order</td>
<td>Asterales</td>
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<tr>
<td>Family</td>
<td>Asteraceae</td>
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<tr>
<td>Genus</td>
<td>Saussurea</td>
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<tr>
<td>Species</td>
<td><em>S. lappa</em></td>
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**2. Phytochemicals**

*Saussurea lappa* contains a variety of phytochemicals of which some are identified and many more are yet to be discovered and isolated. Its main active constituent are terpenes such as costunolide, dihydrcostunolide, 12 methoxydihydro costunolide, dihydrcostus lactone, dehydrocostus lactone (Yang *et al.*, 1998), α-hydroxy dehydrocostus lactone, β-
hydroxy dehydrocostus lactone, lappadilactone (Sun et al., 2003), mokko lactone, betulinic acid, betulinic acid methyl esters (Choi et al., 2009), cynaropicrin, reynosin, santamarine (Cho et al., 1998), saussureamines A-C (Yoshikawa et al., 1993), α-cyclocostunolide, alantolactone, isoalantolactone (Zhao et al., 2008), isodihydrocostunolide, β-cyclocostunolide (Robinson et al., 2008), β-hydroxyl arbusculin A (Choi et al., 2009), arbusculin B (Julianti et al., 2011), saussureal and so on (Talwar et al., 1992), which have antitumor and anti-inflammatory properties. It also contains anthraquinones, mainly three compounds aloemodin-8-β-d-glucopyranoside, rhein-8-α-β-d-glucopyranoside and chrysophanol, alkaloids and flavonoids (Zahara et al., 2014). Four flavonoids glycosides have antibacterial function (Rao et al., 2007). Shikokiolis have antitumor activity (Jung et al., 1998), whereas chlorogenic acid prevents oxidization.

3. Pharmacological Properties

Several researchers investigated different extracts of this plant and found the constituents exhibiting anti-inflammatory, anti-bacterial, anti-tumor, hepatoprotective, anti-ulcer and immunomodulatory activities. Till date, different biologically active ingredients of Saussurea lappa have been isolated and purified. Among those active compounds sesquiterpene lactones such as costunolide and dehydrocostus lactone has been reported to exhibit medicinal bioactivities.

3.1 Antitumor Property

Kanetoshi et al. (2005) inferred that β-peltatin and lignin derivatives from the acetone extracts of S. lappa inhibit human pancreatic cancer cells, lung cancer cells, and squamous cancer cells. Park et al. (2007) found that dehydrocostus lactone and costunolide inhibit the activity of human MCF-7 and MDA-MB-453 mammary tumor cell. The hexane extract of S. lappa was investigated for the chemo preventive potential in autonomous androgen prostate cancer and apoptosis induction in DU145 cells. Results of this study showed that dehydrocostus lactone isolated from the hexane extract of S. lappa induced apoptosis in cells lines of DU 145 human autonomous androgen prostate cancer and inhibited the cell growth (Kim et al., 2012). The effect of costunolide isolated from Saussurea lappa and supposed pathways of action on the induction of apoptosis in HL-60 human leukemia cells. It has been observed that costunolide stimulates the ROS-mediated permeability transition and resultant cytochrome C release. It was concluded that Saussurea lappa extract inhibited cell proliferation through induction of apoptosis (Lee et al., 2001). Cytotoxic activity of chloroformic extract of Saussurea lappa on breast cancer cell lines (MDA-MB) was nearly comparable to that of the standard compound, doxorubicin (Sunkara et al., 2010). Costunolide extracted from Saussurea lappa suppresses tumor growth and metastases of MDA-MB-231, highly metastatic human breast cancer via inhibiting TNF-α induced NF - k B activation (Youn et al., 2013). Saussurea lappa extract inhibits cell proliferation through apoptosis pathway on xB human oral cancer cells (Moon et al., 2013). Cynaropicrin, isolated from S. lappa for its immune modulatory effects on cytokine release, immune suppressive effects, and nitric oxide production. Cynaropicrin repressed Jukart T, Eol-1 and U937 cell lines in a dose dependent manner with IC 50 values of 2.36, 10.90 and 3.11 µmol/L respectively. The results showed that cynaropicrin was more cytotoxic toward leukocyte derived cancer cells than fibroblasts (Cho et al., 2004). The ethyl acetate extract of S. lappa when administered orally in rats, inhibited the production of gastric acid, free acid and total acid by 53.53%, 52.55% and 30.30% respectively which gives confirmation for the treatment of gastric cancer by S. lappa (Niranjan et al., 2011). The hepatocellular carcinoma activity of dehydrocostus lactone isolated from Saussurea lappa was tested by in vitro assays. The results proved its anticancer activity at the IC 50 values of 16.7 and 18.8µmol/L (Hsu et al., 2009). Sun et al. (2008) obtained eight types of compounds that have cytotoxic activity on human cancer cells. Lappa dilactone, dehydrocostus lactone, and costunolide demonstrate non-specific cytotoxicity and their effects on HepG2, OVCAR-3, HeLa, and other cancer cells are similar. Studies on structure-function relationship demonstrate that α-methylene and γ-lactone are the structure necessary for cytotoxic activity, and the presence of hydroxide radical lowers this activity. Robinson et al. (2008) obtained dihydrocostunolide and several known antitumor compounds (costunolide, β-cyclocostunolide, dihydrocostus lactone, and dehydrocostus lactone). Iso-dihydrocostus lactone has
strong cytotoxic activity on human colon cancer (Colo-
205), skin cancer (A-431), and mammary gland cancer
(MCF-7) cells, and general cytotoxic activity on A549
cells. Costunolide and mokko lactone induce the
apoptosis of human leukemia cells (HL-60) by
triggering mitochondrial permeability transition, which
induces the release of cell pigment C or damage of
mitochondrial membrane potential (Lee et al., 2001;
Yun et al., 2004). Cynaropicrin effectively inhibits
the proliferation of leukocyte-like cancer cells such as
U937, EoL-1, and Jurkat T, but it does not possess
apparent inhibitory activity on Chang liver cells and
human fibroblast cells (Cho et al., 2004). Other studies
have shown that dehydrocostus lactone could inhibit
Rb protein and growth of cancer cells, i.e., preventing
cancer cell proliferation by inhibiting CDK2 kinase
activity and inducing cell apoptosis, inhibiting NF-
κB activity (could induce cancer cell resistance to drugs)
by preventing degradation and phosphorylation of
protein 1-κBα in HL-60 cells, and causing the apoptosis
of cancer cells (HL-60) (Oh et al., 2004; Jeon et al.,
2005). Dehydrocostus lactone expresses dose-
dependent inhibitory role on cancer cells tested. Flow-
cytometry shows that dehydrocostus lactone facilitates
cell apoptosis and cell cycle arrest at the G2/M stage,
thereby preventing cell proliferation (Choi et al.,
2010). Dehydrocostus lactone also affects cell viability, cell
cycle distribution and ATP binding cassette transporter
expression in soft tissue sarcoma cell lines. Furthermore,
it led to caspase 3/7 activity as well as caspase-3 and PARP cleavage, which are indicators of
apoptosis (Kretscher et al., 2012). Among all the
antitumor compounds in S. lappa, dehydrocostus
lactone, costunolide and cynaropicrin are the most
extraordinary ones, of which the activities have been
verified by extensive studies (Cho et al., 2004; Choi et
al., 2009; Kim et al., 2012; Rasul et al., 2012, 2013).

3.2 Antibacterial Property

Different type of solvents extracts (e.g.
methanolic, ethanolic, aqueous, petroleum ether) have
been tested for the in vitro antibacterial activity of the
Saussurea lappa and it is observed to be effective
against variety of resistant pathogens. (Yang et al.,
2005) studied the in vitro effects of ethanolic extracts
on five clinical H. pylori strains. The results showed
that, S. lappa extract strongly inhibits all of the strains
tested (the MIC was approximately 40 mg/mL). The in
vitro antibacterial activity of methanolic extract of
Saussurea lappa has shown some degree of antibacterial activity against the tested bacterial strains
(Parekh et al., 2007). Moreover, it inhibits the
expression of hepatitis B surface antigen and core-
related antigens (Chen et al., 1995) as well as growth of
other microorganisms and pathogens (Patil, 2009).
The active ingredients of S. lappa inhibit the binding
and transfer of R plasmids in Shigella flexneri (Li et
al., 2010). The in vitro antibacterial activity of different
extracts of Saussurea lappa was evaluated against E.
coli, Bacillus thuringensis and Corynebacterium by disc
diffusion method. It was concluded that S. lappa
showed significant antibacterial activity against the
mentioned organisms at different concentrations of
plant extract (Irshad et al., 2012). The antimicrobial
activity of methanolic and chloroformic extracts of
Saussurea lappa roots were tested against
Staphylococcus aureus, Pseudomonas aeruginosa, E.
coli, Klebsiella pneumonia, Proteus vulgaris, Candida
albicans and Aspergillus through agar well diffusion
method. It was found to be significantly effective for
all the mentioned organisms (Thara et al.,
2012). The antimicrobial activity of Ethanolic extract of
Saussurea lappa was tested against multi drug resistant
Staphylococcus aureus, Pseudomonas aeruginosa, E.
coli and Klebsiella pneumoniae through agar well
diffusion method. It was found to be effective against
all mentioned bacteria with the minimum inhibitory
concentration ranges from 2.0μg/μg-12.0μg/μl (Hassan
et al., 2013). The in vitro antibacterial activity of
different solvent extracts of Saussurea lappa against
Bacillus subtilis, Staphylococcus aureus, E. coli,
Pseudomonas aeruginosa and Klebsiella pneumonia
was studied. It was found that all the extracts showed
antibacterial activity against mentioned bacteria but
chloroformic extract showed the highest antibacterial
activity (Alaagib et al., 2015).

3.3 Anti Inflammatory Activity

The major anti-inflammatory ingredients in S.
lappa are sesquiterpenes, which stabilize endosomal
release and prevent cell proliferation (Damre et al.,
2003). The methanolic extract of S. lappa was
investigated for anti-inflammatory activity. It was
observed that at 0.1 mg/mL concentration, it exhibited
more than 50% of inhibition on the cytokine induced
neutrophil chemotactic factor induction (Lee et al.,
1995). The ethanolic extract of S. lappa was tested at a
dose range of 50-200 mg/kg, on acute and chronic
inflammation induced in both mice and rats. The result
of this study revealed that the extract showed anti-
inflammatory activity through carrageenan induced
paw oedema and peritonitis in animal models (Gokhale
et al., 2002). In vitro anti-inflammatory activity of
Saussurea lappa was evaluated by monitoring the
TNF-α levels and nitricoxide levels in mouse
macrophages cells (Damre et al., 2003). Costunolide
isolated from Saussurea lappa was analysed for anti-
inflammatory activity, and it was observed that
costunolide hindered the protein and mRNA expression
of interleukin -1b. By means of an electrophoretic
mobility shift assay, it was confirmed that it also concealed the AP-1 transcription activity. So, all these activities proved the anti-inflammatory activity of costunolide (Kang et al., 2004). The potential of dehydrocostus lactone which was isolated from Saussurea lappa was tested for the oxidative osteoblast damage and showed considerable increase in the osteoblast growth and hydrogen peroxide in the tissue. At 0.4-2µg/ml dose, the factors such as calcium deposition, collagen and alkaline phosphatase were improved. These, results confirmed that dehydrocostus lactone compound had potential to be used against oxidative osteoblast damage (Choi et al., 2009). Three sesquiterpene lactones (cynaropicrin, reynosin, and santamarin) were isolated through an active screening test inhibit TNF-α activity, among which, cynaropicrin is possibly the major ingredient that inhibits TNF-α in S. lappa (Cho et al., 1998). Further experiments proved that, cynaropicrin affects inflammation by inhibiting the production of inflammatory factors and the proliferation of lymphocytes, while santamarin inhibited inducible nitric oxide synthase (iNOS) protein, reduced iNOS-derived NO, suppressed cyclo-oxyge-nase (COX)-2 protein and reduced COX-derived prostaglandin E2 production in LPS-stimulated RAW266.7 cells and murine peritoneal macrophages (Cho et al., 2000; Choi et al., 2012). Dehydrocostus lactone inactivates the nuclear transcription factor (NF-xB), inhibits the expression of iNOS genes, and reduces the generation of NO and TNF-α level induced by LPS (Lee et al., 1999; Jin et al., 2000). Saussureamines A and B effectively inhibit NO production induced by LPS and NF-xB activation (Matsuda et al., 2003).

3.4 Hepatoprotective Effect
Yamahara et al. (1985) found that the acetone extract of S. lappa and costunolide have choleretic effect and could inhibit ulcer in mice. Costunolide and dehydrocostus lactone (isolated from S. lappa) had little effect on the viability of the cells. However, they showed inhibitory effect on human hematoma Hep3B cells and on the expression of the hepatitis B surface antigen (HBsAg). It was found that these compounds inhibit the HBs Ag production by Hep3B cells with IC50 of 1.0 and 2.0µmol/L, respectively. Results showed that both costunolide and dehydrocostus lactone has the tendency to be developed as potent anti HBV drugs in the future (Chen et al., 1994). The aqueous-methanolic extract of Saussurea lappa roots against the D-galactosamine and liposaccharide induced hepatitis in mice. Pretreatment of mice with different doses of S. lappa extract (150, 300 and 600mg/kg) significantly prevented the rise in ALT and AST in a dose dependent manner. Post treatment with S. lappa (600 mg/kg) significantly restricted the progression of hepatic damage. It was further verified by histopathology where liver showed improved architectural detail, absence of parenchymal congestion, decreased cellular swelling and apoptotic cells. Hence, rationalizing the traditional uses of S. lappa in liver disorders (Yaesh et al., 2010). Shao et al. (2005) compared the effects of ethanolic extract on bile flow before and after rat medication. Their result showed that ethanolic extract increases bile flow and has a choleretic effect. Liu et al. (2008) examined the effects of S. lappa on gall bladder movement and its mechanism in dogs. The result showed that S. lappa solution induces gall bladder contraction in dogs, but does not affect plasma cholecystokinin.

3.5 Anti Ulcer and Cholagogic
S. lappa is one of the major ingredients of UL-409, a formulation which possesses anti-ulcer activity and the activity may be due to the intonation of defensive factors by improvement in gastric cytoprotection (Mitra et al., 1996; Venkataraman et al., 1998). S. lappa decoction perfusion into the stomach of patients with chronic superficial gastritis and results revealed that the decoction could increase the endogenous motilin release and accelerate the gastric emptying (Chen et al., 1994). The acetone extract of S. lappa and costunolide showed cholagogic and inhibitory effect on the formation of gastric ulcer in mice (Yamahara et al., 1985). The antiulcer activity of herbal formulation of S. lappa was tested in Wistar rats and male pigs by oral route @ 600 mg/kg. The drug showed significant effect in gastric ulceration reduction, induced by alcohol and aspirin, cold resistant induced ulcerations and duodenal ulcer models. It amplified the mucus discharge in all, thereby proving to be an antiulcer agent (Mitra et al., 1996). Ethyl acetate extract of Saussurea lappa was found to be effective in different model of gastric and duodenal ulceration in rats (Niranjan et al., 2011). S. lappa extract apparently protects against acute damage to rat gastric mucosa induced by hydrochloric acid-ethanol and reserpoid (Wang et al., 2004). The three active ingredients (saussureamines A, B and C) isolated from S. lappa remarkably protects against the gastric damage caused by hydrochloric acid and ethanol. Saussureamine A also inhibits stress-induced gastric ulcers in mice (Yoshikawa et al., 1993). Aside from saussureamines A, B and C costunolide and dehydrocostus lactone remarkably improves gastric ulcers in rats (Mastuda et al., 2000).

3.6 Immunomodulator
The immunomodulatory effect of hydroalcoholic Saussurea lappa root extract was
observed at the dose of 100 mg/kg and 200 mg/kg and it was found that 250mg/kg did not show significant effect on humoral immunity and number of antibody producing cells of spleen, reflecting Saussurea lappa has no effect on such responses on short term treatment. Higher doses of Saussurea lappa extract have shown potentiation of immunomodulatory activity in both humoral as well as cellular arms of the immune system (Pandey, 2012). Costunolide and dehydrocostus act as inhibitors of killing activity of cytotoxic T lymphocytes (CTL). Through preventing the increase in tyrosine phosphorylation, costunolide inhibited the killing activity of CTL in response to the cross linking of T cell receptors as inhibitors of the killing function of CTL and the induction of intercellular adhesion molecules -1, dehydrocostus lactone from S. lappa and other guainolides were examined for their structure activity relationship. It was confirmed that guainolide moiety exhibited considerable inhibitory effects towards the induction of intercellular adhesion molecule-1 and killing function of CTL (Taniguchi et al., 1995; Yuuya et al., 1999).

4. Miscellaneous Activities

4.1 Cardio Vascular Effects

It was found that extract of Saussurea lappa helps in lowering of the blood pressure and prevents blood coagulation. S. lappa also showed vasodilatation and reduction in cholesterol and triglycerides in the blood (Upadhyay et al., 1994). Aqueous decoctions of S. lappa strengthen fibrin content of blood (Yu, 1986). The volatile oils of S. lappa inhibited ADP-induced platelet coagulation that was mainly due to dehydrocostus lactone and costunolide content of oil (Hou et al., 2008). S. lappa also inhibited enzyme PTB-1B involved in insulin signal, transduction, hypertension and obesity of type 2 diabetes due to presence of the betulinic acid, betulinic acid methyl ester, makko lactone, dehydrocostus lactone and anthraquinones in the extract (Li et al., 2006; Choi et al., 2009; Choi et al., 2012). S. lappa extract and costus oil also reported to exhibit hypoglycemic effect (Gupta et al., 1967; Wang, 1997).

4.2 Bronchitis

Experiments were conducted to study the effect of different extracts of Saussurea costus against chronic bronchitis and asthma (Dutta et al., 1960; Sastry and Dutta, 1961). The alkaloidal fraction was found to be non-toxic and had little effect on the blood pressure and respiration of the cat and rabbit. It exhibited marked spasmylic effect on the smooth (intestinal) and tracheal muscle of the guinea pig, when stimulated by histamine and antispasmodic effect on the perfused isolated guinea pig lungs (Dutta et al., 1960). Studies were also carried out on Tincture Saussurea, petroleum ether extract, Tincture Saussurea prepared from defatted roots and extracts obtained by successive extraction of the roots of Saussurea costus. The results showed that Tincture Saussurea and petroleum ether extract produced broncho-constriction in guinea pigs while Tincture Saussurea prepared from defatted roots and other extracts produced no such effect thereby suggesting that Tincture Saussurea devoid of the petroleum ether soluble fraction could be a useful drug for chronic bronchitis and asthma (Sastry and Dutta, 1961).

4.3 Anticonvulsant Activity

 Petroleum ether extract of S. lappa roots have potent anticonvulsant activity against pentylentetrazole and picrotoxin induced convulsions in mice, by elevating the seizure threshold through GABAergic receptors (Ambavade et al., 2009). The alcoholic extract of root of Saussurea lappa was reported to show significant anti epileptic activity (Gupta et al., 2009; Harish et al., 2010). The different extracts of S. lappa root for the anticonvulsant activity by picrotoxin induced convulsion, pentylentetrazole and maximal electroshock tests performed on mice. It was proved that the petroleum extract of S. lappa roots showed potent anticonvulsant activity at a dose of 100 and 300 mg /kg (Butola et al., 2010).

4.4 Antiparasitic Activity

The activity of S. lappa was tested against Trypanosoma cruzi, Clonorchis sinensis and some nematode infections. Decoction of plant given orally to Clonorchis sinensis infected rabbits was found to be effective to some extent (Rhee et al., 1985).

4.5 Antihyperlipidemic Activity

The aqueous extract of S. lappa orally administered to rabbits at a dose of 2 mg/kg body weight showed significant hypolipidaemic effect (Upadhyya et al., 1996). The ethanolic extract of S. lappa reduces the triglycerides level as well as it significantly increased the HDL-C level in both serum and the tissues (Anbu et al., 2011).

4.6 Antidiarrheal Activity

The methanolic extract of S. lappa roots against antidiarrheal activity in Wistar rats was studied and it was observed that administration of 100,300 and 500 mg/kg body weight of dose showed 26.33%, 32.28% and 66.77% inhibition of diarrhoea, respectively. The standard drug (loperamide) showed significant reduction (68.02%) in diarrhoea stool at the dose of 5mg/kg body weight. The result of this study concluded
that the dose of root extract at 500 mg/kg body weight showed effect similar to that of standard drug loperamide in reducing diarrhoea stool. The methanolic extract of S. lappa roots showed 32.28% inhibition of diarrhoea at the dose of 300 mg/kg body weight. So, these findings clearly showed that the MeOH extract of S. lappa has significant antidiarrheal activity (Hemamalini et al., 2011). The methanolic extract of S. lappa significantly protected the rats against diarrhoea evoked by castor oil in dose dependent manner (Negi et al., 2013).

4.7 Angiogenesis Effect

The endothelial cell proliferation is suppressed by costunolide (isolated from S. lappa root). Studies proved that the chemotaxis induced by vascular endothelial growth factor of human umbilical vein endothelial cells was noticeably inhibited at IC50 of 3.4 µmol/L of S. lappa. Similarly, by in vivo method the neovascularization of mouse corneal stimulated by vascular endothelial growth factor was reported to be inhibited at a dosage of 100 mg/kg/day (Jeong et al., 2002; Thara et al., 2012; Mohammad et al., 2013).

4.8 Spasmyolytic Activity

It was observed that S. lappa significantly able to relax the contraction induced by carbachol (30µmol/L). The antiperoxidative effects of S. lappa were possibly due to the presence of sesquiterpene lactones. Sesquiterpenes has been recognized to stimulate the Sgc which stimulates extrusion of K ions thereby reducing intrinsic Ca ions through activation of cyclic GMP and PKG pathways, leading to relaxation of smooth muscles (Hsu et al., 2009).

4.9 Anti-Mycobacterial Activity

Herrera et al. (2007) investigated the in vitro anti mycobacterial activity of S. lappa where whole oil and its fractions and pure active compounds were determined by fluorometric Alamar Blue microassay (FMABA) and found that costunolide and dehydrocostuslactone are mainly responsible for anti mycobacterial activity against Mycobacterium tuberculosis H37Rv with MICs of 6.25 and 12.5 mg/L, respectively. Anti-mycobacterial activity was found to be better for the mixture than for pure compounds thus both lactones presented synergistic activity.

5. Conclusion

The present review is a compilation of the research work carried out on different solvent extracts and active constituents of Saussurea lappa. Among these components, terpenes such as costunolide, dehydrocostus lactone and cynaropicrin have showed the major pharmacological activities. Costunolide, cynaropicrin, beta-peltatin and lignin derivatives have been identified as effective against pancreatic, lung, mammary, prostate, leukemia, gastric and colon cancer hence, could lead to the development of anti neoplastic drug. Different extracts of S. lappa are effective against various multidrug resistant Staphylococcus spp., E. coli, Klebsiella, Proteus and Bacillus thuringiensis and antibacterial activity vary with the concentration of the plant material used. Hence, S. lappa root extract has certain antibiotic potential and it could be a new source of antimicrobial agents with possibly novel mechanism of action. Also, cynaropicrin, reynosin and santamarin has been identified as the principal indicator of TNF-alpha and suppressor of COX-II enzymes, hence it has anti inflammatory activity. Dehydrocostus lactone and costunolide have been reported to display strong suppressive effect on human hepatoma antigen in liver and therefore, have been the potential to develop as an antiviral or anti HBV drug. Since, S. lappa has tremendous medicinal applications in traditional medicine system, hence more clinical and pathological studies are required to investigate its active constituents, physiological pathway, pharmacokinetics, bioavailability and safety with detail or assurance. Furthermore, potential active compounds could help in new drug discovery and could be used to treat the neoplasm, viral, bacterial and chronic skin ailments.

References


Chen SF, Li YQ and He FY (1994). Effect of Saussurea lappa on gastric functions, Zhongguo Zhong Xi Yi Jie He Za Zhi, 14: 406-408.


