Reviewing Medicinal Plants of Treasure Land: The Indian Himalayan Range

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Abstract The Himalayan range is home to a diversity of plant due to the altitude, topography gradient and varying climatic conditions. Among the 18,000 already known flowering plants that grow in India, about 2500 of them possess some medicinal property and 25% of these plants reside in Himalayan range at different altitudes. Plants in order to survive and defend themselves in stressful environmental condition adapt and alter their plant physiology leading to the production of secondary metabolites. These medicinal plants have a key role in the lives of the local communities since ages, they rely on them for nutrition and medicinal requirements. Secondary metabolite rich plant is the main source of attraction for researchers as well as the industrialists. Wide Himalayan range not only provide raw material to the pharma industry but also to the cosmetic industry. The vital goal of the current paper is to review the potentially rich medicinal plants, threats and conservation practise of medicinal plants in the Himalayan range.

Keywords Indian Himalaya region · Medicinal plants · Ayurveda · Biodiversity

1 Introduction

Indian Himalayan range is blessed with a diversity of flora. According to the sources out of the 500,000 plant species growing all over the world, only 1% has been phytochemically investigated, which illustrates that these plants have great potential for detecting novel bioactive compounds. The Himalayas stretches cover 3000 km from Northern Pakistan, Nepal, Bhutan and the North-Western and North-Eastern states

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of India with rich biodiversity due to variations in habitat [17]. The Lower Himalaya promotes the growth of luxuriant trees of *Alnus nitida* and *Pinus roxburghii* on the slopes, while the moist rich slopes are occupied by *Alnus nepalensis*, *Quercus leucotrichophora*, *Rhododendron arboreum*, etc. The forests of *Quercus semecarpifolia*, *Quercus floribunda* and *Pinus wallichiana* are characteristic of the higher altitude zones of the Lower Himalaya. The higher altitudes beyond the tree line (above 3600 m) delivers an ironic assemblage of herbs in the alpine meadows and grasslands. The diverse species of herbal plant belonging to genera *Aconitum*, *Picrorhiza*, *Rheum*, *Meconopsis* and the scrubs *Rhododendron anthopogon* and *Rhododendron lepidotum* are some of the vital plants of these heights. *Rosaceae* and *Umbelliferae* are some of the chief Himalayan families with a high degree of endemism. Total endemic plant species are counted to be 3160 [16]. It is determined that close to 15% of about 70,000 known plant species have therapeutic properties which means that over 10,000 plant species are utilized in medicine at one time or another.

The Indian ancient text provides a reference to the herbs growing in the Himalayan region since ages. Ayurveda is an ancient system of life. It is one of the storehouses of antiquated information, which is still in use [25]. Atharveda has a detailed account of the medicinal properties of countless herbs for curing various ailments.

Treatment provided to a sick person using herbal plants tend to possess no side effects on the body, they are completely safe. Since these herbal plants are in a state of harmony with nature, they hold more prominent favourable position over synthetically treated items and manufactured drugs. Ayurvedic herbs are capable of providing holistic healing to an individual for a long run [18].

Apart from being the main source of raw material for the production of medicines for humans, these herbs can be utilized for the preparation of bio-pesticides, example castor plant, natural dyes example rattan jot, brews example rhododendron and perfumes example Jatamasi [28]. In today's time, every individual has understood the damage one has to face after synthetically prepared medicine. Plants based drugs are a vital element for the current health care system in the world. A total of 85% of world population use the locally available herb as medicine [8]. So, keeping the view of severity of medicinal plants, we reviewed and discussed the description, distribution pattern, phytochemistry, medicinal property of some selected medicinal plant of the treasure land Himalaya and also discussed about the threats and conservation practices.

2 Description of Medicinal Plant

In Himalayan range of India, a lot of medicinal and aromatic plants are present. Here, we discussed about the used five medicinal plants such as *Rhododendron*, *Aconitum*, *Bacopa monnieri*, *Berberis* and *Hedychium.* The distribution pattern of the selected medicinal plants is illustrated in Table 1. However, the phytochemical property and part used for the medicinal is illustrated in Table 2. The detail description of selected medicinal plants is discussed below.

Table 1 Altitude and rainfall of selected medicinal plants of Himalayas

Name of the plant	Altitude	Mean annual rainfall
Rhododendron arboreum	1500–3500 m	200–1800 mm
Bacopa monnieri	1300 m	650–830 mm
Berberis aristata	2000–3000 m	1200–1400 mm
Hedychium spicatum	1500–2500 m	1000–1500 mm
Asparagus racemosus	1500 m	600–1000 mm

Table 2 Chemical constituent and phyto-constituent of parts used in selected medicinal plants of Himalayas

Name of the plant	Chemical constituents	Part used	Phytoconstituent present
Rhododendron arboreum	Quercetin	Flower	1.051–12.5%
Bacopa monnieri	Bacoside	Leaves	50–55%
Berberis aristate	Berberine	Root	1.6–4.3%
Hedychium spicatum	β-pinene	Rhizome	16.7%
Asparagus racemosus	Sapogenin	Tubers	0.7–0.9%

2.1 Rhododendron

2.1.1 Descriptions

The presence of Rhododendrons was first verified by Captain Hardwick in Jammu and Kashmir in the year 1776. Rhododendron commonly called as Buras or Laligurans (Nepali name) belongs to the family Ericaceae [10]. There are in total 80 species of Rhododendron but only 12 Species are found in India. Most of these species are reported to be very valuable for the local population. Many species are being widely exploited for fuelwood and incense [4].

It is an evergreen tree with a wide crown, that grows up to 20 m and above in height. The leaves are glossy green from the top and rustic brown at the back, they are crowded towards the base and are lanceolate, narrow in shape. They are 10–20 cm long and 3–4 cm wide. The colour of the flower ranges from pink to red [35]. Fruit type is capsular and has ellipsoid seeds. Last two to three weeks in October are considered suitable for the collection of seeds [39].

2.1.2 Distribution

Rhododendron has been named as the national flower of Nepal and the state tree of Uttarakhand. It is well distributed in Himachal Pradesh, Sikkim, Nagaland, Mizoram, Uttarakhand etc. The moist slopes in the eastern part of the Himalayan region provide the best habitat for well-flourished growth of Rhododendron species. In Uttarakhand,

the *R. arboreum* species are confined to an altitude of 1500–3500 m above mean sea level. It grows best on acidic soil where under such pH condition very few plants can survive [45].

2.1.3 Phytochemistry

Numerous phytochemicals have been extracted from different parts of the Rhododendron. 34 compounds were acknowledged i.e. Leaves of Rhododendron is rich in flavonoid. Quercetin is found in flower and leaves. Rutin and sterol are found in leaves. Betulin, lupeol, ursolic acid is present in the bark [27].

2.1.4 Medicinal Uses

The fresh blossoms are likewise utilized in the treatment of dysentery and dyspepsia. The bioactive constituents of the bark of this plant have antifungal properties. The ethanolic extracts from the leaves exhibit antitumor activity.

2.1.5 Other Rhododendron Species

1. *Rhododendron barbatum*, *Rhododendron falconeri, Rhododendron hodgsonii* are a source of fuel for local people.
2. Leaves and twigs of *Rhododendron anthopogon* are used as a raw material for the preparation of incense stick.
3. Fresh corolla from *Rhododendron arboretum* and *Rhododendron cinnabarium* is used for the preparation of local brews. The tender leaves and woods are used for the production of cups, spoons, boxes and saddle.
4. Leaves and flowers of *Rhododendron anthopogon* are effective in treating indigestion and lung infection [9].

2.2 Aconitum

2.2.1 Description

Aconitum which is also known as aconite, wolfbane, queen's poison or monkshood, comprises of 250 species. It belongs to Ranunculaceae family [13]. Some of the species of Aconitum are remarkably deadly, despite this, they possess a lot of therapeutic importance. Proper measures must be taken to extract the essential compound from the plant without the toxic nature [40]. It is one of the most valued drug and treasured components of Ayurvedic system of medicine. Yearly demand of raw drugs is fairly high in the local market, which has generated immense pressure on the genus

leading to its threatened status in different states of Himalayan range [11]. They are biennial tubers and are economically important. It grows up to a height of 15–20 cm. Leaves are glabrous, heteromorphous and long petioled. It has violet-blue sepals and black coloured pyramidal seeds.

2.2.2 Distribution

Aconitum occurs in the alpine and sub-alpine regions of Himalayas at an elevation of 2000–5000 m. It is native to parts of Western Himalaya [29].

2.2.3 Phytochemicals

Diterpene alkaloids and flavonoids are found in abundance in Aconitum species. The alkaloid aconitine in the tuber's attributes to the medicinal properties of the plant. The other compounds existing in the plant are tannic acid, starch, fatty acids and their glycerides, carbohydrates, etc. [1].

2.2.4 Medicinal Uses

Aconites are quite beneficial in treating the communicable disease, for example, measles. It fruitfully cures problems like asthma, diabetes, leukoderma, leprosy and convulsions etc. phenolic and flavonoid elements of the plant have antioxidant as well as anti-bacterial effect. It is effective in counteracting cough and congestion. It is a good aphrodisiac and bears the features of being a diuretic [2].

2.2.5 Other Aconitum Species

- *Aconitum heterophyllum* is widely used in Ayurvedic medicines because of its hot potency. The seeds have a laxative property. The roots are effective for health problems like anorexia, arthritis and ascaris [42].
- *Aconitum ferox* is also known as Meetha Vish or Monkshood. It has sedative nature because of which it is also prescribed to people dealing with severe anxiety issues, also it is highly effective in fever, diuretic action, asthma and arthritis.
- *Aconitum heterophylloides* also known as Nepal Monkshood or safed bish is a tall hairless herb with tuberous roots. The root of the herb contains 0.9% total alkaloid content which is used in acute headache and rheumatism [24].

2.3 *Bacopa monnieri*

2.3.1 Description

Bacopa monnieri is commonly known as Brahmi. It is a member of Scrophulariaceae family. This family includes more than 4500 species [47]. It has been effectively used in improving memory and other positive psychological abilities in both normal and mentally retarded kids with promising results. It is a creeping plant with a tender stem which grows up to a height of 10–30 cm in length with 1–2 mm of a thickness [48]. It has succulent and sessile leaves that are oppositely arranged on the main stem. Flower and the fruit emergence take place in the summer season. It bears flowers possessing a colour range from white to slightly violet-blue. The fruit is ovoid, with no discrete odour. It has cooling potency [12].

2.3.2 Distribution

It is found in the tropic and sub-tropics regions. It is found in moist and wet places throughout India and Nepal [37].

2.3.3 Phytochemicals

The therapeutic importance of this plant is because of the presence of several compounds in it such as alkaloids, saponins, glycosides, flavonoids and stigmasterols. The saponins of this plant are called “bacosides”. Luteolin and apigenin are the two flavonoids that are found in it. Two alkaloids isolated from *Bacopa monnieri* are herpestine and brahmine, if taken in high dosage may lead to extreme headache [22].

2.3.4 Medicinal Uses

Bacopa monnieri is beneficial for treating skin diseases example eczema, ulceration etc. It is an excellent medicine for Alzheimer and amnesia, thus commonly used as a brain tonic. It is an effective herb for the prevention of hair fall and early greying of hair. It rejuvenates the hair follicle and prevents baldness [3]. *Bacopa monnieri* consists of powerful antioxidants that protect the body against free radical impairment [30].

2.3.5 Other Bacopa Species

- *Bacopa crenata* is a perennial medicinal plant also called moneywort.

- *Bacopa repens* is an annual plant and has a creeping stem.
- *Bacopa rotundifolia*: This plant is not of commercial use [23].

2.4 *Berberis*

2.4.1 Description

Berberis aristate also called as Indian barberry in English or Daru Haldi in Hindi belongs to the family Berberidaceae. Most of the *Berberis* sp. have acquired a significant position in the traditional system of medicine. It is a perennial shrub which grows in a temperate climate [19]. It can grow up to 3 m height. The flower is yellow coloured. The fruit is in the form of an ovoid berry and contains 2–5 seeds, the colour of seed ranging from yellow to pink. The fruit has acidic to sweet taste [38].

2.4.2 Distribution

Berberis is a well know herbal plant of Indian Himalayan Region. It growing in small patches in hilly slopes. It is found at an altitude up to 1800–3000 m (middle altitude areas) in Uttarakhand and Himachal Pradesh [36]. IUCN has kept this plant under endangered status. It is typically cultivated for its edible fruits [34].

2.4.3 Phytochemicals

The most vital constituent of this herbal plant is berberine, a quaternary isoquinoline alkaloid, which is mostly found in the stems and roots. The bark consists of the quaternary ammonium salt of isoquinoline alkaloid. Western Himalayan species of *Berberis* are rich in fibre, protein, fats and some minerals like Calcium and Potassium [41].

2.4.4 Medicinal Use

Berberis is super effective in curing skin disease like melasma. It is effective in safeguarding liver against disorders. It prevents water loss from the body due to loose motion and diarrhoea so utilized as a mild laxative [14]. The roots, stems, leaves and fruits are traditionally utilized to treat wounds, diabetes, inflammations and jaundice. The extracts of this plant have been testified with antibacterial, antiviral, antifungal, anticancer, anti-inflammatory and antidiabetic profiles [33].

2.4.5 Other *Berberis* Species

- *Berberis* vulgaris has anti-inflammatory properties.
- *Berberis heterophylla* has anti-microbial properties [6].
- *Berberis repens*: It has anti-bacterial properties.

2.5 Hedychium

2.5.1 Description

Hedychium spicatum belongs to the family Zingiberaceae, commonly known as Kapoor katcheri in Hindi and spiked ginger lily in English and as Shati Ayurveda. It is a small hardy rhizomatous herb [15]. It is a perennial herb which raises to 1–2 m, which consists of orange whitish flowers. Flowering can be seen in July–August and seeding in September–October. This plant has fragrant leaves with a robust stem which grows up to 1.5 m tall. Leaves are 30 cm long and lanceolate in shape. The rhizome has a strong odour and it tastes bitter. It bears black with red aril [32].

2.5.2 Distribution

Hedychium spicatum is an endemic herb species which is found in countries of South-East Asia. This species is also native to a Himalayan region consisting of various habitats in sub-tropical to temperate zones. The species can be commonly found in the of Central Himalayan Region of India from 1200 to 2400 m in moist and rocky habitat near a water body and oak or mixed forest [32]. It is distributed in Andhra Pradesh, Arunachal Pradesh, Darjeeling, Himachal Pradesh, Karnataka, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, and Sikkim. The species is best for the sub-tropical zone which requires sunny weather. The lowest temperature it can tolerate is −2 °C [31].

2.5.3 Phytochemicals

The extract of tubers contains 4% essential oil, starch, resins, organic acids, glycosides, albumen and saccharides. These extracts are good for the treatment of bronchitis, indigestion, eye disease, inflammations, laxative, stomach ache, carminative, stimulant, tonic to the brain and diarrhoea. Numerous chemical ingredients testified in essential oil are α-pinene, β-pinene, limonene and many others [31] used as tranquillizer, CNS depressant, hypotensive, respiratory disorders, antimicrobial, analgesic, anti-spasmodic and antifungal activities [21].

2.5.4 Medicinal Use

Pharmacological activities of *Hedychium spicatum* testified till now are antidiabetic, tranquillizing, pediculicidal, antimicrobial, antioxidant, antimalarial hepatoprotective, cytotoxic activity, hypocholesterolemic, anthelmintic, stomachic and tonic activity. 1, 8 cineole is compound obtained from the rhizome is used for its antidiabetic property. The anti-microbial property of the essential oil can be seen in against *Staphylococcus aureus*, *Escherichia coli*, *Shigella flexneri*, and *Pasteurella multocida*. It is used for anthelminthic activities also but is not very effective. Most of the essential oils extracted from the tuber are used for the treatment of various problems [5].

2.5.5 Other *Hedychium* Species

- *Hedychium acuminatum*—It best used for liver disease.
- *Hedychium coronarium*—It is super effective in curing cataract.
- *Hedychium marginatum*—Best used against the problem of indigestion [7].

3 Threats and Conservation Practices for Medicinal Plants in Indian Himalayan Region

Loss in Genetic Resources of Medicinal Plants
The demand for raw medicines is pretty high per annum in the domestic marketplace [46]. Major medicinal species of Himalayas are susceptible to extinction due to overharvesting [44]. Result of expansion in urban areas, increasing tourism and other progressive activities like hydroelectric schemes and highway projects cause excessive damage to genetic diversity [43].

Effect of Overgrazing
Grazing animal causes a serious threat to and the dispersal of medicinal plants. The area protected from nomadic grazing shows healthier flora. The diversity of medicinal plants had decreased in the overgrazed locations by nearly 90%. It is also observed that the accessibility of economically and therapeutically important plant species is declining.

Disproportionate Collection of Medicinal Plants
The indiscriminate harvesting of medicinal plant from wild become a source of revenue when sold to traders in informal market. The risk of over-harvesting leading to loss of susceptible plant population has been recognized for years. It is necessary to introduce good harvesting practices to the collectors to decrease the avoidable losses.

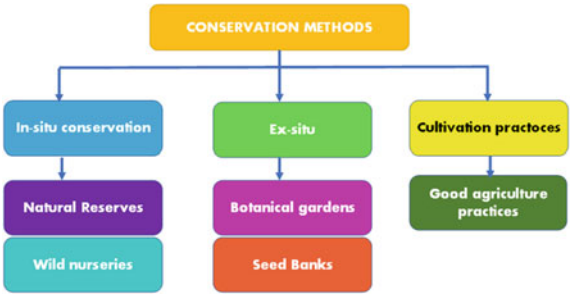

Fig. 1 Common conservation practices

Climate Change
There are indications that climate change is producing visible effects on life cycles and distribution of species of the plants. Although, recently this viewpoint has been given renewed attention.

4 Conservation and Sustainable Development

Conservation of medicinal plant species is done for maintaining gene bank of the vulnerable species. On the other hand, sustainable harvesting decreases the degeneration of renewable non-timber plant resources. Conservation of medicinal plants and their genetic resources can be done through in-situ and ex-situ practices. Ex-situ conservation includes conservation of average plants outside their natural habitat used to protect them from destruction, replacement or deterioration. It includes procedure like seed storage, DNA storage, field gene banks and botanical garden. In-situ is opposite of ex-situ, the conservation of a particular species is done in its habitat (Fig. 1).

5 Organizations Involved the Conservation of Medicinal Plants

The Government of India (GOI) is thoughtful about the maintenance of priceless herbal wealth. The banking segment has also been established for providing economic aids to numerous plans involved in medicinal plant conservation and cultivation plans. The National Bank for Agriculture and Rural Development is supportive in the development of medicinal plant sector in synchronization with NMPB. It is providing bankable models for medicinal and aromatic crops [20] and is also supporting in the capacity building curricula in this direction [26].

6 Conclusion

The Himalaya enjoys the benefit of diverse medicinal and aromatic species, which occupies a very important place in the herbal pharmaceutical sector. Constant research will help in further promoting the rich and rare biodiversity of the range. The medicinal plants of the Himalayan range have a great diversity of medicinal properties including antioxidant, neuroprotective, antidiabetic, hepatoprotective, anticancer, antimicrobial, and immunomodulatory functions. Harvesting these herbs directly from wild has been in practice for a long time, and rising curiosity in herbal medicines has led to the bigger demand of these plants at national as well as global level, which has put this treasure under pressure. Preparing suitable agro-techniques for the domestication of wild species under threat and finding out other ways with which we can conserve them has become the need of the hour.

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