



# Surveillance of *Berberis* Species across Poonch Division of Azad Jammu and Kashmir

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**Abstract:** *Berberis* is one of the most important medicinal plant and it has a great medicinal value. *Berberis* has such pronounced medicinal values that it is used to cure many diseases and has exhibited great therapeutic effects among the local communities throughout the world. Diversity of *Berberis* is uncertain to great extent in Poonch division of Azad Jammu and Kashmir. *Berberis* specimens were collected from four districts comprising fifteen tehsils of Poonch division of Azad Kashmir. About 40 prominent locations were visited during flowering and fruiting stages during 2016-17. A total of seven species and a sub species were identified on the basis of morphological studies. Studies showed that identified *Berberis* species were present in all the four districts. Shanon and Simpson indices were used for calculating diversity of *Berberis* species in the study area along with calculating species evenness and equitability. Diversity indices indicated that there was moderate diversity of *Berberis* species within different districts and different tehsils. Simpson diversity index indicated that there is an 87 % chance that two individuals selected randomly from the study area would be different. Species evenness indicated that each specie identified from each tehsil had maximum chance of occurrence and each identified species is present in every tehsil. Species equability also indicated similar kinds of results which indicated that different species were evenly distributed in each tehsil. It was concluded that there is moderate diversity of *Berberis* species in Poonch division of Azad Jammu and Kashmir. All the identified species were present in all the districts. The present study will advance our knowledge regarding identification and distribution of *Berberis* species in Poonch division.

**Keywords:** Abundance, *Berberis*, Diversity Studies, Shannon Index, Simpson Index

## 1. INTRODUCTION

Barberry (*Berberis* spp.) is a well-known medicinal plant, which has long been used in the world in many old civilizations [1]. This plant is deciduous, evergreen and semi-evergreen small tree or shrub, with regular spines, with inflorescence as racemes, umbels, or solitary red-orange, orange to yellow which grows up to 4 m high and under different ecological conditions [2, 3].

The prominent member in dicotyledonous genus in the Berberidaceae family is the *Berberis*; they are evergreen shrubs or small bushes, woody and spiny in nature. The recent reports showed that [4], the Berberidaceae family had 15 genera

and 650 species around the world. *Berberis* is distributed in many parts of the world like Africa, America, Europe and Asia. In Pakistan *Berberis* is distributed across the mountainous regions (1400-3500 m above sea level). These areas include Kashmir, Khyber Pakhtunkhwa, and northern areas of Baluchistan. *Berberis* is enriched with important chemical compounds. Due to presence of these compounds *Berberis* has a vital role in many systems of medicine [5].

Simple simulation tests and data regarding abundance of species can be used to measure species diversity, equitability, and richness. Most recommended indices or measures of species diversity are Shanon's index, Simpson's index and

Fager's index [6]. These indices are commonly used indices for measuring species diversity as they face less criticism as compared to others. Measures of species richness depends upon size of the sample. Variability in sample size can be misleading and richness and equitability estimating methods for species can not be applied [6].

Diversity is one of the key component of an ecosystem which can be measured or estimated at different levels and in many ways. Diversity can be present within genes, within individuals of a population, within different species of the same genera, within communities and ecosystems [7]. The major problem in estimating biological diversity is that it is not properly defined and is ambiguous [8]. The survival of an area depends upon its biodiversity. If an area donot have variation in its flora and fauna then it has no value. As Reet said, "diversity, in essence, has always been defined by the indices to measure it" [9]. At species level in a community alpha diversity is opposed to  $\beta$ -diversity and  $\gamma$ -diversity: [10] which is also known as species number or species richness, evenness or equitability is the relative abundance of species. The two factors are also used for estimating the diversity of species within an area [9, 11].

Due to human over exploitation and environmental fluctuation in the Himalayan region, floral diversity has greatly reduced. Forest vegetation fragmentation into small patches is mainly due to anthropogenic disturbance. There is a great need of research regarding floral biodiversity identification and conservation in Poonch valley of Azad Jammu and Kashmir. The studies revealed that there were 30 endangered, 145 vulnerable and 68 species near to extinction. The valley determined deterioration in plant diversity because of maximum exploitation of vegetation. For sustainable use *in-situ* and *ex-situ* conservation, afforestation and harvesting by controlled methods can be a solution [12].

Taxonomic studies and identification of *Berberis* species is difficult due to high phytochemical and morpho-pathological variations. These variations may be due to Hybridization and environmental effects [12-14]. Field identification is often made challenging by overlapping characters especially in stem, leaves flower and berry size. In some of the plant species, serrations and leaf

texture vary from environment to environment and with plant's age [13-16]. The present study was the first attempt to explore the diversity of *Berberis* species in each district of Poonch division as it was not well documented; it will serve as a baseline to study diversity and evolutionary relationships of *Berberis*.

## 2. MATERIALS AND METHODS

### 2.1 Study area

The state of Azad Jammu and Kashmir has a total area of 13,297 square kilometres. The total study area which comprises four districts and fifteen tehsils is about 2792 square kilometres, in which district Poonch is about 855 square kilometres, Bagh 770 square kilometres, Sudhnoti 569 square kilometres and Haveli 598 square kilometres. The study area is mostly hilly and mountainous [17].

Azad Jammu and Kashmir has a broad range of climatic conditions depending upon the altitude range (360 m South to 6325 m North). It has dry sub-tropical (South) to moist temperate (North) climate. The average rainfall is ranges from 1000 mm to 2000 mm. Northern districts have 30 to 60 percent precipitation in the form of snow. The snow line is about 1200 m in winters but reduces to 3300 m in summers [17].

### 2.2 Localities selection for specimen collection

For sampling, species identification and to cover the maximum part of study area depending upon the road links sites were selected and those sites were at least 10-15 kilometres apart from each other. The slected sites were grassy fields, orchards, field crops, mountainous regions, forests with bushes and high trees. The coordinate data and altitude of each locality was noted by using Altimeter.

### 2.3 Field visits and collection of specimen

Field visits were performed in the study area of Poonch division of Azad Jammu and Kashmir during flowering and fruiting stages in 2016 and 2017 for the collection of specimen and recording morphological parameters. Collected specimens were submitted to Pakistan Museum of Natural History, Islamabad for the morphological

identification and confirmation of *Berberis* species.

## 2.4 Processing of collected specimen

All the specimen were dried, numbered and preserved by applying standard herbarium techniques [18-20].

## 2.5 Storing of specimen in field

The specimen soaked in 10 percent formalin solution were placed in paper folders and stored in plastic bags.

## 2.6 Pressing and drying

The specimen were brought to the Lab., placed on a paper sheet and pressed with wooden plant presser. The papers between the specimen were changed every day for about 3 to 4 days and the sheets containing specimen were placed in well ventilated and warm place.

## 2.7 Mounting

Glued strips were used to mount the dried specimens on herbarium sheets. Sheets containing specimen were provided with all the standard information like local name, botanical name, locality, family, altitude, date of collection, specimen number and collector's name. All the specimen were deposited in the department of Plant Breeding and Molecular Genetics and Pakistan Museum of Natural History, Islamabad.

## 2.8 Identification of specimen

Identification was done by comparing;

- With already identified specimen at Pakistan Museum of Natural History, Islamabad.
- With taxonomic keys of Flora of Pakistan [15].
- With specimen images and other diagrams.

## 2.9 Statistical analysis

Diversity indices were calculated on the basis of tehsils as well as districts. Shanon weiner and Simpson's indices were used for diversity estimation. Beside diversity estimation evenness and equitability of the species was also estimated

using computer based software PAST 4.03.

## 3. RESULTS AND DISCUSSION

The central theme of ecology is diversity and it has a useful impact on an ecosystem. Measures of diversity most of the time regarded as gauges of security and protection of biological system. The collection and processing of diversity data is time consuming so it is hard to define and difficult to calculate. However, diversity in plant species is considered as fundamentals for plant species recognition. The presence and numerical conformation of total species in an ecosystem is known as its biodiversity. Establishment of diversity depends upon the stability of time and environment [22]. Generally, low diversity is yielded by homogeneous conditions whereas high diversity is yielded by heterogeneous conditions [23].

The richness of individuals within different species and indicating the variety of species present in a habitat are reliable methods of representing co-efficient of diversity in a sample or a habitat [24]. The estimates of floral diversity represent the number and functions of an ecosystem. If heterogeneity of the species is high, it will result in more floral diversity and thus results in higher index or co-efficient of diversity [25].

Two diversity indices evenness and equability were used for the calculation of short-term and long-term changes and continuous monitoring of species in the area. The measures of diversity are considered reliable when more than one indices are used, only one index for measuring diversity in an ecology can be misleading. The single index that measures the observed changes in the diversity can give a wrong impression as the changes occurred in an ecosystem cannot be covered by a single index [26].

### 3.1 Identified *Berberis* species and their taxonomic characters

#### 3.1.1 *Berberis lycium*

Table 1 showed that *Berberis lycium* is diploid having  $2n = 28$ , a shrub 2-3 m tall erect or suberect, semideciduous. Stem and branches

were pale, whitish to greyish. Spines were trifid, 1-2 cm long yellowish to straw coloured. Leaves 2.5-6 × 5.5-12 cm oblanceolate to ovate or elliptic grey or white below, openly veined 2-4 spines were present at margins. Racemes 10-25 flowered and 3-6 cm long rarely shorter. Flower 0.5-0.8 mm across usually pale yellow in colour. Pedicels were 0.6-1.2 cm long. Outer sepals much smaller than the middle and inner sepals; inner sepals were 0.45-0.5 cm long 0.3 cm broad, obovate. Ovules usually 4, shortly stipitate. Berries were 0.7-0.8 cm long and 0.5 cm broad blackish, ovoid with heavy grey-white bloom. Seeds 0.3-0.4 cm long.

### 3.1.2 *Berberis parkeriana*

Data presented in Table 1 showed that *Berberis parkeriana* is diploid having  $2n = 28$ , is a shrub very similar to *Berberis lycium* but leaves usually greenish below, epapillose and berries slightly larger. Stem was pale to whitish. Leaves were 3-6.5 × 6-12.5 cm, spines were absent at the margin of leaves. Thorns were tri-fid and 1.5-2.5 cm long. Flowers were yellow in colour. Racemes were 8-25 flowered. Berries were 0.8-0.9 cm long and 0.6-0.7 cm broad usually obovate blackish in colour. Seeds were usually 2-4 in number.

### 3.1.3 *Berberis ulcinia*

Table 1 depicted that *Berberis ulcinia* is small glabrous shrub, diploid in nature having  $2n = 28$ , 1-2 m tall much branched and densely spiny with 0.5-1 cm long internodes and reddish-brown stem. Thorns were tri-fid 1-1.5 cm long. Leaves were 0.5-1.5 cm long and 0.2-0.4 cm broad and linear-lanceolate or very oblanceolate, often entire to 1-2 spinulose at the margins, veined and minutely spined tip. Inflorescence 3-6 flowers were orange yellow in colour and were 0.5 cm in diameter, pedicellate, pedicel 0.3 to 0.4 cm. Sepals 0.64 cm, petals 0.41 to 0.46 cm. Stamens 6 and 0.33 to 0.39 cm long. Ovules 3 to 5. Berries black, globose, 0.5 × 0.25 cm. Seeds usually 3-5 in number.

### 3.1.4 *Berberis royleana*

*Berberis royleana* diploid in nature having  $2n = 28$ , shrub 1.5-3 m tall stem and branches were red brown. Spines were tri-fid usually red in colour and 1-1.5 cm long. Internodal distance was 1-2.5 cm.

Leaves were oblong-obovate 0.7-1.6 × 0.6-1.3 cm. Raceme 3-8 fold fascicled or subumbellate 1-1.6 cm long. Pedicels 0.5-1 cm long. Berries were blackish, pruinose grey, oblong, 0.75 cm long 0.4 cm broad (Table 1).

### 3.1.5 *Berberis orthobotrys*

Shrub 1-1.5 m tall diploid in nature having  $2n = 28$ , stem dark red sometimes orange yellow or pale brownish (Table 1). Moreover, internode distance was 1-2.5 cm, 1-2.5 cm long reddish or brownish spines usually 3-fid were present. Leaves were 1-3 × 5.5-1.7 cm, spinulose at the margins grey beneath, subsessile shortly petiolate. Raceme usually 5-25 fold and 1.6-3.2 cm long. Flowers 0.7-1.2 cm across, yellow to pale yellow in colour. Sepals 0.4-0.7 cm long. Stamens were shorter than the petals. Ovules were 3-5. Berries oblong, sub-ovoid 0.7-1 × 0.5-0.6 very variable in colour sometimes red or dark coloured when dried, often 3 seeded, seeds 0.3 cm long.

### 3.1.6 *Berberis brevissima*

The species *B. brevissima* is a shrub diploid in nature having  $2n = 28$  with whitish or pale, short, sub spreading almost glabrous stem and branches. Spines of tri-fid and usually 0.5-1 cm long. Leaves were 1-2 × 0.3-0.6 cm, 1-2 spinulose at the margin, pale sub-pruinose below, acute-spinulose at apex. Inflorescence 5-10 flowers yellow in colour, 2-5 fruited fascicled or sub-fascicled long up to 1 cm. Berries sub-globose, 0.35-0.5 cm long somewhat blackish in colour. Style 0.1 cm long berries were 2-3 seeded and 0.2-0.25 cm long (Table 1).

### 3.1.7 *Berberis kashmiriana*

Table 1 showed that *B. kashmiriana* is a shrub 1-2 m tall diploid in nature having  $2n = 28$ . Stem is glabrous pale yellow in colour. Internode distance was almost 2-3.5 cm, spines were usually 1-2 cm long and were of tri-fid. Leaves were 3-6 × 1-1.8 cm. Leaves were narrow obovate-oblong they were very short petioled, green epruinose below, spinulose at the margins, rediculate veined. Racemes were 3-4 cm long, 8-13 fold. Flowers were 0.95-1.35 cm across. Pedicels 0.8-1.7 cm long. Stamens slightly shorter than petals. Ovules 3-4 stipitate. Berries oblong 0.9-1 × 0.5 cm dark red

and very shortly stylose.

### 3.1.8 *Berberis orthobotrys* sub spp. *capitata*

Erect glabrous shrub diploid in nature having  $2n = 28$ , stem red-brown to pale-whitish in colour was present. Leaves were  $1-2 \times 0.5-1.5$  cm, elliptic-obovate, serrated at the margins, petiolated, greenish on both sides and veined. Racemes were short usually 9-20 flowers. Fruits were  $0.7-0.8 \times 0.5-0.6$  cm, oblong, sub-obvoid pale reddish when dried. Pedicels 0.5-10 cm long, 4 ovules, sessile, 2-3 seeded. Seeds were brown in colour (Table 1).

In the present study two indices the Shannon-Wiener's diversity index and Simpson's index were used for the calculation of diversity. Figure 1 is constructed on the basis of coordinate data shows the prominent collection sites of Poonch division of Azad Jammu and Kashmir. Grays reported the validity of indices application on biological data [25]. The Shannon-Wiener's diversity index is dependent upon distribution and suffers least criticism of validity. The calculated values of Shannon's index at various tehsils ranged from 2.05 to 2.08 (Table 2). Diversity indices greater than 2 indicated that there is moderate diversity of *Berberis* species within different districts and different tehsils. Simpson diversity index indicated value of 0.87, which indicated that there is 87 % chance that two individuals selected randomly from the study area would be different. It indicated huge variability among the individual plants that could result in stable population in the area. This variation might be the result of natural crossing resulting in interspecific and intraspecific genetic exchange among individuals or could be the environmental differences. These results could be confirmed via molecular analysis which is least affected by environment. On the other hand, it indicated that there is 13 % chance of the species identified from the area would be same.

Species evenness is the relative abundance of each specie in an area. Table 2 depicted the values ranging from 0.98 to 1 indicating that each specie identified from each tehsil had maximum chance of occurrence and each identified specie is present in every tehsil. Species equability also indicated similar kind of results. Equability values ranged from 0.99 to 1 which indicated that different species

were evenly distributed in each tehsil.

Diversity indices from four districts of Poonch Division of Azad Kashmir were presented in the Table 3. The Table showed that from district Poonch 916 individuals were studied from these individuals eight species were identified. From district Bagh 688 individuals were studied and eight species were identified. From district Sudhnoti 1206 individuals were studied and eight species were identified. From district Haveli 737 individuals were studied and eight species were identified. Simpson diversity index indicated the value of 0.87 which indicated that there is 87 % chance that two individuals selected randomly from each district would be different. It also indicated that there is 13 % chance that the species identified from the area would be same. The values calculated by Shannon's index at different districts were 2.07 indicating that there is moderate diversity within different districts. Species evenness is the relative abundance of each specie in an area. Table 3 depicted the values ranging from 0.98 to 1 which indicated that each specie identified from each district has maximum chance of occurrence and each identified specie is present in every district. Species equability also indicated similar kind of results. Equability values ranged from 0.99 to 1 which indicated that different species were evenly distributed in the study area.

It was observed that with increase in altitude percentage distribution of the species decreases while in low altitudes it was high. The decrease in species distribution is due to human interaction, deforestation, soil erosion, infrastructure development, encroachment pressure, collections of medicinal plants, low number of species, overpopulation, global warming and harsh environmental conditions [27]. In the middle part of the altitudinal gradient, species diversity was high in the tree layer. Due to above mentioned factors it decreased in both upper and lower altitudes. For effective conservation plan which can be implemented by knowing the indigenous flora, species identification and classification, habitat ecology, affecting the population of plants and anthropogenic factors, particularly those of threatened and vulnerable either locally or internationally [28]. Due to over exploitation and high rate of utilization species like *Geranium*



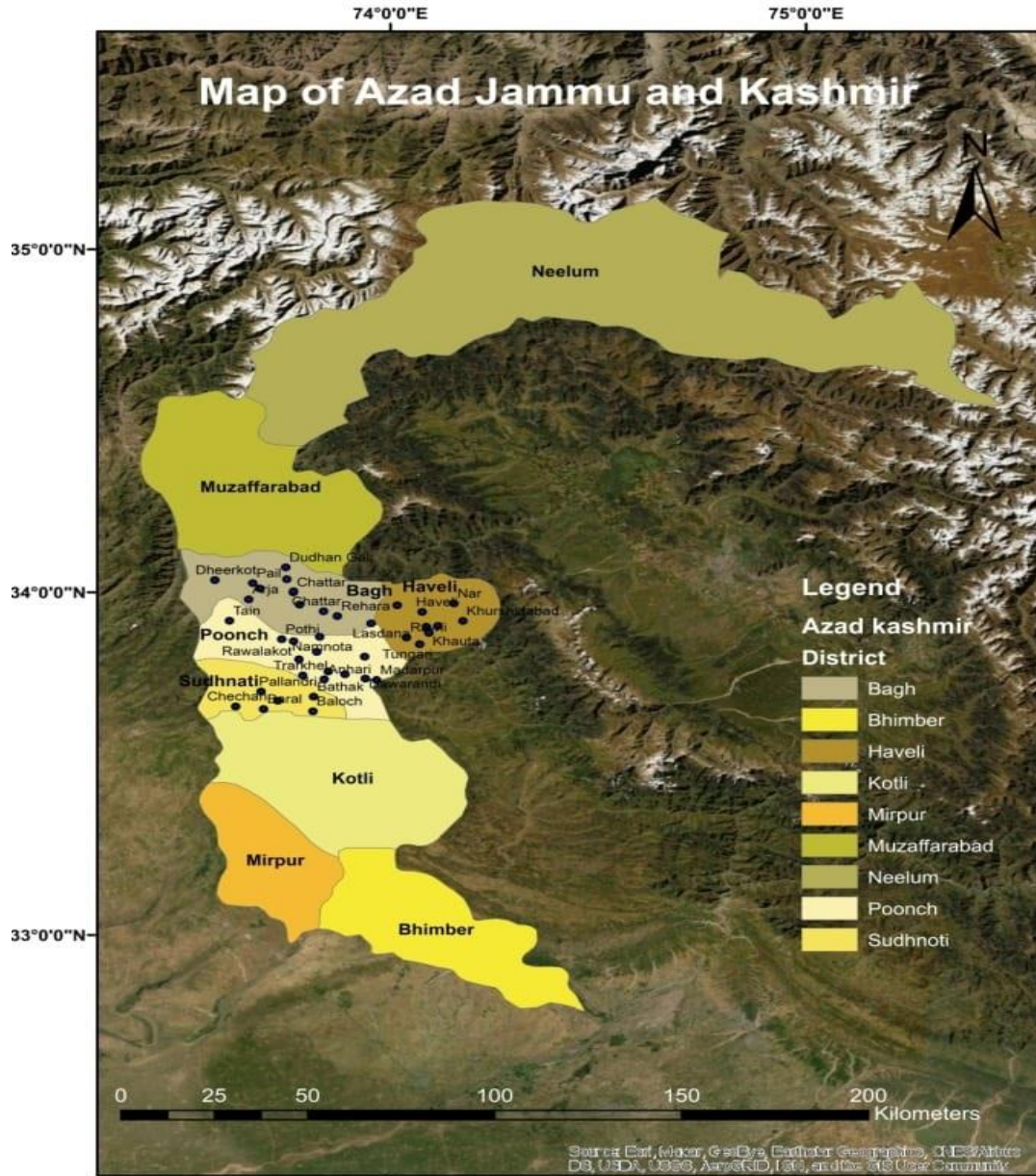


Fig. 1. Map of Azad Jammu and Kashmir showing data collection sites based on coordinate data

Table 3. Calculated values of diversity indices from districts of Poonch division of Azad Jammu and Kashmir

	Poonch	Bagh	Sudhnoti	Haveli
Species	8	8	8	8
Individuals	916	688	1206	737
Simpson	0.87	0.87	0.87	0.87
Shannon	2.07	2.07	2.07	2.07
Evenness	0.99	0.99	0.99	0.99
Equitability	0.99	1.00	1.00	1.00

*wallichianum*, *Bistorta amplexicaule*, *Saussurea lappa*, *Aconitum heterophyllum*, *Ajuga bracteosa*, *Jurinea dolomiaea* and *Berberis lycium* are on the verge of extinction [29]. There is always an increasing demand of these species while their production and conservation declined in the recent past few years. The relationship between functioning of ecosystem and species diversity is always directly proportional. The diversity loss now evolved as a worldwide issue that gained substantial consideration and attention. Floral degradation and disturbance of ecosystem has greatly affected the funna of that ecology. In most of the areas, over grazing of grass lands, over exploitation and destruction of biodiversity resulted in less production and of plant populations which have impacts on human society. To run the ecosystem properly, productivity and population balance have sublime importance which also affects ecosystem functions [30].

#### 4. CONCLUSION

On the basis of present study it was concluded that there is moderate diversity of *Berberis* species in Poonch division of Azad Jammu and Kashmir. All the identified species were present in all the districts. Identified *Berberis* species were evenly and equally distributed within the study area.

#### 5. CONFLICT OF INTEREST

The authors declared no conflict of interest.

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