International Journal of Science, Environment and Technology, Vol. 9, No 2, 2020, 239 – 253

ISSN 2278-3687 (O)
2277-663X (P)

MEDICINAL PLANTS OF THE TRANS- HIMALAYAN COLD DESERT OF LADAKH – A REVIEW

Astha Chauhan, Vaneet Jishtu, Leena Thakur and Tsering Dolma
Forest Ecology and Climate Change Division, Himalayan Forest Research Institute, Shimla, Himachal Pradesh, INDIA
E-mail: asthachauhan92@gmail.com (*Corresponding Author*)

Abstract: Since time immemorial, plants as medicine have been playing a vital role in the development of virtually all civilization, across the globe. These medicinal plants have been regarded as rich resources of traditional medicines, being used as natural aphrodisiacs, to aid other health disorders, add flavour, and conserve food besides, preventing various kinds of disease and epidemics. The medicinal plant wealth from the cold desert of Ladakh has been the mainstay of healthcare in this remote landscape of the Trans Himalaya. The traditional, ***amchi*** system of medicine or the Tibetan medicine system is prevalent in Ladakh and neighbouring areas. This system reveals great amount of traditional knowledge and much scope of consigning novel bio-molecular research. In recent years there has also been a surge in the usage of herbal medicine for healthcare and wellness across the globe. The medicinal flora of Ladakh is facing threats in terms of habitat destruction, unscientific harvest/exploitation of native plants, increased tourism as well as natural disasters. Therefore, it warrants research in the same field and to come up with strategies to propose conservation plans and sustainable utilization practices. Not much work is reported from the cold deserts of Ladakh; however, owing to the current threats faced by the regional flora much current research is obligatory. In this review we have provided a general overview of the medicinal plants of the cold desert of Ladakh- focussing on their diversity, uses and conservation.
Keywords: Trans-Himalaya, medicinal plants, traditional knowledge, *amchi*, conservation.

1. INTRODUCTION

Cold deserts commonly found in the Antarctic, Greenland, Asia and the Nearctic realm, are marked by extreme winters and short, moderately warm summers (Saxena *et al*., 2011). High mountain ranges namely the Karakoram and Zanskar anatomises the cold deserts (Negi, 1995). The major part under cold desert across the world is located in the Asian continent, comprising the Gobi desert (northern part of China and southern Mangolia), Iranian desert (Iran and parts of Afghanistan and Pakistan), Takla Makan desert (western part of China), Turkestan desert (part of the Middle East and South western Russia) and the trans-Himalayan desert (parts of Afghanistan, Pakistan, India and China). The region between the great Central Himalayas and the mountains bordering Tibetan plateau is often referred to as

*Received Mar 20, 2020 * Published April 2, 2020 * www.ijset.net*

the "Dust Bowl of India" (Jishtu *et al*., 2003). Ladakh, the newly formed union territory from Jammu and Kashmir, Lahaul-Spiti district as well as upper Kinnaur in Himachal Pradesh account for over more than 90% area of the cold desert in India whereas the rest abiding 10% area falls in the states of Uttarakhand and Sikkim (Saxena *et al*., 2011).

Cold desert is now the 16th Biosphere Reserve of India, comprising about 7,770 km area, including Pin Valley National Park and Kibber Wildlife Sanctuary in Spiti valley (Srivastava, 2010 and Devi *et al*., 2013). Earliest records of flora of Ladakh and western Tibet have been compiled by Stewart in 1916-17 (831 species in 66 families). Later, Kachroo *et al*., in 1977 described a total of 611 plant species from Ladakh, of which 540 are dicotyledons, 65 monocotyledons and 2 gymnosperms. For a long time, the high-altitude cold desert of the Himalaya has remained secluded and politically closed, mainly because of its unapproachable location (Chandra, 2006) and its strategic border positioning from Pakistan and Tibet - China. The floral elements of the cold desert region bear congruence to those from Afghanistan, Siberia and Tibet. The Indian cold desert flora is sparse, dominated by a few dwarf bushes. Tree line is more or less absent in this zone, however, annual and perennial herbs followed by stunted shrubs and bushes dominate the flora which counts more than 750 plant species (Chaurasia *et al*., 2007); 65 monocots and two gymnosperms (Kachroo *et al*., 1977). The dominant families of the cold desert region are Asteraceae, Brassicaceae, Fabaceae, Graminae, Ranunculaceae, Lamiaceae etc (Jafri, 1973; Aswal and Mehrotra, 1994; Klimeš and Dickoré, 2005; Kumar *et al*., 2011; Srivastava and Shukla, 2015). In general, the flora of Ladakh comes under alpine and high alpine zones and differs remarkably from the rest of the Himalayas due to existing unique physiographic and climatic conditions.

Growth of the herbal based healthcare and wellness sector across the world, including India is putting a high demand on the medicinal plant resources, both wild and cultivated. Total commercial demand of herbal raw drugs for the year 2014-15 was estimated at 5, 12,000 metric tonne and expected to grow to 6, 50,000 MT by 2020 (Goraya and Ved, 2017). Further, the global wellness institute sponsored study in September 2014, had valued the 2013 global wellness economy at US $ 3.4 trillion (Bodeker, 2015). This growth, however is putting a high demand on the medicinal plants in the wild, giving rise to concerns about the sustainability of this important but limited resource.

2. GEOGRAPHICAL EXTENT

Ladakh, which means 'the land of high rising passes', in the local Ladakhi language, is a newly formed Union territory separated from the state of Jammu and Kashmir, India (32° 15'-

36° N; 75° 15'-80° 15'E). The current area of Ladakh is nearly 59,146 km^2 with an average elevation ranging between 2700 to 4200 m (Negi, 1995). Towards the north it is bounded by the eastern range of the Karakoram Mountains, to the south by the western extreme of the main Himalaya, and the Tibetan plateau to the north eastern uplands of Ladakh. The altitude, in general, ranges from 3,000 m in the lower Indus and Nubra valleys to 7,600 m in Zanskar and Karakoram ranges (Rizvi, 1983). Siachen, the largest glacier, is located in the extreme northwest of Ladakh. The world's highest motor able road runs along Khardung-La which is at an elevation of 5,600 m, linking the Nubra valley with Leh. Eastern Ladakh, beyond Taglang-La, forms an extensive plateau, known as the Changthang plateau, an extension of the vast Tibetan plateau, home to the Changpa nomads. Two of the ten major bio-geographical zones of the Indian subcontinent stretch along the trans-Himalayan and main Himalayan ranges (Rodgers and Panwar, 1988).

3. MEDICINAL PLANTS FOUND IN THE COLD DESERT OF LADAKH

The Indian Himalayan Region (IHR) is well known for its diversity of medicinal plants (Jain, 1991; Samant *et al*., 1998, 2001, 2007). The earliest use of plants has been documented in primitive Hindu scriptures like Rigveda (4500–1600 BC), Charaka Samhita (1000–800 BC), Sushruta Samhita (800–700 BC), and others (Rana *et al*., 2014). The cold desert of India is known for specific topography, severe climate and unique vegetation (Singh *et al*., 2009), harbouring unique plants of medicinal value. Numerous studies on floral diversity of Ladakh enlist six habitat communities, namely *Ephedra - Artemisia, Poa annua - Ranunculus hirtellus - Pedicularis oederi, Caragana brevifolia - Cotoneaster, Hippophae rahmnoides - Myricaria germanica, Artemisia- Salsola collina - Kraschenennikovia ceratoides, Agropyron – Trisetum – Oryzopsis - Carex* (Kala and Jayapal, 1999; Mani, 1978; Kala and Mathur, 2002; Joshi *et al*., 2006; Kumar *et al*., 2011). The flora of the cold desert is mainly represented by xerophytic, mesophytic and oiastic vegetation however the snowline flora is mainly that of herbaceous xerophytic elements (Kumar *et al*., 2011). A large number of studies have been carried out on medicinal plants of the North West Himalaya (Jain 1991; Samant *et al*., 1998, 2001, 2007b; Rai *et al*., 2000; Samant and Pal 2003; Kala 2006). The medicinal plants in dry areas is mostly dominated by *Ephedra gerardiana, Chenopodium botrys, Echinops cornigerus, Nepeta eriostachya, Oxytropis microphylla, Tanacetum gracile and Arnebia euchroma* (Kala, 2006). A total of 354 medicinal plants, belonging to 208 genera and 76 families have been recorded from the region (Singh *et al*., 2009). Recently, a research paper documented 67 plant species from 59 genera and 36 families along with their

medicinal and traditional utility (Rana *et al*., 2014). It has been recorded, that vegetative growth initiates with the outbreak of summer, and as the snow melts it provides sufficient moisture to allow the plants to germinate and further flourish (Chaurasia and Singh 1996). Defence Institute of High Altitude Research (DIHAR) also carried out extensive ethno-botanical surveys of various regions of Ladakh and collected 425 plant species used by *amchis*. Ballabh and Chaurasia, 2009 described 57 plant species from 24 families, utilised by the Buddhist tribal community of Ladakh in curing stomach disorders. Gurmet and Stobgais, 2016 compiled nearly 162 plant species of Ladakh, which are used in the *Sowa-Rigpa* system of Tibetan medicine; the prominent ones being *Artemisia annua, Thermopsis barbata, Rheum emodi, Clematis tibetana, Juniperus indica, Rhodiola tibetica* and *Angelica glauca*.

Kala, 2006 investigated a total of 335 medicinal plant species from the Indian trans-Himalaya which are used by the traditional healers for curing various ailments. Blaikie, 2009 defined the practice of '*sman jor*' which means that medicine production is an indispensable part of their medical tradition and identity. Winnnie in 1999 enlisted *Lycium ruthenicum,* locally called 'Khizer' as a valuable medicinal plant from the region. The fruits being locally used to cure early-onset of diabetes, anaemia, vision problems, impotency and lung disorders. Samant *et al*. in 2003 has used the tool of participatory rural appraisal (PRA) to collect information on the medicinal plants. The information on various medicinal plants was compiled followed by its analysis in reference to the utilization patterns following Samant *et al*., in 2002. Chaurasia *et al.* in 2008 have compiled about 266 plant species of flora of Ladakh with their ethnobotanical importance and conservation status. Kaul, 2010 enumerated 6 modern drugs obtained from traditional plants of Kashmir and Ladakh namely *Artemisia annua, Atropa belladonna, Colchicum luteum, Digitalis lanata, Ephedra gerardiana* and *Hyoscyamus niger* along with their therapeutic claim. Nabi *et al*. (2017) reviewed 21 species of medicinal plants for their therapeutic uses, which included *Achyranthes aspera*, *Aconitum heterophyllum*, *Ephedra gerardiana*, *Juniperus communis* and *Rheum emodi*.

4. TRADE IN MEDICINAL PLANTS

The Himalayan region covers approximately 10% of India's total land surface and nurtures 18,440 species of the flora (Singh and Hajra, 1996) out of which 1750 species have medicinal importance (Samant *et al*., 1998). Nearly 80% of the people in developing countries are dependent on traditional medicines for basic health care needs (Farnsworth *et al*., 1985). The global market for the medicinal plants and herbal medicine earns revenue approximating to be worth US$800 billion a year (Rajasekharan and Ganeshan, 2002). India is among the

paramount countries in Asia in terms of the wealth of traditional knowledge systems related to herbal medicine and utilises a large number of plant species include Ayurveda (2000), Siddha (1121), Unani (751) and Tibetian (337) (Kumar *et al*., 2011).

The traditional Ladakh healthcare, the *Amchi* Medical system fosters about 60% of public health of Ladakh (Chaurasia and Singh, 1996; Kala, 2005). It has been perceived that medicinal plants of the trans-Himalayan offer upper hand in having much greater possibilities of bequeathing novel bio-molecules considering the stressed environment (Mani, 1994). Medicinal plants offer auxiliary remedies with enormous opportunities to create revenue in the form of income, employment and foreign exchange especially for developing countries (Rawat and Uniyal, 2004). Amidst 350,000 plant species identified so far, circa 35,000 are used universally for medicinal purposes and less than about 0.5 % of these have been chemically probed (Comer and Debus, 1996). Goraya and Ved in 2017 have mentioned nearly 36 medicinal plants from the Himalaya including Ladakh being in high annual trade which includes 15 Red Listed species; out of these, 8 species are found in Ladakh. Besides, in another list they have mentioned 24 Red Listed plant species in lesser trade out of which 9 are found thriving in Ladakh (Table 1.)

Table 1. Traded medicinal plants requiring priority management

S.No.	**Species**	**Threat status**
Medicinal plant species in high trade needing priority management		
1.	*Aconitum heterophyllum*	CR
2.	*Arnebia benthamii*	CR
3.	*Betula utilis*	CR
4.	*Ephedra gerardiana*	EN
5.	*Hyoscyamus niger*	EN
6.	*Juniperus communis*	-
7.	*Picrorhiza kurroa*	-
8.	*Rheum australe*	EN
Red-listed medicinal plants in lesser trade requiring priority management		
1.	*Arnebia euchroma*	CR
2.	*Bunium persicum*	EN
3.	*Dactylorhiza hatagirea*	CR
4.	*Juniperus polycarpos*	EN

5.	*Jurinea dolomiaea*	EN
6.	*Meconopsis aculeata*	EN
7.	*Podophyllum hexandrum*	CR
8.	*Rheum moorcroftianum*	EN
9.	*Saussurea obvallata*	CR

CR- Critically endangered; EN-Endangered (Goraya and Ved, 2017)

5. AMCHI SYSTEM OF MEDICINE

Amchis being the practitioners of this ethno-medical system have enjoyed high respect and social status among the trans-Himalayan Buddhist communities. With the spread of Buddhism in the trans-Himalayan region, Ayurveda began to influence the Tibetan medical system. Popularly known as the *Amchi* system or the Tibetan medicine is known as Sowa-Rigpa which is the traditional medicine system of the trans- Himalayan regions. It is one of the oldest sustaining well documented scholarly medical traditions of the world dating back 2500 years. There is a teeming indigenous medical knowledge with various traditional *amchis*, which has been conferred by word of mouth from one generation to the next and not yet documented (Kala, 2005). The meaning of *amchi* is self-explanatory in the Buddhist language; it means 'superior to all'. If we follow the tradition, the *amchis* were essentially farmers while medical practice was their secondary occupation. Initially they used to provide their services free of cost, nevertheless in return one member of every family in the village used to help the *amchis* with the planting and harvesting of agricultural crops (Kala, 2005). There are nearly 250 reported *Amchis* in Ladakh and an estimated 500 plant species are reported to be used by them in the practice of Sowa Rigpa (Goraya and Ved, 2017). In a study conducted by Kala (2005) a total of 337 plant species, 38 species of animals and 6 minerals were documented which are being used in this medicine system. The same study explains that the Tibetan system of medicine is diminishing in the study area due to switch in socio-economic patterns and hesitance of the younger generation to embrace *amchi* as a profession (Kala, 2005). During the pre- Buddhist era various forms of medical practices had prevailed in the trans-Himalayas such as Ihaba (shaman) and Onpo (astrologer). *Amchis* being saintly people had received high consideration and respect. Tibetan Medicine Buddha (*Sangyas Smala*) is believed to be one of the many incarnations of Buddha. The original teachings of ancient Tibetan Medicine System (TMS) are generally attributed to the Buddha who is believed to have taught the roots of this tradition of Medicine Buddha (Kala, 2002). It

is also said that the term 'Buddha' was established to refer the medical practice being done by the *amchis* as Medicine Buddha (Kala, 2005). Plant material is the major ingredient in *Amchi* medicine, together with some animal products, minerals and salts. With the passage of time, the *amchis* under the ascendancy of the Buddhism probably have over obliterated the forms of medical treatments, as Buddhism is majorly prevalent in the region.

Moderately, *amchis* also began to sell their knowledge and medicines as the monetary market crept in. A survey by Kala (2005) indicated that in Ladakh the *amchis* catered to 60% of public health. Even today, a major part of the population relies on this practice, especially the far flung villages, where the public health system is hardly visible. Here the maximum centralization of *amchis* (55%) was found along the Indus valley, followed by Changthang plateau (19%) and Nubra valley (12%). The Tibetan medical system in Ladakh was different from that of Lahaul-Spiti in the sense that it was organized in terms of its social institutions ranging across the region. A survey revealed that six minerals and organs of 38 species of animals were documented which were used by the *amchis*. However, the wild plants constitute the main ingredients of Tibetan medicine and barely 200 drugs out of 2000 are that of animal origin (Chaurasia and Singh, 1996).

6. THREATS ASSOCIATED WITH THESE MEDICINAL PLANTS

The higher Himalayas are deprived of richness in tree species although rich in the native and endemic biodiversity. (Dhar *et al*., 1999).The major threats to this habitat includes its unique topography, physical features and harsh climatic conditions which have resulted into drastic decline of various taxa represented in the ecosystem (Kala, 2000; Porwal *et al*., 2003; Uniyal *et al*., 2003; Singh *et al*., 2008; Srivastava, 2010; Srivastava and Shukla, 2013, 2015). The reason for the dwindling population of the medicinal plants of Ladakh region is due to their unscientific extraction, developmental activities, over grazing and various natural disasters (Dar *et al*., 2006), leading to habitat destruction. If the current scenario of over utilization of the medicinal plants and their various parts continues, the number of species will reduce, eventually vanishing from their natural habitats. This is more so in context to the medicinal plants having multiple uses (Samant *et al*., 1998; Samant and Pal 2003). A study documented approximately 337 medicinal plants from the Indian trans – Himalayas, of which 45 species are placed in different threat categories according to the Red Data Book of Indian Plants, CAMP (Conservation Assessment and Management Plan) workshops and other existing literature (Nyar *et al*., 1987; Ved and Tandon, 1998; Kala, 2005). Out of these threatened plants, approximately 20 plants belong to the cold desert landscape of Ladakh (Table 2.).

Dactylorhiza hatagirea, Picrorhiza kurrooa, Rheum webbianum, R. moorcroftianum, Aconitum heterophyllum and *A. violaceum* are among a few species which have become endangered across the Himalayan as well as the trans-Himalayan region as a result of over-collection/harvest (Kala, 1998; Kala, 2005a; Uniyal *et al*., 2006). When we talk about the increase in the number of threatened plants from Ladakh in recent times, small scale medicine production pertaining to Sowa Rigpa has also become 'critically endangered' (Blaikie, 2009).

Table 2. Red list status of candidate species as per Shimla CAMP, December 2010.

S.No.	Botanical name	Habit	% of global population	Global Status	Previous status (Shimla CAMP, 2003
1.	*Aconitum heterophyllum*	H	Approx 60	CR	CR
2.	*Dactylorhiza hatagirea*	H	40-50		CR
3.	*Jurinea dolomiaea*	H	40		EN
4.	*Picrorhiza kurroa*	H	30		EN
5.	*Arnebia benthamii*	H	50-60	EN	CR
6.	*Arnebia euchroma*	H	50	EN	CR
7.	*Betula utilis*	T	20-25		EN
8.	*Podophyllum hexandrum*	H	20-25		EN
9.	*Rheum moorcroftianum*	H	50		EN
10.	*Saussurea obvallata*	H	30		CR
11.	*Aconitum violaceum*	H	50	VU	VU
12.	*Allium consanguineum*	H	75-80	VU	VU
13.	*Ephedra gerardiana*	S	20		EN
14.	*Juniperus communis*	S	10-20		
15.	*Rheum australe*	H	30-40		EN
16.	*Rheum webbianum*	H	50-60	VU	VU
17.	*Hyoscyamus niger*	H	20		EN
18.	*Hyssopus officinalis*	H	30		VU
19.	*Onosma hispidum*	H	40-50		
20.	*Rheum spiciforme*	H	30-40		VU

Ved *et al*., 1998 and Ved *et al*., 2003

7. CONCLUSION

The medicinal plants and the traditions associated with them still persist among the local

people or the ethnic communities of the Indian Himalayan Region (Kala, 2005). These traditional medicine systems also play a vital role in the day to day health care of tribal communities. A majority of the species are being used to cure common gastrointestinal ailments like indigestion, stomach-ache, gastric problems, food poisoning, constipation, diarrhoea, dysentery, etc., which is in agreement with the previous works from the cold deserts (Sood *et al*., 2001; Ballabh and Chaurasia, 2009). Such learning is of utmost importance and of much use to pharmaceuticals point of view which would further dispense baseline information for future research as well as management of the biological resources. Nonetheless, troubles such as overexploitation, habitat destruction, overgrazing, increasing tourism, environmental degradation and unsustainable utilization of scarce and high valued medicinal plants from the wild are the major threat to their existence. As a consequence, *ex situ* conservation and sustainable utilization would prevent their permanent depletion from the area. Devi *et al*., 2013. Therefore, the development of agro techniques for commercially viable medicinal plants and their large-scale cultivation in farmers' fields are necessary for their conservation and to reduce pressures on natural habitats (Samant *et al*., 2007). There is lack of integrated and recent research available on this topic therefore, requires current and updated findings.

Moreover, in the face of the emerging threats of destructive harvesting, habitat destruction and bio piracy (Gadgil, 1996; Utarsh *et al*., 1999), it becomes imperative to document the valuable indigenous knowledge of medicinal plants. It is thus recommended that cultivation techniques be designed, especially for the important medicinal plant species that are used widely, to fulfil the need of the growing international herbal market along with strategies to conserve the threatened biodiversity (Rana *et al*., 2014; Goraya *et al.,* 2017). Unless the management and development by means of traditional and scientific practices is not done, the damage cannot be undone.

With regard to the medicinal plants of Ladakh, there is a promising future as most of the plants here have not been investigated for their medical activities and their hidden potential of medical activities could be vital in the treatment of present and future ailments.

References

[1] Aswal, B.S., Mehrotra, B.N. 1994. Flora of Lahaul-Spiti (A cold desert in North West Himalaya). Bishen Singh Mahendra Pal Singh, Dehradun India.

[2] Ballabh, B., Chaurasia, O.P. 2007. Traditional medicinal plants of cold desert Ladakh— used in treatment of cold, cough and fever. *J Ethnopharma*. **112**:341-349.

[3] Blaikie, C. 2009. Critically Endangered ? Medicinal Plant Cultivation and the Reconfiguration of Sowa Rigpa in Ladakh. Asian Medicine **5**:243-272.

[4] Bodekar, G. 2015. Herbs for wellness: key drivers in the new US$3.4 trillion global wellness industry. NWFP Update. Issue 6: Health & Well-being. FAO.

[5] Chandra, P.K. 2006. Medicinal plants of the high altitude cold desert in India: Diversity, distribution and traditional uses. *The International Journal of Biodiversity Science and Management*. **2**:1, 43-56.

[6] Chaurasia, O.P. and Singh, B. 1996. Cold Desert Plants Leh, India: Field Research Laboratory, DRDO.1-4.

[7] Chaursia, O.P. and Padma G., 2003. A checklist on Medicinal and Aromatic plants of Trans-Himalayan cold desert (Ladakh & Lahaul-Spiti) Field research Laboratory (DRDO) and Amchi Medicine Research unit (CCRAS) Leh-Ladakh.

[8] Chaurasia, O.P., Ahmed, Z, Ballabh, B. 2007. Ethnobotany and Plants of trans Himalaya, Satish Serial Publishing House, Delhi.

[9] Chaursia, O.P., Ahmed and Ballabh, 2007. Ethnobotany and plants of trans-Himalaya, Field research laboratory (DRDO) Leh Ladakh.

[10] Chaurasia, O.P., Khatoon, N and Singh, S.B. 2008. Field Guide: Plant Biodiversity of Ladakh. DIHAR, DRDO and WWF, Leh.

[11] Comer, M. and Debus, E. 1996. A partnership: Biotechnology, biopharmaceuticals and biodiversity. *In. Biodiversity. Science and development.* (Di Castri, F. and Younnes, T. eds.), CAB International, Oxford, 488-499.

[12] Dawa, 2009. A clear mirror of Tibetan medicinal plants vol-1&2, Materia Medica Depertment, Men-Tsee-Khang, Dharamshala H.P

[13] Dawa, S., Hussain, A. and Tamchos T. 2012. Medicinal and Aromatic Plants as a Viable Livelihood Option for the People of Jammu and Kashmir. Indian Horticulture Journal. **3**:1-2.

[14] Devi, U., M.K. Seth, M.K., Sharma, P., and J.C. Rana, J.C. 2013. Study on ethnomedicinal plants of Kibber Wildlife Sanctuary: A cold desert in Trans Himalaya, India**.** **7**(47):3400-3419.

[15] Dhar, U., Rawal, R.S, Samant, S.S, Airi, S, Upreti, J. 1999. People's participation in Himalayan biodiversity conservation: a practical approach. *Curr. Sci*., **76**:36-40.

[16] Dhar, P., Tayade1, A., Ballabh, B., Chaurasia, O.P., Bhatt, R.P. Srivastava, R.B. 2011. *Lycium ruthenicum* murray: A less-explored but high value medicinal plant from trans-

himalayan cold deserts of Ladakh, India *Plant Archives.* **11**(2):583-586.

[17] Farina, A. 1998. Principles and methods in landscape ecology. Chapman and Hall, London, UK.

[18] Farnsworth, N.R., Akelere, O., Bingel, Soejarto, D.D. and Guo, Z. 1985. Medicinal plants in therapy. Bull World Health Org., **63**:965-981.

[19] Gurmet, P. and Stobgais, T. 2016. A Handbook on Medicinal Plants of Himalayas Used in Sowa-Rigpa. National research institute for Sowa Rigpa.

[20] Gadgil, M. 1996. Documenting diversity: An experiment. *Curr Sci.* **70**(1):36-44.

[21] Goraya, G.S. and Ved, D.K. 2017. Medicinal Plants in India: An Assessment of Their Demand and Supply. National Medicinal Plants Board, Ministry of AYUSH, Government of India, New Delhi and Indian Council of Forestry Research and Education, Dehradun.

[22] Jafri, S.M.H. 1973: Brassicaceae. — In: Y.J Nasir & S.I. Ali (ed.), Flora of (West) Pakistan 55.

[23] Jain, S.K. 1991. Dictionary of Indian folk medicine and ethno botany. New Delhi (India): Deep Publications.

[24] Jishtu, V., Subramani, S.P., Kapoor, K.S. and Goraya, G.S. 2003. Medicinal Plants from the Cold Desert of North-West Himalayas. (Nautiyal, S. And Kaul, A.K. eds.). Non-Timber Forest Products of India. Jyoti Publication and Distributors 374, Mohit Nagar Dehra Dun-248006 India.

[25] Joshi, P.K, Rawat, G.S, Padilya, H. Ro, P.S. 2006. Biodiversity characterization in Nubra valley, Ladakh with special reference to plant resource conservation and bio prospecting. *Biodivers. Conserv.*

[26] Kachroo, P., Sapru, B.L., Dhar, U. 1977. Flora of Ladakh. Bishen Singh Mahendra Pal Singh, Dehradun.**15**:4253-4270.

[27] Kala, C.P., Jayapal, R. 1999. Community characterization of vegetation and birds of Ladakh: An autumn survey. Project report of WIIUSFWL. Wildlife Institute of India, Dehradun.

[28] Kala, C.P. 2000. Status and conservation of rare and endangered medicinal plant in the Indian trans-Himalaya. *Biol. Conserv.* **93**:371-379.

[29] Kala, C.P. 2002. Medicinal Plants of Indian trans-Himalaya (Focus on Tibetan use of Medicinal Resources). Dehradun, India: Bishen Singh Mahendra Pal Singh. 200

[30] Kala, C.P., Mathur, V. 2002. Patterns of plant species distribution in the trans-Himalayan region of Ladakh, India, *J. Veg. Sci*., **13**:751-754.

[31] Kala, C. P. 2005. Health traditions of Buddhist community and role of amchis in trans-Himalayan region of India. *Curr. Sci*. **89**:1331-1338.

[32] Kala, C.P. 2005a. Indigenous Uses, Population Density, and Conservation of Threatened Medicinal Plants in Protected Areas of the Indian Himalayas. *Conserv. Biol*. **19**(2):368–378.

[33] Kala, C.P. 2006. Medicinal plants of the high altitude cold desert in India: diversity, distribution and traditional uses. *Int J Biodivers Sci Manage*. **2**(1):43–56.

[34] Kala, C.P. 1998. Ecology and Conservation of Alpine Meadows in the Valley of Flowers National Park, Garhwal Himalaya. Ph.D. Thesis, Forest Research Institute, Dehradun, India; 180.

[35] Kaul, M.K. 1997. Medicinal plants of Kashmir and Ladakh, Temperate and cold arid Himalaya, Regional Research Laboratory (C.S.I.R) Jammu.

[36] Kaul, M.K. (2010). High altitude botanicals in integrative medicine case studies from Northwest Himalaya. *Indian Journal of Traditional Knowledge*. **9**(1):18-25

[37] Klimeš, L. and Bernhard, D.2005. A contribution to the vascular plant flora of Lower Ladakh (Jammu & Kashmir, India), Willdenowia 35(1), 125-153.

[38] Kumar, G.P., Kumar, R., Chaurasia, O.P. and Sing, S.B. 2011. Current status and potential prospects of medicinal plant sector in trans-Himalayan Ladakh. *Journal of Medicinal Plants Research.* vol. **5**(14), pp. 2929-2940.

[39] Kumar, G.P., Kumar, R. and Chaurasia, O. P. 2011. Conservation Status of Medicinal Plants in Ladakh: Cold Arid Zone of Trans- Himalayas. Research Journal of Medicinal Plant **5**(6): 685-894.

[40] Kunez A. 2012. Etho-Medico Botany of Western Ladakh with respect to Sowa-Rigpa, Articles on 2nd International conference on Tibetan medicine, Dharamshalsa H.P

[41] Mani, M.S. 1994. High-Altitudes of the Himalaya (eds Pangtey, Y. P. S. and Rawal, R. S.), Gyanodaya Prakashan, Nainital. 1-10.

[42] Nabi, S., Rather, S.A., Nabi, B. and Qaisar, K.N. 2017. Botanicals and their use with special reference to J&K. International Journal of Science, Environment and Technology. **6**:3174-3180.

[43] Nautiyal, S. and Kaul, A.K. 2003. Non-Timber Forest Products of India. Jyoti Publication and Distributors 374, Mohit Nagar Dehra Dun-248006 India

[44] Nayar, M. P. and Sastry, A. R. K., *Red Data Book of Indian Plants*, Botanical Survey of India, 1987.

[45] Negi, S.S. 1995. Cold Deserts of India. Indus Publishing Company FS-5, Tagore

Garden, New Delhi.

[46] Porwal, M.C., Sharma, L. And Roy, P.S. 2003. Stratification and mapping of *Ephedra gerardiana* Wall. in Poh (Lahaul and Spiti) using Remote sensing and GIS. *Curr. Sci.* **84**: 208-212.

[47] Rai, L.K., Prasad, P., Sharma, E. 2000. Conservation threats to some important medicinal plants of the Sikkim Himalaya. *Biol Conserv*. **93**:27–33.

[48] Rajasekharan, P.E. and Ganeshan, S. 2002. Conservation of medicinal plant biodiversity in Indian perspective. *J. Med. Arom. Pt. Sci*. **24**:132-147.

[49] Rana, K.R., Kumar, P. Singhal, V.K., Rana, J.C. 2014. Uses of Local Plant Biodiversity among the Tribal Communities of Pangi Valley of District Chamba in Cold Desert Himalaya, India. Hindawi Publishing Corporation Scientific World Journal.

[50] Rawat, R.B.S., Uniyal, R.C. 2004. National Medicinal Plants Board, Committed for overall development of the sector. *Agrobios*. **1**:12-17.

[51] Rodgers, W.A., Panwar, H.S 1988. Bio geographical Classifications of India, Wildlife Institute of India, Dehradun.

[52] Samant, S.S., Dhar, U., Palni, L.M.S. 1998. Medicinal Plants of Indian Himalaya: Diversity Distribution Potential Values. Gyanodaya Prakashan, Nainital.

[53] Samant, S.S., Dhar, U., Palni, L.M.S. 2001. Himalayan medicinal plants: potential and prospects. Nainital (India): Gyanodaya Prakashan.

[54] Samant, S.S., Joshi, H.C., Arya, S.C., Pant, S. 2002. Studies on the structure, composition and changes of the vegetation in Nanda Devi Biosphere Reserve of West Himalaya. Final Technical Report submitted to Ministry of Environment and Forests; New Delhi, India.

[55] Samant, S.S., Pal, M. 2003. Diversity and conservation status of medicinal plants in Uttaranchal State. *Indian For*. **129**(9):1090–1108.

[56] Samant, S.S., Joshi, H.C., Arya, S.C., Pant, S. 2003. Planning for the conservation and management of natural resources using participatory approach: a case study from Pindari area of Nanda Devi Biosphere Reserve, West Himalaya, India. Van Vigyan. **38**(1–4):41–54.

[57] Samant, Pant, S., Singh, M., Lal, M., Singh, A. Sharma, A., and Bhandari, S. 2007. Medicinal plants in Himachal Pradesh, north western Himalaya, India. *The International Journal of Biodiversity Science and Management*, **3**:4, 234-251.

[58] Samant S.S., Butola JS, Sharma A. 2007b. Assessment of diversity, distribution, conservation status and preparation of management plan for medicinal plants in the

catchment area of Parbati Hydroelectric Project Stage – III in North western Himalaya. *J Mt Sci*. **4**(1):34–56.

[59] Saxena, K.G., Liang, L., and Xue, X. (eds) 2011. Global Change, Biodiversity and Livelihoods in Cold Desert Region of Asia. Bishen Singh Mahendra Pal Singh, New Connaught Place, Dehra Dun 248 001. 322

[60] Singh, D.K., Hajra, K. 1996. Floristic diversity. In: G.S. Gujral and V. Sharma (eds.), Changing Perspectives of biodiversity status in the Himalayas. British Counsel Division, New Delhi. 23-38.

[61] Singh, K.N., Gopichand, Kumar, A. and Lal, B. 2008. Species diversity and population status of threatened plants in different landscape elements of the Rohtang Pass, Western Himalaya. *J. Mt. Sci*. **5**:73-83.

[62] Singh, A., Lal, M and Samant, S.S. 2009. Diversity, indigenous uses and conservation prioritization of medicinal plants in Lahaul valley, proposed Cold Desert Biosphere Reserve, India. *International Journal of Biodiversity Science & Management*. **5** (3):132–154.

[63] Sood, S.K., Nath, R., Kalia, D.C. 2001. Ethnobotany of cold desert tribes of Lahaul-Spiti (N.W. Himalaya). Deep Publications, New Delhi.

[64] Srivastava, S.K. and Shukla, A.N. 2010. Ladakh ki pramukh upyogi ausadhiya vanaspatiyna, **19**:106-111.

[65] Srivastava, S.K. and Shukla, A.N. 2013. Impact of tourism on the flora of Chandertal lake-An alpine Ramsar site of the Himalaya in "International Conference on Climate Change and the Himalayas: Current status and future perspective (ICCCH-2013)" held at CSIR-NISCAIR, 16-17.

[66] Srivastava, S.K. and Shukla, A.N. 2015. Flora of Cold Desert Western Himalaya, India. Government of India, Botanical Survey of India. **2**:4-5.

[67] Stewart, R.R. 1916-1917. The flora of Ladakh, Western Tibet. Ph.D. Thesis, Columbia University.

[68] Tsering, D.D. 2008. A handbook of Tibetan medicinal plants, Tibetan medical and astrological institute (Men-Tsee-Khang), Dharamshala, H.P.

[69] Uniyal, S.K., Awasthi, A. and Rawat, G.S. 2003. Is the future of Eurotia ceratoides safe in Changthang? *Curr. Sci.* **85**:1395.

[70] Uniyal, S.K., Kumar, A., Lal, B. and Singh, R.D. 2006. Quantitative assessment and traditional uses of high valve medicinal plants in Chhota Bhangal Area of Himachal Pradesh, Western Himalaya. *Curr. Sci.* **91**:1238-1242

[71] Utarsh, G.M., Gadgil, M.., Rao, P.R.S. 1999. Intellectual property biological resources: Benefiting from Biodiversity and peoples knowledge. *Curr. Sci*. **77**(11):1418.

[72] Ved, D. K. and Tandon, V. 1998. Report for High altitude medicinal plants of Jammu–Kashmir and Himachal Pradesh. Foundation for Revitalization of Local Health Traditions, Bangalore.

[73] Ved, D.K., Mudappa, A. and Shankar, D. 1998. Regulating export of endangered medicinal species-need for scientific rigour. Current Science **75** (4), 341-344.

[74] Ved, D.K., Kinhal G.A., Ravikumar K., Prabhakaran V., Ghate U., Sankar R.V. and Indresha, J.H. 2003. CAMP Workshop Report: Conservation Assessment and Management Prioritisation for the Medicinal Plants of J & K, H.P. & Uttaranchal, Shimla, H.P., FRLHT, Bangalore, India. 206.

[75] Wylie, T. 1959. 'A Standard System of Tibetan Transcription', *Harvard Journal of Asiatic Studies* **22**:261–67.