8TH HIMALAYAN POPULAR LECTURE

Prof. Rajinder S. Chauhan

September 10, 2021
Kullu

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(An autonomous Institute of Ministry of Environment, Forest & Climate Change, Govt. of Bharat)
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Conservation and Sustainable Utilization of High Valued Medicinal Herbs of North-Western Himalayas

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Conservation and Sustainable Utilization of High valued Medicinal Herbs of North-Western Himalayas

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Introduction

Medicinal herbs have a rising demand in global healthcare. Out of total 18,532 plants found in India, approximately 7000–7500 rich varieties of medicinal plants are being widely used for various therapeutic applications (shiva, 1996). India is the second largest exporter of raw herbal drugs in the global market, following the lead of China (Lange, 2004). Major parts of the raw materials utilized for exportation purpose constitute the Himalayan region medicinal plants (Rawat, 2005). North-western Himalayan region in India include the states of Jammu and Kashmir, Himanchal Pradesh and Uttarakhand, have been the shelter for these medicinal plants since ages. Indian Himalayan region contains about 1750 different varieties of medicinal plants with traditional and modern uses (Samant et al., 2007). Humans have been using medicinal plants for their food, fodder and remedy since the Vedic period. Ayurvedic, Unani, siddha, folk (tribal) and also the Tibetan system of medicine are based on the use of Himalayan species of medicinal herbs.(Article, 2015). Herbal drugs used in pharma industries are mostly derived from wild plant species. Recent times have shown how these medicinal plants can play a major role in the economy of our country. But due to high commercial demand and less production these high valued medicinal plants are in threat to getting extinct. Herbal drugs used in pharma industries are mostly derived from wild plant species. Recent times have shown how these medicinal plants can play a major role in the economy of our country. But due to high commercial demand and less production, these highly valued medicinal plants are on the verge of becoming threatened or extinct.

Pharmacological importance of Medicinal herbs:

Medicinal plant-derived drugs have drawn a special attention due to their higher efficiency and minimum side effects. The pharmacological benefits of these plants are primarily due to bioactive phytochemicals produced in the plant tissues in the form of primary and secondary metabolites. Most of these phytochemicals include terpenoids, alkaloids, glycosides, flavonoids, phenolic, saponins, tannins and steroids (Sukhpal Singh, 2022). These phytochemicals have various therapeutic uses such as anti-inflammatory, antiviral, antitumor, antimalarial, antibacterial, anticancer, antioxidant, hepatoprotective, antipyretic, immunomodulatory, antidiabetic.(Aye et al., 2019) Medicinal plants are also a valuable source to produce a wide range of secondary metabolites with applicability in pharmaceuticals, agrochemicals, flavors, fragrances, colors, food preservatives, biopesticides (Singh & Sedha, 2018)

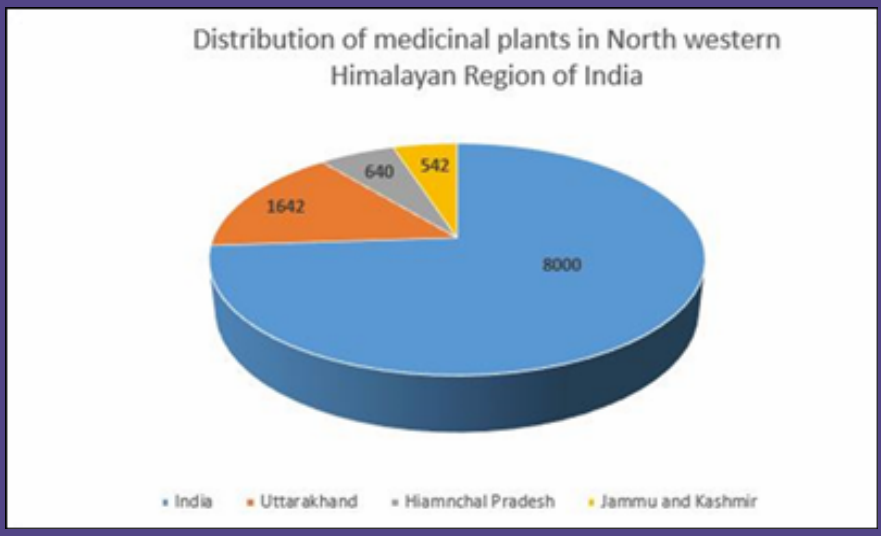

Figure 1: Distribution of medicinal plants in North western region of India. (Source: BSI and data from different states)

Common medicinal and aromatic plants found in north western region of Indian Himalayas with their conservation status and medicinal values are listed in the Table 1 below.

S. No.	Scientific name	Common Name	Part used	Conservation status	Medicinal value
1.	Picrohiza kurroa	Kutki	Roots, rhizome	Endangered	Hepatoprotective, immunomodulatory, anti-inflammatory, in treatment of jaundice, periodic fever, nausea and anorexia, dyspepsia, bronchial asthma
2.	Nardostachys jatamansi DC	Jatamansi	Rhizome	Critically endangered	Diuretic, antiarrhythmic activities, anti-spasmodic, in treatment of epilepsy, hysteria, convolutions, heart palpitation, intestinal colic
3.	Swertia chirayita	Chirata	Whole plant		Liver disorders; stomach disorders like dyspepsia and diarrhea, intestinal worms, ulcer, gastrointestinal infections, and kidney diseases
4.	Podophyllum hexandrum	Bankakri	Roots, rhizome	Critically endangered	Treatment of colds, constipation, septic wounds, burning sensation, erysipelas, mental disorders plague, allergic and inflammatory conditions of skin, cancer of brain, bladder and lung, venereal warts, leukemia
5.	Rubia cordifolia	Manjith	Stem, roots	Threatened	Treatment of cancers, tuberculosis, rheumatism, hematemesis, metrorrhagia, epistaxis, and menoxenia, healing wounds, inflammation, skin infections
6.	Aconitum chasmanthum	Zaharmora	Rhizome	Endangered	Nephroprotective, Antidiarrheal, Antimicrobial, anthelmintic, anti-emetic, anti-inflammatory.

7.	Boswellia serrata	Indian oli-banum, Salai guggul	Dried gum resin	Not extinct; not yet assessed for the IUCN Red List	Analgesic, Anticomplementary, Anti-inflammatory, reduce blood glucose levels
8.	Gymnocladus assamicus Kanjilal ex	Menangmanbashi	Seeds	Critically endangered	Used in skin diseases including eczema and acne. They are also used to feed livestock
9.	Tribulus terrestris	bindii	Fruit	Least concern	It has diuretic, aphrodisiac, antiurolithic, immunomodulatory, antidiabetic, absorption enhancing, hypolipidemic, cardiotonic, central nervous system, hepatoprotective, anti-inflammatory, analgesic, antispasmodic, anticancer, antibacterial, anthelmintic, larvicidal, and anticariogenic activities.
10.	Commiphora wightii	Guggul	Dried reisin and gum	Criticaly endangered	The gum has anti-inflammatory and efficacious in the treatment of arthritis, rheumatism, hyperlipidemia,thrombosis,and hypercholesterolemia.
11.	Dolomiaea costus	Kuth	Rhizomes	Critically endangered	anti-inflammatory, anti-ulcer, anticancer and hepatoprotective activities

12.	Angelica glauca Edgew	Chora, Choru, Gandrayan	Roots Rhizome	Endangered	It is used in dyspepsia, constipations, ulcer of palate, infantile atrophy, dysentery, menorrhagia and rinderpest
13.	Alkanna tinctoria	Ratanjot	Roots	critically endangered	Possesses antipyretic, cancer, contraceptive, emollient and vulnerary. It is used in the treatment of measles, mild constipation, burns, frostbite, eczema, dermatitis properties
14.	Phytolacca acinosa Roxb	Jharka	Complete plant	Endangered	Ech part of plant sedative, antispasmodic, in convulsive disorders and as an antidote for poisoning.
15.	Berberis aristata	Chitra Daru haldi	Whole plant	Least concern	It has antibacterial, antiperiodic, antidiarrheal and anticancer activity
16.	Betula utilis	Bhojpatra	Bark	Least concern	It is used to treat skin disinfectant, diseases of the blood and the ear, convulsions, wound healing, bronchitis, leprosy
17.	Bunium persicum	Kala jeera	Seeds and fruit	Not extinct; not yet assessed for the IUCN Red List	It helps in gastro intestinal illnesses, including diarrhea and inflammatory bowel disease
18.	Colchicum luteum	Suranjan,Hirantutiya	Corms and seed		It is used to treat gout, rheumatism, and diseases of liver and spleen, it also relives inflammation and pain

19.	Dactylorhiza hatagirea	Salampanja	Tubers, roots	Critically Endangered	It is used for its astringent and aphrodisiac properties, and it is widely used to treat dysentery, diarrhea, chronic fever, cough, stomachache, wounds, cuts, burns, fractures and general weakness
20.	Desmodium gangeticum DC	Sarivan	Roots and whole plant	Data not avaliable	Plant has febrifuge, aphrodisiac, analgesic, diuretic, antiinflammatory, and haemorrhagic properties
21.	Didymocarpus pedicellata R.Br	shilapushpa pasanbheda	Root	Laest cocern	It treats renal diseases particularly kidney stones and bladder Khare
22.	Solanum virginianum	Baniatakari	Rhizomes	Endangered	It is useful in digestive disorders, sore of throat for struma, diarrhea, irritability, abdominal pain, wounds, burns, anemia.
23.	Crinum latifolium	Somvalli	Leaves	Vulnerable	It is a stimulant and helps in medicine for colds, coughs, bronchitis, asthma, and arthritis
24.	Lilium polyphyllum	Kakoli	Roots and corms	Critically endangered	It has anti-asthmatic, anti-rheumatic, anti-tussive properties properties.
25.	Habenaria intermidia D. Don	Riddhi	Tubers	vulnerable,	It is used to treat pitta and vatta, agalactia, seminal weakness, internal and external haemorrhages, cough, bronchitis, burning sensation
26.	Hyoscyamus Niger	Khurasani ajwain	Leaf , flower and seed	decreasing	Used to treat ailments of the bones, rheumatism, toothache, asthma, cough, nervous diseases, and stomach pain

27.	Hypericum perforatum	Choli phulya	Tuber	Endangered	It is used as used as intellect promoting, aphrodisiac, depurative, anthelmintic, rejuvenating and tonic
28.	Hyssopus Officinalis	Jupha/ Zufa.	leaves and flowers	Decreasing	It is a stimulant, carminative and expectorant and is used in colds, coughs, congestion and lung problems
29.	Juniperus communis	Aaraar, haubera, abhal	Berries, leaf, bark and wood	Least concern	It has diuretic, anti-arthritis, anti-diabetes, antiseptic as well as it is used to treat gastrointestinal and autoimmune disorders
30.	Commiphora wightii	Gugul	root	Critically Endangered.	It is used in treatment of different types of fever
31.	Gloriosa superba	Kalihari	Bulb and roots	critically endangered	It is used in the treatment of hyperdipsia, intermittent fever, haematemesis, rheumatalgia, bronchitis and general disability
32.	Litsea glutinosa	medh, chandna, maidalakri	Root, bark, leaves	Least concern	It is used in reducing fever, reducing swelling, and treat diarrhoea
33.	Malaxis acuminata	Jeevak	Bulb	Vulnerable	It is useful for sterility, vitiated conditions of pitta and vata, seminal weakness, internal and external hemorrhage, dysentery, fever, emaciation, burning sensation and general debility
34.	Alkanna tinctoria	Ratanjot	Roots	Threatened	Possesses antioxidant, anti-inflammatory, cytotoxicity and antibacterial actions
35.	Oroxylum indicum	Sonapatha	Whole Plant	Endangered	Astringent, tonic, anti-diarrhoeal, diuretic, anodyne, and is used to cure dropsy it also possesses anti-rheumatic

36.	Paeonia emodi	Mamekh	Rhizomes	Vulnerable	Used for treatment of hysteria, abdominal spasm, hypertension, palpitations, congestive heart failure and atherosclerosis
37.	Paris polyphylla	Satuva	Rhizomes	Critically endangered	Used for analgesic, antibacterial, anti- phlogistic, antispasmodic, antitussive, any poisonous bites, burn, cut or injury, depurative, detoxification, diarrhea, dressing, dysentery, febrifuge, fever, gastric, gastritis, intestinal wounds, narcotic, poisoning, rashes or itching, scabies, skin diseases, sleeplessness, snake bite, stomach pain, typhoid, ulcer and wounds
38.	Polygonatum verticillatum	Maida	Rhizome	Endangered	adaptogenic, antioxidant, cardiotonic, demulcent, diuretic, energizer, hypoglycemic, tonics, antibacterial and antifungal
39.	Rheum rhabarbarum	Rhubarb	roots, stems, leaves	not yet assessed for the IUCN Red List	It is used for the management of renal function disorders, hyperlipidemia, cancer and improves the memory in senile patient. It also cures indigestion, abdominal diseases, astringent, boils, purgative, wounds and flatulence.
40.	Roscoea procera	Kakoli	roots	Threatened	Used to treat diabetic, hypertension, diarrhea, fever, inflammation
41.	Saussurea obvallata (DC.)	Brahma Kamal	Roots	endangered	Used in paralysis, cerebral ischemia, wounds, cuts, bruises, liver disorders, bone-ache, cough, intestinal and urinal problems.
42.	Selinum vaginatum	Bhutkeshi	Roots	Threatened	It is used to treat high blood pressure, sleeping disorders, neurological disorders

43.	Skimmia laureola (DC.)	Ner dhoop	leaves	Endangered	The leaves are used in the treatment of smallpox.
44.	Symplocos paniculata	Lodh	Bark	Endangered	Used to treat treatment for dysentery, bowel complaints, inflammations, snake bites, vaginal discharges and miscarriages
45.	Abies webbiana	Talispatra	leaves and bark	Endangered	Used to treat common cold, cough, fever, and pain.. Also possesses Anti cancerous activity
46.	Terminalia chebula	chebulic myrobalan, Harar	Dried fruits	Least concern	Antibacterial, antifungal, antiviral, antidiabetic, antimutagenic, antioxidant, antiulcer and wound healing. Prevents cardiac damage and for treatment of kidney disease.
47.	Uraria picta	Prishniparn Pithavan, Dabra	Roots and whole plant	Least concern	Anti-inflammatory, expectorant, and diuretic properties. It isalso used for healing fractures.
48.	Zanthoxylum armatum	Tejbal, Nepali dhaniya, Timir	Fruits, seeds, and bark	Least concern	Used in dyspepsia and fever also has stomachic, carminative, antioxidative, anti-inflammatory, antimicrobial, insecticidal, larvicidal and antihelminthic properties
49.	Withania somnifera	Indian ginseng	Dried roots	not yet assessed for the IUCN Red List	anti-microbial, anti-inflammatory, anti-tumor, anti-stress, neuroprotective, cardioprotective, and anti-diabetic
50.	Aconitum ferox Pennel	Meetha vish	Roots	Endangered	Diaphoretic, diuretic is analgesic, febrifuge, anti-inflammatory, anti-rheumatic, anti-pyretic, and vermifuge. Sedative, narcotic.

51.	Eremostachys superba	Gajar moola, Van Mooli	Roots	Endangered	Used for treatment of human ailments related to liver, stomach, gout etc.
52.	Gentiana kurroo Royle	kuru	Rhizome	Endanegered	antiperiodic,expectorant, astringent, stomachic,anti-inflammatory, antipsychotic,sedative, anthelmintic and antibacterial
53.	Schrebera sweitenioides	Banpalas Mokhdi Mokha	Leaf Stem Root Bark	vulnrable	digestive, thermogenic, stomachic, depurative, constipating urinary astringent and anthelmintic
54.			Leaf and stem	Threatened	Provide relief in sores, swelling, sciatica, liver diseases, stomach aches, chest pain and respiratory problem
55.		Kunai	Pseudobulbs	Endangered	Detoxification and treatment of cough. It is also used to stop bleeding and relieves pain.
56.			Leaves and roots	Threatened	sudorific and aphrodisiac , hair tonic
57.	Artica dioica	Kanali	Leaves and fruits	Highly threatened	Used to treat body and muscle pain
58.		Graiti , Katrar	Wood	Endangered	used to treat cuts and wounds.
59.	Meizotropis pellit	Patwa	Leaves	Critically endangered	Antioxidant , Antimicrobial, Anticancerous
60.	Trachycarpus takil	Kumaon fan palm, Jamar	Leaf	Endemic	

Apart from medicinal applications, herbs are also used in natural dyes, pest control, food additives, perfumes, tea and so on. Furthermore, some herbs are also used to keep ants, flies, mice and flee away from homes and offices.

Medicinal herbs are important sources for pharmaceutical manufacturing eg. Many medicinal herbs such as Guggul (Commiphora wightii), Kutki (Picrorhiza Kurroa), Kuth (Saussurea lappa), Jatamansi (Nardostachys Jatamansi) are a major raw material for many industries such as Dabar, Zhandu, Himami, etc. Another report by World Health Organization reveals that about 80% of the world's population relies on medicinal herbs for healthcare in one or the other aspect of their needs of primary health care (WHO, 2003). It has been estimated that about 20,000 different varieties of plants worldwide have the possibility of being used as medicinal plants. Government of India shares that 65% of the Indian population depends on herbs for their health care needs. Herbal plants being safe with minimal side effects are the biggest advantage when compared with modern ways of treatment. In recent years, the demand for Indian medicinal plants has increased considerably both at local and global levels.

Threatened status of medicinal plants:

Himalayan forests house a diverse range of medicinal and aromatic plants; and its Indian counterpart has been observed to be a mega-biodiversity hotspot throughout the world (Marris, 2010). However, the habitat destruction of medicinal plants due to modern agriculture has led to the loss of indigenous knowledge. It has been estimated that about 90% of medicinal plants presently in use are collected from the wild. Of these collected medicinal plants, 70% of collection mainly involves destructive harvesting (Ved, 1998). Majority of the herbal material being used by us is collected from wild that has resulted in the endangered status of these medicinal herbs.

Major factors responsible for the threatened state of these medicinal plants have been enlisted as follows:

1. Non sustainable, destructive and high density harvesting by plant collectors

2. Decline in traditional knowledge among local communities regarding use of medicinal plants

3. Overharvesting of material due to low value of plant material paid to them Increased international demand of medicinal herbs

4. Commercialization of medicinal plants and increased accessibility of traders to remote areas

5. Excessive or prolong deforestation

6. Natural phenomenon like landslide, forest fire, global warming, draught, cloud burst

7. Poor reproducibility and lack of good harvesting practices

Increasing demand for uncontrollable collection and deforestation has led to their depletion in wild. Moreover, natural as well as manmade calamities has led to further depletion of these naturally occurring medicinal herbs. Since ancient times Indian subcontinent has been known for its diversity in medicinal herbs and old age traditional traditions of medicine. It is a golden fact that use of herbal treatment is independent of any age or gender. Local inhabitants rely on these medicinal herbs for their medicinal needs since generations. These medicinal plants are also a source of livelihood and income generating source for many local communities (Lacuna-Richman, 2002). Conventional and plant based healthcare industries depend on these medicinal plants for their manufacturing needs. Trade industry comprises of about 960 medicinal plants of which only 187 are found to have annual consumption of 100 million Tonnes (Indian Medicinal Plant Board, 2010).

The age-old traditional values attached with the various forest types and the varieties of forest products (i.e., medicinal plants) have gained tremendous importance in the present century especially at this present time of Covid-19 pandemic old aged valued and different types of herbs and other medicinal products have gained tremendous importance. Eg? Moreover, present-time cosmetic industries are using a lot of natural ingredients and most of the natural ingredients have direct or indirect relationship with medicinal plants. (C. Kala, 2004). Recent time has seen an escalating trust and Trust in the Herbal medicine. Allopathy medicines are known to cure wide range of disease but being very expensive they are not in the easy reach of common people in a developing nation like India. Further the side effects of these allopathic medicines have made people to move back to herbal medicines that are now only within reach of common people but are also known to have fewer side effects (Kala et al., 2006). The rising demand in plant based pharmaceutical products have unfortunately created a huge pressure on these industries resulting in overharvesting from the wild habitat (Nautiyal et al., 2002). It has been clearly seen that many of these herbal plants

have slow rate of reproducibility, slow growth rate, low population densities, and narrow geographic range due to which they are more in threat of being extinct. (Chen et al., 2016) Also, due to increasing population there has been a good rise in the use to these plants as food and fodder by the local habitants as majority of the population in developing countries depends on.

The overharvesting has led to the decrease in their wild populations (Nautiyal et al., 2002). It is also known that 25% of the available medicines in market are one or the other way derived from plants that has added to the adulteration of these medicinal and aromatic plants occurring in the wild. (Rao et al., 2004). One of the major reasons for decline in growth and natural habitat of these Himalayan plants are due to rapidly changing environmental conditions; as a result of increasing pollution and rapidly changing temperature of our ecosystem Any eg?. With the passage of time, traditional knowledge of these plants is not carried forward to the next generations, consequently, resulting in negligence of their importance (some example?). It has also been seen that many a times overgrazing by the livestock limit the presence of the herbal material in a specific area. With the increasing population people have started constructing their houses in the natural habitat of these plants. This step has not only destroyed the plant variety from that particular area but also decreased the chances of their growth in their natural habitat. Non-natives in a particular location adulterate the natural habitat of these plants that has resulted in their disappearance from that particular area. Like certain areas of Himanchal Pradesh and Uttarakhand were only inhabited by local residents due resent time has seen huge amount of construction For tourists especially has led to threat of many useful medicinal plants. Many of these medicinal plants do not have any alternatives as a result they are overexploited by humans. The degree of overexploitation decreases with plants having alternatives in their use. Sometimes natural agents such as birds, pathogens, landslides, land erosion, etc. also act as enemies to the medicinal plants growing in a particular area. (Kala et al., 2006)

Flora of Indian Himalayan region is being destroyed at a rapid and alarming rate and in order to serve the health needs of people it has become very necessary to protect and conserve these medicinal plants through different traditional as well was modern ways (Conservation, National Medicinal Plants Board, Ministry of AYUSH, Government of India. Available from: https://www.nmpb.nic.in/content/conservation (Accessed (not set) March 2020).) After understanding the great significance and increasing threats on this invaluable resource, conservation efforts are being made on priority basis. Presently, about 4.5% of the geographical area of India, i.e., approximately 10 million hectares, are under the in-situ conservation

programme. (N.P. Singh, 2002). Different agro-techniques developed by various institutions on cultivation of Himalayan plants are still in their initial stages and are yet to be implemented in farmer's field. Initiating cultivation of medicinal plants is viewed as the most viable long term alternative to ensure sustainable supply of the raw material (UCN. 1993). Some species of these medicinal plants can be protected through increased regulation and the introduction of sustainable wild harvesting methods to certain extent (WHO, 2003). These procedures are not adequate for meeting bulk demand of medicinal raw materials to the pharmaceutical industries.

Table: Medicinal plants that are commonly used in Indian household (Peter & Singh, 2018)

Medicinal Use	Plants
Heal wounds, Sores and Boils	Cinnamon, myrrh, aloe, sandalwood, ginseng, red clover, burdock, bayberry, and safflower
Treat a fresh cut and wound	Honey, turmeric, marshmallow and liquorice
Nutritive and Rejuvenates	Giloe, Golden seal, Aloe and Barberry
Stimulants	Lal Mirch, Myrrh, Camphor and Guggul
Reduce toxins in Blood	Aloe, Golden seal, Barberry and Chirayata
Cardiac stimulants	Chamomile, Calamus, Ajwain, Basil, Cardamom, Chrysanthemum, Coriander, Fennel, Peppermint and Spearmint, Cinnamon, Ginger and Turmeric
Expectorants	Ginger , Eucalyptus, Cardamom, Wild cherry and cloves
Antiseptic	Aloe, sandalwood, turmeric, sheetraj hindi and khare khasak
Astringents	Sandalwood and Cinnamon
Antipyretic	Chirayita, black pepper, sandal wood and safflower

Factors affecting the increasing demands of medicinal plants

From seasons to years, the use of medicinal plants sees a rapid change. For example, the use of medicinal plants increases in winters as compared to the summer season. People usually suffer from cold, cough, flu etc. during winters as a result of which demand for herbal medicine increases that is usually low during summers. Further local residents use these herbs for various homemade drinks such for not only treating these problems but also for increasing the immunity during winters. Some of the major herbs used by local inhabitants include Tulsi (Ocimum sanctum), Haldi (Curcuma longa), Giloy (Tinospora cordiofolia), Black pepper (Piper nigrum), Ginger (Zingiber officinale), Clove (Syzygium aromaticum), Cardamom (Elettaria cardamomum), lemon (Citrus limon) and Ashwagandha (Withania somnifera).

Change in lifestyle of people has played a major role in use of medicinal plants nowadays people are shifting themselves from allopathy to herbal ways to treatment this has not only put some extra burden on industries but also increased the use of medicinal plants. As our economy is growing fast, we find more startups being formed year per year and most of these startups are relying on natural ingredients as their raw products that has further adulterated the medicinal herbs collected from wild. Also, as new diseases are getting introduced people are relying on herbs and herbal drinks in order to protect them. In recent times due to COVID19 pandemic the use of medicinal plants has increased not only at household level but also at industrial scale. There is a huge gap in supply and demand of medicinal plants to manufacture Ayurvedic medicines in India. As per the report from 'All India Trade Survey of Prioritized Medicinal Plants' (2019) stated that the demand for high-value medicinal plants has increased by 50% in contrast to a decline in their availability by 26%. This increasing demand has led degradation of natural habitat and increased over-exploitation not only pharmaceutical industries but also by local inhabitants as these plants are a major source of their revenue. . This also resulted in 65 species (i.e., 10% of the total species) falling into the critically endangered, endangered, vulnerable, and nearly threatened categories. (ibef.org)

Why is conservation necessary?

Conservation deals mainly with the sustainable use of these plants in such a way that they neither get depleted nor their ecosystem is destroyed. Various parts of the plant such as leaves, bark, roots, fruits, seeds or even whole plant are indiscriminately uprooted from wild sources without taking proper care of saving the plant sources. As more than 95% of the available medicinal plants are collected from wild that has resulted in the habitat destruction of these plants (ref?). Due to overexploitation many of these medicinal plants are at either endangered or at the

verge of extinction. There is a high need of either cultivating these plants for their multiplication along with preventing them from overexploitation. Many of these medicinal plants are eradicated due to large number of deforestation activities. (Chandra De, 2016).

With increase in demand and limited supplies, sustainable use of wild resources can be a very good way to conserve there high valued medicinal plants. The sustainable management of the medicinal herbs is necessary as it is crucial to conserve these unique genetic resources. When underground parts such as roots and rhizomes or whole-plants are harvested, it is more pernicious to medicinal plants than collecting their leaves, stems or fruits (Hamilton, 2004; Kurian & Sankar, 2007). Therefore, vulnerability of species depends upon the utility and collection process of whole / specific parts of the plants. For these herbs, good harvesting practices must be formulated, particularly when collecting roots and rhizomes so that we not only get good quantity of produce but also good quality.

Conservation of medicinal plants involves a group of activities that aim to prevent them from getting extinct. These activities may either be traditional methods or modern ways of conservation. As these plants have traditional, medicinal as well as economic importance for majority of Indian population conservation and sustainable use is very important in order to prevent these plants from getting extinct.

Different strategies used for conservation and sustainable use of medicinal and aromatic plants:

Legislation:
Conservation of medicinal plants through Legislation means making laws for conservation of medicinal plants. As for now India holds no special law that accounts for conservation of high valued medicinal plants however there are different acts responsible for protecting wild flora. Some of the major laws include:

1. Indian forest act 1927.

2. Wildlife protection act, 1972 and wildlife amendment protection act, 1991

3. Forest conservation act, 1980

4. Environment protection act, 1986

5. National forest policy, 1988

6. National biodiversity act, 2002

7. Scheduled tribes and other traditional forest dwellers act, 2006

In situ ways of conservation: In situ conservation of medicinal plants includes conservation of plant species in their particular area where it grows naturally. Major benefits with In situ conservation include.

1. It preserves the plants in their natural environment

2. It also helps to create and maintain condition for adaption and evolution within their own environment

They mainly include:

a. **National parks:** It is the designated area for protection of natural by means of long-term land planning and limiting agricultural and real estate activities. This park is created and protected by national government for conservation of flora in their ecosystem. Here plants grow in their natural environment and no additional efforts are needed for their conservation. Minimum size of a national park is 1000 acre. Visitors are allowed to enter for inspirational, educative, cultural, and recreative purposes.in India there are about 106 national park that cover the vast area of 43,716 km2 that accounts for 1.33% of the total geographical area of India.

b. **Wild nurseries:** Wild nursery is a place that is located in a very near location where plan exists in its natural habitat. A wild nursery is established for cultivating and domesticating endangered medicinal plants in a protected area, natural habitat, or a place that is only a short distance from where the plants naturally grow (Chen et al., 2016)

c. **Biosphere reserves:** biospheres are protected areas that are meant for conservation of plants and help in conservation of biodiversity in that particular area. They are also known to restore the life of tribal people in their vicinity. The program of biosphere reserve was started by UNESCO in 1971. Biosphere reserve is provided with a buffer zone that are open to certain economic activities

In India there are 18 biosphere reserves that are playing a major role in conservation of endangered plants.

1. Cold Desert, Himachal Pradesh
2. Nanda Devi, Uttrakhand
3. Khangchendzonga, Sikkim
4. Dehang-Debang, Arunachal Pradesh
5. Manas, Assam
6. Dibru-Saikhowa, Assam
7. Nokrek, Meghalaya
8. Panna, Madhya Pradesh
9. Pachmarhi, Madhya Pradesh
10. Achanakmar-Amarkantak, Madhya Pradesh-Chhattisgarh
11. Kachchh, Gujarat (Largest Area)
12. Similipal, Odisha
13. Sundarban, West Bengal
14. Seshachalam, Andhra Pradesh
15. Agasthyamala, Karnataka-Tamil Nadu-Kerala
16. Nilgiri, Tamil Nadu-Kerala (First to be Included)
17. Gulf of Mannar, Tamil Nadu
18. Great Nicobar, Andaman & Nicobar Island

Importance of biosphere reserve:

Conservation
Biosphere reserves conserve the species, ecosystems, genetic diversities, and landscapes without affecting the inhabitants.

Development
It ensures sustainable developments including economic, cultural, social and economic developments.

Restoration
The biosphere reserves restore any damage caused to the ecosystems and habitats.

Education and Research
These areas provide a lot of information on how to restore, conserve, and develop the ecosystem. The researches provide ways to recreate landscapes that have been affected by human activities.

Land Use Planning
All the landowners, public institutions, farmers, scientists, industry, and conservation groups found in these areas can work together to look for comprehensive land management.

Healthy Ecosystems
They help in maintaining healthy ecosystems by preventing soil erosion, protecting water springs, and maintaining the decomposers to maintain the soil quality.

Ex situ ways of conservation: Ex situ conservation of plants means conservation and maintenance of plants outside their natural environment. Major benefits with ex situ conservation techniques are:

1. It gives longer life time and breeding activity to animals

2. Genetic techniques can be utilized in this process

3. Captivity breed species can again be reintroduced in the wild

They mainly include
a. Botanic garden

b. Zoological Park

c. Seed banks

d. Cryopreservation

e. Field gene bank

Botanic gardens: Botanic Garden or botanical garden is a garden dedicated collection, cultivation, preservation and display wide variety of plants. Botanical gardens are used to study and conserve different varieties of plants. In botanical plants are grown and maintained in conditions other than their natural habitat. Botanical survey of India plays a major role in Ex situ conservation of different plant varieties throughout India by its chain of botanical gardens that are located all over India at different locations. About 2, 00,000 different varieties of plants are conserved in about 123 botanical gardens all over India. (Kadam & Pawar, 2020)

Seed banks: The most effective and convenient method of conserving endangered medicinal plants is the storage of seeds of these high valued medicinal plants in seeds banks. Seed banks can be a very useful way of storing seeds of those very important medicinal plants that are losing their genetic diversity. Many plants have been used for centuries for medicinal and other purposes seed banks ensure that seeds of these important plants are kept safe under constant low temperature and low humid conditions. Due to any reason if the plant gets extinct these seed banks can play a major role in regenerating that that can further be used by human population. The only challenge with storing seeds in seed bank is to know which seed to store and which seed not to store. Seeds stored in seed banks can also be used to create genetically modified version of the same species with more efficacy.

Field Gene Banks: In this method plants are planted in fields for conservation of their genes that creates nad artificial ecosystem for them. Field gene bank must not be confused with farm gene bank where crop germplasm is conserved insitu by farmer. In field gene bank we pick plant from their natural habitat and transfer them for conservation to another site. The advantages of field gene banks is that the species are easily accessible for utilization and evaluation can be undertaken while the material is being conserved (ref: Hawkes J.G., Maxted N., Ford-Lloyd B.V. (2000). Field Gene Banks, Botanic Gardens, in vitro, DNA and Pollen Conservation. In the ex-situ conservation of Plant Genetic Resources. Springer, Dordrecht.) Field gene banks can also be a very appropriate way of conserving vegetatively propagated genotypes that generally produce genetic variation. However, the planting material grown in field gene bank is susceptible to pests and microbes.

Biotechnology method of Ex situ conservation

Germplasm Technique of Conservation – Germplasm refers to the total content of genes transmitted to the offspring through germ cells. Germplasm provider the raw material to the breeder to develop new variety of crops. Germplasm conservation refers to maintaining the germplasm in such a state that results in minimum loss of germplasm. Germplasm can also be directly planted to the field. The most important objective of germplasm conservation is to preserve the genetic diversity of a plant for its use at any time in future .Due to decreasing number of species of medicinal plants it is very important to save these endangered plants. Extinction of these endangered plants would result in loss of genetic traits present in those medicinal plants One of the main strategies behind germplasm conservation is to maintain the biological integrity and provide germplasms with validated phenotypic and genetic descriptions (Bhatia, 2015). The available germplasm may be conserved either in form of seed or in form of meristem cultures. Preservation of germplasm

through seed is considered to be the best way as it is not only easy to store but also easy to maintain. Germplasm technique of conservation is considered to be the most efficient way of conserving genetic traits highly endangered medicinal and aromatic plants. In germplasm technique of conservation

Methods involved in preservation of germplasm include the following:

a. Cryopreservation

b. Cold storage

c. Low pressure and low oxygen storage

Cryopreservation: Cryopreservation is a technique of preserving any material using liquid nitrogen (at -165°C to -196°C). In this technique germplasm is stored in extreme low temperate using liquid nitrogen. Mainly seeds and pollens are conserved using this technique. Cryopreservation is an optimum technique to preserve greater crop diversity and conserve more genetic resources for future generations. There are some exceptional plants that cannot be preserved through seed banks for example some plant varieties that do not produce seeds or some plants that are highly susceptible to cold conditions. Cryopreservation of seeds can act as an efficient way for storage, preservation and future study of plant species. At this such low temperature there is no cellular or chemical reaction possible in seed or pollen.

Not only seeds but many a times pollens of high valued endangered plants are also cryopreserved in order to preserve them. Pollen preservation is a very important method of conservation of high valued medicinal plants. It plays a very important role in controlled pollination of high valued medicinal plants especially in fruit tree species. Pollen storage has also been considered as an emerging technology for genetic conservation. (Withers LA. Biotechnology and plant genetic resources conservation. In: Plant Genetic Resources Conservation and Management. Paroda RS, et al. editors. New Delhi: IBPGR Regional Office; 1991. p. 273–297). In recent times many countries have developed cryo banks to conserve pollens of different endangered species.

New Cryopreservation techniques – (Kadam & Pawar, 2020)

a. Encapsulation and dehydration.

b. Vitrification

c. Encapsulation and vitrification

d. Desiccation

e. Pre-growth

f. Pre-growth and Desiccation

g. Droplet freezing

Three National Gene Bank for Medicinal and Aromatic Plants at the Central Institute of Medicinal and Aromatic Plants, Lucknow and NBPGR(National Bureau of Plant Genetic Resources), New Delhi, for the northern region; and the Tropical Botanical Garden and Research Institute, Trivandrum, for peninsular India have been established. These banks will conserve a variety of important species of proven medicinal value, which are categorized as endangered, threatened or rare and are used extensively in traditional systems of medicine, difficult to propagate, have significance for research and development for the future, and are of commercial values. India is the regional coordinator for Asia and also the overall coordinator for the establishment of Gene banks of Medicinal and Aromatic Plants among G-15 countries. (UNIT 2 EX-SITU CONSERVATION Structure, n.d.)

Tissue Culture Techniques Used for Conservation:

Plant tissue culture is one of the most scientific techniques used for conservation and prevention of high valued medicinal plants. It is a process of invitro culture of cells, tissue, organ or complete plant under controlled conditions. Plant tissue culture is gaining more popularity as compare to any other conservation technique as it is the most effective and simplest tool used by researchers. Along with research tissue culture has also gained much popularity by industries. For effective ex situ conservation preservation of genetic information is most important task and the best way to preserve that is plant tissue culture. Not only can tissue culture preserve genetics but it can also be used to cultivate strains with extreme genetic precision in a conservative amount of space. Primary studies show that the micropropagation technique holds great for all the varieties of high valued medicinal plants that are either endangered or at the blink of extension. Micropropagation studies plant varieties without causing much harm to their natural population or environment. Small parts of plants known as explants are known to produce hundreds

Species that are endangered can be easily grown in controlled environmental conditions free from any microbial contamination and then reintroduced to their natural habitat once they reach their maturity phase. In this way we can reintroduce them back to their natural habitat without disturbing their ecosystem. The plants produced through tissue culture include proper supply of pH, nutrients, adequate temperature and humidity along with optimum amount of plant hormones. (Oseni et al., 2018). Tissue culture is mainly used in those plants where regeneration by conventional methods is not possible. Plant varieties whose population has decreased in recent times can be restored with the help of tissue culture. Also, plants that yield higher amount of their active constituents can not only be preserved but their numbers can also be increased with the technique of tissue culture. (Kadam & Pawar, 2020). Plant tissue culture can also used to produce such plants of endangered species that would be free from any pathogen thus preventing damaged caused due to pathogens.

Some other ways may include:

Cultural heritage: Cultural heritage is a legacy of customs and traditions that are passed from generation to generation. Medicinal plants had a great cultural heritage in our past as they were not only worshipped but also used for day-to-day activities. Re-establishing that cultural heritage will not only reestablish the lost value of these high valued plants but will also play a major role in their conservation. Knowing the cultural value of these medicinal plants local inhabitants would not allow their adulteration.

Proper harvesting methods: Harvesting properly matured plants can be a good way to conserve high valued plants. Also harvesting only, the aerial part of the plant for use instead of the complete plant will not only prevent the damage to the plant but will also ensure that the same plant can be harvested in the next season.

Use of alternates: Many pharmacological ingredients come from more than one variety of crop only making difference in their quantity. Thus, using the alternate plant source with less pharmacological ingredient will not only prevent the plant ecosystem but can play a major role in conserving the high valued medicinal plants.

Sacred forests: There were times when forests were regarded as a very sacred entity and using plants in recklessly was considered a crime. Villagers had a rule of taking permission from the god of forest before using any plant from that forest. Also, they used to take only the desired quantity of that plant. This not only maintained the medicinal property of the plant but also plants grew in their natural

habitat without getting overexploited.

Cultivation: With advancements in science and technology now we have ways to cultivate these high valued plants in their natural environment. Cultivation of these plants must be encouraged to that we have enough raw material for our pharma industry.

Educating farmers: Farmers must be educated about the social as well as economic benefits of these plants so that they put some efforts for the cultivation of these plants. Farmers must be introduced with scientific knowledge that may be useful for the cultivation of these plants. Seminars and workshops must be organized from time to time in order to tell them about various governmental schemes and market value of these plants. Industrial visits should be organized from time to time in order to minimize the gap between industry and farmer.

Sustainable use of medicinal plants:
For medicinal plants with limited abundance, slow growth, over and destructive harvesting has resulted in resource exhaustion resulting in endangered status of most of the medicinal plants in India. (Chen et al., 2016). Therefore, good harvesting practices along with sustainable use must be considered in order to make sure these plants keep meeting our needs in future also. In case of medicinal plants roots and whole plant harvesting is a very common practice that has resulted in the depletion of Plant resources. More emphasis must be given to using aerial parts of plant such as leaves and shoot so that complete plant is not destroyed and is ready to be used in the next season. Most of the herbal plants have an alternate that has the same pharmacological activity but may contain the small amount of pharmacological ingredient. Efforts should be made to use the alternate so that there is no burden in particular species of medicinal plant. In case of herbal drugs made of complete plant research and development should be initiated to make a herbal formulation with the leaf of the same plant.

Good agricultural Practices: Good agricultural practices in case of medicinal plans include various steps to be followed while cultivating the medicinal some of them include:

a. **Testing of soil sample:** soil sample must be free from any heavy metal or aflatoxin in order to make sure that our primary product is free from heavy metals and aflatoxin.

b. Clean and reliable source of water: clean water makes sure that plant is free from any contamination.

c. Checking the best suitable medicinal plant for the area

d. Sowing seeds at proper time and maintaining proper distance between seeds

e. Proper pest and weed management

f. Following practice of crop rotation in order to maintain fertility of the soil

g. Using the correct planting material: some plants show good growth with seeds while others with vegetative parts. it is important to select the proper planting material in order to get the enhanced yield.

h. Use organic manure in order to avoid any contaminants to the products.

Good collection Practices for medicinal plants: Collection of these medicinal plants decides the quality of the produce. While collecting the produce following points must be kept in mind in order to avoid overexploitation of these high valued plants:

a. Plants must be collected from the wild at the proper physiological phase in order to ensure the presence of maximum pharmacological ingredients.

b. While collecting plants from wild it must be made sure that all plants are not collected from the area some plants should be left intentionally.

c. Ensuring that the whole plant is not harvested leaving roots to grow into a complete next year. In many cases, it is seen that stem and leaves are all enough to be used in the pharma industry but a complete plant is harvested. Such practice must be avoided in order to prevent overexploitation of the plant.

d. frequency of collection should also be kept in mind as frequent collection from wild not only effects the number of plants in particular area but slows down the regrowth for the next season.

e. It must be made sure that plants collected from wild are healthy as unhealthy plants can detoriate the complete lot.

f. one must also keep in mind that collected material is free from any toxic weed as the presence of any toxic weed can have adverse effect on the quality of the produce.

Post-Harvest Processing: Along with good agricultural practices good post-harvest techniques also play a major role in the conservation of high valued medicinal plants. Major post-harvest techniques contributing in conservation of medicinal plants include:

Primary Processing: Primary processing plays very important role in maintaining the purity of the produce. After harvesting all the mud and soil must be properly removed. If the plant needs washing portable and clean water must be used in order to avoid any contamination.

Drying: Primary product should be properly dried before packing and transporting it to any industry. Proper drying makes sure that primary product is free from any contaminant before transportation to any industry. The primary product must be dried according to the need for example some plants need shade dry while others prefer sun-dry. It should also be made sure that the product is not over dried as overdyeing leads to loss of pharmacological ingredients.

Storage:

Transportation:

Need of strong medicinal plant policy in India

With the growing demand for medicinal plants in India and exploitation of these natural herbs, it is need of the hour for a long-term strategy to conserve and sustainably harvest these plant products. In recent years we have not only seen an increase in domestic demand for herbal plants but also there has been a great increase in the export of herbal plants from India. There is a great difference between production and consumption of herbs in India as a result of we are experiencing a great loss in number of medicinal plants. There are no particular laws that deal with the prevention and conservation of medicinal and aromatic plants due to which these plants are overexploited from the wild. Whether it be collectors or traders all are indulged in illegal deals of these highly important medicinal plants due to lack of any particular law. If we want to stop illegal procurement and illegal collection of these medicinal plants from wild, we need to have strict laws making all illegal activities dealing with these important herbs a punishable offence. India outstays

7 different laws that deal up with protection of flora and fauna but none of them focuses only on medicinal plants. Forest (Conservation) Act ,1980 and the Wildlife (Protection) Act, 1972, pay some attention to preservation of medicinal plants but these laws are limited to protected areas and domains and most of the medicinal plants do not grow in protected areas. Those plants that grow in these protected areas need special attention but their negligence leads to their extension. We must also focus on our export policy of medicinal herbs. Some norms should be set up for export of these highly endangered medicinal herbs so that highly endangered species are protected.

Discussion:

With increase in global demand of medicinal herbs there has been a depletion of the naturally occurring medicinal herbs. Loss of habitat and decreasing number of medicinal plants is a great point to concern. Therefore, it has become need of hour to focus so that we do not have to compensate with them in future. Most of the raw material used by herbal industries is collected from wild. It has become very important to fulfil their needs without causing much danger to existence of these high valued plants. It has become very important to not only conserve these medicinal plants but also follow the practice of sustainable use. With advancements in science and technology along with traditional methods scientific methods can also be used for prevention and conservation of different plant varieties. Different techniques mentioned above can help in prevention and sustainable use of these high valued medicinal herbs so that they n continue to fulfil healthcare needs of humans.

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G.B. Pant National Institute of Himalayan Environment (NIHE)

G.B. Pant National Institute of Himalayan Environment (formerly known as G.B. Pant National Institute of Himalayan Environment and Sustainable Development, was established in 1988-1989, during the birth centenary year of Bharat Ratna Pt. Govind Ballabh Pant, as an autonomous Institute of the Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India. The Institute has been identified as a focal agency to advance scientific knowledge, to evolve integrated management strategies, demonstrate their efficacy for conservation of natural resources, and to ensure environmentally sound management in the entire Indian Himalayan Region (IHR). The Institute functions under a Society, guided by a Governing Body and Science Advisory Committee. It has a decentralized set up, with its Headquarters at Kosi-Katarmal, Almora, and at present six regional centres are operational at Srinagar (Garhwal Regional Centre), Mohal-Kullu (Himachal Regional Centre), Tadong-Gangtok (Sikkim Regional Centre), Itanagar (North-East Regional Centre), Ladakh (Ladakh Regional Centre) and Mountain Division (at MoEF&CC, New Delhi). The R &D programmes of the Institute have been reoriented in to four functional Centres based of stakeholder needs, viz., Centre for Land and Water Resource Management (CLWRM), Centre for Socio-Economic Development (CSED), Centre for Biodiversity Conservation and Management (CBCM) and Centre for Environmental Assessment & Climate Change (CEA&CC). (Details: http://gbpihed.gov.in).

Himachal Pradesh Regional Center (HPRC)

Himachal Regional Center is located in Mohal of the Kullu district of Himachal Pradesh state. The Himachal Regional Center was established on July 01, 1992, in a rented building at Dhalpur, District Kullu, and continued up to June 1993. The foundation stone of the center's office and residential complex was laid by Shri Kamal Nath, Hon'ble Union Minister for Environment and Forests on June 2, 1993, in Mohal village of Kullu district. During the construction of the office and residential complex, the work of Himachal Regional Center was conducted from June 1993 to March 1999 at the rent building of Shamshi, Kullu. After the construction of a permanent building in Mohal in the year 1998, on April 02, 1999, the office and residential complex were duly inaugurated by Hon'ble Shri Suresh Prabhu, Environment Minister, Ministry of Environment and Forests, Government

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