

Medicinal plant resources in Skuru watershed of Karakoram wildlife sanctuary and their uses in traditional medicines system of Ladakh, India

Abstract

Background: The objectives of the present study were to document the medicinal plant resources of Skuru watershed in Karakoram Wildlife Sanctuary and their uses in traditional medicines system (Amchi) of Ladakh. Amchi system of medicines is a complementary medicines system in Ladakh. The medicinal plants were collected in the summer season of 2015 and 2016. These medicinal plants were identified at H.N.B. Garhwal University Herbarium and from some published literature. During these surveys, 73 plant species belonging to 31 families were recorded. It was also found that maximum plant species were being in use for ailments related to digestive system, followed by musculoskeletal, respiratory system, skin, cardiovascular system and blood, and nervous system. Among the plant parts used, leaves were in maximum use for herbal medicines preparations followed by whole plants, flowers, shoot, roots, stem, seeds, fruits, bulbs, bark, rhizomes and tuber.

Keywords: amchi, leh ladakh, medicinal plants, traditional knowledge

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Introduction

India is considered as one of the leading countries in the world regarding the wealth of traditional knowledge systems for the use of plant species. The country is blessed with the rich and diverse heritage of traditional medicinal systems like Ayurveda, Siddha, Unani and Sowa-Rigpa. Sowa-Rigpa is also known as Tibetan medicine system in Western countries. It is one of the oldest/ancient surviving and thoroughly documented medical traditions/wisdom of the world. It has been widely practiced in Himalayan regions of India, Tibet, Bhutan, Mongolia, Nepal, some parts of China, and few parts of Soviet Union. In India, this traditional medicines system is practiced in the Ladakh region of Jammu and Kashmir, Lahoul and Spiti (Himachal Pradesh), Sikkim, Darjeeling (West Bengal) and Arunachal Pradesh.¹ In Ladakh, Sowa-Rigpa is also known as Amchi medicine system. Most of the population in Ladakh is Buddhist and they depend on the Amchi system of medicine, which has been in vogue for a long time and widely in practice. It offers fascinating knowledge of the ancient medicinal system.² Medicinal plants of this region can open opportunities for economic growth in the rising global market. It has been understood further, medicinal plants of the trans-Himalaya, offer the favorable position in having considerably more prominent potential outcomes of giving novel bio-molecules in perspective of the natural pressure.³ These medicinal plant resources offer alternative remedies along with great opportunities for the generation of employment, income and foreign exchange for developing nations.⁴

Ladakh is situated in the extreme altitude of the Trans-Himalayan region of India, which lies between latitude 31°44'57"–32°59'57"N and longitude 76°46'29"–78°41'34"E and covers an area of more than 65,000km².⁵ Ladakh is comprised of two districts, namely Leh and Kargil in the Jammu and Kashmir state of India. More than, 1,180 vascular plant taxa were recorded by Klimeš and Dickoré⁶ through systematic floristic survey in these regions;⁶ this number is considerably higher than those reported by Kachroo et al.,⁷ 611 species and 880 species by Kachroo⁸ in previously published volumes

of flora of the area.^{7,8} The vegetation of Ladakh is in the range of 2,700m to 6,000m a.s.l. altitude and comes under alpine to high alpine zone. Physiographically, Ladakh can be divided into five valleys - Leh, Nubra, Changthang, Zaskar and Suru. Ethno-floral studies for traditional medicines in Ladakh have been carried out by many authors like Gurmet,¹ Butth and Navchoo,² Angmo et al.,⁹ Angmo et al.,¹⁰ Abrol Chopra,¹¹ Stewart,¹² Namgyal and Phuntsog,¹³ Singh et al.,¹⁴ Kala,^{15–17} Ballabh and Chaurasia,^{18–20} Kumar et al.,²¹ Rinchen and Pant.²² However, very few researchers like Kumar et al.,²³ and Pal et al.,²⁴ have focused on Ethno-floral studies with special reference to Nubra valley.^{23,24}

There is no information available on the public domain regarding the medicinal plants from Skuru watershed till date. This watershed has rich medicinal plants resources. The pressure of tourism activities is already high on the fragile ecosystem of Ladakh, but this study area is still not affected considerably. The Rakuru village can only be reached by nearly 18km trek. Tourists were not allowed to visit beyond Hunder village (20km from the nearest survey site) till recently due to security reasons, as these villages are close to the border of Pakistan. The area is now open for trekking, but very few trekkers cross the area. In near future, the number of trekkers in this area likely to increase, as the tourist influx in Leh district is increasing considerably year by year. So, before any drastic transformation takes place in the area, documentation of the medicinal plant's resources of Skuru watershed is very important. Therefore, the present research was carried out to document the medicinal plant's resources in the area and their uses for different ailments in traditional Amchi system of medicines.

Materials and methods

The study area

The Nubra valley lies between the two mountain ranges- Ladakh and Karakoram on the South and North respectively. The valley located between 34°15'45" to 35°31'00" N and 76°55' to 78°05'E

co-ordinates.²³ The valley is broad and well vegetated with groves of seabuckthorn (*Hippophae rhamnoides*) then the other valleys of Ladakh. It is a thorny shrub, used by the villagers at a large scale for fuel and fencing their agriculture fields, to protect their crops from the domestic, stray and wild animals. The altitude ranges are approximately between 2,700 to 6,000m above m.s.l. The climatic condition of the region is a cold arid type, precipitation is erratic and scanty (<80mm per annum) and temperature reaches lower than 0°C to as high as 38°C.²⁵

The Skuru watershed is a part of the Shayok river basin (Figure 1). The elevation is in the range of 2981-6061m a.s.l. The medicinal plants were collected from three sites Skuru village (3,115m above m.s.l.; 34°40'21"N and 77°17'40"E), Rakuru village (4,000m above m.s.l.; 34°35'10"N and 77°15'13"E) and high altitude pasture land (Phu) (5,000m above m.s.l.; 34°32'27"N and 77°13'23"E). The elevations and coordinates were recorded during the field visits. Skuru village is the lowest point in the watershed situated on the bank of the river Shayok. A stream from the eastern side of village flows from south-north direction. There is an open area grazing land covered scantily with shrubs in western side. The vegetation on the banks of the stream and river are covered with shrub and bush species like *Hippophae rhamnoides*, *Myricaria elegans*, *Tamarix gallica*, *Rosa webbiana*, *Phragmites* spp., *Clematis tibetana* and *Berberis ulcina*. The commonly cultivated crops, vegetables, timber plants, fruit trees and fodder plants of the village include *Triticum vulgare*, *Hordeum vulgare*, *Pisum sativum*, *Brassica nigra*, *Raphanus sativus*, *Brassica rapa*, *Brassica oleracea*, *Allium cepa*, *Allium sativum*, *Solanum tuberosum*, *Daucus carota*, *Cucurbita* spp. *Spinacia* spp. *Lycopersicon esculentum*, trees *Populus nigra*, *P. balsamifera*, *P. Euphratica* *P. alba*, *Salix alba*, *S. tetrasperma*, *S. Daphnoides*, *Prunus armeniaca*, *Pyrus communis*, *Juglan regia*, *Prunus persica*, *Elaeagnus angustifolius*, *Medicago sativa* and *M. falcate*. Rakuru village, situated at a higher altitude than Skuru, grows few cultivated crops of cereals, pulses, vegetables and stunted tree species like *Hordeum vulgare*, *Pisum sativum*, *Raphanus sativus*, *Brassica rapa*, *Daucus carota*, *Salix divergence* and *S. alba*. The high altitude pastures land, which is only used in the summer season by villagers for grazing livestock (dZo, dZomo, cow, yak, donkey, goat and sheep). The area is covered with important medicinal plant resources. The pasture is used for grazing by the people of three villages Skuru, Rakuru and Terchey.

Data collection

Information regarding the landscape, natural habitat and medicinal plants resources were collected from intensive field observations during the period of two years (2015;16). The plants were photographed and collected in the months of June-July for identification. Identification of the medicinal plants was done at H.N.B. Garhwal University Herbarium and also with the help of published literature especially by Klimeš and Dickoré,⁶ Kachroo et al.,⁷ Stewart,²⁶ Chaurasia et al.²⁷ The uses of medicinal plants were reviewed from the published literature on Amchi medicine system. The commonly cultivated crops, vegetables, timber plants, fruit trees and fodder plants of these villages were documented through observations and interviews with the locals during field visits. The coordinates and elevations of the study sites were recorded with the help of GPS (Garmin eTrex 30x).

Amchi system of medicines

Amchi system of medicines is synonymous to Sowa-Rigpa or Tibetan medicine, as the fundamental concepts and basic practices that they follow are the same. The Sowa-Rigpa medicine system reveals a holistic way of thinking in which sickness is treated as a physical,

emotional and spiritual whole. The rGyud-bZhi, or 'Four Tantras', is the holy scripts containing the body of medical knowledge.^{28,29} According to the Four Tantras, Sowa-Rigpa is based on the principles of Jung-wa-lna (five elements), and Nespa gsum (three humors). All living beings are formed by the five cosmo-physical elements- Sa (Earth), Chu (Water), May (Fire), rLung (Air or wind) and Namkha (Space). Therefore, all the diseases and their antidotes are five elements of origin and composition respectively.³⁰ The three humours-rLung (wind), mKris-pa (bile) and Badkhan (phlegm) are considered the functional physiological units of the five cosmic-physical elements.³¹ These humors created certain physical, physiological and emotional characteristics.³² The rGyud-bZhi states that the composition of our body is same as the universe. This relationship between the macrocosm (the universe) and the microcosm (body), clarifies the equal impacts that one element has on the others and the reliance that associates the individuals to the environment.³¹ In view of this connection, any changes in our environment may be it positive or negative brought comparable changes in our body system. The Law of Interdependence is a basic principle in Buddhist teaching and which can be seen in this medical system also. Every substance on the Earth believes to have medicinal properties and therapeutic value in Sowa-Rigpa,³⁰ Medicinal substances are categorized into eight major category: Rinpoche sman (prized metal and stone), sa sman (drugs from mud and earth), rdo sman (stones), shing sman (drugs from trees), rtsi sman (essence and exudates medicines), thang sman (plant ingredient for decoction/shrub), sno sman (herb) and srog chags sman (animal parts). The constituents of medicine are used in both single and compound forms; compound medicine is based on two major combinations, ro (taste) and nus-pa (potencies). From, nearly seventeen different types of preparation, decoction, powder, paste, pills, medicated ghee, linctus, bhasmas, medicated wine and medicated bath are some of the main medicinal preparation.¹

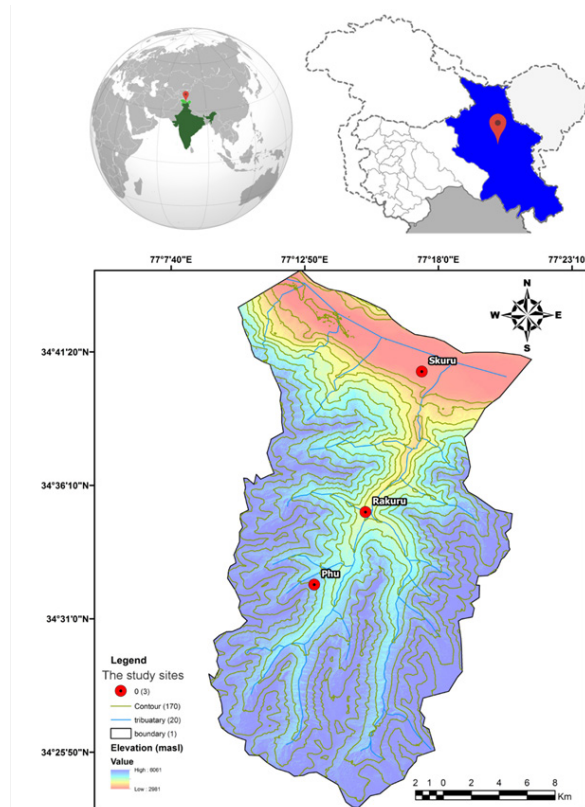


Figure 1 Map of the study area with altitudinal gradient.

Results and discussion

The medicinal plants in Skuru watershed grow in the diverse range of habitats, such as valley plains, alpine pastures, rocky, dry slopes, boulders and alpine mountains. The Amchi system is totally dependent upon natural resources for the collection of plants and their parts.¹⁵ During the survey, 73 medicinal plant species belonging to 61 genera of 37 families from the area were recorded (Table 1). The uses of the collected medicinal plants for Amchi medicine system were reviewed from secondary published sources. Asteraceae was the most dominant (19%) family with 14 plant species, followed by Fabaceae and Lamiaceae families (8%) with six species each. Polygonaceae was represented by five species (7%) and Amaryllidaceae by four species (5%). Ranunculaceae, Rosaceae and Scrophulariaceae were represented by three species each (4%). Amaranthaceae, Apiaceae, Chenopodiaceae Geraniaceae, Solanaceae and Utricaceae families were represented by 2 species each (3%). Remaining 17 families (Berberidaceae, Boraginaceae, Brassicaceae, Campanulaceae, Capparaceae, Convolvulaceae, Crassulaceae, Elaeagnaceae,

Ephedraceae, Juglandaceae, Malvaceae, Orchidaceae, Orobanchaceae, Plantaginaceae, Plumbaginaceae, Salicaceae and Tamaricaceae) were monotypic (1%) used for traditional medicine system (Figure 2). The results of the present study revealed that from the recorded 73 species of medicinal plants, maximum (72.6%) plant species were used for ailments related to digestive system, followed by musculoskeletal (30.14%), respiratory system (27.4%) cardio-vascular system and blood related problems (24.66%), skin related problems (24.66%), renal system related problems (17.81%), nervous system (13.7%), gynaecological (10.96%) and men's sexual health (5.48%). A bulk (45.21%) was used for other ailments (Table 2). Except for the seven plant species, all medicinal plants recorded were used for more than one ailment. The plant parts which were in maximum use for herbal medicines were leaves (33%) followed by whole plant (12%), flowers (12%), shoots (11%), roots (8%), stems (8%) seeds (7%), fruits (4%) bulbs (2%), bark (1%), rhizomes (1%) and tubers (1%) (Figure 3) Some of the most important medicinal plants photographs have also been given in Figure 4.

Table 1 Medicinal plants species, their vernacular names and parts used in treatment of ailments in Amchi system of medicines

	Species	Family	Vernacular name	Part use	Medicinal properties	Sources*
1	<i>Acantholimon lycopodioides</i> (Girard) Boiss.	Plumbaginaceae	Longze	Whole plant	Cardiac disorders	10,23,27
2	<i>Aconogonum tortuosum</i> (D. Don) H. Hara	Polygonaceae	Snyalo	Leaves & whole	Blood purifier & painful urination	5,10
3	<i>Allium cepa</i> L.	Amaryllidaceae	Tsong	Bulb & leaves	Loss of appetite & vomiting	10,19
4	<i>Allium humile</i> Kunth	Amaryllidaceae	Kyu	Leaves & bulb	Stomach complaints & indigestion	22
5	<i>Allium przewalskianum</i> Regel	Amaryllidaceae	Skotse, Kangmar	Shoot & leaf	Dysentery & stomachache	10,19,23
6	<i>Allium sativum</i> L	Amaryllidaceae	sGogpa	Leaves & bulb	Indigestion & loss of appetite	10,19
7	<i>Amaranthus spinosus</i> L.	Amaranthaceae		Roots & leaves	Spasm, gastric troubles, irregular menstruation & kidney problems	5,22,24
8	<i>Arabidopsis wallichii</i> (Hk. F. & Th.) N. Busch.	Brassicaceae	Imatso.	Leaves	Appetizer	23
9	<i>Arnebia euchroma</i> (Royle) I.M. Johnst.	Boraginaceae	Demog	Leaves & roots	Hair tonic, backache, cough, cold, lungs & pulmonary problems, blood purifier, blood vomiting & kidney problems	0,22,23
10	<i>Artemisia maritima</i> L. ex Hook.f.	Asteraceae	Burtse	Leaves & stem	Skin diseases & intestinal parasites	10
11	<i>Artemisia absinthium</i> L	Asteraceae	Burs-kar	Whole plant	Rheumatism, malaria, anti-worm	10
12	<i>Artemisia brevifolia</i> Wall. Ex DC	Asteraceae	Khampa	Leaves & flowers	Gastrointestinal disorder, intestinal worm, aphrodisiac, antiseptic, laxative & blood purifier	10,19,27
13	<i>Artemisia moorcroftiana</i> Wall. Ex DC.	Asteraceae	Burtse	Whole plant	Malaria fever	10
14	<i>Aster flaccidus</i> Bunge	Asteraceae	Lukmik	Flowers & stem	Eye problem, liver disease, fever, cold & cough	10,27
15	<i>Berberis ulcina</i> Hk. f. & Th.	Berberidaceae	Khitser, shinnar	Stem, bark, roots & fruits	Arthritis, cough, fever, ring worm, skin diseases, constipation, antiseptic & tonic	2,22,23,27

Table Continued...

	Species	Family	Vernacular name	Part use	Medicinal properties	Sources*
16	<i>Biebersteinia odora</i> Stephan ex Fisch	Geraniaceae	Drakspos, Sari	Whole plant & roots	Urino-genital disorder,, peptic ulcer, diarrhea, blood purifier, cuts, wounds, & skin sore	10,22,27
17	<i>Bistorta vivipara</i> (L.) Gray	Polygonaceae	Langna	Flowers & stem	Abdominal pain & backache	10
18	<i>Capparis spinosa</i> L	Capparaceae	Kabra	Leaves & stem	Paralysis, rheumatism, gout, tonic, toothache, hyperacidity, liver, skin & stomach problem	2,10,2327
19	<i>Caragana versicolor</i> Benth.	Fabaceae	Tsaon	Whole plant	Food poisoning, fever & throat infection	10
20	<i>Carum carvi</i> L.	Apiaceae	Kosnyot	Leaves, roots & seeds	Rheumatism, spasm, acidity, gastric troubles, indigestion, intestinal worm, stomache, irritable condition of bladder, promotes urination, cold, promote menstruation & tonic	2,5,10,19, 22,23
21	<i>Chenopodium album</i> L.	Amaranthaceae	Janchikarpo	Leaves, seeds & flowers	Gastric troubles, painful urination & diuretic	2,22
22	<i>Chenopodium botrys</i> L	Chenopodiaceae	Snue	Flower & leaves	intestinal worm, constipation, stomach complaints	10,27
23	<i>Chenopodium glaucum</i> L	Chenopodiaceae	Sanek	Leaves	Constipation	10
24	<i>Chesneya cuneata</i> (Benth.) Ali	Fabaceae	Bigangbo	Roots	Antiseptic	35
25	<i>Cicer microphyllum</i> Benth.	Fabaceae	Sari	Leaves & seed	Stress, fatigue, jaundice, tongue infections & sore throat	10,27
26	<i>Cirsium arvense</i> (L.) Scop	Asteraceae	Biangtser	Shoot	Vomiting & headache	10
27	<i>Clematis orientalis</i> L	Ranunculaceae	rBisho, Emong	Shoot	Indigestion	10,19
28	<i>Clematis tibetana</i> Kuntze	Ranunculaceae	rBisho, Emong nakpo, Zakgic	Whole plant	Indigestion & scabies	10,27
29	<i>Codonopsis ovata</i> Benth	Campanulaceae	Lurdud-dorjey	Shoot & leaves	Ulcer, lungs & liver problems, chest conjunction, blood purifier, rheumatism.	10,27
30	<i>Convolvulus arvensis</i> L.	Convolvulaceae		Whole plant	Rheumatic, pain, cuts & wounds	22
31	<i>Dactylorhiza hatagirea</i> (D.Don) Soó	Orchidaceae	Angbo-lakpa, Sanchu	Tuber	Round worm, asthma, lungs & pulmonary problems, hypoactive sexual desire disorder, nervine tonic, skin problems, wounds, kidney disorder, burning sensation of urine, regulation of urine discharge, sedative & restoring regenerative fluids	5,19,23,34
32	<i>Datura stramonium</i> L	Solanaceae	Datura	Leaves & stem	Ear problems, impotence, intestinal worms & respiratory problems	10
33	<i>Delphinium brunonianum</i> Royle	Ranunculaceae	Ladharmentok	Leaf, flower & whole plant	Colic, malaria & throat pain	2,22,27
34	<i>Dracocephalum heterophyllum</i> Benth.	Lamiaceae	Kalchor tsa, Zypsi	Shoot, leaves flowers & whole plant	Peptic ulcer, hypertension, headache, cough & cold.	23,27
35	<i>Echinops cornigerus</i> DC	Asteraceae	Aczema, Kaqtsaymaq	Leaves, seeds, flower & shoot	Food poisoning, tonic, septic wound & jaundice	10,27

Table Continued...

	Species	Family	Vernacular name	Part use	Medicinal properties	Sources*
36	<i>Elsholtzia densa</i> Benth.	Lamiaceae	Sanik	Leaves	Menorrhagia, pathogenic diseases of uterus, pain due to cuts & burns	18,22
37	<i>Ephedra Gerardiana</i> Wall. Ex Stapf	Ephedraceae	Tseapath	Roots, stem, leave, branches, fruits & shoot	Bronchitis, asthma, rheumatism, syphilis, heart ailments, fever, hepatic diseases, irregular menstruation, bleeding, blood purification, liver disorders & tonic	2,10,22, 27,35
38	<i>Euphrasia himalayica</i> Wettst	Scrophulariaceae	Skianglo	Leaves	Eye problems & cardiac ailments	10
39	<i>Geranium pratense</i> L.	Geraniaceae	Gugchuk, Gadur,	Leaves & whole	Fever, , pneumonia, influenza, inflammation of lungs & veins, swelling of limbs, dysentery, diarrhoea , analgesic, & tonic	10,19,27
40	<i>Heracleum pinnatum</i> C.B. Clarke	Apiaceae	Spru	Shoot & root	Inflammation & pain caused by fever, leprosy, chicken pox, small pox, irregular menstruation, haemorrhage & abdominal cramps	10,27
41	<i>Hippophae rhamnoides</i> L.	Elaeagnaceae	Tsog, tSestalulu	Fruit, flower, seed & stems	Anti-ageing, anti-cold, memory restoration, energy boosting, blood purifier; peptic ulcer, lung disorders, cuts, wounds, tonic for malnourished children & pregnant ladies & multi vitamins source especially 'C'.	2,10,27, 22,19
42	<i>Juglans regia</i> L	Juglandaceae	Starga	Seeds, leaf & bark	Itch, rheumatism, constipation, tooth & gums related problems	2,10,22
43	<i>Lactuca lessertiana</i> (Wall. Ex DC.) Wall. Ex C.B.Clarke	Asteraceae		Leaves & shoot	Rheumatism & skin diseases	10,27
44	<i>Lactuca tatarica</i> (L.) C.A.Mey	Asteraceae	Bshakha	leaves	Headache, fever, internal wounds & vomiting	10,22
45	<i>Lancea tibetica</i> Hook. F. & Thomson	Scrophulariaceae	Raikse, Chagna, Spang-ali	Root, & Leaves	Tonic, wound, heart diseases, cough, & chest congestion	10,23
46	<i>Leontopodium alpinum</i> Colm. Ex Cass	Asteraceae	Tzima	Whole plant	Septic wounds	10
47	<i>Malva verticillata</i> L	Malvaceae	Chirotil/ Suchuli	Roots & stem	Liver tonic & piles	10
48	<i>Melilotus officinalis</i> (L.) Pall.	Fabaceae	Buksuk	Whole plant	Relieves gas, induce urination, improve blood circulation, nervous tension, painful menstruation, insomnia, palpitations, wounds, cut & bruises.	35
49	<i>Mentha longifolia</i> (L.) Huds.	Lamiaceae	Pholing	Leaves & shoot	Abdominal pain, dysentery, diarrhoea, stimulant, vomiting, diuretic, headache & rheumatism.	19,23, 24,27
50	<i>Myricaria elegans</i> Royle	Tamaricaceae	Umbu	leaves	Blood purifier	10
51	<i>Nepeta floccosa</i> Benth.	Lamiaceae	Changmagog	Leaves & flowers	Fever, cough & cold	10,27
52	<i>Oxyria digyna</i> (L.) Hill	Polygonaceae	Changskur, Chu-ichum, Lamanchu	Leaves & shoot	Indigestion, loss of appetite & gastritis	2,10,19,22

Table Continued....

	Species	Family	Vernacular name	Part use	Medicinal properties	Sources*
53	<i>Pedicularis cheilanthifolia</i> var. <i>Albida</i> (Pennell) P.C.Tsoong	Orobanchaceae	<i>Lugru-serpo</i> , <i>Landay-snumpo</i> ,	Whole plant	Stomachache, leucorrhoea & menorrhagia	18,19,27
54	<i>Perovskia abrotanoides</i> Kar.	Lamiaceae	<i>burtsey</i>	Leaves & flower	Cough, headache, infection, constipation, & painful urination	5,23,27
55	<i>Physochlaina praealta</i> (Decne.) Miers	Solanaceae	<i>Langtang</i>	Whole, leaves flowers, stem, seeds & oil	Rheumatic pains, toothache, ulcer & eye diseases	23,27,36
56	<i>Plantago himalaica</i> Pilg.	Plantaginaceae	<i>Tharum</i> , <i>Humbuksuk</i>	Seeds & leaves	Diarrhoea, gastric disorder & liver related problems	2,10,22
57	<i>Potentilla anserina</i> L.	Rosaceae	<i>Troma</i>	Rhizome & leaves	Diarrhoea, kidney stone & stomach complaints	10
58	<i>Prunus armeniaca</i> Linn.	Rosaceae	<i>Chuli</i>	Oil	Tonic & stimulate long and healthy hair	2
59	<i>Rheum spiciforme</i> Royle	Polygonaceae	<i>Lachu</i>	Roots & Leaves	Swellings, wounds, chronic bronchitis, piles, constipation & rheumatism.	10,23,27
60	<i>Rhodiola tibetica</i> (Hook. F. & Thoms.) Fu	Crassulaceae	<i>Choango</i> , <i>Shrolo</i>	Leaves & shoot	Headache, stress, memory loss, tonic	10,18,27
61	<i>Rosa webbiana</i> Wall. Ex Royle	Rosaceae	<i>Sai marpo</i>	Flowers & fruits	Bleeding, hepatitis, jaundice, deficiency of vitamin C & liver problems	10,27
62	<i>Rumex patientia</i> L.	Polygonaceae	<i>Shoma</i>	Leave & shoot	Constipation, fever, skin disorder, rheumatism & backache	10,27
63	<i>Salix alba</i> L.	Salicaceae	<i>Malchang</i>	Tender leaves	Knee, hip pain & fever	10,23
64	<i>Stachys tibetica</i> Vatke	Lamiaceae	<i>Churukpa</i>	Shoot	Insecticide, mites & lice control	10
65	<i>Tanacetum dolichophyllum</i> (Kitam.) Kitam.	Asteraceae	<i>Khampa-serpo</i>	Leaves & flower	Intestinal-worm	19,20,27
66	<i>Tanacetum gracile</i> Hook. F. & Thomson	Asteraceae	<i>Ribong-sburtsey</i> , <i>Khamchu</i> ,	Leaves & flower	Intestinal-worm	10,19
67	<i>Taraxacum officinale</i> Webb	Asteraceae	<i>Han</i> , <i>Khorkhorma</i>	Roots, leaves & flower	Blisters, liver problems, digestive problems, intestinal worms, blood purifier, headache, weak immune system, kidney disorder, painful urination, diuretic, alcoholism, skin problems, back ache, stomache, hepatic stimulant, tonic, sedative & analgesic	5,10,19, 22,23,27
68	<i>Thermopsis inflata</i> Cambess	Fabaceae	<i>Dugsrad</i>	Whole pant	Swelling	10
69	<i>Trigonella emodi</i> Benth	Fabaceae	<i>Bugsug</i>	Leaves & stem	Fever, anaemia & peptic ulcer	10
70	<i>Urtica dioica</i> L.	Urticaceae	<i>Rdoastat</i>	Shoot	Paralysed limbs & rheumatism.	35
71	<i>Urtica hyperborea</i> Jacq. ex Wedd.	Urticaceae	<i>Zatsod</i>	Leaves & whole plant	Cold & cough, stomachache, rheumatism & joint pain	10
72	<i>Verbascum thapsus</i> L.	Scrophulariaceae	<i>Shondok</i>	Shoot, stem, leaves, flowers & fruit	Asthma, frost bite, aphrodisiac, impotency, amenorrhoea, menorrhagia, chest problems, diarrhoea, bleeding, diuretic, blood disorder, sores, infections, bleeding wounds & cuts	10,27,35
73	<i>Waldheimia tomentosa</i> (Decne.) Regel	Asteraceae	<i>Palu</i>	Leaves, seeds & whole plant	Acidity, headache, wound & arthritis	2,10,22,27

Table 2 Percentage of recorded plant species used against ailments of different human organ systems

Health problem related to main body parts	Specific conditions	Percentage
Digestive system	Constipation, indigestion, dysentery, acidity, cramps, hepatic problems, food poisoning, peptic ulcer, diarrhoea, piles	72.6
Musculo-skeletal	Gout, arthritis, back pain, rheumatism	30.14
Respiratory system	Cough, cold, bronchitis, chest conjunction, sore throat, asthma	27.4
Cardiovascular system & blood related	Palpitation, haemorrhage, hypertension, malaria	24.66
Skin /dermatological	Wound, cuts, bruises, swelling, scabies, blister, frostbites	24.66
Renal/kidney system	Urinary retention, infection (pyelonephrtes), painful urination, stone (kidney/bladder)	17.81
Nervous system	Tension/anxiety, memory loss, paralysis, insomnia, headache	13.7
Gynaecological	Painful menstruation, discharge, amenorrhoea	10.96
Mens health	Impotency	5.48
Others	Toothache, aging, eye problems, weakness etc.	45.21

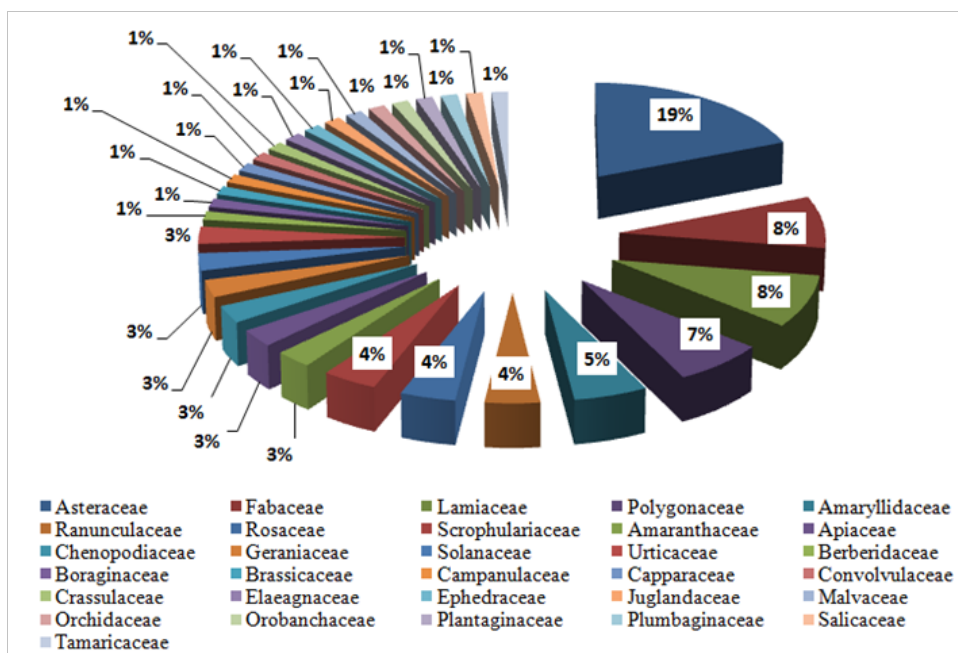


Figure 2 Percentage of medicinal plants species recorded in each family.

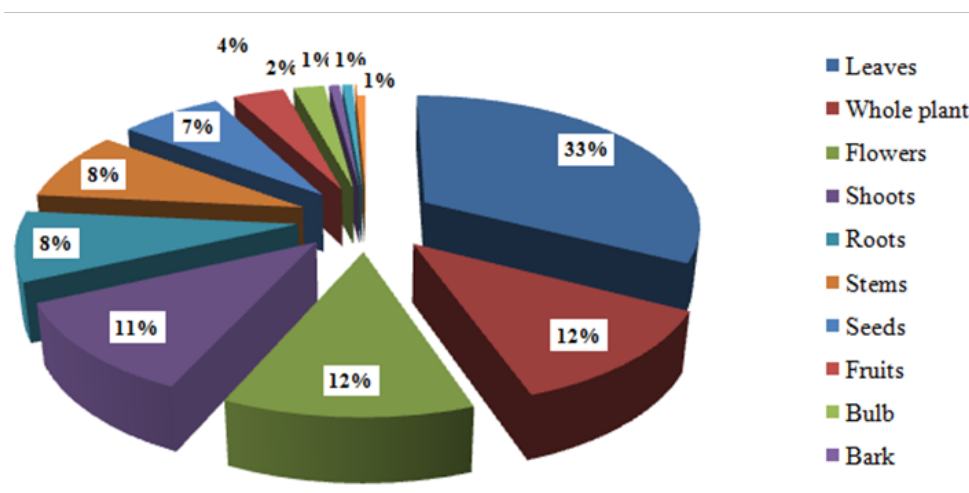


Figure 3 Percentage of plant parts of recorded species used in traditional medicines.



Figure 4 Medicinal plants: a. *Acantholimon lycopodioides*; b. *Allium przewalskianum*; c. *Arnebia euchroma*; d. *Aster tibeticus*; e. *Biebersteinia odora*; f. *Capparis spinosa*; g. *Cicer microphyllum*; h. *Dactylorhiza hatagirea*; i. *Delphinium brunonianum*; j. *Geranium pratense*; k. *Hippophae rhamnoides* l. *Lancea tibetica*; m. *Perovskia abrotanoides*; n. *Rhodiola tibetica*; o. *Urtica hyperborean*.

The Plant like *Dactylorhiza hatagirea* has been widely used to cure various health problems like asthma, lungs and pulmonary problems, hypoactive sexual desire disorder, neuro tonic, skin problems, wounds, kidney disorder, burning sensation of urine, regulation of urine discharge, roundworm, sedative and restoring regenerative fluids. It is also widely used in modern medicines. It has been categorized as critically endangered plant species (CAMP status), critically rare (IUCN status) and is listed under Appendix II of CITES.^{17,33,34} *Acantholimon lycopodioides* and *Arnebia euchroma* are endangered in both Jammu and Kashmir state and North West Himalaya. However, *Hippophae rhamnoides* is in low risk-near threatened in North West Himalaya and vulnerable in Jammu and Kashmir. *Ephedra Gerardian* is vulnerable in North West Himalaya and endangered in Jammu and Kashmir. Threats to the species were determined by field study, visual estimation, literature and herbaria; the criterion for categorization of threatened species is based on the IUCN.²¹ Kumar et al.,²¹ observed that the frequency of presence of some important medicinal and aromatic plants of Ladakh, which were in abundant before, have greatly declined due to their unscientific exploitation, natural calamities, road construction, uprooting for fuel, overgrazing and other activities. This damage has left many species endangered and threatened. Such threatened plants need to be conserved in ex-situ or in-situ habitats.²¹ The government agencies like the Department Wildlife of Jammu and Kashmir, Defense Institute of High Altitude Research (DIHAR),

Central Arid Zone Research Institute (CAZRI), Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST) and NGO like World Wildlife Fund for Nature - India (WWF) are working for the conservation of medicinal plants through their research work and organizing workshops and trainings for the people. But, these are not enough; there is a need of focussing conservation activities in the rural areas. In the surveyed villages most of the inhabitants were of the opinion that there is no profit from traditional farming. They say that the investment amount is higher than the earned income. Earlier times, all the family members work together, the children were also involved in farming. But now, the children are studying in schools and colleges. Adult men are busy in armed forces, tourism-related activities, day labor in army camps and Border Road Organization (BRO). As all the children and most of the adults in most of the villages of Nubra valley are busy in their respective works, during the period of harvesting and threshing. Therefore, the villagers are forced to hire labors for the same. Only the women and senior citizens are involved all through the agricultural season in farming and harvesting. The transportation of manure from home to the field, ploughing fields, harvesting and threshing were earlier carried out on draught animal but now these activities are carried out with hired tractors and load vehicles. All the villagers pay for it in cash.³⁵⁻³⁷ Money was not used earlier for these works. All these farming activities were performed by helping each other in the villages. Therefore, there is a dire need for sustainable alternate livelihoods like growing important medicinal plants other than traditional farming, dependent on tourism and armed forces. In the surveyed villages, growing of medicinal plants is not in practice. If the medicinal plants are obtained directly from the farmers for the traditional medicine system and herbal companies, then there will be less exploitation of medicinal plants in nature. It will certainly help to conserve these resources in wild. This will also help in conserving medicinal plants in wild. On 18 July 2016, M/S Dabur India Ltd signed a MoU with the Defence Institute of High Altitude Research (DIHAR), Leh. Under this, Dabur officials will impart training to the villagers on the sustainable cultivation of herbs with the primary focus on helping the local community and augmenting the population of medicinal herbs in the country. There is also a need of such more initiatives and also more focused research. The farmers should be given training for cultivation and marketing for medicinal plants by the Ladakh Autonomous Hill Development Council or State government or the Government of India through their respective departments for enhancing their livelihood and reducing pressure on the medicinal plants thriving in wild.

Conclusion

From the current research work, it has been concluded that the watershed of the Karakoram wildlife sanctuary was rich in Medicinal plant resources during the study period. Good knowledge of Amchi system of medicine about the uses of the local medicinal plants for different ailments was also found. The pressures to these medicinal plants were increasing from unscientific exploitation, uprooting for fuel, overgrazing, natural calamities and other activities in Ladakh region. So, to minimize the pressure on these resources, the villagers should be encouraged and well trained for growing medicinal plants. If medicinal plants are obtained directly from the farmers for the traditional medicine system and herbal companies, then there will be less exploitation of medicinal plants in nature and can also provide a sustainable alternative livelihood to the villagers.

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Conflict of interest

Authors declare that there is no conflict of interest.

References

- Gurmet P. "Sowa-Rigpa": Himalayan Art of Healing. *Indian Journal of Traditional Knowledge*. 2004;3(2):212–218.
- Buth GM, Navchoo IA. Ethnobotany of Ladakh (India) Plants used in Health Care. *Journal of Ethnobiology*. 1988;8(2):185–194.
- Mani MS. The Himalaya, its Ecology and Biogeography: A Review. In: Pangtey YPS, Rawal RS, editors. *High Altitudes of the Himalaya (Biogeography, Ecology and Conservation)*. New Delhi: Gyanodaya Prakashan; 1994. p. 1–10.
- Rawat RBS, Uniyal RC. Status of medicinal and aromatic plants sector in Uttaranchal: Initiatives taken by the Government of India. *Financing Agriculture*. 2004;36:7–13.
- Ballabh B, Chaurasia OP, Ahmed, Z, et al. Traditional medicinal plants of cold desert Ladakh Used against kidney and urinary disorders. *Journal of Ethnopharmacology*. 2008;118(2):331–339.
- Klimeš L, Dickoré WB. Flora of Ladakh (Jammu & Kashmir, India). *A preliminary checklist*. 2006.
- Kachroo P, Sapru BL, Dhar U. *Flora of Ladakh: an Ecological and Taxonomical Appraisal*. Shiva Printers, Dehradun, India; 1977.
- Kachroo P. *Plant Diversity in Northwest Himalaya a Preliminary Survey*. In: Dhar U, editor. *Himalayan biodiversity: Conservation strategies*. Nainital: Gyanodaya Prakashan; 1993. p. 111–132.
- Angmo K, Adhikari BS, Rawat GS. Sowa-Rigpa: A healthcare practice in Trans-Himalayan region of Ladakh, India. *SDRP Journal of Plant Science*. 2017;2(1):1–8.
- Angmo K, Adhikari BS, Rawat GS. Changing aspects of Traditional Healthcare System in Western Ladakh, India. *Journal of Ethnopharmacology*. 2012;143(2):621–630.
- Abrol BK, Chopra IC. Some Vegetable Drug Resources of Ladakh. *Current Science*. 1962;31(8):324–326.
- Stewart RR. Medicinal plants of Ladakh (Jammu & Kashmir). *Journal of economic and taxonomic botany*. 1984;5:401–407.
- Namgyal G, Phuntsog ST. *In Amchi Pharmacotherapeutics Central Council for Research in Ayurveda and Siddha*. Cambridge Printing Works, New Delhi; 1990.
- Singh B, Chaurasia OP, Jadhav KL. An Ethnobotanical Study of Indus Valley (Ladakh). *Journal of economic and taxonomic botany*. 1996;12:92–101.
- Kala CP. Health traditions of Buddhist community and role of Amchis in trans-Himalayan region of India. *Current Science*. 2005;89(8):1331–1338.
- Kala CP. *Medicinal Plants of Indian Trans-Himalaya*. Dehradun: Bishen Singh Mahendra Pal Singh, Dehradun India; 2003.
- Kala CP. Status and Conservation of Rare and Endangered Medicinal Plants in the Indian Trans-Himalaya. *Biological Conservation*. 2000;93(3):371–379.
- Ballabh B, Chaurasia OP. Herbal Formulations from Cold Desert Plants used for Gynecological Disorders. *Ethnobotany Research & Application*. 2011;9:59–66.
- Ballabh B, Chaurasia OP. Medicinal plants of cold desert Ladakh used in the treatment of stomach disorders. *Indian Journal of Traditional Knowledge*. 2009;8(2):185–190.
- Ballabh B, Chaurasia OP. Traditional medicinal plants of cold desert Ladakh—used in treatment of cold, cough and fever. *Journal of Ethnopharmacology*. 2007;112(2):341–349.
- Kumar GP, Kumar R, Chaurasia OP, et al. Current status and potential prospects of medicinal plant sector in Trans-Himalayan, Ladakh. *Journal of Medicinal Plant Resources*. 2011;5(14):2929–2940.
- Rinchen T, Pant S. Ethnopharmacological uses of plants among inhabitants surrounding Suru and Zaskar valleys of cold desert, Ladakh. *International Journal of Pharma and Bio Science*. 2014;5(1):486–494.
- Kumar GP, Gupta S, Murugan PM, et al. Ethnobotanical Studies of Nubra Valley—A Cold Arid Zone of Himalaya. *Ethnobotanical Leaflets*. 2009;2009(6).
- Pal MM, Raj XJ, Kumar GP, et al. Phytofoods of Nubra valley, Ladakh – the cold desert. *Indian Journal of Traditional Knowledge*. 2010;9(2):303–308.
- Joshi PK, Rawat B, Padilya H, et al. Biodiversity Characterization in Nubra valley, Ladakh with special reference to plant resources conservation and bioprospecting. *Biodiversity Conservation*. 2006;15(13):4253–4270.
- Stewart RR. The Flora of Ladakh and Western Tibet. *Bulletin Torrey Botany Club*. 1916;43:571–590.
- Chaurasia, OP, Khatoon N, Singh SB. *Field Guide Floral Diversity of Ladakh*. WWF-India, DIHAR & Dept. of Wildlife Protection, Govt. of J&K; 2008.
- Clark B. *The Quintessence Tantras of Tibetan Medicine*. Ithaca, New York: Snow Lion Publications; 1995.
- Yeshi D. *The ambrosia heart tantra*. Library of Tibetan Works and Archives, Dharamsala, India; 1977;23(3):357.
- Gurmet P. *An Introduction to Sowa Rigpa; Himalayan Art of Healing*. In: Gombu M, Singh MK, Goyal DM, editors. *Sowa Rigpa: The Science of Healing*. Himalayan Buddhist Cultural Association, Bela Road, Delhi; 2005. p. 281–288.
- Phuntsok T. *Origin and Development of Sowa Rigpa Tradition*. In: Gombu M, Singh MK, Goyal DM, editors. *Sowa Rigpa: The Science of Healing*. Himalayan Buddhist Cultural Association, Bela Road, Delhi; 2005. p. 240–253.
- Yeshi D. *Health through balance, An Introduction to Tibetan Medicine*. In: Hopkins J, editor. Ithaca: Snow Lion Publications; 1986.
- Samant SS, Dhar U, Palni LMS. *Himalayan Medicinal Plants: Potential and Prospects*. Gyanodaya Prakashan, Nainital; 2001.
- Pant S, Rinchen T. *Dactylorhiza hatagirea*: A high value medicinal orchid. *Journal of Medicinal Plants Research*. 2012;6(19):3522–3524.
- Hamid K, Raina AK. Ethnobotanical uses of Plants in and Around Kanji. *International Journal of Science and Research*. 2014;11(3):538–545.
- Kumar S. Traditional Medicinal Plants of Zaskar (Ladakh). *Annals of Pharmacy and Pharmaceutical Sciences*. 2012;3(2):55–58.
- Deche KT. *A Brief on Tibetan Medical (Sowa Rigpa) Pharmacology*. In: Gombu M, Singh MK, Goyal DM, editors. *Sowa Rigpa: The Science of Healing*. Himalayan Buddhist Cultural Association, Bela Road, Delhi; 2005. p. 240–253.