The Importance Value Index of medicinal plants traditionally used by local and tribal communities of Chenab Valley of Jammu and Kashmir, India

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Research

Abstract

Background: Medicinal plants constitute an integral component of the traditional healthcare system, particularly in Jammu and Kashmir. The indigenous communities of Doda Valley rely extensively on ethnomedicinal knowledge for primary healthcare. This study systematically documents and evaluates the medicinal potential species utilized in the region, providing quantitative insights into therapeutic significance and ethnobotanical relevance.

Methods: A quantitative ethnobotanical assessment was conducted using standardized indices, the Importance Value Index (IVI), Percentage Respondent Knowledge Index (PRKI), Informant consensus Factor (ICF), and Fidelity level (FL) to evaluate the significance of medicinal plant species. Plant diversity was analyzed across 15 sites using a quadrat-based approach with of 10 m × 10 m (trees) 5 m × 5 m (shrubs) and 1 m × 1 m (herbs.) Species is identification, collection and enumeration following standard taxonomic protocols, ensuring methodological rigor and reproducibility.

Results: A total of 21 medicinal plant species belonging to 31 medical applications. Digestive disorders showed a high Informant consensus factor (0.96), with Cannabis sativa having the highest Fidelity Level (96.7). Topical use and decoctions were common (42.8%), with 35% of remedies using whole plants. Most plants (61.9%) were sourced from natural habitats, 14.2% from cultivated areas, and 23.8% from both.

Conclusions: The ethnobotanical findings reveal the substantial therapeutic potential of medicinal plants in the Doda Valley, with certain species exhibiting high fidelity in traditional medicine. Future research should prioritize the isolation, structural elucidation, and pharmacokinetic characterization of bioactive compounds to advance novel drug discovery and promote sustainable utilization.

Keywords: Ethnobotany, Medicinal plants, Percent use-value, Informant consensus factor.

Background

The Himalayan Mountain region is regarded as a significant biocultural diversity center or biocultural refugia due to its abundance of food and medicinal plant diversity (Stryamets *et al.* 2021). Local and indigenous communities in this region depend extensively on non-timber forest products, which serve as essential resources for of traditional healthcare systems. The plant- derived Bio Sources play a pivotal role in ethnomedicine, contributing to both primary healthcare management and the preservation of indigenous therapeutic knowledge. (Rehman *et al.* 2018, Haq*et al*. 2021). They supply food and medicine, plants are vital to the life of those people that reside in the Himalayan Mountains (Rehman *et al.* 2018, Asif *et al.* 2021). Ethnobiologists debate the sustainability and preservation of traditional knowledge in the face of rapid modernization and globalization. Research indicates that the remarkable changes in society have led to a loss, and disappearance, of conventional ecological knowledge (Fernández & Fillat 2012).

Globally, plants are becoming more significant in basic healthcare (Ahmed, 2016). A significant section of the populace in many developing nations receives their main medical treatment from traditional practitioners. The Himalayan area is biogeographically hotspot serves as a crucial reservoir of phytochemical diversity, supporting extensively ethnobotanical practices and traditional medicinal systems (Dar *et al*. 2008, Dar & Khuroo, 1984, Tali *et al.* 2018).

Jammu and Kashmir, a region in the northernmost part of India, is renowned not only for its picturesque landscapes but also for its rich biodiversity. This region, nestled in the lap of the Himalayas, boasts a unique and diverse range of flora, including a plethora of medicinal plants that have been utilized for centuries in traditional medicine systems such as Ayurveda, Unani, and local folk medicine (Koul *et al.* 2012). Jammu and Kashmir's medicinal plants are an essential component of the area's cultural legacy and are used extensively in local healthcare practices. The varied climatic conditions and altitudinal ranges of Jammu and Kashmir create a conducive environment for the growth of a wide variety of medicinal plants (Dutt *et al.* 2015). These plants are found in diverse habitats, from the temperate regions of Jammu to the alpine zones of Kashmir and Ladakh (Dar & Naqshi, 2008, Kaul, 2010).

Numerous tribal settlements, each with a unique culture and traditional knowledge base, can also be found in the area. However, the biodiversity and related traditional Knowledge (TK) in the Himalayan region are very vulnerable to extinction due to ongoing economic expansion and the ensuing sociocultural shifts. This research aims to evaluate the range, distribution, and traditional knowledge related to medicinal plants in the Himalayan region of Jammu and Kashmir.

Jammu and Kashmir is recognized as a rich repository of diverse plant species, many of which possess significant therapeutic (Dar *et al.* 2008, Dar & Khuroo 2013). Over the past century, numerous researchers have documented the various medicinal uses of plants among the region's ethnic communities (Gupta *et al.* 198, Uniyal, 1981, Srivastava and Gupta 1982, Dar *et al.* 1984, Bhattacharyya 1991, Dhar & Siddique, 1993, Singh, 1995, Kirn *et al.* 1992, Singh 2002, Beigh *et al.* 2003, Ganai & Nawchoo 2003, Khan *et al.* 2004, Kak 2007, Ballabh & Chaurasia 2009).

This research aimed to identify the plant species and to document the usage of medicinal plants and related traditional knowledge for treating a range of illnesses among the diverse Doda Valley people groups. Analysis was also done on the information gathered on the respondent's gender, age, and knowledge transfer. The aim of this research as to record the data as a baseline for further pharmacological and phytochemical investigations. Recording species of medicinal plants may also aid in preserving indigenous people's cultural history for future generations.

Materials and Methods

Study area

Jammu and Kashmir studied within the Indian Himalayan range, is administratively divided into two regions: Jammu and Kashmir. Despite its rich floristic diversity, scenic landscapes, and fertile land, comprehensive studies on woody and tree diversity is limited. The Jammu division has spans 26,293 km2 covering the districts of Jammu, Doda, Kishwar, Rajouri, Poonch, Kathua, Reasi, Ramban, Udhampur and Sambha. In Doda, agriculture and livestock farming serve as the primary livelihood sources, while nomadic communities such as the Gujjar and Bakarwals on transhumant pastoralism. However, rapid development activities had led to the overexploitation of natural resources, posing significant challenges to the region's agrarian and pastoral economies (Ahmed, 2021).

The geospatial and Digital elevation map (DEM) of the study area, Doda district is presented in (Figure 1). Geographically, Doda district is located at 33.1371285 latitude and 75.5469986 longitudes, spanning an altitudinal range of six hundred (600) to seventeen hundred (1700) meters above sea level, which contributes to diverse topographical and ecological conditions essential for plant diversity and ethnobotanical practices. The region experiences a subtropical climate, with hot summers (maximum 45°C, minimum 34°C) and cold winters (5-6°C daytime, dropping to 0 to -1°C at night). This climatic variability, coupled with altitudinal gradient, influences the distribution, phenology and phytochemical composition of medicinal plant species. The dominant subtropical vegetation supports a wide range of ethnomedicinal flora traditionally utilized by local communities for primary healthcare. Additionally, the Chenab and Tawi River play a crucial role in shaping the microclimatic conditions and sustaining plant resources, particularly those harvested for medicinal and ethnobotanical applications.

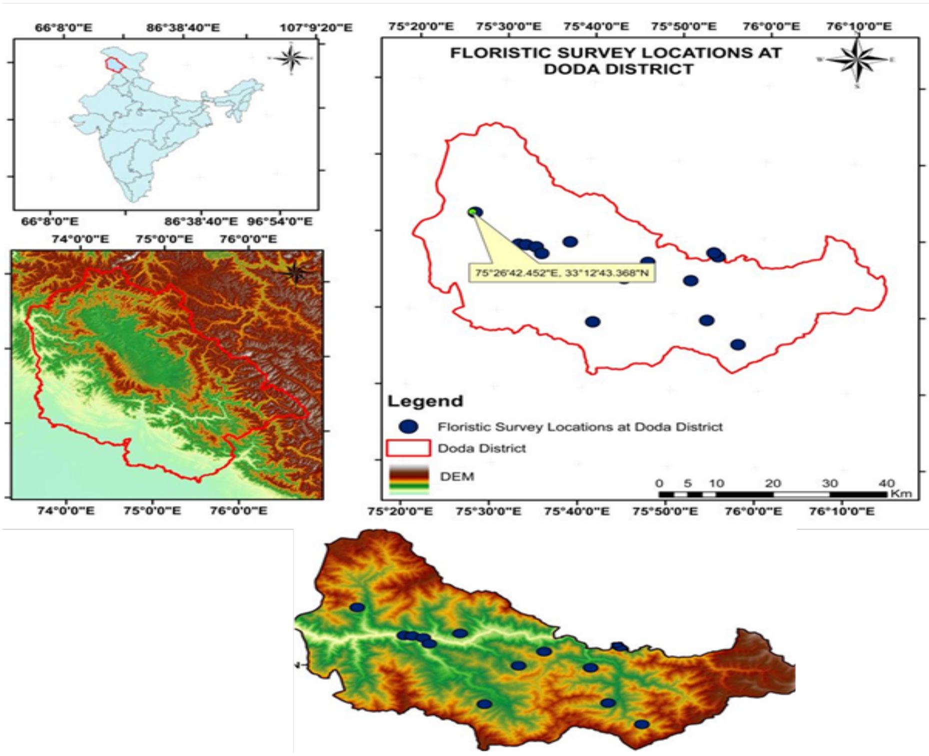

Figure 1.Geospatial map and Digital Elevation Model (DEM) of the study area

Field survey to collect the data

The fieldwork for this study was carried out from the year 2023 to 2024. Participants were selected using purposive and snowball sampling techniques, focusing on individuals aged 18 to 75 (Ghaljaie *et al.* 2017). Purposive and snowball sampling techniques were employed to ensure the selection of knowledgeable individuals with expertise in traditional herbal medicine, allowing for the identification of key informants and the recruitment of additional participants through community networks. A total of 120 participants were identified from four different elevations, chosen based on their extensive knowledge of traditional herbal medicine.

Personal information such as age, marital status, gender, location, educational background, and methods of herbal preparation were collected from each participant. All participants provided verbal, voluntary, and informed consent before the interviews. The acquisition of socio-demographic data, including as age, marital status, gender, location and educational background, is critical for analyzing the dynamics of ethnobotanical knowledge transmission across diverse communities. Age and educational attainment influence the depth of traditional knowledge retention, while gender roles dictate variations in medicinal plant selection, preparation, and application. Furthermore, geographical and altitudinal variations directly affect plant distribution, shaping the accessibility and utilization of ethnomedicinal resources. Systematic documentation of herbal preparation techniques is imperative for the preservation, pharmacological validation, and potential therapeutic integration of indigenous medicinal practices.

This study aims to document and analyses the traditional use of medicinal plants in Doda district, Jammu and Kashmir, focusing on their therapeutic applications and conservation status. Ethnobotanical data were collected using semi-structured interviews and questionnaires, following established methodologies. This approach was informed by previous studies on collect ethnobotanical research (Cunningham 2001, Maroyi *et al*. 2011). To minimize the inclusion of secondary information and guarantee the accuracy of the material, participants were asked to identify the source of their knowledge. The languages of Bhaderwahi, Kashmiri, and Gojri were used for the interviews. The plants' scientific names, families, and authority were confirmed using resources such as the International Plant Names Index (www.ipni.org) and the Royal Botanic Gardens, Kew (www.theplantlist.org).

Quantitative analysis of data

Ethno botanical indices including respondent knowledge (PRK), fidelity level (FL), and informant consensus factor (ICF) were used to assess the reliability and significance of medicinal plant usage. These indices help verify data consistency, with ICF and PRK measuring agreement among respondents quantifies the proportion of participants citong a specific plant for the same therapeutic purpose (Table 1).The application of these indices aligns with established ethnobotanical methodologies, as described in previous studie (Ugulu, 2012). Futhermore, these quantitative measures aid in identifying plant species with high therapeutic potential, contributing to future pharmacological investigations and drug development. These indicators were also used in recommendations for medication development and in identifying possible plant species for additional pharmacological research (Umair *et al.* 2017).

Table 1.Different qualitative analysis of ethnobotanical data with formula

Ethnobotanical data	Formula	Reference	Ethnobotanical data	Formula	Reference
ICF	ICF = Nur - Nt / Nur - 1	Trotter and Logan, 1896.	ICF	ICF = Nur - Nt / Nur - 1	Trotte and Logan, 1896.
UV	Number of respondent citing the species /Total number of respondents interviewed × 100	Phillips *et al.* 1994; Tugume *et al.*2016, Friedman *et al.* 1986. Alexiades 1996.	UV	Number of respondent citing the species /Total number of respondents interviewed × 100	Phillips *et al.* 1994; Tugume *et al.* 2016, Friedman *et al.* 1986. Alexiades 1996.
FL	FL (%) = Np/N × 100	Tsioutsiou *et al.* 2019, Heinrich 2000.	FL	FL (%) = Np/N × 100	Tsioutsiou *et al.* 2019, Heinrich 2000.
RSI	RSI=d/a+b+c-d×100	(Dahiru, 2008).	RSI	RSI=d/a+b+c-d×100	Dahiru, 2008.

Where, Nur is the quantity of insightful reports for every category; Nt is the number of species (taxa) are included in each group; Np is the number of participants who claimed they have used a specific plant species to treat a particular illness; N is the total number of participants who cited the species for any disease; FL is the represents the frequency and significance of a species being used to treat a specific ailment, as reported by informants in the study area; a is the quantity of distinct plant species found in region a; b is the quantity of distinct plant species found in region b; c is the quantity of plant species that are similar in both areas a and b; d is the quantity of common plant species used in both regions for diseases that are comparable; ICF is the Informant consensus factor; UV is the percentage of respondent knowledge (percent use-value); FL is the fidelity level; RSI is the Rahman's similarity index

Indices Estimation

The fundamental inputs into the ecological system are the overall number of distinct species and their relative dominance. It was determined using a number of indices, including the important value index (Table 2), relative density, relative frequency, dominance, and relative density.

Table 2. Different ecological parameters and indices with calculation formulae

Parameters	Formula
Density (D)	$\frac{Ts}{Q}$

Frequency (F)	$\frac{Qs}{Q} \times 100$
Dominance (D)	$\frac{Bs}{A}$
(RD)	$\frac{Ds}{D} \times 100$
(RF)	$\frac{Fs}{F} \times 100$
(RD)	$\frac{\mathrm{Ds}*}{D*} \times 100$
(IVI)	RD+ RF+ RD*

Where, Ts is the total number of plant species, Q is the total number of quadrats; Qs is the no. of quadrats in which a plant species are present; Bsis the basal area of a species; Ais the total sampled area; Ds is the density of a species; D is the total density; Fs is the Frequency of a species; Fis the Total frequency; Ds* is the dominance of a species; D* is the total dominance; RD is the Relative Density, RFis the Relative; Frequency and RD* is the Relative Dominance.

Results

Respondent characteristics

Out of the 120 individuals interviewed most were men 81 (67.5%) and low or no formal education. These factors may influence their knowledge and use of medicinal plants. People mostly learned about plants from their family or local herbalists as outlined in (Table 3). The families Berberidaceae (45%) and Cannabaceae (46.6%) were reported to have the highest number of taxa. Several plant species were found to be used in treating a wide range of ailments. For instance, (Table 4) indicates that *O. exilis* was associated with 15 health conditions, while *B. wilsoniae* was linked to 13 different ailments.

Table 3. Demographic profile of respondents (n=120)

Variables	Categories	Count	Percentage
Gender	Male	81	67.5
	Female	39	32.5
Age	18-29	22	18.33
	30-39	29	24.16
	>40	69	57.5
Marital status	Married	72	60
	Unmarried	48	40
Education	Primary	36	30
	Secondary	22	18.33
	None	62	51.66

Table 4. Frequently observed ailments and plant species with high PRK

Name of plant species	Number of ailments	PRK (%)
Prunus armeniaca L	11	28.33
Pinus roxburghii Sarg.	13	17.5
Cedrus deodara(Roxb.) G.Don	4	32.5
Verbascum phlomoides L.	12	17.5
Cannabis sativa L.	7	46.6
*Oxalis exilis*L.	15	43.3
*Malvaneglecta*Wallr.	11	42.5
Artemisia campestris L.	9	38.3
Galium verum L.	5	26.6
Euryops pectinatus (L.) DC.	3	17.5

Fagopyrum esculentum Moench.	8	9.1
Aeonium sedifolium (Haw.) H.Christ	2	12.5
Bergenia ciliate (Roxb.) Sternb.	12	37.5
Potentilla atrosanguinea (D. Don) G.Don	4	13.3
Berberis wilsoniae C.K.Schneid.	13	45
Mentha arvensis L.	6	32.5
Pyrus communis L.	3	14.1
Euphorbia serrata L.	2	10
Ficus palmate L.	6	26.6
Quercus acutissima Carruthers	2	19.1
Olea cuspidata (Wall.) A. DC	2	24.1

Preparation and administration of herbal remedies were most commonly done through topical application and decoction, each accounting for 42.8% (Figure 2). Most respondents used the whole plant for remedy preparation, accounting for 35% of the total plant usage (Figure 3). However, for many plants, multiple parts were utilized in the preparation process.

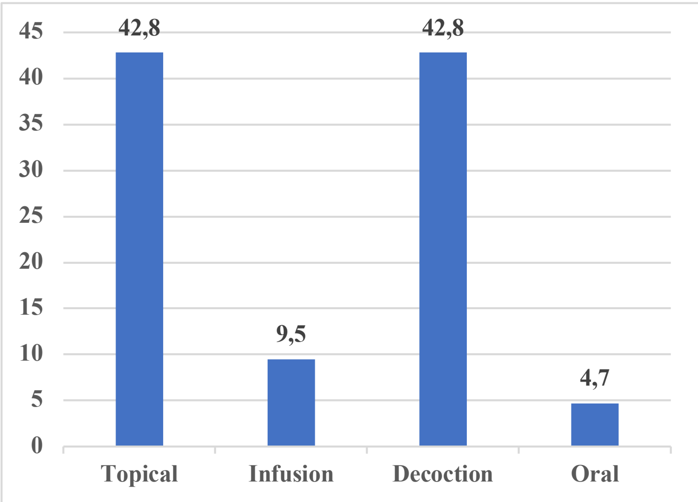

Figure 2. Administration of herbal remedies

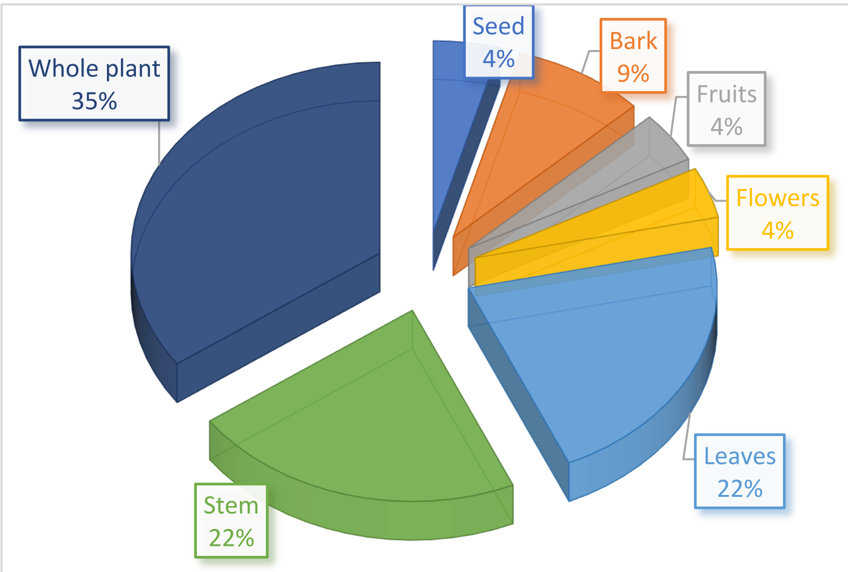

Figure 3. Percentage of part used in medicinal remedies

In the study area, 61.9% of the medicinal plants were found in natural habitats such as bushes, open ground, woodlands, and fallow areas (wild settings) (Figure 4). Meanwhile, 14.2% of the plant species were classified as cultivated due to their scarcity in the wild. Additionally, 23.8% of the plants were found in both cultivated and wild environments

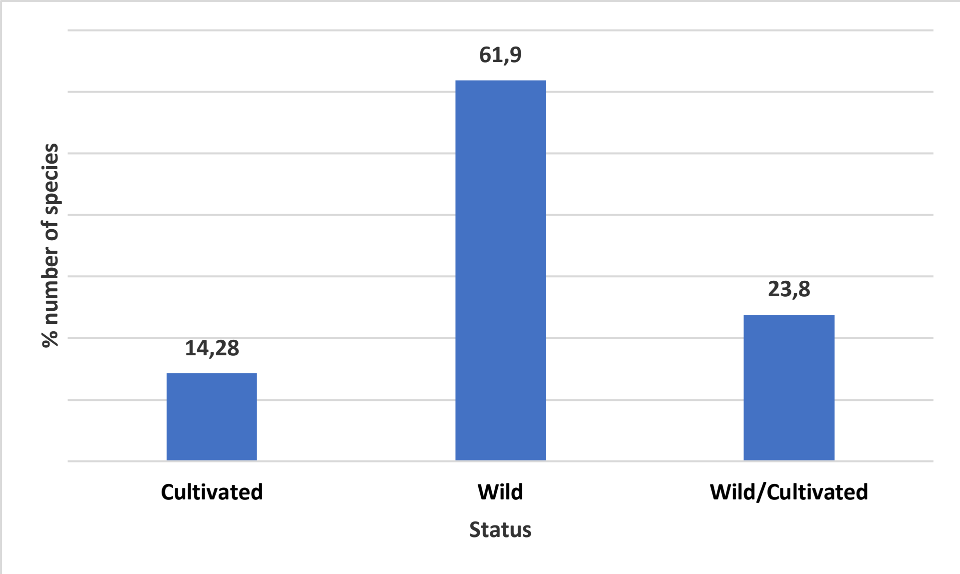

Figure 4. Conservation status of the medicinal plants

Percentage respondent's knowledge (percentage use-value)

Plant species documented by over 40% of respondents are detailed in (Figue 5) with *C. sativa* emerging as the most culturally significant taxon , acknowledged by 46.6% of participants for its medicinal and ethnobotanical relevance.

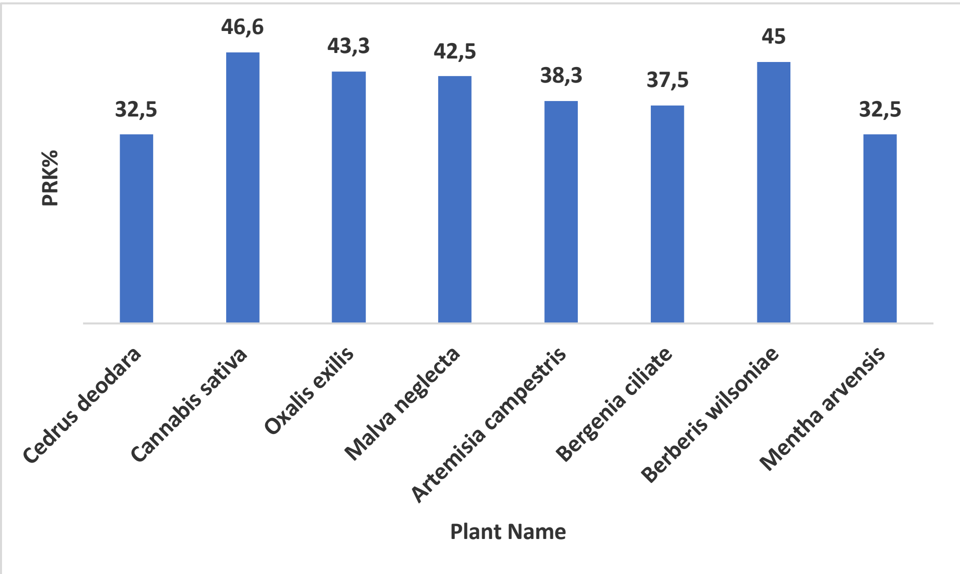

Figure 5. The most significant medicinal plant species based on their Priority Ranking

Informants consensus factor about medicinal plants (ICF)

Thirty-one medical conditions were categorized into seven utilization groups after being documented (Table 5). After calculating the informant consensus factor (ICF) for each category, gastrointestinal and digestive ailments had the highest ICF score (0.96).

Table 5. Types of ailments addressed by various medicinal herbs

Use category	Ailments
Infectious & parasitic diseases	Hernia, jaundice, migraine, dizziness, measles, malaria, headache, and brucella
Gastrointestinal/digestive disorders	Constipation, dysentery, vomiting, diarrhea, ulcers, colic discomfort, deworming, and stomachaches
Metabolic disorders	Diabetes, dehydration
Respiratory system disorders	Sinusitis, asthma, Tuberculosis, and cough
Ophthalmia	ocular infections Like conjunctiva, cornea, intraocular and itching
Cardiovascular disorders	Palpitations, anemias, hypertension, and purification of blood vessel
Other purposes	Arthritis with sepsis,

Fidelity levels of the most commonly reported plant species.

The highest fidelity level was observed in C. *sativa* for the treatment of snake bite (FL = 97.6), followed closely by *O. exilis* for wound healing (FL= 97.0). The remaining frequency cited medicinal plants exhibited fidelity level values ranging from 72.0% to 88.2 %, indicating a substantial degree of consensus among informants regarding their therapeutic application (Table 6).

Table 6. The major uses of medicinal plants and fidelity levels of the frequently reported plants

No of Plant species	Family	Therapeutic application	Np	N	FL (%)
Cedrus deodara	Pinaceae	Antiseptic for animals.	34	46	73.9
Cannabis sativa	Cannabaceae	Used for the treatment of snake and scorpion bite.	42	43	97.6
Oxalis exilis	Oxalidaceae	Wounds	65	67	97
Malva neglecta	Malvaceae	It is used for constipation.	32	41	78
Artemisia campestris	Asteraceae	To treat intestinal worm infection.	39	46	84.7
Bergenia ciliata	Saxifragaceae	To heal wound of.	56	61	91.8
Berberis wilsoniae	Berberidaceae.	Diabetics, Jaundice.	49	51	96
Mentha arvensis	Lamiaceae	Cooling effect in stomach.	45	51	88.2

Column 4 : The percentage of participants who use a species to treat a disease is indicated by the letter Np;
Column 5: N represents all the informants who claimed they used the herb in any way; Column 6: FLThe fidelity level.

Rahman's similarity index (RSI)

According to the study, which applied Rahman's similarity index, there was a 52.38% overlap in the use of medicinal plants among ethnic communities across four different altitudes, with 11 plant species commonly used in all altitudinal zones.
Distribution of medicinal plant in different four altitudes

Medicinal plants species exhibited a spatial distribution pattern that was both random and clustered, occurring throughout the forest ecosystem and adjacent habitats. Out of the 21 reported species, *F. palmata, C. deodara, P. roxburgii, M. neglecta, C. sativa, B. wilsoniae, A. campestris, O. cuspidata* are distributed relatively evenly throughout the forest and adjoining area. Some were evenly distributed throughout the area, while others exhibited clustered patterns. Various factors such as seed distribution processes and biotic interactions could impact this clustering.

As shown in Figure 6(a), the IVI ranged from 145 to for the different plant species found in the research area. With relative frequencies, relative densities, and relative abundances of 66.6, 15.2, and 0.22, respectively, *O. cuspidata* achieved the highest IVI score (145). With relative frequencies, relative densities, and relative abundances of 33.33, 0.013, and 37.38, respectively, *F. palmata* got the lowest IVI score (70.). The IVI ranged from 52.5 to 18.8 for the different plant species found in the research region, as shown in Figure. 6(b).
The study found that *M. neglect* had the highest Importance Value Index (IVI) of 52.5, with a relative density of 26.4, a relative frequency of 13.0, and a relative abundance of 13.0. In contrast, *O. exilis* had the lowest IVI at 18.8, with relative density, frequency, and abundance values of 5.2, 13.0, and 0.50, respectively. The IVI for the various plant species observed in the study area ranged from 36.7 to 9.1, as shown in Figure 6(c). *O. exilis* had the highest IVI at 36.7, with a relative density of 7.6, a relative frequency of 12.0, and a relative abundance of 17.0, while *F. esculentum* had the lowest IVI at 9.1, with relative density, frequency, and abundance values of 0.7, 8.0, and 0.4, respectively.

As seen in Figure 6(d), the important value index for the various plant species observed in the research region varied from 100.1 to 21.2. While *V. phlomoides* has the lowest IVI value of 8.0, 11.7, and 1.4 values of relative density, relative frequency, and relative abundance, respectively, *P. armeniaca* is discovered to have the largest value (100.1) with relative density, relative frequency, and relative abundance of 2.6, 5.8, and 91.5, respectively.

The study also examined the distribution pattern and species composition of several species of medicinal plants that are linked to quadrates. The *Oleaceae* family was the most dominant family at an altitude >600 meters, *M. neglecta* was the most dominant family at an altitude >1000 meters, *O. exilis* was dominant at an altitude >1500 meters and *P. armeniaca* at an altitude 1700 meters. The presence of the dominant plant families at different altitudes analysis suggested that the family Oleaceae was the most dominant family at altitudes above 600 meters. At altitudes above 1000 meters, the most dominant family was *M. neglecta*. *O. exilis* took dominance at altitudes exceeding 1500 meters, and *P. armeniaca* was the most dominant family at an altitude of 1700 meters as shown in Table 7.

The dominance of the family Oleaceae at altitudes above 600 meters indicates that this family is well-adapted to the conditions found in this elevation range. Oleaceae includes various species such as olive, ash, and jasmine, which are known to thrive in diverse habitats. The specific species within Oleaceae that dominate at these altitudes would depend on the local environmental conditions.

At higher altitudes exceeding 1000 meters, the dominance shifts to *M. neglecta*, a member of the family Malvaceae. *M. neglecta,* commonly known as common mallow, is a hardy plant that can tolerate cooler temperatures and is often found in disturbed areas. Its dominance suggests that it possesses adaptations that allow it to thrive in these higher elevation habitats. As the altitude continues to increase, *O. exilis* becomes the dominant family above 1500 meters. *O. exilis* belongs to the family Oxalidaceae and is commonly known as Alpine wood sorrel. This family likely possesses adaptations that enable it to withstand the harsher environmental conditions associated with higher elevations, such as colder temperatures and reduced oxygen availability. Finally, at an altitude of 1700 meters, *P. armeniaca*, a member of the family Rosaceae and commonly known as apricot, becomes the dominant family. This suggests that apricot trees are well-suited to the specific environmental conditions found at this altitude, such as the temperature range, precipitation levels, and soil characteristics shown in (Figure 7).

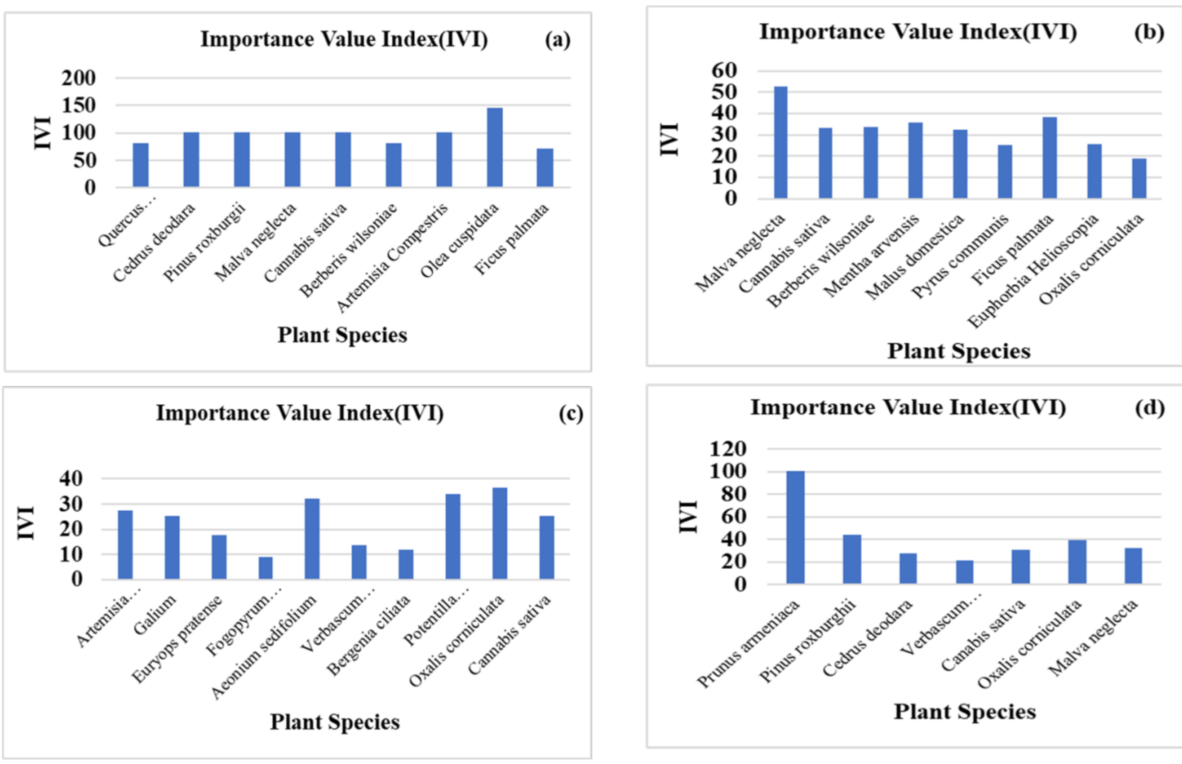

Figure 6. IVI with number of Plants species at different altitudes (a) shows >600 m, (b) >1000 m, (c) >1500 m and (d) >1700 m

Figure 7. Study sites of different location showing using forest resources for their livelihood.

Overall, the dominance of different plant families at varying altitudes reflects the adaptations and ecological preferences of these plant groups to specific environmental conditions associated with each altitude range. These patterns are a result of the interplay between environmental factors, species traits, and competitive interactions among plant species.

Discussion

The utilization of medicinal plants across all four elevation zones in this study aligns with traditional practices observed in various regions of the country elevation-based zone classification of plant use and ecological zones is common in ethnobotanical and ecological studies worldwide. Elevation-based classification of ecological zones and plant use is a widely adopted approach in ethnobotanical and ecological research globally. For instance, studies conducted in Ethiopia, the Andes and Nepal commonly stratifies areas into distinct ecological zones based on variation in altitude and climate.

Out of the 120 individuals interviewed for this study, 81 (67.5%) were male, while the remaining participants were female. A significant portion of the respondents had low levels of education, with 36 (30%) having only primary education, and 62 (51.66%) having no formal education. The demographic characteristics of the participants appear to influence outcome of the study particularly regarding the knowledge and use of medicinal plants. The predominance of male respondent may reflect gender-specific roles in the acquisition and transmission of ethnobotanical knowledge, where men have more exposure to wild plants collection or interaction with traditional healers. The participants primarily acquired their knowledge of plants from parents, grandparents, and other local herbalists, as outlined in (Table 3). The families Berberidaceae (45%) and Cannabaceae (46.6%) were reported to have the highest number of taxa. Several plant species were found to be used in treating a wide range of ailments. For instance, (Table 4) indicates that *O. exilis* was associated with 15 health conditions, while *B. wilsoniae* was linked to 13 different ailments.

Both men and women are actively involved in traditional healing practices, demonstrating the inclusive nature of ethnomedicinal knowledge system Our finding also aligns with previous research highlighting the intergeneration transmission of medicinal plant knowledge, a key mechanism for the preservation and continuity of indigenous healthcare traditions (Asiimwe *et al*. 2014; Phillips *et al*. 1994). It is common ethnobotanical that younger generations- particularly children to accompany elder family member during the harvesting of medicinal plants and administration of traditional treatment. This participation engagement serves as a primary mechanism for experiential learning, facilitating the transmission of ethnomedicinal knowledge through direct observation. This mode of cultural transmission ensures that traditional knowledge is retained and disseminated over time, typically passed from parents to their offspring and extended to close community members and peers, thereby reinforcing its role within the socio-cultural fabric of the community.

Table 7.Phytosociological attributes of Plants species in forest and nearby villages at various altitudes (RD-Relative Density, RF-Relative Frequency, RD*-Relative Dominance)

Plants Species	**>600 m**			**>1000 m**			**>1500 m**			**>1700 m**		
	RD	**RF**	**RD***	**RD**	**RF**	**RD***	**RD**	**RF**	**RD***	**RD**	**RF**	**RD***
Olea europaea	0.10	100	45.04									
Ficus palmata	0.01	33.3	37.38	1.32	4.34	32.76						
Berberis wilsoniae	0.05	66.6	15.18	9.27	13.04	11.43						
Quercus acutissima	15.23	66.6	0.22	26.49	13.04	13.04						
Malus domestica	-	-	-	7.94	13.04	11.43						
Pyrus communis	-	-	-	3.97	8.69	12.57						
Euphorbia helioscopia	-	-	-	5.29	8.69	11.43	7.64	12.00	17.07			
Euryops pratense	-	-	-	-	-	-	1.01	7.99	8.53			
Galium sp.	-	-	-	-	-	-	5.09	12.00	8.10			
Fogopyrum esculentum	-	-	-	-	-	-	0.76	8.00	0.42			
Aeonium sedifolium	-	-	-	-	-	-	6.37	12.00	13.86			
Verbascum phlomoides	-	-	-	-	-	-	1.52	12.00	0.13			
Bergenia ciliata	-	-	-	-	-	-	0.50	4.00	7.46			
Potentilla astrosonguinea	-	-	-	-	-	-	6.11	12.00	16.00		-	-
Prunus armeniaca	-	-	-	-	-	-	-	-	-	2.67	5.88	91.54
Verbascum phlomoides	-	-	-	-	-	-	-	-	-	8.03	11.76	1.43
Cedrus deodara	0.07	100	0.45	-	-	-	-	-	-	9.82	17.64	0.28
Pinus roxburgii	0.08	100	0.29	-	-	-	-	-	-	25.89	17.64	0.42
Malva neglecta	0.18	100	0.14	-	-	-	-	-	-	19.64	11.76	0.94
Artemisia campestris	0.09	100	1.04	-	-	-	1.78	8.00	17.71			
Oxalis exilis	-	-	-	5.29	13.04	0.50		--	-	21.43	17.64	0.28
Cannabis sativa	0.22	100	0.49	19.86	13.04	0.38	2.54	12.00	10.66	12.5	17.64	0.31

Some plant species are more common at all elevations than others, which might be explained by the same climate and topography of these regions. The Rahman's similarity index data (RSI = 52.38%) show that there is little ethnocultural resemblance between the populations using medicinal herbs at various elevations. In addition to the finding from the present study, several of the medicinal plants documented here have also been reported in previous ethnobotanical literature for treating either similar or different ailments. For example, *Oxalis* has been used to treat wounds and diabetes (Bharti *et al*. 2024) B. wilsoniae has been used to treat diabetes and jaundice (Belwal *et al*. 2020); *A. campestris* has been used to cure intestinal worms (Nakhare and Garg, 1991); and *M. neglecta* has been used to treat constipation (Elsagh *et al*. 2015). This emphasises how important these plants are to these societies' cultures.

This study identifies the Cannabaceae, Oxalidaceae, and Malvaceae families are predominant in medicinal usage, corroborating prior ethnobotanical finding (Adejumo *et al.* 2017, Argueta *et al.* 2020). Similar trends have been reported conducted in Jammu and Kashmir and the western Himalayas (Rashid & Sharma, 2012, Kour and Sharma, 2014, Hussain *et al*. 2014, Singh & Singh 2019) where these families contribute significantly to traditional pharmacopoeias. Medicinal plant distribution in the study area followed both random and aggregated patterns, shaped by factors such topography, soil properties, microclimate, and biotic interactions. Aggregated distribution, the most common in nature (Odum 1998), often results from habitat preferences, limited seed dispersal, or ecological interactions. Recognizing these patterns is vital for the effective conservation and sustainable use of ethnomedicinal biodiversity.

Previous studies, including Porter & Felder (2001), have highlighted the medicinal relevance of the Cannabaceae family, especially in addressing nervous system disorders and alleviating pain. The Cannabaceae family's medicinal qualities are ascribed to the existence of flavonoids, alkaloids, phenolic compounds, polysaccharides, amides, phytosterols, fatty acids and their esters, and terpenoids (ElSohly 2002). The use of various plant parts, including leaves, roots, fruits, seeds, and complete plants, for the production of herbal remedies has been thoroughly recorded by other researchers (Adia *et al.* 2014, Anywar *et al.* 2020, Kisangau et al. 2007, Namukobe *et al.* 2011).

The use of plants combinations in traditional herbal medicine has been attributed to the potential additive or synergistic effects of bioactive compounds when blended, thereby enhancing therapeutic efficacy across a range of ailments (Seddon *et al*. 2020, Senouci & Ababou 2019). Additionally, variation in plant species composition across different elevational gradients have been documented by several researchers, reflecting the influence of altitude on floristic diversity and ethnobotanical usage patterns (Manzoor & Jazib 2021)

Conclusion

Medicinal plants are important for maintaining human health. The people of Doda valley have a long history of using these plants for traditional healthcare. In our report, we have documented 21 medicinal plant species used in the traditional healthcare systems of Doda. The people in Doda Valley often use herbal remedies to treat human illnesses. This highlights the importance of preserving and protecting indigenous knowledge for the sustainable use of plant resources. In order to prevent vulnerable and endangered species from extinction, we need to start conserving them in the wild right away. Plants with high agreement and fidelity ratings for traditional uses should be the focus of further pharmacological research to support their traditional applications. The various uses identified in this study demonstrate the value of scientific investigations in validating traditional medicinal practices, and in developing new therapeutic agents from medicinal plants found in Jammu and Kashmir.

Declarations

List of abbreviations: UV- Used value; FC- Frequency of citation; UR- Used report; ICF - Informant consensus factor; RSI- Rahman's similarity index; PRK - Proportion of respondent knowledge ;SA - Shazia Akhtar; SN - Suman Naithani; AT - Asha Thapliyal; AB - Archana Bachheti

Ethics approval and consent to participate: The development of the study followed the ethical and legal guidelines for the development of research on traditional knowledge.

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