



Medicinal value and mechanism of light adaptation in *Lepidium latifolium* in Ladakh region

Verma A. K. ✉, Goyal Y. and Dev K.

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Abstract

Medicinal plants have been used from ancient times in treatment of many diseases. These plants are the cheap source of drugs and have very fewer side effects. *Lepidium latifolium* is an invasive plant belongs to Brassicaceae family. It found in the mountainous area of Ladakh. It used as a phytofood in the Ladakh area. It is used in treatment of many diseases due to its medicinal properties. It has several natural antioxidants which suppress the biological system. From ancient times, it mainly used as stomach tonics and diuretics. Although it also used in the treatment of other diseases like kidney related diseases, hypertension, diabetes and many more. It also has anti-tumor properties. Due to the mountainous region, Ladakh has very low temperature. Due to its physiological plasticity, *Lepidium latifolium* can grow in the extremely harsh conditions of Ladakh area. In this review, we will discuss about the medicinal properties and the light adaptation of *Lepidium latifolium* in Ladakh area.

Key Words: *Lepidium latifolium*, Ladakh, phytofood and Brassicaceae.

Introduction

From ancient time, medicinal plants have been used to get relieve and cure many diseases. Even now for major part of world's population medicinal plants use as a cheap source of drugs. Medicinal plants also provide numerous new chemicals starting points in synthesis of new drugs having better pharmacological properties (Ballabh *et al.*, 2008). Due to fewer side effects and cost effectiveness of medicinal plants, World Health Organization (2002) has given emphasis to consumption and development of herbal medicines. In traditional medicinal systems, crude form of specific drug or in combinations is favored over compound formulations. According to WHO, 80 percent of the developing countries population depend on the traditional medicinal systems as their primary source of health care. Traditional medicinal system in India offers great medicines for nervous, gastrointestinal and heart related diseases (Mukherjee and Wahile 2006). Ladakh is a mountainous region located in the Trans-Himalaya area, which located between 76°46'29" - 78°41'34"E longitude and 31°44'57" -32°59'57" N

Author's Address

Medical Biotechnology Lab. Department of Biotechnology, Jamia Millia Islamia (Central University), New Delhi – 110025, India.

E-mail: averma2@jmi.ac.in

latitude (Negi *et al.*, 2019). It comprises area over 65000 km² among two districts Kargil and Leh. It also described as 'the land of Lamas', 'a piece in between earth and sky', 'the land of Buddha'. It is very famous for its high mountains, rivers (Shyok, Suru, Dras, Indus, Zaskar and Nubra), glaciers and lakes (Tsomorir, Hanle, Pangongtso, etc.). It has numerous precious remedial herbs. Among these medicinal herbs many are endemic. The main five valleys of Ladakh are Indus, Changthang, Zaskar, Suru and Nubra. Annual precipitation is extremely low in this area (mainly snowfall, followed by slight rainfall). High wind speed, very little humidity (<50%), huge difference between high and low temperature of the same day and rugged landscape are the characteristics of this area (Kala and Mathur 2002). Many works have been done on the ethnobotany of the medicinal plants of the Ladakh. The Amchis (traditional herbalists) are expert in treating with remedial plants of the Ladakh and also in combination with some exotic medicinal plants, against various diseases (Ballabh *et al.*, 2008). Table 1 enumerates the numerous medicinal plants found in cold desert Ladakh and their uses. These medicinal plants are used in treatment of several diseases. *Lepidium* genus has more than 150 species across the world and it is among largest genera of family Brassicaceae



(Mummenhoff, Brüggemann, and Bowman 2001). *Lepidium latifolium* is also known as Peppergrass, Pepperwort and Perennial pepperweed. It is an invasive species (Reynolds and Boyer 2010) of south east Europe and west Asia (Grover *et al.*, 2012). *Lepidium* is well known for its medicinal properties and widely used in the medication of stomach related diseases along with its economic, ecological and agronomic importance (Martínez Caballero *et al.*, 2004). Leaves of *Lepidium latifolium* mainly consumed as salad and vegetables in Ladakh area (Gupta *et al.*, 2012). Therefore, the aim of the paper is to review traditional use of *Lepidium latifolium* against various diseases, and mechanism of light adaptation in *Lepidium* in Ladakh region.

***Lepidium latifolium*:**

Lepidium latifolium is a perennial species and belongs to Brassicaceae family. It can be up to 2m in length. It has waxy leaves and stems are woody and greyish green in color. This plant has small white color flowers arranged in groups. The fruits of these plants are ~1.6 mm in diameter and has 2 reddish seeds (Jouad *et al.*, 2001; Navarro *et al.*,

1994). *Lepidium latifolium* is found in the cold zone of Ladakh, India. It grows geographically at height of 2500 m to 4500 m above the sea level. In Leh - Ladakh area, it is also used as phytofood (Kaur, Bhat, *et al.*, 2013). Lower cauline leaves of this plant are long 1 to 7 cm and upper cauline leaves are not stalked. Leaf blades are elliptical ovate to oblonglanceolate and 1 to 9 cm in length and 0.3 to 4.5 cm in width. Sepals are 1 to 1.4 mm in length and 0.8 to 0.9 mm in width. Sepals are white in color at apex and margin. Petals are milky white in color and 1.8 to 2.5 mm in length and 1 to 1.3 mm in width and apex rounded (figure 1). Stamens are 6 in number and having tetradynamous arrangement (2 short and 4 long). Filaments are 0.9 to 1.4 mm in length. Pistil is 2 mm in length, style is barely visible, stigma is prominent. Fruits are marginally flattened and two chambered, 1.8 to 2.4 mm in length and nearly 1.3 mm in width. One chamber of fruit contains 1 seed, light reddish brown in color, wingless, having simple but long hairs and 1 to 1.3 mm in length and 0.7 to 0.9 mm in width (Francis and Warwick, 2007).

Table 1: Remedial plants of Ladakh used against various diseases (Ballabh *et al.*, 2008; Ballabh and Chaurasia, 2007).

S N	Plant name	Family	Local name	Parts used	Uses
1	<i>Aconitum heterophyllum</i>	Ranunculaceae	Bona-karpo	Roots	Uses against fever
2	<i>Achillea millefolium</i> Linn.	Asteraceae	Chuang	Complete plant	Used in remedy of kidney related disorders, cold and cough
3	<i>Aconogonum tortuosum</i>	Polygonaceae	Serpalulu	Complete plant	Used in treatment of painful micturition
4	<i>Agropyron repens</i>	Poaceae	Zamak	Rhizomes	Promotes micturition
5	<i>Althaea rosea</i>	Malvaceae	Hollyhock	Roots	Used in remedy of kidney related disorders
6	<i>Amaranthus spinosus</i> Linn.	Amaranthaceae	Neu	Leaves	Used in remedy of kidney related disorders
7	<i>Arctium lappa</i> Linn.	Asteraceae	Pizums	Roots	Used in remedy of kidney related disorders
8	<i>Arenaria bryophylla</i>	Caryophyllaceae	Lekhum	Complete plant	Used in remedy of kidney related disorders
9	<i>Arnebia euchroma</i>	Boraginaceae	Demok	Roots	Used in remedy of kidney related disorders
10	<i>Artemisia brevifolia</i>	Asteraceae	Phur-nag	Leaves	Remedy of fever
11	<i>Aster tibeticus</i>	Asteraceae	Skalzungme ntok	Flowers	It is used against cold, cough and fever
12	<i>Artemisia dracunculus</i> Linn.	Asteraceae	Burtse	Complete plant	Promotes micturition
13	<i>Artemisia. sieversiana</i>	Asteraceae	Khamchu	Leaves	Used in remedy of kidney related disorders
14	<i>Astragalus tribulifolius</i>	Fabaceae	Yanglo	Complete plant	Promotes micturition



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15	<i>Avena sativa</i> Linn.	Poaceae	Yupo	Seeds	Promotes micturition
16	<i>Berberis lyceum</i>	Berberidaceae	Dama	Roots	It is used against cold, cough
17	<i>Bidens pilosa</i> Linn.	Asteraceae	Gurgur Cha	Leaves	It is used against cold, cough
18	<i>Bergenia stracheyi</i>	Saxifragaceae	Gatilas	Rhizomes	Used in remedy of kidney related disorders
19	<i>Capsella bursa</i>	Brassicaceae	Shamso	Leaves	To stop haemorrhage of kidney
20	<i>Carum carvi</i> Linn.	Apiaceae	Umbu	Seeds	Promotes micturition
21	<i>Chaerophyllum reflexum</i>	Apiaceae	Lcha-wa	Roots	Promotes micturition
22	<i>Centaurea depressa</i>	Asteraceae	Vashakha	Complete plant	It is used against fever, cold and cough
23	<i>Chrysanthemum pyrethroides</i>	Asteraceae	Sepan	Flowers	It is used against high fever
24	<i>Chenopodium album</i> Linn.	Chenopodiaceae	Neung	Leaves	Used in treatment of painful micturition
25	<i>Chrysanthemum griffithii</i>	Asteraceae	Serpan	Flowers	Used in remedy of kidney related disorders
26	<i>Cuscuta capitata</i>	Cuscutaceae	Deelasazin	Complete plant	Promotes micturition
27	<i>Corydalis govaniiana</i>	Fumariaceae	Ralchhat nagpo	Roots	It is used against fever
28	<i>Cremanthodium ellisii</i>	Asteraceae	Ming-chen-ser-po	Complete plant	It is used against fever
29	<i>Dactylorhiza hatagirea</i>	Orchidaceae	Ambolakpa	Tubers	Used in remedy of kidney related disorders and used against fever
30	<i>Dracocephalum heterophyllum</i>	Lamiaceae	Zimthigle	Complete plant	It is used against cold, cough
31	<i>Ephedra gerardiana</i>	Ephedraceae	Chhapat	Stems	It is used against fever
32	<i>Ermania lanuginose</i>	Brassicaceae	Measlo	Leaves	To stop haemorrhage of kidney
33	<i>Epipactis helleborine</i> Linn.	Orchidaceae	Penginlo	Complete plant	It is used against cold, cough
34	<i>Galium aparine</i> Linn.	Rubiaceae	Ranche	Leaves	Promotes micturition
35	<i>Galium pauciflorum</i>	Rubiaceae	Phomongo	Complete plant	It is used against fever
36	<i>Gentiana algida</i>	Gentianaceae	Tikta	Flowers	Treat epidemic fever
37	<i>Gentianella moorcroftiana</i>	Gentianaceae	Spang-Gain-karpo	Complete plant	It is used against fever, cold and cough
38	<i>Geranium pretense</i> Linn.	Geraniaceae	Ga-dur	Leaves	It is used against fever
39	<i>Galium serpyllodes</i>	Rubiaceae	Pimantso	Leaves	Promotes micturition
39	<i>Gentiana squarrosa</i>	Gentianaceae	Ziang	Roots	Promotes micturition
40	<i>Geranium tuberaria</i>	Geraniaceae	Yusiang	Complete plant	Used in treatment of painful micturition
41	<i>Heracleum pinnatum</i>	Apiaceae	sPru-ma	Roots	Used in the treatment of pain due to fever
42	<i>Herminiummonorchis</i> Linn.	Orchidaceae	Peo	Tubers	Promotes micturition
43	<i>Helianthus annuus</i> Linn.	Asteraceae	Kanglanyes her	Seeds	Used in remedy of kidney related disorders
44	<i>Iris hookeriana</i>	Iridaceae	Tesma	Complete plant	Promotes micturition
45	<i>Inula racemose</i>	Asteraceae	Manu	Roots	It is used against fever, cold and cough
46	<i>Inula rhizocephalan</i>	Asteraceae	Turjit	Roots	It is used against fever, cold and cough
47	<i>Juniperus communis</i> Linn.	Cupressaceae	Sukpa	Fruits	Promotes micturition
48	<i>Juniperus macropoda</i>	Cupressaceae	Sukpa	Fruits	Used in remedy of kidney related disorders
49	<i>Lancea tibetica</i>	Scrophulariaceae	sPa-yang rtsa-ba	Complete plant	Treat against cold, cough
50	<i>Lavatera kashmiriana</i>	Malvaceae	Sazposh	Complete plant	Used in treatment of painful micturition



51	<i>Lepidium latifolium</i> Linn.	Brassicaceae	Sauson or Seoji	Complete plant	To stop haemorrhage of kidney
52	<i>Lycium ruthenicum</i>	Solanaceae	Umila	Leaves	Removes blocked urine
53	<i>Lagotis kunawurensis</i>	Scrophulariaceae	Hong-len	Complete plant	Treat cold, cough and fever
54	<i>Lomatogonium carinthiacum</i>	Gentianaceae	Tikta	Complete plant	Treat cold and cough
55	<i>Malaxis muscifera</i>	Orchidaceae	Jeewak	Roots	Promotes kidney function
56	<i>Malva verticillata</i> Linn.	Malvaceae	Suchili	Complete plant	Removes blocked urine and remedy for whooping cough
57	<i>Melilotus officinalis</i> Linn.	Fabaceae	Ole	Complete plant	used to reduce fever
58	<i>Nepeta podostachys</i>	Lamiaceae	Bathse	Complete plant	Promotes kidney function
59	<i>Nepeta floccose</i>	Lamiaceae	Jimthegala	Leaves	Treat cold, cough and fever
60	<i>Orobanche hansii</i>	Orobanchaceae	Gro-shang-rtse	Complete plant	To stop haemorrhage of kidney
61	<i>Pedicularis longiflora</i>	Scrophulariaceae	Pennel	Flowers	Used in remedy of kidney related disorders
62	<i>Peganum harmala</i> Linn.	Zygophyllaceae	Sepan	Seeds, leaves	Promotes micturition and used as a remedy of fever
63	<i>Perovskia abrotanoides</i>	Lamiaceae	Iskiling	Leaves	Used in treatment of painful micturition
64	<i>Podophyllum hexandrum</i>	Berberidaceae	Ol-mose	Fruits	Remedy of fever
65	<i>Potentilla atosanguinea</i>	Rosaceae	Chisheng	Complete plant	Treat fever
66	<i>Picrorhiza kurrooa</i>	Scrophulariaceae	Hanglang	Roots	Promotes kidney function
67	<i>Rhodiola heterodonta</i>	Crassulaceae	Shro-lo dkar-po	Roots	Fresh or dried roots are used against cold, cough and fever
68	<i>Raphanus sativus</i> Linn.	Brassicaceae	Labook	Roots	Diuretic and removes kidney stone
69	<i>Rubia cordifolia</i>	Rubiaceae	bTsod	Roots	Used against all kinds of kidney and urinary disorders, soothing, and controls urine discharge, inflammation and bleeding in the kidney
70	<i>Rosa webbiana</i>	Rosaceae	Siah-marpo	Flower, fruits	The flowers and fruits are used in preparation of tablets against the remedy of fever due to food poisoning.
71	<i>Saussurea gnaphaloides</i>	Asteraceae	Yuliang	Complete plant	Promotes micturition
72	<i>Saussurea bracteate</i>	Asteraceae	Jar-bag	Flowers	Against cold and cough
73	<i>Saussurea lappa</i>	Asteraceae	Kuth	Roots	Treat cold, cough and fever
74	<i>Solanum nigrum</i> Linn.	Solanaceae	Tsigma	Fruits	Promotes micturition, Treat cold, cough and fever
75	<i>Swertia petiolate</i>	Gentianaceae	Tikta	Complete plant	Treat high fever
76	<i>Tagetes erecta</i> Linn.	Asteraceae	Kanglanyesher	Leaves	Promotes kidney function
77	<i>Taraxacum officinale</i>	Asteraceae	Yamngi	Roots	Promotes kidney function
78	<i>Thlaspi alpestre</i> Linn.	Brassicaceae	Bumbuk	Seeds	Used in treatment of painful micturition
79	<i>Tribulus terrestris</i> Linn.	Zygophyllaceae	gZe-ma	Fruits	Promotes kidney function
80	<i>Taraxacum officinale</i>	Asteraceae	Han	Complete plant	Cure chronic fever
81	<i>Urtica paviflora</i>	Urticaceae	dZaZut	Leaves	Promotes micturition
82	<i>Vitis vinifera</i> Linn.	Vitaceae	Gun	Fruits	Used in the removal of kidney stones
83	<i>Waldheimia stoliczkai</i>	Asteraceae	Solo nagpo	Complete plant	Treatment of cold, cough and fever
84	<i>Zea mays</i> Linn.	Poaceae	Manmeselotok	Inflorescence ash	Supports normal functioning of kidney



Medicinal value of *Lepidium latifolium*:

Lepidium latifolium has many medicinal properties. It is widely used as stomach tonics and diuretics (Navarro *et al.*, 1994). Navarro *et al.* (1994), reported that the aqueous extract of *Lepidium latifolium* leaves improved the urinary excretion among rats. The leaf extract had given in 100 and 50 mg/kg doses through oral route and intraperitoneal respectively. The standard suggested dose for *Lepidium latifolium* for man was 3 to 5 gm/day in the form of tea (Navarro *et al.*, 1994). Some reports also suggested that the perennial pepperweed is also used in the treatment of hypertension and it has a property of anti-hypertensive (Tabassum and Ahmad, 2011). Conde-Rioll *et al.* (2018), determined that the leaf extract of *Lepidium latifolium* showed antitumor activity against HT-29, a cultured human colon cancer cell line.

mitochondrial dehydrogenase inhibition activity of HCC (human hepatocellular carcinoma) cells (Hanschen *et al.*, 2015). *Lepidium latifolium* leaves extracts also comprises many natural antioxidants. These antioxidants act as reducing agents, chelating agents, free radical scavengers and antioxidative defense enzyme systems activator which suppress the ion damages in biological systems (Kaur *et al.*, 2013). *Lepidium latifolium* ethanolic leaf extract also comprises many natural antioxidants which show free radical sifting activity. These compounds are Kaemferol-3-O-robinoside-7-O-(2''''- (E)-feruloyl)-sophoroside, Quercetin-3-O-β-D-sophoroside-7-O-α-L-rhamnoside, Kaempferol-7-O-α-L-rhamnopyranoside and Apetalumoside B6 (Xiang *et al.*, 2018). *Lepidium latifolium* also uses traditionally against kidney related diseases and renal lithiasis (Tabassum and Ahmad, 2011). This plant also show activities against prostatic hyperplasia (Lisciani *et al.*, 1984).

Mechanism of light adaptation in *Lepidium latifolium*:

Lepidium latifolium plant grows in harsh environment. Temperature is less than -20°C during night which shows its biochemical adaptation. Several studies have been started to connect its low temperature surviving ability with the low temperature regulated genes from the cold desert Ladakh (Aslam *et al.*, 2009). Ahmed *et al.* (2010), demonstrated that seeds of *Lepidium latifolium* had not germinated in dark under saline and non-saline conditions. Whereas, Bhat *et al.* (2016), study revealed that *L. latifolium* has high capability of physiological plasticity which allows it to grow in high altitude area of Ladakh? It comprises light dependent regulation of xanthophyll conversion, responses of antioxidants to environmental stresses and photosynthetic efficiency mechanism for high photosynthetic efficiency. They also found that there is no considerable photoinhibition in *Lepidium latifolium* in the resource limited conditions which suggest its adaptive potential. Francis and Warwick (2007), observed the germination response of *Lepidium latifolium* seeds against light, increasing salinity and reducing water potential. They found that seed germination was highest in light (30% after 14 days) environment and light/dark alternating environments. Seed germination was reduced to 4%

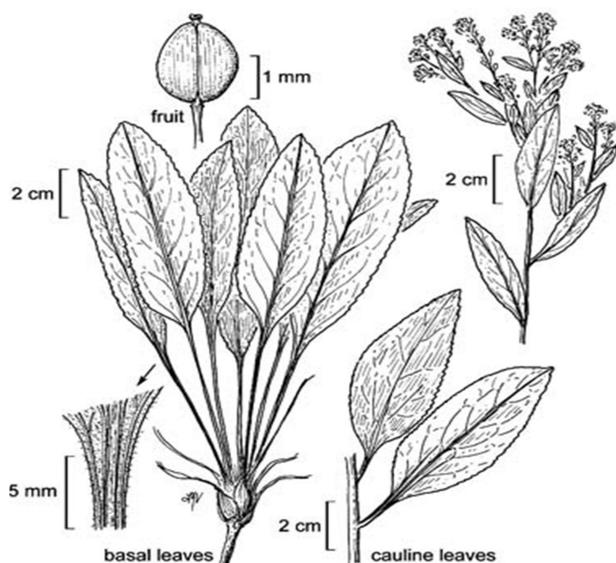


Figure1. *Lepidium latifolium*

This cell line was recognized to then CEPT (1-cyano-2,3-epithiopropene) compound that present in leaf extract. They also found that *Lepidium latifolium* juice also exhibits in vivo high antitumor activity against various cell lines (Conde-Rioll *et al.* 2018). But Hanschen *et al.* results did not find the apoptotic effects of CEPT against human cancer cell lines. However, they suggested that the antitumor activity should be attributed to



(for light/dark) and 16% (light), when seeds were exposed to salt stress. Sonnentag *et al.* (2011), suggested that the appropriate amount of light reached even to the lowest leaves of the *Lepidium latifolium* plant.

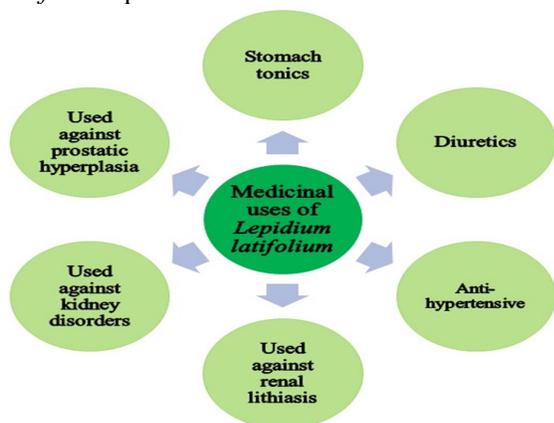


Figure2. Medicinal uses of *Lepidium latifolium*.

Conclusion

Several medicinal plants have grown in Ladakh area. Ladakh is mountainous region located in the Trans-Himalayan area. *Lepidium latifolium* (also known as Perennial pepperweed) is an invasive plant, mainly found in southern east Europe and western Asia. It belongs to the family Brassicaceae and *Lepidium* genera have more than 150 species. It is also found in the mountainous region of Ladakh area in India. Traditional herbalists used *Lepidium latifolium* in the treatment of many diseases. It is widely used as vegetable and in salads in cold desert Ladakh. It has numerous medicinal properties and used in the treatment of many diseases. *Lepidium latifolium* is mainly used as stomach tonics and diuretic. It is also used in kidney related diseases. At some places, it is also used in the treatment of hypertension and prostatic hyperplasia. Many studies reported the diuretic activity of *Lepidium latifolium*. Navarro *et al.* study also revealed the standard dose for human of *Lepidium latifolium* leaves was 3 to 5 gm/day in the form of tea for improved urinary excretion. *Lepidium latifolium* leaves extract and juices also exhibit the anti-tumor activities. It grows in very low temperature of Ladakh. Many studies revealed that the *Lepidium latifolium* has high capability of physiological plasticity due to which it grows in the high altitude and low temperature region of Ladakh. It can be concluded that *Lepidium*

latifolium has several medicinal uses against many diseases and it is tolerant to extreme temperature and light conditions due to which it can grow in Ladakh area.

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