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Review Paper

Critical review of some important medicinal and aromatic plants of western Himalaya

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Abstract

Critical review of some medicinal and aromatic plants of western Himalaya has been undertaken. For evaluation purpose plants were prioritized on basis of present IUCN status, current market value in India, estimated annual trade and conservation strategies available in public domain. Twenty (20) species were selected most of which were endemic to the region. Moreover, IUCN status of most of the plant species was found to be "critically endangered" which meant that immediate attention needs to be given to such species. The author has tried to compile the data in such a manner which could be utilized for in situ and ex situ conservation of the species. Various research organizations working actively in this region has also been highlighted.

Keywords: Medicinal, aromatic, Himalaya, endemic, critically endangered.

Introduction

Indian Himalayan Region (IHR) is extremely rich in its biodiversity due to its changing climatic and altitudinal range. It is an abode of high valued medicinal plants 25% of which are endemic to this region including- bryophytes, pteridophytes, gymnosperms, angiosperms and lichens[1]. It enjoys the status of one of the major hot spots of biological diversity across the world[2].

The entire area is approximately 2800 km in length and 220-300 km in width and constitutes about 18% of India[3], with an altitudinal range from 200 to 8000 m[4]. The flora is comprised of different species of lichens (1159 species, 11% endemic), bryophytes (1737 species, 33% endemic), pteridophytes (600 species, 25% endemic), gymnosperms (44 species, 16% endemic) and angiosperms (8000 species, 40% endemic)[5].

The thick flora of the IHR apart from having a commercial significance also acts as large "carbon sink" for storing carbon-di- oxide during photosynthesis and simultaneously producing oxygen, thus assisting in the global fight against climate change. The plants in the IHR are valued since the Vedic periods (Rig Ved 4500-1600 BC) and earn a special place for themselves. Charak (1000-800 BC) and Susruta (800-700BC), two great figures of the ancient era who initiated herbal science in India also described Himalayas as a major habitat of medicinal plants. Man has been using these forests since was back his existence on this earth in some way or the other e.g. as secondary metabolites, fuel, fodder, timber, edible, agriculture etc. In the pre- industrial times, these natural habitats were selectively used but in the present scenario rapid industrialization and population explosion directly or indirectly resulted in faster degradation of forests of the IHR. It is estimated that medicinal plants in bulk have reached endangered category or facing different threat levels[6]. Although, quite recently the effect of human disturbances on species diversity in IHR has attracted the attention of several workers[7-10] there is little information regarding the status of medicinal plants of Himalayan region[11-13].

In this article, status, threats and conservation strategies for some medicinal and aromatic plants of Kumaon region of Uttrakhand are discussed along with other details to explore some avenues of thoughts and action plan for conserving and efficiently utilizing them.

Adopted criteria for prioritizing plants

Kumaon Himalaya is perhaps the most attractive regions from the scenic as well as the floristic point of view among all the sectors of Western Himalayas.

It is located between $28^0 43'$ to $30^0 49'$N latitudes and $78^0 44'$ to $81^0 4'$E longitudes and includes six districts viz. Nainital, Almora, Pithoragarh, Champawat, Bageshwar and Udhamsingh Nagar. The high altitude regions are chiefly in the districts Pithoragarh especially in Dharchula and Munsiari tehsils except Pindari which falls in Almora district.

Twenty (20) medicinal plants were selected after rigorous literature search from various research articles and databases. Prioritization and critical review was undertaken using present IUCN status, current market value in India, estimated annual

trade and conservation strategies available in the present scenario.

Anthropogenic pressures (local and commercial) have threatened their survival as most of the medicinal plants are consumed as folk medicine in rural areas and also traded commercially in bulk (for both domestic demand and export). Thus, an increasing gap between demand and supply has reached that level that if we do not take concrete steps now for conservation of these species then perhaps in coming years we would be devoid of their excellent medicinal properties.

The author has tried to review the list in a detailed manner covering maximum information about the species. While searching literature assistance from Google Scholar was also taken using target specific key words. The compiled data adds vital information at one place which could be useful in effective management and conservation of the discussed species.

Exploitation and Threat to some medicinal plants of Kumaon Region

It has been reported from time to time that increasing biotic influence and over exploitation of some taxa of medicinal plants have threatened their survival and become endangered, hence, these plants urgently need critical management for protection in their regions of occurrence.

Using IUCN criteria, about 121 species have been recorded in Red Data Book from Indo- Himalayan-Region, of these 17 are medicinal plants[14]. Unscientific tapping of drug plants results in the loss of important gene pools which is quite alarming. The status of rarity of the medicinal plants of *Aconite* species has been thoroughly studied. The results revealed that these species are restricted to specific pockets and had a very low population density[15]. Illegal trade and over-exploitation of these species pose a threat to their existence.

The extent of commercial exploitation of some medicinal plants of Himalaya region has also been documented[16]. Thus, it is feared that continuous exploitation of these valuable drug plants may endangered their own existence in future unless immediate steps are taken to protect them from over-exploitation and for the conservation. In the last few decades a number of publications have been brought out especially with regard to taxonomy and ethnobotany. Only recently few attempts have been made to assess the status and natural habitats of medicinal plants.

Few workers in Uttakhand have produced records regarding "status" of medicinal plants of IHR[17-19]. The present data has been compiled by the author from Department of Functional Plant Biology, Kumaon University, Almora Campus, Almora, Uttrakhand, India. Vital information regarding the medicinal plants as present IUCN status, plant part used in medicine, altitudinal range (Table-1), active constituents and indigenous uses (Table-2) has been presented. Indigenous uses were documented with the help of local villagers and old/experienced people from nearby villages in an around Almora city. Moreover, current market value of the medicinal plants in India and their estimated annual trade has also been depicted (Table-3). Lastly, both *in situ* and *ex situ* conservation methods for the given species has been discussed in detail (Table-4).

Causes of medicinal plant loss in Kumaon Himalaya

Domestic consumption by local people which is based on traditional knowledge and causes harm. Moreover, heavy demands of herbal drugs in Indian Pharmaceutical Industries which is growing tremendously. Newer habitats are exploited for extraction for the use in pharmaceutical industry. It is harmful and causes concern.

Further, herbal plants are being used extensively in Homeopathy, Unani and Ayurvedic system of medicines from the past so many years resulting into over exploitation from wild. Bridging demand and supply gap has always been a big challenge for all the stakeholders in this industry. Further, population explosion and inevitable urbanization are two major factors for biodiversity loss in the Indian Himalayan Region as it directly destroys habitat of plants and makes them vulnerable in a given environment.

Moreover, forest land conversion to agriculture land and for other activities as well also restricts forest cover and threatens medicinal plants. National census revealed that Uttrakhand population grew from 8.5 million in 2001 to 10.1 million in 2011 and 10.4 million by 2018. Above it, forests are being ruthlessly cut to fulfill the demands of the growing population of the country i.e. for secondary metabolites, edibles, fuel, timber and agricultural tools etc. High frequency of human interference in forests as-construction of roads, dams etc is yet another reason for the loss of medicinal plants.

This has resulted in clearing of large areas which were covered with shrubs and herbs etc. Industrialization also has a negative impact on the environment and forest as it pollutes air, water and soil quality as well.

Large number of small scale industries are running without proper certification from accredited government authorities without following environmental norms resulting into severe damage to both flora and fauna. Forest fire is yet another reason for the destruction of the plant species. It alters the natural habitat.

Flora dominated by oak- pine forest is the real culprit behind forest fires as they secrete certain compounds which are highly inflammable. Regular mapping and monitoring of such areas is required at local and community level and also through use of drone technology so that damage can be restricted.

Table-1: IUCN status and other details of important medicinal plants of Indian Himalayan Region[1,28].

Botanical Name	Family	Common Name	Part used in medicine	Altitudinal Range Meters	Category of IUCN
Aconitum ferox Wall.	*Ranunculaceae*	Vatshanabh	Rt	3000-3600	CE[20]
Aconitum. heterophyllum Wall.	*Ranunculaceae*	Ativisha	Rt	3000-3700	CE
Abrus precatorius Linn.	*Fabaceae*	Gunja	Rt	300-1200	T
Angelica glauca. Edgew.	*Apiaceae*	Chorak	Rt/Rh	3000-3800	CE
Swertia chirata. Buch-Ham.	*Gentianaceae*	Kiratikta	Wh Plt.	1500-2500	CE
Oroxylum indicum. Vent.	*Bignoniaceae*	Syonak	Wh Plt.	400-1500	T
Podophyllum hexandrum Royle	*Podophyllaceae*	Bankakri	Rh	2500- 3700	CE
Taxus wallichiana Zucc. (*Taxus baccata* L.)	*Taxaceae*	Rakhal	bark, Lf	1800-3400	CE
Rheum australe Don	*Polygonaceae*	Kankustha	Rh	3000-4200	Vu
Polygonatum verticullatum L.	*Liliaceae*	Meda Mahameda	Rh	2400-4700	Vu
Rauwolfia serpentina L	*Apocynaceae*	Sarphgandh	Wh Plt	1300- 1400	E
Delphenium denudatum. Wall.	*Ranunculaceae*	Nirvishi	Rt	1500-2500	CE
Nardostachys jatamansi. DC.	*Valerianaceae*	Jatamansi	Wh Plt	3200-5000	CE[21]
Berberis aristata D.C	*Berberidaceae*	Kilmora	Rt	1200-3500	E
Ephedra gerardiana Wall. Ex.J.A Mey	*Ephedraceae*	Somlata	Wh. Plt.	2400- 5000	E
Picorrhiza kurroa Royle ex Benth.	*Scrophulreaceae*	Kutki	Rt	3000-5000	E
Plumbago zeylanica L.	*Plumbaginaceae*	Chitrak	Rt	Upto 1400	R
Betula utilis D. Don	*Betulaceae*	Bhojpatra	Bark (stem)	2700- 4500	CE[22]
Valeriana hardwickii Wall	*Valerianaceae*	Tagar/Samaya/Mushakbala	Rt	1200-4000	T
Gloriosa superba L.	*Liliaceae*	Langli	Lf/Tubers	400-2200	E

*****Rt= Root; Rh= Rhizome, Wh. Plt.= Whole Plant; Lf= Leaf; CE= Critically Endangered; T= Threatened; Vu= Vulnerable; ; E= endangered; R= Rare

Table-2: Life Form, Active constituents and Indigenous uses.

Botanical Name	Life Form	Active constituents	Indigenous/Important Uses
Aconitum ferox Wall.	Perennial Herb	Pseudaconitine[23]	Stimulant, febrifuge, tonic, cardiac, rheumatism
Aconitum. heterophyllum Wall.	Perennial Herb	Astisine, Hetisine, Heteratisine[23]	Digestive disorders, stomach ache, cough, dysentery, vomiting, fever, diarrhea, antihelminthic, piles
*Abrus precatorius*Linn.	Perennial Climber/ Herb	abrol, abrasine, precasine, precol[24]	Treatment of leucoderma, tetanus, sores, wounds, diabetes, inflammation, fertility, malaria, kidney problems, has immunomodulator and immunostimulator properities too
Angelica glauca. Edgew.	Perennial Herb	Terpinene, lactones, selinene, d-α cadinene, nerolidol, bisabolene, germacrene, d-α phellandrene[25]	Stomach, liver and gastric complains, Dysentery, colic and renal complications, gastrointestinal disorders
Swertia chirata. Buch-Ham.	Annual/ Perennial Herb	Chiratol, Chiratamin, Swertiamin[26]	tonic, stomach ache, blood purifier, leprosy, asthma, skin disease, fever, bronchitis, inflammation, antiemetic to pregnant women, blood purifier
Oroxylum indicum. Vent.	Perennial Tree	Flavones (baicalein, pinostrobin, oroxylin), Sterol (Stigma-7-en-3-ol)[27]	Enlarge spleen, hypertension, rheumatism, asthma, snake bite, leucoderma, throat infection, dysentery, diarrhea, bowl movement, fever, tonic, increase appetite
Podophyllum hexandrum Royle	Perennial Herb	Podophyllin/podophyllotoxin and podophyllo resin[28]	Tumor, cancer, wounds, cut, cough, fever, menstrual disorder
Taxus wallichiana Zucc (*Taxus baccata* L.)	Perennial Tree	Taxol[28]	Tumor, cancer, aromatic
Rheum australe Don.	Perennial Herb	Rutin, hyperin, tannins, quercitin, heterodianthrones, sennidine[25]	Laxative, swelling ulcers, wounds and sprains, dysentery, abdominal pain, appetite, piles, fever, asthma, bronchitis
Polygonatum verticullatum L.	Perennial Herb	Phenolics, steroids, triterpenes, tannins, alkaloids[29]	Urinary problems, appetite, nerve tonic
Rauwolfia serpentina L	Perennial Herb, Shrub	Reserpine/Rescinnamine/Serpentine, Deserpidine[30]	Antidote for snake bite, blood pressure, stomach trouble, malarial fever
Delphenium denudatum. Wall.	Perennial Herb	Denudatine[25]	Antihelminthic, abdominal pain, ulcer, tooth ache, respiratory
Nardostachys jatamansi. DC.	Perennial Herb	jatamansone , jatamol, spirojatamol[23]	Heart disease, blood pressure, insomnia, jaundice, skin problem, for respiratory, nervous, digestive, urinary and circulatory disorders, anti bacterial, anti fungal, antiseptic, analgesics, hysteria, blood purifier
Berberis aristata D.C	Perennial Shrub	Berberine[23]	Snake bites, eye disease, boils, jaundice
Ephedra gerardiana Wall. Ex. J.A. Mey	Perennial Shrub	Ephedrine, pseudoephedrine[31]	Blood purifier, rheumatism, asthma, headache, hepatitis
Picorrhiza kurroa Royle ex Benth.	Perennial Herb	iridoid glucosides, picroside I (PI), PII, PIII, PIV, kutkoside, pikuroside[32]	Fever, jaundice, anemia, abdominal pain, asthma, dysentery, cold, stomach problems
Plumbago zeylanica L.	Perennial Herb/Shrub	Plumbagic acid, plumbazeylanone, β- sistosterol, lupeol, norcanelilline[33]	For intestinal worms and infection, skin disease, ring worm, scabies, leprosy, sores, ulcer of leg, dermatitis, haemorrhoids
Betula utilis D. Don	Perennial Tree	Betulin, Betulic acid, lupeol, lupenone, β- sitosterol[22]	Hysteria, fever, cuts, antiseptic, wounds, jaundice
Valeriana hardwickii Wall	Perennial Herb	Maaliol, β- sitosterol, valeranone, stearic acid[25]	Skin disease, hysteria, urine complain, antidote, epilepsy
Gloriosa superba L.	Perennial Herb/Climber	alkaloids, saponins, flavonoids, steroids, glycosides, terpenoids, tannins,colchicine[34]	Abortifacient, antihelminthic, fever, snake bite, fever, leprosy, scabies, anti- cancer

Table-3: Market statistics and estimated annual trade[35].

Botanical Name	Current Market Value in India (Rs/Kg)	*Source	*Estimated Annual Trade (MT)
Aconitum ferox Wall.	900 - 1250	W	50- 100
Aconitum. heterophyllum Wall.	450- 6300	W	100 - 200
Abrus precatorius Linn.	250- 1000	C/W	200 - 500
Angelica glauca. Edgew.	5750- 9500	W	10 - 50
Swertia chirata. Buch-Ham.	320- 80000	C/W	500 - 1000
Oroxylum indicum. Vent.	60 - 100	W	500 - 1000
Podophyllum hexandrum Royle	60-100	W	10 - 50
Taxus wallichiana Zucc (*Taxus baccata L.*)	40 - 50	C/W	100 - 200
Rheum australe Don.	150-575	W	100 - 200
Polygonatum verticullatum L.	16 - 50	W	<10
Rauwolfia serpentina L	700- 1000	C/W	200 - 500
Delphenium denudatum. Wall.	1000	W	<10
Nardostachys jatamansi. DC.	550-1750	W	500 - 1000
Berberis aristata D.C	500- 600	W	1000 - 2000
Ephedra gerardiana Wall. Ex. J.A. Mey	80- 100	W	100 - 200
Picorrhiza kurroa Royle ex Benth.	1370 - 2100	W	1000 - 2000
Plumbago zeylanica L.	120 - 1100	W	5000 - 1000
Betula utilis D Don	215 - 400	W	100 - 200
Valeriana hardwickii Wall	380 - 2360	W	<10
Gloriosa superba L.	200 - 2500	C/W	100 - 200

*C= Cultivated; W= Wild

Conservation strategies: The endemic species of Uttrakhand needs special attention. Inventerization/documentation (reflecting the social concerns with regard to conservation) of such medicinal plants is of prime importance if we wish to obtain long lasting benefits. Important concerns includes *in situ* and *ex situ* conservation.

In situ conservation (*on site*): In view of the commercial importance and frequent demand of medicinal plants it is desirable to cultivate them in suitable localities which in due course can be developed in established farms by the traders, medicine men, and pharmaceutical concerns; the medicinal plants growing in wild should be brought under systematic cultivation; germplasm should be collected and maintained under protected conditions; there should be rotational extraction of drug plants, in no case more than 60-70% of the population should be collected in any given season; recognized agencies consisting of trained personnel for scientific collection as well as maintenance of plants and plant parts needs to be created for the collection and supply of raw materials; ecological restoration of degraded habitats should be done; the additional areas like waste lands should be extended for cultivation of such species; this can be done around their natural homes as well as away from it under protection; conservation status of the species should be quantitatively assessed; educate common people through Government and Non Government Organizations (NGOs); the rules which are formed by the Ministry of Environment Forest and Climate Change, Government of India should be strictly followed and under no circumstances should be violated and those who found guilty should be punished irrespective of their power and authority.

Ex situ conservation (*off site*): *In vitro* germplasm conservation in form of gene banks or seed banks (cryopreservation); use of tissue-culture-techniques for large scale clonal propagation of important medicinal plants after tracing them in nature.

Both *ex situ* and *in situ* conservation of medicinal plants along with their phytochemistry and pharmacognosy have attained little attention in this region. However, research organizations (in this case all from Kumaon region of Uttrakhand state) like GB Pant National Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora, Kumaon University campus Nainital and campus Almora, GB Pant University of Agriculture and Technology, Pantnagar, CIMAP Regional Centre, Nagla, NBPGR Bhowali, Horticulture Experiment and Training Centre, Chaubattia, Raniketh, Defence Agro technological Research Laboratory, Pithoragarh, Herbs Development Scheme co- operative Department, Raniketh and Indian Institute of Ayruveda for Drug Research, Tariketh, Raniketh are working efficiently in this area. Different aspects of research on medicinal plants includes: germplasm conservation, survey and documentation, population studies, agrotechnology, both *in situ* and *ex situ* conservation, ethnomedicine, genetics and plant breeding, microbiology, physiology and biochemistry, phytochemistry, disease and pest management, taxonomy and ethnobotany, drug research and formulation, marketing and procurement etc.

Table-4: Conservation strategies available (Both *in situ* and *ex situ*)

Botanical Name	*In- situ* Conservation (On site)/ Cultivation Trials	*Ex- situ* Conservation (off site)/ Plant Tissue Culture	
		Explant used	References
Aconitum ferox Wall.	Yes	Root tip	36
Aconitum. heterophyllum Wall.	Yes	Leaf and petiole; nodal segments; leaves, nodes, axillary buds; shoot tips	37,38,39,40
Abrus precatorius Linn.	Yes	Nodes; internode and leaf; node, internode and tendril	41,42,43
Angelica glauca Edgew.	Yes	Seedling; leaf; rhizome	44,45, 46
Swertia chirata. Buch-Ham.	Yes	Nodes; shoot tip; immature seeds; leaf	47,48,49,50
Oroxylum indicum. Vent.	Yes	Nodal segments; nodal segments; leaf & cotyledonary leaf	51,52,53
Podophyllum hexandrum Royle	Yes	Root; seeds and excised zygotic embryos; roots and rhizome; rhizome	54,55,56,57
Taxus wallichiana Zucc (= T. baccata L.)	Yes	Buds and embryos; stem and leaf; leaf	58,59,60
Rheum australe Don.	Yes	Shoot tip and leaf; shoot tip; axillary buds from rhizome and stem segment; leaf	61,62,63,64
Polygonatum verticullatum L.	Yes	Stem disc; hypocotyle and leaf; leaf	65,66,67
Rauwolfia serpentina L	Yes	Shoots; axillary bud; nodes, internodes, leaves, shoot tips; nodes, shoot apices, leaves; shoot tip	68,69,70,71,72
Delphenium denudatum. Wall.	No	No	No
Nardostachys jatamansi. DC.	Yes	Petioles	73,74
Berberis aristata D.C	Yes	Leaf dried callus	75
Ephedra gerardiana Wall. Ex. J.A. Mey	No	Nodes, internodes; nodes	76,77
Picorrhiza kurroa Royle ex Benth.	Yes	Axillary buds, nodes; axillary shoot tip; axillary shoot tip	78,79,80
Plumbago zeylanica L.	Yes	Shoot buds; nodes; leaf segments; shoot tip and nodes; embryo and nodes; nodes	81,82,83,84,85,86
Betula utilis D Don	No	No	No
Valeriana hardwickii Wall	No	No	No
Gloriosa superba L.	Yes	Apical and axillary buds; tuber; corm bud	87,88,89

Conclusion

Indian Himalaya is a reservoir of many drug plants many of which have been exploited by the pharmaceutical industries in the country. Also, there is considerable direct or indirect human activity in the region leading to a heavy depletion of plant resources resulting into natural habitat shrinkage. Many of the endemic species of medicinal plants in the Himalayan region have become scared in natural habitats and need adequate protection. It should be our priority that medicinal plants diversity should be conserved for future use. For this, efforts should be made to the preservation of types in natural habitats and in natural reserves (*in situ*) and collection and conservation of germplasm (*ex situ)*.

Micropropagation of medicinally important plants through tissue-culture is yet another potent method to restore the biodiversity. This *in vitro* procedure takes comparatively lesser time to regenerate large number of true-to-type plants. Attention needs to be paid to the education and training of local people.

Research, monitoring and training programs are essential components. The conservation strategies may necessarily includes protection of habitats as first priority.

The problem of forest conservation is basically a problem of protection and multiplication of suitable trees herbs, aromatic and medicinal plants according to the environmental conditions so as to maintain the ecological balance. Thus, it needs a serious and sincere thinking at the local as well as national level, so that the conservation working plans for protection and rehabilitation of forests prepared by forest experts may be applied and carried out in right prospective to check the denudation, soil erosion, heavy land slide and devastating floods. The masses should be educated at root level and the laws already formed under Forest Conservation Act, 1980 and National Forest Policy 1988 should be strictly followed. Moreover, Forest Right Act or Tribal Right Act of 2006 should be effectively implemented all across India which empowers the tribal and other forest communities dwelling in forest areas to become one of the stakeholders in the whole process of forest conservation. National Green Tribunal (NGT) which was formed under the National Green Tribunal Act, 2010 should play a proactive role in dealing with cases related to protection of environment, forests and other natural resources of the country as sustainable development is the key to a healthy ecosystem functioning.

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