



## ***Ex situ* conservation as field gene bank of medicinal and aromatic plants at Ranichauri, Tehri Garhwal, Uttarakhand, India**

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### **Abstract**

Medicinal and aromatic plants are considered as vital substrate for human health since the dawn of civilization. India is well known for the 'Ayurveda' that has been used for the benefit of human being for more than 5000 years. Domestic use of Plants is as old as human civilization itself whereas it becomes commercialized in recent years. There is a growing demand today for plant-based medicines, health products, pharmaceuticals, food supplements, cosmetic, etc. in the international market. Studies have also shown that many plant species are in danger of extinction, while some have already become extinct. The major reasons for the depletion of such important natural resource are over exploitation from wild populations and un-sustainable management practices, in addition to other factors such as destruction, reduction and translation of natural habitat, competition by invasive weeds, climate change, etc. Bio-industries causing a serious damage to the wealth due to its overexploitation leading to depletion of resources. It is estimated that more than 90% of all the herbal raw material is a produce of collections from the wild.

**Keywords:** Garhwal Himalaya, medicinal plants, conservation, ayurveda, environment

### **Introduction**

The Himalaya is the perennial source of attractions, curiosity and challenge to human intellect through the ages. Amongst several assets, the vegetation provides an everlasting and interesting field of investigation. The diversity, copiousness as well as uniqueness of the plant components in various habitats retained sound and aesthetic environment of the Himalaya. However, in the recent past couple of years, excessive exploitation of vegetation, unplanned land use, natural disasters and several developmental processes, accelerated deterioration of vegetation or loss of individual species since we do not possess the detailed botanical record for several of the localities or region. One of such botanical interests and little-known region is the Ranichauri in district Tehri, which sustain unique and rich genetic resources.

The present rates of habitat loss, landscape alteration and extinction of the species, community and even at the ecosystem levels, have scrambled conservation biologists to devise methods and tools for species protection and preservation. To overcome challenge of MAPs conservation various techniques are underway throughout the world. Commonly used strategies for conservation of plant genetic resources are *in situ* and *ex situ* conservation. *In situ* methods refers to the conservation of a species or population on-site where they occur naturally whereas *ex situ* conservation involves the conservation of selected species away from their natural habitat in botanical gardens, field gene banks, seed gene banks, cryopreservation banks, etc. *In situ* conservation is difficult; particularly for most of the Universities in the Indian system due to different reason e.g. availability of land in particular habitat, availability of fund, area management, etc. Thus, *ex situ* conservation of MAPs is possible practice due to the alarming rate of loss of MAPs diversity. However, *ex situ* conservation provides a higher degree of protection to germplasm as compared to *in situ* conservation. One of the most effective biological

techniques to conserve such important biodiversity is the establishment of field gene banks. Most of the crop species in our agriculture are conserved by *ex situ* means using field gene banks, seed gene bank and in certain cases, tissue culture and cryopreservation gene bank.

Conservation of MAPs of Himalayan areas is very important as many species had been categorized threatened from this region. Conservation of MAPs diversity of temperate Himalaya a field gene bank is being establish to provide support for MAPs, gaps in existing collections, to understand taxonomic and evolutionary relationships, genetics, seed and vegetative regeneration methods, seed storage methods, formulation of crop descriptors, germplasm characterization and evaluation.

In view the main aim of the establishment of field gene banks of the MAPs in the temperate region of district Tehri Garhwal of Uttarakhand i) To collect, conserve, evaluate, characterize, MAPs diversity of the temperate Himalaya ii) To provide awareness and training in the *ex-situ* conservation of important MAPs. iii) Development of package of practice for potential MAPs for income generation in temperate region and iv) To develop efficient germplasm multiplication techniques for threatened MAPs and distribution of quality plating material to interested growers.

### **Material and Methods**

#### **Study area**

Tehri Garhwal is one of the mountainous districts of Uttarakhand is lies between latitudes 30°03' and 30°53' N and longitudes 77°56' and 79°04' E. The district is bounded by Uttarkashi district in the north, Rudraprayag district in the east, Pauri Garhwal district in the south and Dehradun district in the west. The geographical area of the district is 3796 km. The administrative convenience Tehri Garhwal district, a part of Garhwal Division, has been divided into five tehsils viz. Pratapnagar, Tehri, Narendranagar,

Ghanshali and Devprayag and nine Developmental Blocks viz. Pratapnagar, Bhilangana, Jakhnidhar, Jaunpur, Thouldhar, Chamba, Narendranagar, Devprayag and Kirtinagar. There are 1836 villages, out of which 1768 villages are inhabited, 42 villages are uninhabited and the rest 26 are categorised as forest villages.

In general, the climate of the study area represents the mild summer, higher precipitation and colder or severe cold prolonged winter. The climate factors *i.e.* precipitation, temperature, relative humidity and wind, in association with elevation (valleys or mountain range from temperate zone), proximity to Great Himalaya, slope aspects, drainage, vegetation etc are responsible for the micro-climate of this area.

Major output of precipitation is in the form of rain fall, besides occasional occurrence of due, hailstorm, fog, frost, snow fall etc. During summer months, the valley has hot climate prevailing for few hours in a day, the maximum temperature during May-June is recorded between 30°C-35°C however, nights are cool. The first half of monsoon start with high velocity winds of South-West to North-West direction, winters have usually northern winds. Foggy clouds during rainy season and winter fog in valleys, more or less depend on humidity and wind impacts in the region.

## Results and Discussion

Literature on temperate medicinal plant of Himalayan region revealed that more than 150 medicinal and aromatic plants species can be conserved in mid hill region. Based on the criteria fixed for selection of species in this region >50 species had been collected and conserved in the field gene bank. Few important among them are - *Allium humile*, *Bergenia ciliata*, *Berberis aristata*, *Nardostachys jatamansi*, *Picrorhiza kurrooa*, *Podophyllum hexandrum*, *Saussurea lappa*, *Valeriana wallichii*, etc. A list of collected species is presented in Table 1.

The species conserved in the field gene bank are important as many of these belong to threatened categories. A list of threatened species, along with their botanical name, trade name, economic part, different medicinal systems using species, important chemical constituents, medicinal properties and threat status is presented in Table 1. Further, few species were selected for large scale multiplication program based on climate, topography, potential for region, farmers requirements, availability of fund, etc. The second and foremost step after collection is characterization of the germplasm. Value of any germplasm is known once it is characterized. Rare, unique, and native plants can be preserved as living collections.

Such species can be conserved via *in-situ* methods for sustainable use as well as *ex-situ* methods for regular market supply. One of the goals of many conservation programmes, in addition to habitat preservation, is to maintain existing

level of genetic variation in species that are rare or threatened.

Genetic variation present in a species is a valuable biological resource in this area of genetic engineering. The loss of species genetic diversity represents a type of partial extinction. The need for conservation of genetic variation in plants is widely recognized and gained significant importance. Gene bank operations may be linked with plant breeding and crop improvement activities for evaluation of accessions. Expected benefits to the medicinal and aromatic plants (MAPs) industry and consumers include access to unique genetic materials essential for the improvement of our present and future requirement.

In contrast, unique germplasm of the other priority species and threatened MAPs also be added to the field gene bank and put into long-term storage. Germplasm characterization and evaluation will concentrate on the high-ranking species. Recently we started conservation of a number of such important MAPs in the field gene bank.

Among high valued medicinal plants Kutki (*Picrorhiza kurrooa* Royle ex Benth.) Ban kakri (*Podophyllum hexandrum* Royle) and Kuth (*Saussurea lappa* (Falc.) Lipsch. are few important medicinal plants which need immediate attention due to over exploitation from the wild habitat. There is an urgent need to develop the agro-techniques of these plants to meet the industrial demands and to conserve the wild resources. On the other hand, the organically grown crops and their products have gained wide acceptability in international market and in even in national markets, the quality conscious people pay higher prices for such products. The practices of organic cultivation are more relevant for medicinal and aromatic plants cultivation. The development of agro-techniques of such high value medicinal plants based on organic production could provide alternative and economic livelihood support to the farmers of temperate areas of Himalaya region. Very few efforts have been made in this direction and if such high value medicinal plants come under cultivation, the farmers could be benefited by getting the right quality of raw materials and ultimately the end users could get the quality products.

Uttarakhand is an important part of the central Himalaya situated in the northern boundary of the India. It is endowed with an enormously rich flora of medicinal and aromatic plants. The physical and cultural environment here is highly conducive for the growth of many MAPs. The state govt of Uttarakhand has thus decided to adopt a policy that allows the extraction of medicinal plants from the wild only up to a sustainable extent and the promotion of large-scale cultivation of MAPs to meet the growing demands of industries. It is visualized that such an eco-friendly policy shall ensure proper development and conservation while at the same time providing suitable opportunities of better economic returns to the local communities.

**Table 1:** Detail of species conserved in field gene bank at Ranichauri along with their medicinal importance

S.N	Botanical name/ Family	Vernacular/ Trade name	Useful part (s)	Major chemical constituents	Medicinal systems	Important medicinal properties
1.	<i>Acorus calamus</i> L. (Araceae)	Sweet Flag, Bach,	Rhizome	Acorin, 6 $\beta$ -diol	Ayurvedic, Folk, Siddha, Tibetan, Unani, Western	Emetic, carminative, flatulence, diarrhea, digestive complaints, bronchitis, sinusitis. (Alam <i>et al.</i> , 2011) [1]
2.	<i>Ajuga bracteosa</i> Wall. Ex Benth	Nilkanthi	Whole plant	Limonene, $\alpha$ -humulene, $\beta$ - Myrcene, Elemol,	Folk	Astringent and tonic, diarrhea and dysentery, fevers as a substitute for

	(Lamiaceae)			Camphene, $\beta$ -Caryophellene, $\alpha$ -hellendrene		quinine (Kayani <i>et al.</i> , 2016) <sup>[16]</sup>
3.	<i>Allium humile</i> Linn. (Alliaceae)	Jambu faran	Aerial parts	flavonoids, alkaloids, phenols, terpenoids, and saponins.	Folk	Use as treating fever and heal stomach-related ailments, anti-microbial. (Kala and Nautiyal, 2023) <sup>[15]</sup> .
4.	<i>Aloe barbadensis</i> Mill (Liliaceae)	Aloe/ Ghikawar Ghrir kumari	Leaves	Aloin, anthranol, aloemodin, and chrysophanic acid (chrysophanol).	Ayurveda, Folk, Siddha, Tibetan, Unani, Western	Use in stomach disorders, acts as a pain reliever, due to analgesics in salicylic acid. It can also be used on blemishes and dandruff.
5.	<i>Aloe vera</i> L. Burm. T. (Liliaceae)	Gheekawar, Aloe	Leaves	Aloin, Vitamins A, B1, B2, B3, B6, B12, creatin, creatinine, HDL cholesterol.	Ayurveda, Folk, Siddha, Tibetan, Unani, Western	Wounds healing hydrating, rejuvenating and toning for skin Aloe vera moisturizes and softens your skin
6.	<i>Ammi visnaga</i> (L) Lam (Apiaceae)	Gangahi, Honey Plant,	Fruit and seeds	Xanthotoxin	Folk, Ayurveda	Cough, asthma (Alam <i>et al.</i> , 2011) <sup>[11]</sup> .
7.	<i>Amomum subulatum</i> Roxb. (Zingiberaceae)	Large Cardamom, Badi Elachi	Fruit and seed	1,8-cineol, limonene, terpinene, terpinyl acetate, sabinene Cardamomin limonene	Ayurveda, Folk, Siddha, Tibetan, Unani	Plant pacifies vitiated kapha, vata, anorexia, colic, flatulence, peptic ulcer, vomiting, wounds, ulcers, cardiac debility, cough, bronchitis, fever and diarrhea (Bisht <i>et al.</i> 2011) <sup>[8]</sup> .
8.	<i>Artemisia annua</i> Linn. (Asteraceae)	Sweet Wormwood	Leaves	Artemisinin, Arteether, artemether, artemotil, arteminol, dihydroartemisinin.	Ayurveda and Folk	Parasite treatment, Malaria treatment, cancer treatment, antimalarial activity (Gupta and Tandon, 2004) <sup>[12]</sup>
9.	<i>Asparagus officinalis</i> L. (Liliaceae)	Tendori, shatavar	Roots	Steroidal saponins, asparagusic acid anti-S-oxide methyl ester Steroidal saponins. Vitamins A, B1, B2, and folic acid. arginine, tyrosine, flavonoids	Ayurveda and Folk	Diuretic, laxative, induce sweating, gout, dropsy, and rheumatism, tonic, dysentery (Alam <i>et al.</i> , 2011) <sup>[11]</sup> .
10.	<i>Asparagus racemosus</i> Willd. (Liliaceae)	Satawar, Satamuli,	Root	Asparagin, shatavarin	Ayurveda, Folk, Siddha, Tibetan, Unani	Antidiarrhoeal, refrigerant, diuretic, antidysenteric, nutritive, tonic, demulcent, galactagogue, aphrodisiac and antispasmodic (Gupta and Tandon, 2004) <sup>[12]</sup>
11.	<i>Berberis aristata</i> DC. (Berberidaceae)	Barberry, Kilmor	Root, bark	Berberine, Berbamine, Palmatine, Oxyacanthine	Ayurveda, Folk, Siddha, Tibetan, Unani	diuretic <i>i.e.</i> promote urination in dropsy, jaundice and gonorrhoea (Bisht and Badoni, 2009) <sup>[7]</sup>
12.	<i>Berberis lycium</i> (Berberidaceae)	Berberis	Fruit, roots bark	Alkaloids, berberine, almatine	Ayurveda	sore eyes, broken bones, wounds, gonorrhoea, curative piles
13.	<i>Bergenia ciliata</i> (Haw.) Sternb. (Saxifragaceae)	Pashanbheda/ Silparari	Root, stolon	Gallic acid, Tannic acid, (+)-Catechin, Gallicin.	Ayurveda, Homoeopathy, Siddha, Tibetan, Unani	Urinary troubles, earaches, fevers, diarrhoea and pulmonary affections, coughs and colds, hemorrhoids, asthma. Root of dissolving stones in the kidneys (Zafar <i>et al.</i> 2019) <sup>[24]</sup>
14.	<i>Carum carvi</i> L. (Apiaceae)	Kala zeera,	Seeds	Limonene, carvone, apiole	Ayurveda, Folk, Homoeopathy, Siddha, Tibetan, Western	Food flavoring, fever, headache, (Semwal <i>et al.</i> , 2010) <sup>[22]</sup> ,
15.	<i>Centella asiatica</i> (L.) Urb. (Hydrocotylaceae)	Mandukparni	Leaf, Whole Plant	Glucoside asiaticoside and asiatic acid	Folk, Western	memory enhancer, coolant and relieves headache (Semwal <i>et al.</i> , 2010) <sup>[22]</sup> .
16.	<i>Chrysanthemum cinerariifolium</i> (Trevis) Vis. (Asteraceae)	Pyrethrum	Flower	Pyrethrins	Folk, Western	Natural insecticide, oleoresin. Pyrethrins attack the nervous systems of all insects,
17.	<i>Cinnamomum tamala</i> Nees and Eberm. (Lauraceae)	Tejpat	Fruit, Leaves Bark	Methyl eugenol, eugenol, trans-cinnamyl acetate and $\beta$ -Caryophyllene	Ayurveda, Folk, Siddha, Tibetan, Unani	flavouring tea, confectionary, cough and cold, Spice.
18.	<i>Curcuma longa</i> L. (Zingiberaceae)	Haldi, Turmeric	Rhizome	Curcumene	Ayurveda, Folk, Homoeopathy, Siddha, Tibetan, Unani	A wide range of biological activities e.g. anticancer, antimicrobial, anti-inflammatory and free radical scavenging activity.
19.	<i>Cymbopogon flexuosus</i> (Nees ex Steud.) Wats. (Poaceae)	Lemmon grass	Leaves	Citral-a (46.60%), Citral-b (27.7%)	Folk, essential oil	antibacterial, headaches, toothaches, baths, diuretic agent for fever, insect repellent (Farooqi and Sreeramu, 2010) <sup>[11]</sup> .
20.	<i>Datura starmonium</i> L. (Solanaceae)	Datura, Umathi	Leaves, seed	Tropane alkaloids, flavonoids, Coumarins, tannis, scopolamine,	Ayurveda, Folk, Homoeopathy, Siddha, Unani	Bronchitis, asthma

				hyoscyamine and metaloidin		
21	<i>Datura metel</i> L. (Solanaceae)	Kala Datura	Leaves, Fruit, seed	Stramonium hyoscyamine and small quantities of atropine and scopolamine	Ayurveda, Siddha, Western	Narcotic, an antispasmodic, bronchitis cigarettes or smoked in a pipe, Parkinson's disease (Farooqi and Sreeramu, 2010) [11].
22	<i>Digitalis lanata</i> Ehrh. (Scrophulariaceae)	Foxglove	Leaves	Digitoxin, digitoxigenin, glucogitoroside, glucolanadoxin, varadoxin, stropeside.		Cardiac glycoside, used in heartbeat slows, stimulates the flow of urine, used to treat ulcers in the lower abdomen.
23	<i>Digitalis purpurea</i> Linn. (Scrophulariaceae)	<i>Foxglov</i> , lady's glove	Leaves	digitoxin and digoxin		Medication for heart failure "reduced dropsy", increased urine flow and had a powerful effect on the heart
24	<i>Gloriosa superba</i> L. (Colchicaceae/ Liliaceae)	Glory lily, Kalihari	Fruit (seed), Root	Alkaloids, colchicines, colchicoside.	Ayurveda, Folk, Siddha, Tibetan, Unani	Traditional medicine, gout, infertility, open wounds, snakebite, ulcers, arthritis, cholera, colic, kidney problems, typhus, itching, leprosy, bruises, sprains, hemorrhoids, cancer,
25	<i>Gentiana kurroo</i> Royle (Gentianaceae)	Kadwi	Leaves, Roots	C-glucoxanthone mangiferin, iridoids, C-glucoflavones, and xanthenes	Ayurveda, Folk	Antibacterial, anti-arthritic, antioxidant, analgesic, anti- inflammatory, and anti-diabetic
26	<i>Hedychium spicatum</i> Sm. (Zingiberaceae)	Kapur kachari	Root	Essential oil, resins, organic acids, glycosides, albumen.	Ayurveda, Folk, Tibetan, Unani	Externally as eardrop during secretion from ears. asthma and bronchitis (Semwal <i>et al</i> , 2010, Bisht <i>et. al</i> . 2017) [4]
27	<i>Heracleum candicans</i> (Apiaceae)	Hogweed	Whole Herb	Isophellodenol, Candinol, Candibirins, Trifuranocoumarin canditirins candinols.	Ayurveda, Homoeopathy, Tibetan, Unani	Anti- microbial
28	<i>Inula racemosa</i> (Asteraceae)	Pushkarmool	Rhizome	Sesquiterpene lactones, alantolactone, isoalantolactone, inunal, isoalloalantolactoe, essential oil	Folk, modern, essential oil	Antiseptic, anti-bacterial, anti-fungal, anti-inflammatory, analgesic and mild diuretic, contagious fevers, heart disease cough, hiccup, bronchial asthma, indigestion, flatulence
29	<i>Iris germanica</i> L. (Iridaceae)	Ghurbach Puskaramulam	Root	Irigenin S, iriside A, stigmasterol (1), $\alpha$ -irone, $\gamma$ - irone 3-hydroxy-5- methoxyacetophenone irilone, irisolidone, irigenin, iridin	Folk, essential oil	diuretic, expectorant, stomachic, coughs, catarrh and diarrhea, wounds, dropsy
30	<i>Matricaria chamomilla</i> L. (Asteraceae)	Chamomile	Aerial parts, flower	farnesene, chamazulene, flavonoids and coumarin.	Homoeopathy, Unani, Western essential oil	Sore stomach, irritable bowel syndrome, gentle sleep aid, mild laxative, anti-inflammatory,
31	<i>Mentha arvensis</i> L. (Lamiaceae)	Pudina	Aerial parts,	Isomenthone, 1,8-cineole, borneol, and piperitenone oxide, carvone, limonene	Ayurveda	dehydration, vomiting and liver diseases indigestion (Semwal <i>et al</i> , 2010) [22]
32	<i>Mentha piperita</i> L. (Lamiaceae)	Peppermint, Menthol	Leaves	Menthol, methyl acetate, menthone, menthofuron, pinene, limonene,	Ayurveda	Respiratory congestion, coughs, bronchitis, inflammation digestive complaints, such as colic in infants, flatulence, diarrhea, indigestion.
33	<i>Ocimum basilicum</i> Linn. (Lamiaceae)	Sweet Basil, kali Tulsi, Ban tulsi	Whole plant, Fruit seeds	Camphor, cineole, estragol, eugenol, linalool, pinene		Diaphoretic, digestive, expectorant, stimulant, stomachic, abdominal cramps, gastro-enteritis, constipation, nausea and poor digestion.
34	<i>Pelargonium graveolens</i> L. Herit (Geraniaceae)	Geranium	Herbaceous parts	Geranial, citronello		Perfume scenting soaps, rhodinal (Farooqi and Sreeramu, 2010) [11].
35	<i>Perilla frutescens</i> Linn. Brit. Var. (Lamiaceae)	Bhangjeera	Folk	Perillaldehyde, perilla ketone, (Z)-3-hexenal (green), egoma ketone, isoeogoma ketone $\alpha$ - linolenic acid.	Folk	Oriental medicine, pungent, antibacterial, antidote, antipyretic, antiseptic, antispasmodic, antitussive, carminative, diaphoretic, emollient, expectorant.
35	<i>Picrorhiza kurroo</i> Royle ex Benth. (Scrophulariaceae)	Kutki, Karvi Kedar	Stolen & roots	Picroside I and Picroside II	Ayurveda, Folk, Siddha, Tibetan, Unani, modern	Fever, stomach ache, jaundice and dysentery (Semwal <i>et al</i> , 2010) [22]. Hepatoprotective.
37	<i>Plantago ovata</i> Forssk. (Plantaginaceae)	Isabgul, Syllium	Seed, Husk	Colloidal mucilage xylose, arabinose, galacturonic acid, rhamnose and galactose,	Ayurveda, Folk, Siddha, Unani, Western	Antidiarrhoeal drug, constipation, intestinal disorders, promoting regular. Antioxidant, antibacterial, anti- inflammatory,

38	<i>Podophyllum hexandrum</i> Royle (Berberidaceae)	Ban kakri, Bakr-chimka	Root and rhizome	medicinal resin which is utilized almost entirely for podophyllin	Ayurveda, modern	Skin diseases, wounds and cancers, blood purifier (Semwal <i>et al.</i> , 2010) [22]
39	<i>Potentilla fulgens</i> Wall.ex Hk.f. Nepolinsis hook (Rosaceae)	Bajardanti	Whole plant	Polyphenols, tannins, flavonoids, riterpenoids	Ayurveda, folk	Teeth cleaning, toothache and pyorrhea (Semwal <i>et al.</i> , 2010) [22]
40	<i>Rheum emodi</i> Wall. Ex Meissn. (Polygonaceae)	Archa, Rhubarb	Rhizomes	revandchinone-1, revandchinone-2, revandchinone-3, revandchinone-4, emodin, aloe-emodin, chrysophanol, rhein,	Folk, Ayurvedic	Root paste and turmeric powder mixed with refined fat is applied for skin problem; paste is taken orally to relieve muscular pain, abdominal pain and dysentery (Semwal <i>et al.</i> , 2010) [22].
41	<i>Rosa damascena</i> Mill. (Rosaceae)	Damask Rose	Flower, Petals,	Citronellol, nonadecane, geraniol hencicosane, $\beta$ -phenyl ethylalcohol	Ayurveda, Folk, Homoeopathy, Siddha, Unani	Perfumery materials cosmetics, beverages, cold drinks as flavoring agent (Farooqi and Sreeramu, 2010) [11].
42	<i>Rosmarinus officinalis</i> L. (Lamiaceae)	Rosemary	Flowers, leaves	1,8 cineole, borneol, camphor, linalool, $\alpha$ -pinene, camphene, $\beta$ -pinene, sabinene, myrcene	Folk, Homoeopathy, Western	Cosmetics, Culinary purposes, Flavouring Perfumery (Farooqi and Sreeramu, 2010) [11].
43	<i>Roylea cinerea</i> (D.Don) Baillon (Lamiaceae)	Karwi	Whole Plant	Terpenoids, alkaloids, and phenols cetylalcohol, palmitic acid, stearic acid, oleic acid, triterpenoid, moronic acid	Folk, Homoeopathy,	For treating diabetes, fever, jaundice, ma laria, pimples, and flatulence. It is also used as a blood purifier and for treatment of common cold and cough. (Pundir, and Mahindroo 2019) [19].
44	<i>Rubia manjith</i> , syn. <i>Rubia cordifolia</i> (Rubiaceae)	Majith, Manjistha	Root	Purpurin, xanthopurpurin, mujistin, free alizarin	Ayurveda, Folk, Siddha, Tibetan, Unani	Tonic, astringent, antidysenteric, antiseptic, deobstruent properties. rheumatism ulcers, inflammations, skin troubles (Ravikiran <i>et al.</i> 2022) [20].
45	<i>Salvia sclarea</i> Linn (Lamiaceae)	Clary Sage	Fruit (seed)aerial parts	$\alpha$ -pinene, cineole, linalyl acetate, thujone, borneol, bornyl acetate, farnesol and camphor		Perfumes, flavoring wines and liqueurs. anxiety and fear, menstrual-related problems, cramping,
46	<i>Saussurea costus</i> (Falc.) <i>S lappa</i> Lipsch. (Asteraceae)	Kuth, Kushta	Root, Stem	Saussurine and taraxasterol	Ayurveda, Folk, Siddha, Tibetan, Unani	Antiseptic, disinfectant, insecticidal, carminative properties, pulmonary disorders, difficulty in swallowing and wasting of muscle tissues (Nautiyal and Nautiyal, 2004) [17]
47	<i>Spilanthes acmella</i> Murr. (Asteraceae)	Akarkara	flower head and root	Alkaloids, tan-nins, essential oils and flavonoids (Jagan Rao <i>et al.</i> , 2012) [13]	Folk Ayurveda	vitiated vata, kapha, pain, arthritis, tooth ache, stomatitis, fungal infections, ulcer, general weakness (Dubey <i>et al.</i> 2013) [10].
48	<i>Swertia angustifolia</i> Buch. -Ham ex D. Don (Gentianaceae)	Chiraeta, Shireen	Whole plant	14 tetraoxygenated penta-oxygenated xanthenes	Ayurveda, Unani	Treat malaria fever, cold, cough (Bhatt <i>et al.</i> 2007) [2]
49	<i>Swertia chirayata</i> (Roxb. Ex Fleming) H. Karst. (Gentianaceae)	Chiraiyata	Whole plant	Amarogentin, Swerchirin	Ayurveda, Folk, Homoeopathy, modern	Stomach ache, and febrifuge, anathematic fever, diarrhea and weakness (Nautiyal <i>et al.</i> , 2004) [17].
50	<i>Swertia chordata</i> (Gentianaceae)	Chirayata	Whole plant	Xanthenes, Iridoids and secoiridoids Triterpenoids, Flavonoids, Lignans,	Ayurveda	Anathematic fever, diarrhea and weakness (Nautiyal <i>et al.</i> , 2004) [17].
51	<i>Tagetes minuta</i> L. Schrank (Asteraceae)	Wild Marigold	Aerial part	dihydrotagetone, tagetone, ocmenone	Folk, modern, essential oil	Anti-infectious, anti-microbial, antibiotic, anti-spasmodic, anti-parasitic, antiseptic, insecticide and sedative, fungal infestation (Reddy <i>et al.</i> 2015) [21]
52	<i>Taxus wallichiana</i> Zucc. (Taxaceae)	Himalayan Yew		abeo-baccatin, buJanone, buJanol,	Ayurveda, Homoeopathy, Western	Anticancer drug, paclitaxel
53	<i>Urtica dioica</i> L. (Urticaceae)	Kandeli, Bicchu-booti, Nettle	Leaves	$\beta$ -sitosterol, trans-ferulic acid, dotriacotane, erucic acid, ursolic acid, scopoletin, rutin, quercetin and p-hydroxybenzalcohol.	Ayurveda, Folk, modern essential oil	Paralysis, Joints and muscular pain (Semwal <i>et al.</i> , 2010) [22].

54	<i>Valeriana jatamansi</i> Jones (Valerineaceae)	Indian Valerian/ Musakbala, Tagar	Root, rhizome	Valeric acid, valerenic acid, valechlorine, limonene, choline, tannins, resins and bornyl formate, eugenyl, isovaleriate.	Ayurveda, Folk, Homoeopathy, Siddha, Tibetan, Unani	Sleep disorders and anxiety, headaches, depression, (Negi <i>et al</i> ; 2007) <sup>[18]</sup>
55	<i>Viola odorata</i> (Linn.) (Violaceae)	Banafshah		Nonadienal, parnone, hexyl alcohol, bezyl alcohol, ionone, viola quercitin	Folk	Emetic, purgative, expectorant, emollient, diaphoretic, expectorant, lung troubles, cough, kidney and liver diseases
56	<i>Withania somnifera</i> (L.) Dunal (Solanaceae)	Ashwagandha winter cherry	Root, Whole Plant	Withanine A, somniferine, withanolides	Ayurveda, Folk, Homoeopathy, Siddha, Tibetan, Unani	Consumerism, sexual and general weakness and rheumatism, diuretic ulcers, inflammations. Crystalline

## Conclusion

The efficacy of the medicinal plants that grow here is perhaps as old as these mountains itself. The therapeutic value of some of these plants are mentioned in the oldest Hindu scriptures i.e. *Rigveda*, which is said to be the source of ancient medicine, the system of Ayurveda. *Charaka* also describes the Himalayas as the best habitats for medicinal herbs.

In recent years, the search for safe and new therapeutic agents from plant sources has been intensified all over the world due to increasing awareness about the harmful side effects of modern synthetic drug and antibiotics, and it form an essential and integral component of the new drug development programme. This has increased the demand of more medicinal plants to meet the requirements of pharmaceutical industries and research institute of the world and since the plant materials required are collected from natural sources, the over exploitation has caused serious threat to the survival of medicinal plants in their natural habitats. Landslides, erosion, avalanches threaten the natural resources of Garhwal Himalaya further, construction of road and dams, mountaineering, tourism, earth quakes and grazing by sheep, goats and other domestic animals. And it is an acknowledged fact that if such heavy grazing and destruction of medicinal plants continued, the time is not far when these plants will become scarce or disappear from their natural habitats. This will not only be a set back to the drug industry but will also result in the non-availability of safe plant-based drugs for humanity.

Some treasured medicinal plants of Garhwal Himalaya, collected from study area, which are over exploited for sale or other purposes and have become rare in their natural habitats e.g *Acorus calamus* Linn., *Asparagus adscendens* Roxb, *Asparagus racemosus* Willd, *Bacopa monnieri* Linn., *Dioscorea deltoidea* Wall. ex. Kunth, *Hedychium spicatum* Ham. ex Sm., *Nardostachys jatamansi* DC. *Valeriana jatamansi* Jones etc.

A major problem in the conservation of Himalayan medicinal species is the uncontrolled and illegal exploitation. (Bhadula *et.al*, 2000). Moreover, the rate of exploitation far exceeds the rate of their natural regeneration. That is why most of the medicinal plants in this area have attained endangered status (Bisht 2005, Bisht and Bhatt 2012) <sup>[5, 6]</sup>. Increasing dependency on forest is an essential prerequisite to check the conservation of forest-based biodiversity. Ecologists are generally good diagnosticians of human environmental interactions but aren't successful in managing or changing those interactions. With the scientists and specialists outside the natural science and academics, applying their views and

knowledge for "how earth is changing and what can be done about it?" we can save our vegetational wealth.

Ex situ conservation is some cases effective way legislation is needed to protected medicinal plants species. For ex situ conservation, there are provisions in the legislation (Klemm, 1990). However, in respect to others, it has been observed that regulations have been largely ineffective in controlling medicinal plant exploitation (Cunningham, 1993). Even, sometime such regulation increases manifold pressure on species growing in the wild, especially endemic ones, that cannot be supplied to the concerning agencies from any other source/ region. Officially these and many other important species are not allowed for collection and trade but the threat of illegal business to these herbs has increased at the rate even more than that occurred due to legal collection in the past (Bhatt, 1999). The other possibility to explore alternative, easy and effective method of conserving rare species in situ, at the moment, seem to be the ex-situ cultivation of herb at least if the species required in great quantities for medicine.

Himalayan range is unique on this planet with its rich biodiversity, scenic richness and home for many prominent rivers. The Himalayan mountains have been a subject of profound and paramount interest by the explorers, naturalists and researchers. In the Himalayan region the pace of development in every aspect and its impact on human societies has not achieved a proper momentum. The difficult terrain and the insufficient investigations may be the reason for its social and regional imbalances. With the formation of the Garhwal Himalaya it is anticipated that more attention would be paid to overcome these imbalances.

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