Distribution and utilization pattern of herbal medicinal plants in Uttarakhand Himalaya: A case study

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Abstract
The present study was carried out in forest fringe area villages of Garhwal Himalaya to understand the distribution and utilization patterns of medicinal plants. We found 32 plant species that are being used by local communities. Among these plant species, most of the species were found frequently distributed. As per the utilization pattern, 7 medicinal plant species were found underutilized while 5 species were recorded as over-utilized species. The study recommends a sustainable use of over-utilized species and commercial utilization of underutilized species.

Keywords: Medicinal Plants, Distribution Pattern, Utilization Pattern, Uttarakhand Himalaya, Frequency of Use

Introduction
Uttarakhand, a natural environment of the Himalayas also known as ‘Dev Bhoomi’, is rich with a great wealth of medicinal plants, and traditional medicinal knowledge (Kumar et al., 2018) [1]. Several herbal plants are readily available in rural Uttarakhand for the treatment of various diseases at the local level. In Uttarakhand state, these resources have taken a distinguished position in the arena of socio-culture, spiritual, and medicinal (Dangwal et al., 2010) [2]. About two-third population live in rural Uttarakhand is depend on diverse natural resources to fulfill their need for food, fuel, fodder, timber, medicine, etc. The local communities use a large variety of medicinal plants for treating diverse diseases (Kala, 2000; Bisht et al., 2013) [3, 4]. Although, the traditional knowledge associated with the use of plants is wealthy but still carrying forward and orally transmitted by indigenous people (Deoli et al., 2015) [5].

Pimm et al. (1995) [6] have reported that the current loss of plant species is between 100 and 1000 times higher than the expected natural extinction rate and that the Earth is losing at least one potential major drug every 2 years. 15,000 plant species are threatened with extinction from over harvesting and destruction (Bentley, 2010) [7]. The accelerated loss of species and habitat destruction worldwide has increased the risk of extinction of medicinal plants, especially in India (Heywood and Iriondo, 2003) [8]. Although, there are plenty of studies available on qualitative aspects of medicinal plants; there is a need to evaluate the relationship between resource availability and resource utilization. Resource availability, consumption pattern, and frequency of use of these wild plants are now central aspects of this sector in the light of the sustainability of resources. Thus, there is an urgent need to document plant-specific harvesting frequency, plant resource availability, and their extraction intensity. Hence, the present investigation aimed to document and analyze medicinal plants based knowledge in the study area concerning the availability and uses of these resources.

Methodology
Study Area: The present study was carried out in Gwad-Khirsu, a hill station in Pauri Garhwal district of Uttarakhand which is situated at 30°17’22” N, 78°86’ 80” E with an altitude of 1700 m. It lies at a distance of 11 KM towards North from Pauri and 92 KM from Dehradun city towards the west. The study area was dominated by Banj-oak forests, whereas the lower reaches of the study area were comprised of Chir-pine forests. The north-facing aspect of the study area
Forms the watershed area of Khandah gad while the south aspect of the study area comes under the Pabo gad watershed area; the whole study area is the part of the Alaknanda river catchment. Forests play an important role in the local economy as various economic practices are interwoven with the forests.

Methods
Regular field visits were conducted during 2018-19 for the collection of ethnomedicinal information from the local community of Gwad-khirsu village and their surrounding hamlets (small villages). The 75% data were collected from Gwad-khirsu village and remaining from surrounding villages. Most of the medicinal plants are available in the Banj-oak forest which is the major source of collection of medicinal plants. Most of the information has been collected from the elderly person and we observed that younger generations are not interested to participate and they do not have sufficient knowledge about the use of medicinal plants. A questionnaire survey was carried out in the study villages using both open and close-ended questions and a total of 30% of villagers were interviewed in this survey. Later, a group of knowledgeable people among villagers has been deputed for the validation of collected data through a field visit. Most of the plant species were locally identified but few of them were verified with the help of Northern Regional Centre of the plant species were hard to know the scientific names of any species. The study revealed that the village community using 32 medicinal plant species.

Results
The study revealed that the village community using 32 medicinal plants to treat various ailments. They have one or two separate vernacular names for each plant species and they are hard to know the scientific names of any species. The scientific name, vernacular name, habit, habitat, and uses of each medicinal plant are listed in Table 1.

Table 1: Medicinal plants, their habits, habitats and medicinal uses

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Species</th>
<th>Vernacular Name</th>
<th>Habit</th>
<th>Habitat</th>
<th>Medicinal Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ajuga bracteosa Wall. ex Benth.</td>
<td>Neelkanti, Kadwi patti</td>
<td>Herb</td>
<td>Crop fields, Road and Path edges, Hill slopes, Open places, Loose soil area</td>
<td>Leaves juice used in fever, Plant extracts used as a tonic</td>
</tr>
<tr>
<td>2</td>
<td>Aloe vera (L.) Burm.f.</td>
<td>Patangwar, Ghigwar</td>
<td>Herb</td>
<td>Crop field edges, Forest field edges, Degraded lands, Cultivated</td>
<td>Leaves juice used for healing wounds and sores, Leaves flesh used in stomachache</td>
</tr>
<tr>
<td>3</td>
<td>Asparagus adscendens Roxb.</td>
<td>Jhirani, Satalwar</td>
<td>Under shrub</td>
<td>Forests (Oak, miscellaneous), edges of jungle paths, Shrubby localities</td>
<td>Tubers used in dysuria, diabetes, and dysentery mixing with honey, Ripe fruits are known to cause abortion</td>
</tr>
<tr>
<td>4</td>
<td>Berberis aristata DC.</td>
<td>Kingod, Kasmod</td>
<td>Shrub</td>
<td>Open forests, Hill slopes, Oak and Pine forests</td>
<td>The bark of stems and roots used in opthalmia, Infusion of roots given in fever</td>
</tr>
<tr>
<td>5</td>
<td>Berberis asiatica Roxb. ex DC.</td>
<td>Kilmoda, Kilmod</td>
<td>Shrub</td>
<td>Scrub forests, Edge of forest, Dry hill slopes</td>
<td>Root bark used in opthalmia</td>
</tr>
<tr>
<td>6</td>
<td>Bergenia ciliata (Haw.) Sterbn.</td>
<td>Silpada, Silpadi</td>
<td>Herb</td>
<td>Wet and shady slope and rocks, Moist places of the north aspect</td>
<td>Rhizomes used as tonic and febrifuge, Digestive and cutaneous disorders</td>
</tr>
<tr>
<td>7</td>
<td>Centella asiatica (L.) Urb.</td>
<td>Brahmi</td>
<td>Herb</td>
<td>Along paths, Shady and moist places, Edges of agricultural fields</td>
<td>A plant extract used for mental peace and as a blood purifier, Leaf paste applied for skin diseases</td>
</tr>
<tr>
<td>8</td>
<td>Cuscuta reflexa Roxb.</td>
<td>Amarbel, Akaslaguli</td>
<td>Parasitic Herb</td>
<td>Parasitic twinners on several shrubs and small trees</td>
<td>Dressing of stem used in rheumatic pain and swellings and also other skin ailments</td>
</tr>
<tr>
<td>9</td>
<td>Dicliptera bupleuroides Nees</td>
<td>Kuladnode</td>
<td>Her or under shrub</td>
<td>Grassy slopes, Exposed localities</td>
<td>Leaves applied to check to bleed, Leaf juice is useful in cough and gastric</td>
</tr>
<tr>
<td>10</td>
<td>Drymaria cordata (L.) Wild. ex Schult.</td>
<td>Pithpadpa</td>
<td>Herb</td>
<td>Moist and shady places, Exposed localities</td>
<td>Plant extracts used in bile complaints</td>
</tr>
<tr>
<td>11</td>
<td>Echinops cornigerus DC.</td>
<td>Kantyalu, Kandaru</td>
<td>Herb</td>
<td>Hill slopes, Open waste places</td>
<td>Root extracts promote the emergence of teeth in infant, Root juice given in fever and urinary troubles</td>
</tr>
<tr>
<td>12</td>
<td>Euphorbia hirta L.</td>
<td>Doodhi</td>
<td>Herb</td>
<td>Agricultural fields, Grassy fields, in association with doob</td>
<td>Plant extracts used in bronchial infection and asthma, Latex is applied on warts</td>
</tr>
<tr>
<td>13</td>
<td>Galium acutum Edgew.</td>
<td>Kuru</td>
<td>Herb</td>
<td>Shady places, Along paths</td>
<td>Herbaceous juice used in urinary disorders</td>
</tr>
<tr>
<td>4</td>
<td>Geranium ocellatum Jaquem. ex Cambess.</td>
<td>Kaflya</td>
<td>Herb</td>
<td>Edges of crop fields, moist places, Shaddy localities</td>
<td>Roots are antiseptic, Plants extract given in liver troubles and fever</td>
</tr>
<tr>
<td>15</td>
<td>Hedychium spicatum Nees</td>
<td>Kapoorachtri, Van Haldu</td>
<td>Herb</td>
<td>Grassy slopes, Shaddy and moist places, Banj-oak forests</td>
<td>Rhizome used in asthma and tuberculosis, Seeds believed to cause abortion</td>
</tr>
<tr>
<td>16</td>
<td>Inula acapra (Buch.-Ham. ex D.Don) DC.</td>
<td>Athhuu</td>
<td>Shrub or under shrub</td>
<td>Open forests, Hill slopes, Oak and Pine forests</td>
<td>Roots extracts given in urinary trouble</td>
</tr>
<tr>
<td>17</td>
<td>Mentha longifolia (L.)</td>
<td>Podina, Pudeena</td>
<td>Herb</td>
<td>Wet and moist places, edges of</td>
<td>Leaves juice used in vomiting and indigestion</td>
</tr>
</tbody>
</table>
Table 2: Medicinal plants and their distribution scores.

<table>
<thead>
<tr>
<th>Distribution Score</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Aloe vera (L.) Burm. f., Stephania glabra (Roxb.) Miers</td>
</tr>
<tr>
<td>4</td>
<td>Asparagus adscendens Roxb., Echinops coriniger DC.</td>
</tr>
<tr>
<td>5</td>
<td>Centella asiatica (L.) Urb., Euphorbia hirta L., Galium acutum Edgew., Geranium ocellatum Jacquem. ex Cambess., Inula cappa (Buch.-Ham. ex D.Don) DC., Mentha longifolia (L.) L., Spermacctyon sauveolens Roxb., Viola canescens Wall., Zanthoxylum armatum DC.</td>
</tr>
<tr>
<td>6</td>
<td>Bergenia ciliata (Haw.) Sternb., Ajuga bracteosa Wall. ex Benth., Drymaria cordata (L.) Willd. ex Schltr., Potentilla fulgens Wall. ex Sims, Scutellaria repens Buch.-Ham. ex D.Don, Senecio nudaicaulis Buch.-Ham. ex D.Don, Valeriana jatamansii Wall.</td>
</tr>
<tr>
<td>7</td>
<td>Berberis asiatica Roxb. ex DC., Dicliptera bupeiroides Nees, Reimwardia indica Dumort., Roylea cinerea (D.Don) Baill., Rubia cordifolia L., Rumex hastatus D. Don, Tridax procumbens (L.) L., Urтика dioica L.</td>
</tr>
<tr>
<td>8</td>
<td>Berberis aristata DC., Cuscuta reflexa Roxb., Hedychium spicatum Sm</td>
</tr>
<tr>
<td>9</td>
<td>Oxalis corniculata L.</td>
</tr>
</tbody>
</table>

As per the distribution score, most of the species were found within the bracket of 5 to 7. The least numerical strength (3 Distribution score) was shown by Aloe vera (L.) Burm.f. and Stephania glabra (Roxb.) Miers whereas Asparagus adscendens Roxb. and Echinops coriniger DC. were not in the commanding position in the field with a 4 distribution score. Oxalis corniculata L. was found most dense species with a 9 distribution score followed by Berberis aristata DC, Cuscuta reflexa Roxb., Hedychium spicatum Sm with a 8 distribution score (Table 2).

Most of the plant species were found regularly (17) followed by contagiously (12) distributed. A random distribution was recorded in Euphorbia hirta L., Geranium ocellatum

"109"
Frequency of use had shown how many families were using plant resources in the study area. *Roylea cinerea* (D.Don) Baill. (65%), *Rubia cordifolia* L. (62%), *Valeriana jatamansi* Wall. (48%) and *Mentha longifolia* (L.) L. (42%) were the most dominated plant species as far as the frequency of use (%) was concerned. Least usable species were *Euphorbia hirta* L. (2%), *Galium acutum* Edgew. (3%) and *Inula cappa* (Buch.-Ham. ex D.Don) DC. (3%). The frequency of use (%) was found between 20 to 38% in most of the species (Fig. 1). Seven plant species were found as underutilized species as their distribution and numerical strength in the field is good enough but their frequency of use is low. *Euphorbia hirta* L., *Galium acutum* Edgew., *Inula cappa* (Buch.-Ham. ex D.Don) DC. were among these species. Some species like *Echinops cornigerus* DC., *Centella asiatica* (L.) Urb., *Viola canescens* Wall. and *Stephania glabra* (Roxb.) Miers were found as over-utilized plant species as their distribution or numerical strength in the study area is low but the frequency of use (%) is high (Table 4).

**Table 3**: Medicinal plants and their distribution patterns.

<table>
<thead>
<tr>
<th>Contagious</th>
<th>Random</th>
<th>Regular</th>
</tr>
</thead>
</table>

**Table 4**: Medicinal plants and their utilization patterns.

<table>
<thead>
<tr>
<th>Under-utilized medicinal plants</th>
<th>Over-utilized medicinal plants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distribution Score &gt; or = 5</strong></td>
<td><strong>Distribution Score &lt; or = 5</strong></td>
</tr>
<tr>
<td><strong>Frequency of use ≤10 or = 10</strong></td>
<td><strong>Frequency of use &gt;25 or = 25</strong></td>
</tr>
</tbody>
</table>
Discussion

The documented medicinal plants were categorized by habit wise and it was found that 21 out of 32 plants were herbaceous (herb) in nature. Two species were in the category of herb or undershrub while one species was under parasitic herb. Five species were recorded under the shrub category and one each in the shrub or undershrub and undershrub category. There was only one twinner was documented in this study. Tugume and Nyakoojo (2019) have also reported that herbs formed the highest proportion of medicinal plant species. The predominance of herbaceous medicinal species in the study area may be related to the fact that most of them obtained easily from human interference areas (Thomas and Damme, 2010) which is evident in the study area. All the species have their vernacular name either one or two; 21 species have two vernacular names, whereas 11 species have one vernacular name. A good repository of vernacular names of medicinal plants showed the ability of hidden knowledge and wisdom of people in the region as well as their attention on the various characters of plants that help them in local nomenclature. Most of the recorded medicinal plant species (24 out of 32) come under the bracket of good distribution score (between 5 and 7) showed that most of the plant species have good numerical strength in the study area. This indicates a rich repository of medicinal plants in the study area the region is rich in terms of medicinal resource availability. Low distribution score (3) was recorded for Aloe vera that might be due to lower temperature in the study area and due to its particular geographical restriction (Sachedina and Bodeker, 1999) as it is a level-land crop. The low distribution score (3) in Stephania glabra might be the result of overexploitation of plant species in the study area as the plant species is marked as endangered in several places of its occurrence (Chhetri et al., 2005).

Oxalis corniculata and Berberis aristata were recorded highly distributed plant species in the study area. The ample presence of both species is due to its home range as both species belong to this altitudinal range. Most of the recorded species were found either regularly or contagiously distributed in the study area that is the most common form of distribution in nature. Only a few species like Euphorbia hirta, Geranium ocellatum and Roylea cinerea were recorded as randomly distributed species. This random distribution of species showed unpredictable spacing and it is the least common form of distribution in nature. In this way, these randomly distributed species have emerged as they neither attract nor repel one another. It showed a lack of any strong social interactions with neighboring individuals and abiotic factors. Roylea cinerea (D.Don) Baill. (65%), Rubia cordifolia L. (62%), Valeriana jatamansi Wall. (48%) were most frequently used medicinal plants because these species are regularly used by local herbal healers; Roylea cinerea (skin diseases and malaria fever), Rubia cordifolia (ringworm), Valeriana jatamansi (as an insecticide). The study revealed 7 underutilized plant species and 5 species that are overexploited. Most of the underutilized species are being used at the community level and no herbal healer is practicing with these species. On the other hand, all five over-used species (Echinops cornigerus DC. Centella asiatica (L.) Urb, Viola canescens Wall. Stephania glabra (Roxb.) Miers, Mentha longifolia (L.) L.) are being commercially used by herbal healers of the study area.

Conclusion

High medicinal value plant Stephania glabra was found least distribution and over-utilized plant species in the study area; its pilot cultivation should be started. Titova et al. (2012) also suggested a scale-up scheme for the cultivation of this plant on a commercial scale. Randomly distributed species like Euphorbia hirta, Geranium ocellatum and Roylea cinerea have the least interaction with other species as well as the abiotic environment. This indicates an unhealthy growth of these species in the future; we recommend an in-depth scientific study on these species. The study strongly recommends the sustainable use of over-utilized medicinal plants as well as commercial utilization of under-utilized medicinal plants.

References