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Phytosociology of Important Non-Timber Forest Product Woody Species in Western Himalaya

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***Abstract*:** The region of the Indian Himalaya is rich in NTFPs that serve a variety of purposes and satisfy the needs of rural residents. The current study was conducted in the Lansdowne Forest division of Pauri Garhwal in western Himalaya. A total of 28 trees and 17 shrub species were reported during field survey. These plant species were also categorized on the basis of their utilization pattern by local people from secondary literature. This study reveals that the species with the highest total basal cover in this region for tree species was *Shorea robusta* (9,3082.04), while *Albizia lebbeck* had the lowest (134.55 and for shrub species the highest was found in *Murraya koenigii* (4.71/25m^2) and the lowest was found in *Woodfordia fruticosa* (0.07/25m^2). The species with the highest frequency among trees was *Shorea robusta* (47.50%) and with the lowest frequency was *Aegle marmelos* (2.50%), followed by *Albizia lebbeck* (2.50%), *Anogeissus latifolia* (2.50%), and *Bombax ceiba* (2.50%) respectively, while the species with the highest frequency among shrubs was *Lantana camara* (45%) and with the lowest frequency was *Carissa opaca* (2.50%) followed by *Cestrum aurantiacum* (2.50%) and *Glycosmis pentaphylla* (2.50%), respectively. *Shorea robusta* had the highest density (101.88 ha^{-1}), while *Aegle marmelos* lowest (0.63 ha^{-1}), followed by *Albizia lebbeck* (0.63 ha^{-1}) and *Bombax ceiba* (0.63 ha^{-1}), respectively. However, for shrub, *Eupatorium adenophorum* had the highest density (2.0/ 25m^2), while *Carissa opaca* had the lowest (0.05/25m^2). The tree with the highest importance value index was *Shorea robusta* (59.13), and the lowest was *Albizia lebbeck* (1.83). The shrub the highest importance value index was *Lantana camara* (49.36) and *Glycosmis pentaphylla* had the lowest (1.43).

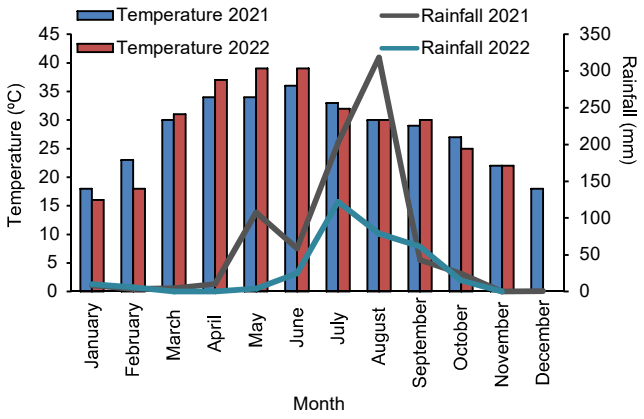
***Keywords*:** Non timber forest products, Western Himalaya, Diversity, Medicinal importance

The Himalayan region is well known for diversification of 5000 plant species (Rao 1994). Whereas nearly 50% of all blooming plants in India, in which 30% blooming plants are indigenous to the Himalayan region, are found there. In the Himalayan region, there are more than 816 tree species, 675 edible plants, and almost 1743 different medicinal plants have been documented by various authors (Samant et al 1998, Thakur et al 2005, 2017). Threats to biological diversity, conservation and utilization pattern of plant species in the Himalayan region might have a significant positive economic impact on the local population and help foster sustainable development (Khoshoo 1992, Dhar 1997). The sustainable utilization of non-timber forest products (NTFPs) is more important in the Himalayan region, in which a large proportion of the rural population relies on forests to meet their basic needs Joshi et al (2018). NTFPs contribute significantly to livelihoods dependency of local people and diverse range of plants products are source of food, nutrition, fodder, fiber, medicine, dye, and a variety of other uses that meet household needs and generate profitable revenue (Sundriyal and Sundriyal 2004, Saxena 2003). The sale of forest products is estimated to provide 10-50% of household income in many local communities (Olsen et al 1997). As a result, numerous development organizations and environmental protection groups have promoted the significance use as goods with reference to promote forest conservation and reducing rural scarcity (Marshall and Schreckenberg 2003). A wide variety of NTFPs have been found in the Himalaya region due to ecological diversity, community structure and their distribution in which certain NTFPs have been used for significant cultural significance, sources of food and building materials, and serve in health care systems (Pradhan et al 2008, Thakur et al 2007). However, the importance of wild edible plants to food security and economic generation has been overlooked (Uprety et al 2012). Therefore, the objectives of this study are to identify NTFPs bearing species and study their diversity, abundance, and density in Western Himalaya, and assessment of their utilization pattern.

MATERIAL AND METHODS

Location and climate: The present study was carried out in Lansdowne Forest Division in Pauri district of Western Himalaya. The study area is located between 29^{0}43' 58.54" N - 29^{0}50' 05.93" N to 78^{0}31' 54.80"E- 78^{0}91' 38.81" E having an altitude from 350-1550 msl., A total of forty quadrate were

laid to determine the community structure and species composition in the study area. The study area comprises deciduous Sal mixed forest (5/B/C2) at lower altitude and lower Shivalik chir pine forest (9/C1a) at upper altitude.



Vegetation sampling and analysis: For phyto-sociological analysis a quadrate size of 20 x 20 m for tree and 5 x 5 m for shrub species were laid randomly from January 2021 to November 2022 by using 20 x 20 m plot for trees. Each plot was sub divided in to 5 x 5 m sample plot for recording shrubs diversity. Forty plots were randomly placed in the entire area, representing all the vegetation type and localities. In each plot, trees and shrubs species were recorded and their height and diameter/collar diameter were measured for vegetational analysis frequency, density, abundance, and Importance Value Index (IVI) for tree and shrub species calculated by using the formula given by Curtis and Mc Intosh (1950).

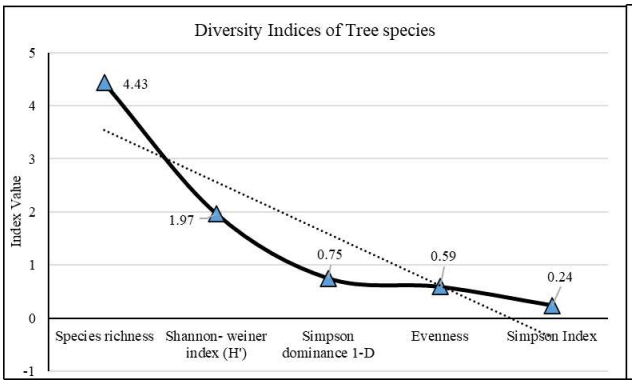
Diversity indices were also calculated by using the formula given by Shannon and Wiener (1963), Pielou (1969), Margalef (1957), Simpson (1949). Species diversity (H) was calculated using following formula as described by Shannon and Wiener (1963) and total basal cover as: (TBC) = Mean basal area of species × density of species. (Shah et al 2016).

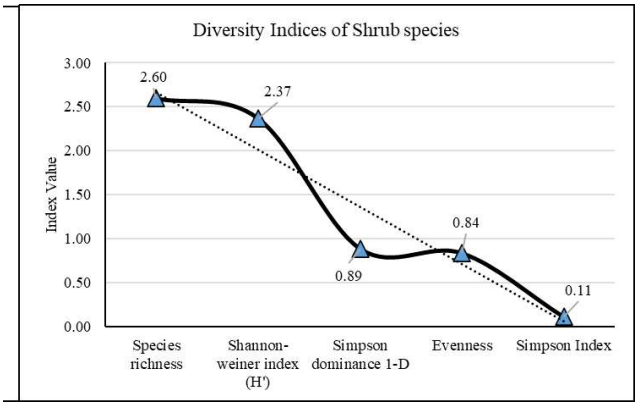
RESULTS AND DISCUSSION

In the present study, a total of 28 tree species and 17 shrub species were reported to assess the phytosociological status in Lansdowne Forest Division of Pauri Garhwal in Garhwal Himalaya. The maximum total basal cover was found for *Shorea robusta* (93082.04) and minimum was found in *Albizia lebbeck* (134.55) due to occurrence of species in few quadrates. The highest Frequency was for *Shorea robusta* (47.50%) followed by *Pinus roxburghii*, *Mallotus philippensis*, *Holoptelea integrifolia*. The maximum density was r for *Shorea robusta* (101.88) followed by *Pinus roxburghii* , *Acer oblongum* , *Holoptelea integrifolia* and *Mallotus philippensis.* The maximum importance value was for *Shorea robusta* (59.13) followed by *Pinus roxburghii*, *Adina cordifolia*, *Holoptelea integrifolia* (14.69), *Mallotus philippensis* (12.73), *Mitragyna parvifolia* (12.28), *Albizia procera* (10.93), *Bombax ceiba* (10.28) (Table 1).

The highest total basal cover was found in *Murraya koenigii* (4.71/25m^2) and the lowest total basal cover was found in *Woodfordia fruticosa* (0.07/25m^2). The highest frequency of shrub species was in *Lantana camara* (45%), *Murraya koenigii* (45%) followed by *Eupatorium adenophorum, Clerodendrum infortunatum* , *Rhus parviflora*. The highest density was found in *Eupatorium adenophorum* (2.00/25m^2) followed by *Rhus parviflora, Lantana camara*, *Murraya koenigii*, *Maesa motana*. However, the highest importance value was of *Lantana camara* (49.36) followed by *Murraya koenigii*, *Rhus parviflora*, *Eupatorium adenophorum* and *Maesa motana* (Table 2).

Diversity indices: In tree species, the trendline of various diversity indices shows the peak for species richness (4.43) and gradually decreases for Shannon-Wiener index (1.97), Simpson dominance (0.75), evenness (0.59) and Simpson index (0.24), respectively. Similarly, the trendline of diversity indices for shrub species indicate the species richness at its peak and gradually decreases for other indices, forward.





Ethnomedicinal uses of the tree and shrub species: In current study, a total of 45 plant species were identified during field observation in Lansdowne Forest Division, and

Table 1. Phytosociological status of tree species in Lansdowne Forest Division, Pauri Garhwal

Species	TBC/ha	Frequency	Density/ha	IVI
Acer oblongum	16499.27	5.00	11.25	10.04
Adina cordifolia	22686.61	12.50	7.50	15.88
Aegle marmelos	538.22	2.50	0.63	3.53
Albizia lebbeck	134.55	2.50	0.63	1.83
Albizia procera	3980.89	5.00	1.25	10.93
Anogeissus latifolia	4433.83	2.50	2.50	6.63
Bombax ceiba	2132.22	2.50	0.63	10.28
Cassia fistula	2534.11	12.50	5.63	8.40
Cassine glauca	1433.72	7.50	1.88	5.80
Diospiros montana	340.59	2.50	1.25	2.21
Erythrina suberosa	2911.74	7.50	4.38	6.45
Holoptelea integrifolia	14345.82	17.50	11.25	14.69
Lannea coromandelica	2105.89	10.00	3.13	7.04
Mallotus philippensis	3776.83	20.00	9.38	12.73
Mitragyna parvifolia	5105.72	2.50	1.25	12.28
Moringa oleifera	1305.93	2.50	0.63	6.78
Myrica esculenta	497.61	2.50	0.63	3.36
Pinus roxburghii	42889.37	32.50	88.13	46.81
Quercus leucotrichophora	3809.03	5.00	4.38	5.96
Rhododendron arboreum	1204.22	2.50	1.25	4.03
Sapium insigne	407.64	5.00	1.25	3.38
Schleichera oleosa	898.19	5.00	1.25	4.42
Semecarpus anacardium	3085.24	7.50	2.50	7.27
Shorea robusta	93082.04	47.50	101.88	59.13
Tectona grandis	3818.12	5.00	2.50	7.01
Terminalia tomentosa	5598.13	7.50	3.13	8.97
Toona ciliate	2070.86	2.50	0.63	10.02
Wrightia arborea	1039.31	5.00	3.75	4.16

Table 2. Phytosociological status of shrub species in Lansdowne Forest Division, Pauri Garhwal

Species	TBC/25m^2	Frequency	Density/25m^2	IVI
Berberis aristate	0.042	5.00	0.10	2.82
Carissa opaca	0.127	2.50	0.05	1.84
Cestrum aurantiacum	0.363	2.50	0.08	2.92
Clerodendrum infortunatum	1.85	30.00	1.00	26.76
Colebrookea oppositifolia	1.2	17.50	0.75	17.52
Eupatorium adenophorum	1.52	37.50	2.00	36.60
Glycosmis pentaphylla	0.025	2.50	0.05	1.43
Inula capa	0.173	7.50	0.28	5.71
Justicia adhatoda	0.726	12.50	0.30	9.99
Lantana camara	4.584	45.00	1.73	49.36
Maesa motana	3.83	20.00	1.10	32.12
Murraya koenigii	4.71	45.00	1.53	48.21
Pogostemon beghalensis	0.423	7.50	0.15	5.69
Rhus parviflora	3.465	25.00	1.75	37.91
Rubus ellipticus	1.267	10.00	0.65	14.26
Senna occidentalis	0.220	2.50	0.15	3.07
Woodfordia fruticose	0.07	5.00	0.20	3.77

their medicinal importance were documented from secondary sources. On the basis of secondary literature available on medicinal importance of these plant species, 24 species in curing skin disorders, 23 species in fever, 23 species in dysentery, 21 species in diarrhoea, 19 species in constipation, 18 species in headache, 17 species in pain killer, 15 species in ulcer, 13 species in muscle sprains, 13 species in cholera, 12 species in tumors, 12 species in cough, 12 species in leucorrhoea, and 11 species in toothache are widely used in various parts of the country (Fig. 1).

Among 45 species, the leaves of 24 species, bark of 17 species, root of 13 species, fruit of 12 species, seed of 10 species, flower of 7 species and gum of 5 species are extracted to utilize in treatment of various diseases (Fig. 2).

Phyto-sociological parameter such as basal area, frequency, density, importance value index and diversity indices play important role to identify the community structure and composition and its pattern in an ecosystem. The current study was conducted to find the variation in species diversity and composition of 28 trees and 17 shrubs species in Lansdowne Forest Division of Pauri in Garhwal Himalaya. The results obtained from present study are well aligned with the results reported earlier by many authors who worked in different parts of Himalayan region and country.

The total basal cover was recorded from range of 215.29 to 4984.57 for *Albizia lebbeck* and *Mitragyna parvifolia* which is similar to the basal cover reported by (Singh et al 1994) in Kumaun Himalaya. Moreover, the total basal cover for species was reported on the basis of their numbers present in all quadrate. However, the anthropogenic disturbance or maladaptation in some parts of Forest Division might be responsible for number of stems of the species. The density was reported between a range from 0.63 to 101.88 tree ha^{-1} present in study area which is similar to the value reported by Negi et al (2018) and Rawat et al. (2018) while working in mixed broadleaf forest of Garhwal Himalaya. However, the importance value index was found within the range from 59.13 to 1.83 in present study. Moreover, the IVI was used as a relative measure of the ecological perspectives and corresponded to resource apportionment within the plant community. Geometric

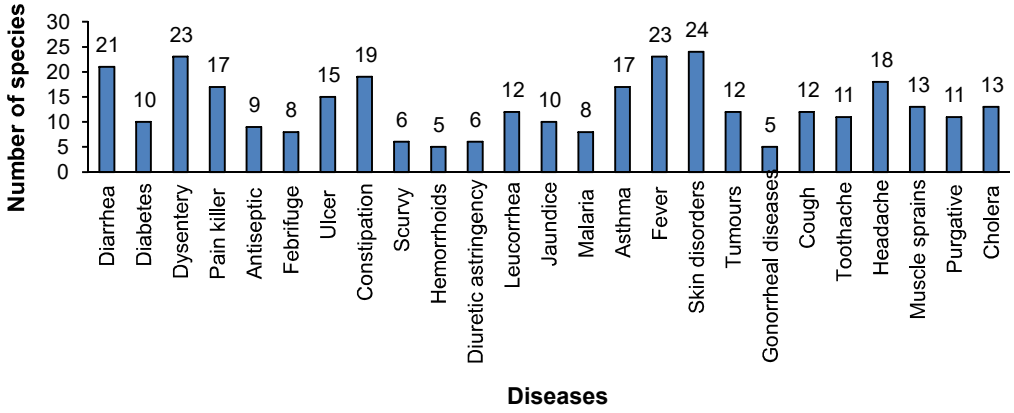


Fig. 1. Medicinal uses of species present in Lansdowne Forest Division

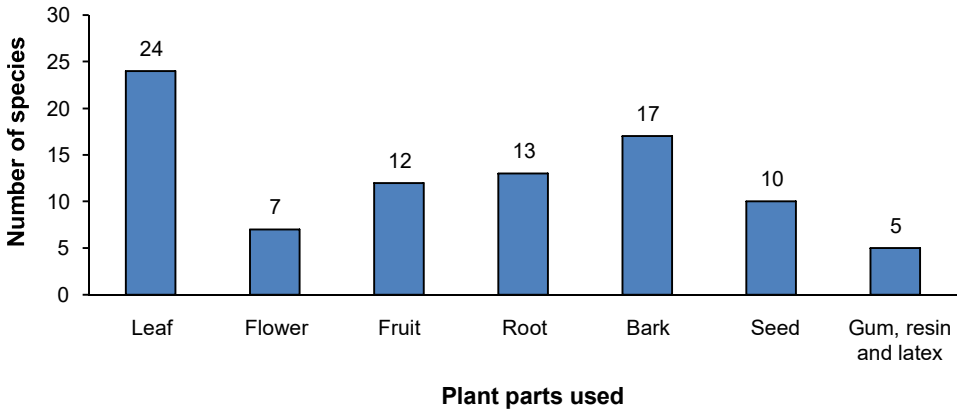


Fig. 2. Plant parts used in curing various diseases

distribution is usually exhibited by the ecological population which have low species community subject to low competition due to the proportion of utilization pattern of species IVI (Whittaker 1972).

The Shannon-Wiener index value of species were reported in the present study was similar to reported by Gairola et al (2011) while working in moist tropical montane valley of Garhwal Himalaya. The reason for variation in diversity in the study region may be due to the wide range of geographic factors such as altitude, aspect, temperature, rainfall and productive soil. Generally, the species diversity is directed by long term ecological process that influence the community stability and evolutionary time period (Verma et al 2004). However, the value of Simpson dominance (0.75) was close to the value reported by Rawat and Rawat (2010). The values of Simpson dominance depend on species richness and the lower values are associated with high species richness and *vice versa* (Malik 2014, Malik and Bhatt 2015). Though, evenness for species in present study was close to the study done by Gairola et al (2011). It has been always observed and confirmed the opposite relationship between Shannon-Wiener diversity and Simpson Index (Khumbongmayum et al 2005, Gairola et al 2011, Malik and Bhatt 2015).

AUTHORS CONTRIBUTION

The First author Shubham Chauhan (SC) and A. K. Negi (AKN) conceptualized the idea. SC performed the sampling and tabulation of the data. Dinesh Singh (DS) performed the analysis of data. SC and Dharmendra Shah (D) wrote the manuscript. DS and AKN reviewed and finalized the manuscript.

CONCLUSION

The conservation biodiversity is essential to understand the species distribution and factors governing the community structure and composition in western Himalaya. The present study reveals that how the variation in community structure plays vital role in conservation of biodiversity. The phytosociological status and diversity indices affect the plant communities (either tree or shrub) and give a better assessment about their distribution pattern. However, the conservation of biodiversity in the region is important to conserve the customary health care system, which is concentrated in the local community. The ethno-medicinal properties of these plant species are not sufficient to deal with sustaining the utilization as medicinal resources. Therefore, it is important to study and focus on these plant species in Himalayan region for sustaining the forest ecosystem in future perspectives.

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