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Phytochemistry of Endangered Plants of Kashmir Himalaya

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Abstract

The Kashmir Valley is recognized as a biodiversity hotspot of the north-western Himalayas and harbours numerous medicinal plant species that are threatened due to overharvesting, habitat degradation, grazing pressure, and climate change. Many of these endangered plants are rich sources of bioactive secondary metabolites such as alkaloids, glycosides, flavonoids, terpenoids, phenolics, and iridoids, which contribute to their medicinal value and are frequently being used for various ailments since time immemorial by a vast range of human communities. The Indian Himalayan Region (IHR), which forms part of one of the 36 global biodiversity hotspots, is known for its rich and unique biodiversity elements. In last decades, plant-based medicines have gained popularity over synthetic pharmaceutical products as they are retained less harmful. However, increased demand of these plant-based medicinal products has caused over-harvesting, unmonitored trade, habitat destruction and anthropogenic pressure on MAPs. The study strongly recommends prohibition of unmanaged extraction of medicinally important threatened plants from the wild and encourages their cultivation. This chapter documents some most important and critically endangered medicinal plants of Kashmir Himalaya, highlights their phytochemistry and utility in the present pharmacology.

Key Words. Biodiversity Hotspot, Habitat, Endangered Plants, Secondary Metabolites, Kashmir Himalaya

1. Introduction

The Himalayan region expand around 595,000 km2 and harbor rich biodiversity with nearly 18,440 plant species, out of these 1800 are medicinal plants, 675 wild edibles and about 30% are endemic to the region. For the protection of the biodiversity 5 Biosphere reserves, 28 National parks and 98 Wildlife sanctuaries with an area about 51,899 km^2 have been established in Indian Himalayan region. In the last few decades, much attention has been paid to the conservation of the medicinal plants, due to their increasing demand and economic point of view. Most of the high value medicinal plants of the Himalayan region are facing high threat and listed as endangered and critically endangered in Indian Red data book. Over-exploitation, climate change, habitat degradation, pollution, and introduction of alien species are major threats for useful plant species. High altitude kashmir alpine meadows contain rich herbaceous species diversity incliding several medicinal plants species which are in use since time immemorial i.e. Aconitum heterophyllum Wall ex Royle, Picrorhiza Kurrooa Royle ex Benth, Dactylorhiza hatagirea (D.Don) Soó, Meconopsis

aculeata Royle, etc. These medicinal plants naturally grow in alpine meadows, slopes and on the rock and boulder. Meconopsis aculeata Royle belonging to family papaveraceae commonly known as Himalayan poppy or Blue poppy (UT plant of Jammu and Kashmir), is an endemic endangered medicinal plant that naturally grow on moist rocks and boulders.

Medicinal plants are playing a pivotal role in human healthcare systems across civilizations and continue to be vital in traditional and modern medicine. The main aim of this study was to determine the presence of phytochemical components in various endangered medicinal plant species of Kashmir Himalaya. Phytochemicals are non-nutritive plant chemicals that have protective or disease preventive properties. These components are produced by plants to protect themselves, but recent researches demonstrate that they can also protect humans against diseases. Our research shows the presence of active pharmaceutical components like methanol, ethanol, chloroform, and distilled water in various plants under study. Traditionally some of the herbs had been used for the treatment of various disorders like paralysis of limbs, cerebral ischemia, narcotic, expectorant, bronchitis, urinary tract problems, cough, etc. there is clear cut indication of the presence of active components like alkaloids, flavonoids, terpenoids, etc., are responsible for the modulation in different disorders like Alzheimer, stroke, and epilepsy, etc. Our research team is carrying out a detailed investigation of components of various medicinal plants and their role in different disorders.

The Kashmir Himalaya being the rich source of valuable medicinal plants has been included in biodiversity hotspot of the north-western Himalaya. The World Health Organization estimates that up to 80% of the global population relies on herbal remedies for primary healthcare, particularly in developing nations. The Kashmir Valley, rich in floral diversity due to its topographical uniqueness, harbours approximately 500 medicinal plant species, of which over 300 are integrated into Indian Systems of Medicine (ISM). However, habitat degradation, overexploitation, and rapid urbanization and other threats have pushed them in various threatened categories. However, the world conservation strategies, both in situ and ex situ, are essential to ensure the sustainable use of endangered medicinal flora.

Major Endangered Plants of Kashmir Himalaya and their Phyto-chemistry

Gentiana kurroo

G. kurroo Royle belongs to the family Gentianaceae. The Gentianaceae family is represented by more than 90 genera and 1650 species; they are annual and perennial herbs or shrubs, native to northern temperate areas of the world. The Gentiana family is characterized by six genera and 55 species in the Kashmir Himalaya, an important domain of the Himalaya hotspot *G. kurroo* was first reported in the Kashmir Himalaya by at an altitude of 1850–2000 m (a.s.1) from the Pahalgam area, followed by] from the localities of Kangan and Wangat.

G. kurroo Royle has been found to have enormous medicinal properties reported by several researchers. The medicinal values date back to when human beings first got to know natural cures for different diseases from natural products. In folkloric treatment, leaf powder of *G. kurroo* (Neilkanth) is mixed with oil and is applied on ulcer and fungal infection. However, the root of *G. kurroo* is used in stomach-ache and in urinary infections; the root with ginger root powder is also used for curing high fevers. The roots were

also used as bitter tonic, and as an antiperiodic, expectorant, astringent, stomachic, anti-inflammatory, antipsychotic, sedative, anthelmintic and antibacterial. Gentianine (alkaloid) in *G. kurroo* possesses anti-infammatory, analgesic, anticonvulsant, hypotensive, antipsychotic, sedative, diuretic, antimalarial, anti-amoebic and antibacterial properties, whereas some traditional doctors use the whole plant against cough, fever, headache, liver ailments and as a blood purifier. The drug obtained from *G. kurroo* is very helpful in removing all kinds of weakness and overtiredness of body from prolonged illness, recovers digestive system and lack of appetite. In the Ayurvedic (Unani) system of medicine, the flower tops (Gule-Ghafis) are used for treatment of inflammation, pain, antipyretic and hepatitis and in the preparation of tonics for stomachic. It is also curative for the skin disease leucoderma, leprosy, dyspepsia, colic, anorexia, flatulence, helminthiosis, anti-inflammatory, amenorrhea, dysmenorrhoeal, haemorrhoids, strangury, constipation, urinary infections as an antiseptic, bitter tonic, cholagogue and bronchial asthma. However, there are some scientific validations of the folkloric uses of the critically endangered medicinal plant *G. kurroo* Royle.

Overexploitation has pushed the species into a critically endangered category. Ann. Roy. Bot. Gard. (Calcutta) 1905.

Meconopsis aculeata

Meconopsis aculeata Royle belonging to family papaveraceae commonly known as Himalayan poppy or Blue poppy and Kalihari in Garhwal, is an endemic endangered medicinal plant that naturally grow on moist rocks and boulders. The plant is perennial and monocarpic with a height between 1 and 2feet, prickly, erect, unbranched stem. It is distributed in the Western Himalayan region from Kashmir to Kumaon and found at an elevation range of 3300–4600 m. In Uttarak hand, the plant grows between 3000 and 4700 m. It has analgesic, febrifuge, cooling potency, used in Tibetan medicine and also to treat the bones near the ribs related problem. Flower of the species used for the treatment of asthma, fever, cough, and commonly used by inhabitants of Himachal Pradesh and Uttarakhand. Several studies reveal that plants are rich source of natural antioxidants and polyphenolics which can be utilised further as antioxidant supplements. Due to the high medicinal demand, it is over-exploited from wild and thus it is banned for wild collection.

Saussurea costus

It is an endemic species in geographically limited places of the Himalayas, where it grows on moist slopes at altitudes of 2500–4000 m. The species is critically endangered and is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In addition, it is one of the 37 endangered and highly medicinal plants of the Kashmir Himalayas.

The roots of *S. costus* have been widely used for curing Diarrhea, jaundice, stomachache, respiratory tract infections, antispasmodic agents against spasms caused by asthma, cholera, rheumatism, chronic skin diseases and leprosy[3]. Further, oil extracted from the roots (referred to as Costus oil) is used for making high grade perfumes and hair oils[4]. In addition, many studies have shown that extracts of *S. costus* have potent anti-cancer, anti-inflammatory and anti-ulcer properties[5]. Because of the high demands for roots, most natural populations of *S. costus* are on the verge of extinction[6].

Inula racemose.

A resourceful critically endangered medicinal herb in the Himalayas is traditionally utilized to cure various human disorders. The species is a wealthy source of sesquiterpene lactones has many pharmacological properties. The LC-MS/MS investigation revealed significant variability in the content of sesquiterpene lactones in different plant tissues (stem, leaf, and root). An upsurge in the quantity of isoalantolactone and alantolactone was noticed with increasing ploidy levels along the increasing altitudes.

Rheum australe

(Himalayan Rhubarb) is a multipurpose, endemic and endangered medicinal herb of North Western Himalayas. It finds extensive use as a medicinal herb since antiquity in different traditional systems of medicine to cure a wide range of ailments related to the circulatory, digestive, endocrine, respiratory and skeletal systems as well as to treat various infectious diseases. The remedying properties of this plant species are ascribed to a set of diverse bioactive secondary metabolite constituents, particularly anthraquinones (emodin, chrysophanol, physcion, aloe-emodin and rhein) and stilbenoids (piceatannol, resveratrol), besides dietary flavonoids known for their putative health benefits.

Additionally, efficient and reproducible in vitro propagation studies holding vital significance in preserving the natural germplasm of the plant and for its industrial exploitation have also been highlighted.

Berberis lycium Royle,

A member of Berberidaceae family is an evergreen shrub native to the Himalayan region, particularly to Nepal. Several phytochemicals including alkaloids, saponins, tannins, vitamins, proteins, carbo hydrates, lipids, berberine, berbamine, and sindamine have been extracted from various parts of the plant. The plant has also been shown to contain minerals such as calcium, copper, sodium, manganese, iron, sulphur, zinc, potassium, lead, and phosphorus. Owing to the presence of such biologically active chemicals. The extracts of the plant show several pharmacological activities like hyperlipidemic, hypoglycemic, hepatoprotective, anti- carcinogenic, and antipyretic. Moreover, the plant is being traditionally used to treat diarrhoea, intestinal colic, jaundice, piles, internal wounds, ophthalmia, rheumatism, and diabetes. Because of its important therapeutic characteristics, the plant is under risk of over-exploitation and other forms of anthropogenic pressure. Its roots were primarily utilized to cure hemorrhagic dysentery by the tribal inhabitants of Kashmir Valley. According to Ahmed et al., water extract of root bark is used to treat scabies, diabetes, and pustules, while powdered root paste is used to treat bone fractures. A decoction is made by drying the root in the shade and then boiling it in water. This decoction is then condensed before being dried at room temperature. “Rasaunt” is the final product, which is used to treat eye infections. For the same function, crushed new, typical vegetative shoots, and sap are employed. A rhizome decoction is also used by traditional practitioners to cure jaundice. Stem powder of B. lycium is used to treat jaundice and diarrhoea while root powder is used to treat muscular and rheumatic pain and tea is made from the leaves. Spleen disorders, cough, lungs, throat, and intestinal problems, diarrhoea, eye burning, and fractured bones are all treated with the plant extract. The fruits of B. lycium are used as hypoglycemic, anti-inflammatory, anti-carcinogenic, and antipyretic agents, as well as a coagulant. Locals utilize the entire plant as a treatment for sore eyes, jaundice, fractured bones, rheumatism, and ulcers.

Dioscorea deltoidea

It is native to a range of countries, including India, Tibet, Pakistan, Nepal, China, Bangladesh, Thailand, Cambodia, Vietnam, Bhutan, Afghanistan, and Laos. It thrives at altitudes ranging from 450 to 3100 m above sea level in these regions. Numerous investigations have revealed that D. deltoidea are abundant in the northwestern Himalayan region. The region between the rivers Chenab and Beas produces excellent-quality material, and a significant amount of rhizome can be harvested from this area every year. The highest number of naturally occurring Dioscorea plants with massive rhizomes and up to 8 % diosgenin content may be found in Bhadarwah. D. deltoidea is extensively distributed from Kashmir and Punjab eastward to Nepal and China at elevations of 300–10,000 feet.

Numerous ethnomedicinal surveys and studies, as highlighted by, emphasize the notable role of D. deltoidea in various traditional healing systems globally. Traditionally, diverse communities have utilized this species to address a broad spectrum of health issues, including gastrointestinal problems, urogenital disorders, diarrhea, respiratory conditions such as abdominal pain, cough and cold, intestinal worms, wounds, joint pain, anemia, irritability and also ophthalmic conditions. Dioscoreae deltoidea has a variety of phytochemicals that have been identified by various researchers. These include diosgenin, campastrol, 25-D-spirostan-3,5 diene, stigmasterol, dioscorin, B-sitosterol and dioscin. Roots are a rich source of carbohydrates, tannin, and phytosterols. The phytochemical screening performed by Akalya in 2016 revealed the presence of terpenoids, anthro quinones, polyphenols, phlobatannins, tannin, saponins, and tritepenoids in D. deltoidea leaves. Steroidal glycosides are well known plant compounds having anticancer, hemolytic, fungicidal, antibacterial and hypocholesterolemic properties. Research findings indicate that the extract of D. deltoidea comprises a variety of compounds, including sterols, alkaloids, resins, flavonoids, saponins, unsaturated triterpenoids, tannins, carbohydrates, and glycosides. Additionally, substances such as ascorbic acid, aluminum, riboflavin, beta-carotene, calcium, cobalt, chromium, iron, magnesium, ash, manganese, potassium, phosphorus, proteins, sodium, selenium, tin, thiamine, silicon and zinc have been identified in the plant. Due to the presence of these elements and chemicals this plants is having a great industrial importance.

Picrorhiza kurroa (Kutki)

Belongs to family Plantaginaceae. The Important phytochemicals found here are**:** Picroside I, Picroside II, Kutkoside, Apocynin, Cucurbitacins and Phenolic compounds. Pharmacological significance is Hepatoprotective, Immunomodulatory, Antioxidant, Anti-inflammatory, Anticancer potential. The iridoid glycosides (picrosides) represent the major active constituents responsible for the medicinal properties of this endangered Himalayan herb. Joshi, R.K., 2016.

Aconitum heterophyllum

Belongs to family Ranunculaceae. Important phytochemicals found here are: Diterpenoid alkaloids, Atisine, Heteratisine, Aconitine derivatives and Flavonoids. The Pharmacological significance is: Analgesic, Antipyretic, Anti-inflammatory, Traditional treatment of fever and gastrointestinal disorders. Several *Aconitum* species occurring in Kashmir are threatened due to intensive collection. Their phytochemistry is dominated by diterpenoid alkaloids, which possess significant biological activity but may also be toxic. Rezaei and Kamkar, 2007.

Iris kashmiriana

It belongs to the family Iridaceae. Important phytochemicals found here are Isoflavones, Isonigricin, Irisolidone, Isoirisolidone, Phenolic compounds. The Pharmacological significance is: Antioxidant, Antimicrobial, Immunomodulatory, Antitumor potential. Research has identified several unique isoflavones in *Iris kashmiriana*, making it an important species for phytochemical and pharmacological investigations. Pandita, et al., 2015.

Major Phytochemical Groups Found in Endangered Kashmir Plants

Phytochemical Class	Examples	Biological Activities
Alkaloids	Atisine, aconitine	Analgesic, neuroactive derivatives,
Flavonoids	Quercetin isoflavones	Antioxidant, anti-inflammatory
Phenolics	Phenolic acids, tannins	Antioxidant, antimicrobial
Terpenoids	Diterpenoids, triterpenoids	Anti-inflammatory, anticancer
Iridoid Glycosides	Picrosides, swertiamarin	Hepatoprotective, immunomodulatory
Xanthones	Gentisin derivatives	Antioxidant, antimicrobial

Joshi, et al., 2016.

Conservation Importance

Many endangered medicinal plants of Kashmir accumulate high concentrations of secondary metabolites because they grow under harsh alpine and subalpine conditions characterized by strong UV radiation, low temperatures, and environmental stress. These adaptations enhance the production of alkaloids, phenolic, terpenes, and glycosides that have pharmaceutical value. In order to avoid the future loss of endangered, endemic and rare species, conservation of plant genetic resources has long been realized as an integral part of biodiversity conservation. Plant cell and tissue culture has been a powerful tool for rapid propagation and biomass production of valuable species. To overcome environmental constraints in-vitro cultures (cell, callus, buds and shoot) provide the best alternative choice for the smooth and constant supply of plant active ingredients. However, there are no effort in literature for *ex-situ* conservation and micro propagation of some critically endangered plants like *Sassuria sacra*, *S. costus etc*. The purpose of this research was to establish an effective and efficient clecklist of all the endangered medicinal plant applications and their composition. However, uncontrolled harvesting threatens both the species and the valuable phytochemical resources they contain. Conservation through in situ protection, cultivation, and tissue-culture-based propagation is therefore essential.

Conclusion

The endangered flora of Kashmir Valley represents a valuable reservoir of medicinally important phytochemicals. The primary screening process involved investigating bioactive compounds present in various organ extracts of medicinal plants in different solvents. These bioactive components might play

an important role in modulation in a different disease like Alzheimer, stoke, Parkinson and diabetes etc. Species such as Gentiana kurroo, Picrorhiza kurroa, Aconitum heterophyllum, Iris kashmiriana, and Meconopsis aculeata contain diverse bioactive compounds including iridoid glycosides, alkaloids, flavonoids, and phenolic compounds. These metabolites underpin their traditional and modern medicinal uses, making conservation and phytochemical research critical for both biodiversity preservation and future drug discovery. Our research team is carrying out detailed investigations of the chemical composition and mechanism of actions of these herbal plants including in-vitro and in-vivo studies, and its role in neurodegenerative disorders.

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