The role of plants in traditional medicine and current therapy: A case study from North part of Kashmir Himalaya

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Research

Abstract

Background: In many rural areas, especially in developing nations, medicinal plants serve as the main source of the healthcare systems. The purpose of this study was to document the therapeutic plants used by the local population in the Kashmir Himalayas.

Methods: Ethnobotanical data were collected through semi-structured questionnaire was used to conduct one-on-one interviews and group discussions with selected informants. Use value (UV), relative frequency of citation (RFC), and informant consensus factor (ICF) were three quantitative indicators used to assess the homogeneity of the ethnobotanical data.

Results: A total of 72 medicinal plants belonging to 41 different families were reported. Asteraceae, Lamiaceae and Polygonaceae were the dominant families. Leaves were the most commonly plant part used and infusion the dominant plant preparation. Gastrointestinal and hepatobiliary conditions, followed by dermatological disorders and musculoskeletal conditions were treated by highest number of plant species. Highest UV was reported for *Artemisia absinthium* (0.65), *Rheum webbianum* (0.59) and highest RFC is reported for *Arnebia benthamii* (0.61), *Taraxacum officinale* (0.59). The highest IFC values are reported for Gynecological disorders (0.99), Muscular and joint diseases (0.98) disease categories. Out of 72 medicinal plants reported 59 medicinal plants were used for different ethno-biological uses other than medicinal values. A total of 8 medicinal plants were exotic species, and 14 were reported in IUCN red list.

Conclusion: Due to increasing human activity and environmental degradation, traditional knowledge on plant use is slowly disappearing in many regions. The promotion of the transmission of traditional knowledge requires immediate action. In order to boost local economic development and uphold the principle of biodiversity protection, it is also necessary to ensure the sustainable use of medicinal plants.

Keywords; Kashmir, local communities, Medicinal plants, Traditional therapies.

Background

Plant usage is influenced by cultural traditions (Teixidor-Toneu *et al.* 2018). According to several studies (da Costa Ferreira *et al.* 2021; Lin *et al.* 2021; Kunwar *et al.* 2022; Turpin *et al.* 2022) medicinal plants are utilized traditionally throughout world. According to (Pan *et al.*2013: Qureshi *et al.* 2016), modern medicine has interest in traditional uses of medicinal plants, which had previously been used to treat and manage a variety of illnesses. The importance of plant-based medical knowledge is rising, and it is now acknowledged on a global scale as an invaluable resource for health care practices and as a motivator for the preservation of medicinal plants (Haq et al. 2023a; Waheed *et al.,* 2022). Examples of expertise seen as essential to the knowledge needed for drug development include ethnobotany and ethnopharmacology. With an emphasis on various therapeutic methods or processes aimed at improving one's health, "ethnomedicine" examines cultural interpretations of health, sickness, and illness (Khoja *et al.* 2022a). According to the Food and agriculture organization (FAO), up to 50,000 different species of medicinal plants are now recognized, accounting for 18.9% of the world's total flora (Baydoun *et al.* 2017; Waheed *et al.* 2022a). The World Health Organization (WHO) report estimates that about 80% of the population in developing countries depends on herbal medicines for the treatment of aliments, despite the fact that traditional ethnomedicinal approaches may be considered to be outmoded in comparison to modern westernized approaches to health care (Tangjitman *et al.* 2015; Waheed *et al.* 2020). The interaction between the plants and the indigenous communities has been better understood thanks to ethnobotanical study in many regions of the world (Kassa *et al.* 2020; Mir *et al*. 2021a; Kutal *et al.* 2021; Kunwar *et al.* 2022). Such studies are primarily concerned with educating people about important indigenous plant species (Cox, 2000), but they also play a key part in safeguarding traditional knowledge and preserving biodiversity (Jessen *et al.* 2022).

Local and indigenous populations frequently have a tight relationship with the environment (Sajem and Gosai 2006), and since they frequently reside in natural areas, they have a wealth of traditional knowledge regarding the utilization of forest resources (Uniyal *et al.* 2006; Haq *et al.,* 2023b; Haq *et al.,* 2023c; Waheed *et al.,* 2023). It is widely accepted that traditional medicine has aided in the discovery of a large range of allopathic medications (Kirtikar and Basu 1918). According to Ali *et al.* (2018), communities rely heavily on forest products like food, medicine, and fodder for their daily needs. Local knowledge includes a variety of components, such as human cognition, social networks, cultural beliefs, regional categorization systems, language, religion, and information access (Phumthum *et al.* 2020; Gosal *et al.* 2019). Many nations, including China, Pakistan, India, and Japan, place a high value on traditional medicines (Olofsson *et al.* 2021; Waheed *et al.,* 2023c; Haq *et al.,* 2023d). The most significant health problems are frequently digestive difficulties brought on by poor sewage systems and a lack of clean drinking water (Jeelani *et al.*2018). More than half of India's biodiversity may be found in the Himalayan area, which is also a significant source of food and medicine (Khoja *et al,* 2022). The flora of the area is heavily relied upon by the locals that live there (Khoja *et al.* 2023b; Waheed *et al.* 2023a; Waheed *et al.* 2023b). According to Haq and Singh (2020), forest resources are a source of money, employment, accommodation, shelter, food, fodder, fuel, timber, vegetables, and medicine.

Our main goal was to identify medicinal plants used by the indigenous people in the region: What are the plant species used by the indigenous people in tradition health care system? What are the diseases categories treated by the reported plants? Other ethnobiological uses of the identified the plants and sustainable use of medicinal plants? We will be able to provide more ethnobotanical knowledge on the forest resource that can aid in the preservation of local plant diversity and their interactions by responding to the aforementioned question.

Materials and Methods

Study area

Kupwara, one of the remote border regions in the northern section of the Kashmir valley, is situated between 34°0106°N and 74°1506°E. The region has 368 localities with a total size of 2379 km^2 (Haq *et al.* 2023). The population density is 366 people per km^2, and there are 870,354 people overall, according to the 2011 Census (Figure 1). 7.97% of the local population belongs to a scheduled caste or tribe (Khoja *et al.* 2023). Phari, Gojree, and Kashmiri are the three most widely used languages. Numerous ethnic groups call it home, including the Gujjars, a nomadic community that surrounds the territory and moves periodically, the Kashmiri, who live in the main valleys and make up the majority, and the Bakarwals, who live in the high-altitude areas of Kupwara (Bhat *et al.* 2021). Maximum summer temperatures in the primarily mountainous region range from 35 C˚ to -6 C˚ (Aadil *et al.* 2021). The area is known for its Himalayan dry temperate to subalpine forest types (Aadil et al. 2021).

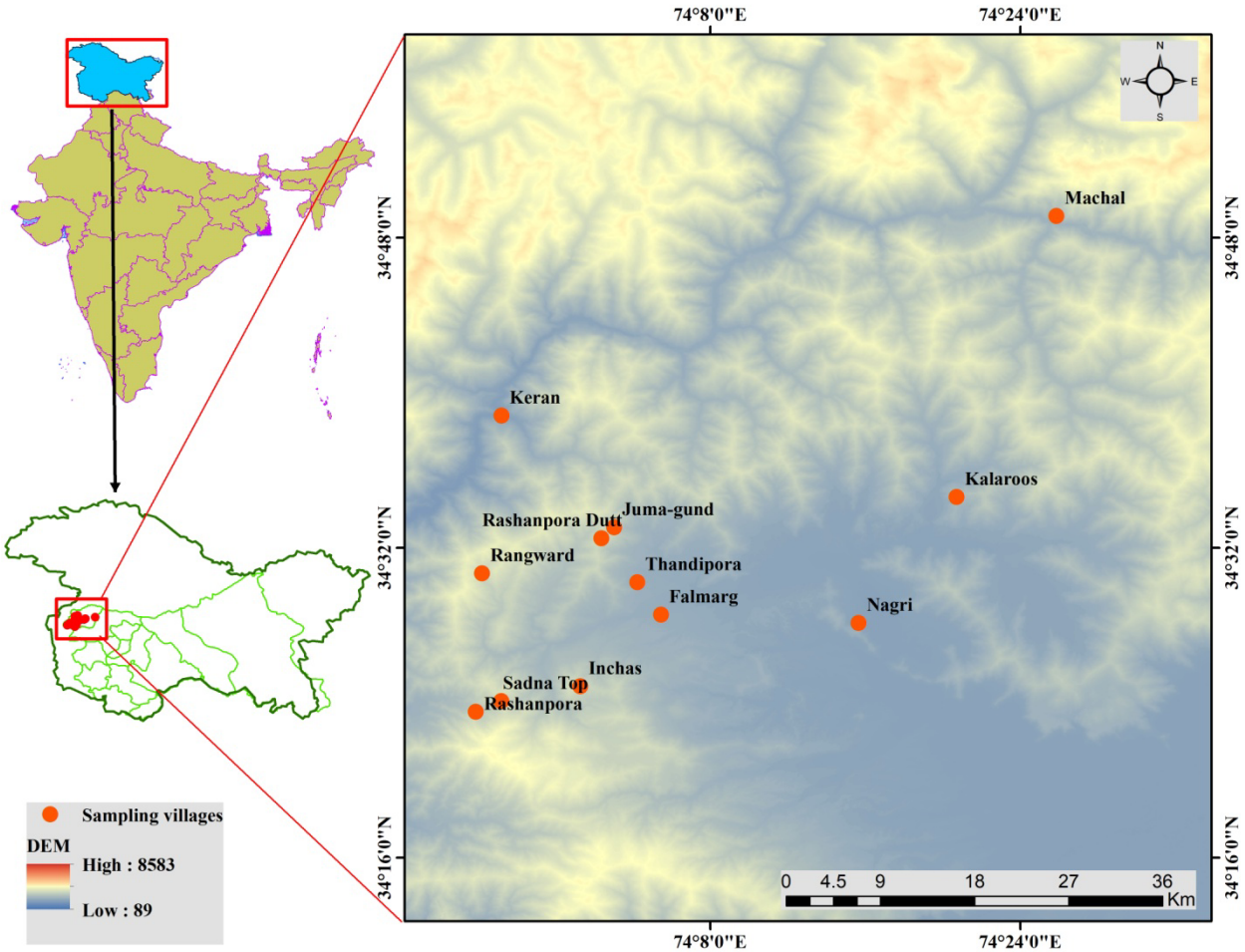


Figure 1. Map of the study area, showing studied sites.

Data collection

Following the methodology of Heinrich et al. (2008), field trips were done from March 2020 to October 2022 during each of the four seasons. Convenience sampling was used to randomly pick 128 respondents for the study, 71 of whom were men and 57 of whom were women. A semi-structured questionnaire was used to conduct one-on-one interviews and group discussions with selected important informants as reported by (Khoja et al. 2021a) in order to gather ethnobotanical data (Haq *et al.* 2023a). Informed consent was obtained verbally from all participants prior to the study (International Society of Ethnobiology Code of Ethics, 2006). The informants were asked to provide information regarding the local names of the medicinal plants, plant parts used, methods of preparation, mode of administration, diseases treated by herbal remedies, and other ethnobiological uses like food, fodder, fuelwood, timber, etc. The interviews, which were held in the regional languages of Kashmiri and Urdu, included both mixed-gender and single-gender debates. The informants' ages ranged from 25 to 90. All participants provided oral prior informed consent.

Plant Identification and Conservation

The plant species were pressed and placed on herbarium sheets (Martin 2010). The Indian flora was used for taxonomic identification, and the International Plant Name Index (IPNI) (www.ipni.org), The World Flora Online (https://www.worldforaonline.org), and The Plant List (https://www.theplantlist.org) were used to find the right botanical names. The University of Kashmir's KASH herbarium verified the authenticity of the plant samples.

A Principal Component Analysis (PCA) was conducted to visualize the utilization of provisioning services and plant components. The function of fact was extra was used to illustrate the PCA biplot, contribution plot, and even values corresponding to the variance described by each principal component. To show the relation between medicinal preparation, plant part used and disease categories of plant species, chord diagram was prepared in Origin Pro software (version 9.95) (Haq *et al.* 2023b).

Quantitative ethnobotanical data analysis

Use value (UV), relative frequency of citation (RFC), and informant consensus factor (ICF) are three quantitative indicators that were used to validate and assess the homogeneity of the ethnobotanical data that was gathered.

Informant consensus factor (ICF)

To calculate this index, the formula provided by (Albuquerque *et al.* 2006) was used.

$$ICF=Nur-Nt/(Nur-1)$$

Where Nt represents the total number of taxa utilized in that disease category, and Nur represents the total number of usage reports cited for each disease category. The ICF value varies from 0 (if informants do not exchange information) to 1 (if it is discovered that informants do).

Frequency of Citation (FC)

According to Tardo M. Pardo-De-Santayana (2008), the frequency of citations enables us to evaluate the veracity of the information obtained and the level of plant knowledge of the sampled community. The number of informants who cited a certain species is represented by the frequency of citation (FC) of that species.

Relative frequency of citation (RFC)

To measure the degree of agreement among informants on the stated species, the relative frequency of citation (RFC) has been determined. The purpose of this index is to show how important each species is locally (Tard'o M. Pardo-De-Santayana 2008). Using the following formula, the index of relative frequency of citation (RFC) was calculated.

$$RFC =FC/N$$

N is the total number of informants, and FC is the number of informants reporting use of a certain species.

Use value

To measure the significance of species, Philips and Gentry (1993) proposed the UV index. The formula described by (Albuquerque *et al.* 2006) is used to compute UV.

$$UV = \sum Ui/N$$

Where Ui is the total number of uses for a specific species that were mentioned by all of the informants, and N is the total number of informants.

Results and Discussion

Demographic Descriptions of the Informants

To gather ethnobotanical data on plant uses in various regions of Kashmir Himalayas, 39 field visits were made during this time. In total, 128 local residents who were all informants for the study were used. Men (55.47%) and women (44.53%) man made up more than half of the informants, which can be somewhat explained by the fact that men tended to collect plants more often than women. In the study population, people between the ages of 46 and 65 made up the largest age group (35.94%), followed by those 65 and over, who made-up the second-largest group (42.97%) compared to people between the ages of 25 and 45 (21.09%) (Table 1). The informants who were 65 years or older had the most comprehensive knowledge on the usage of therapeutic plants. There are a number of socioeconomic characteristics that have been demonstrated to have impact on knowledge of plant usage, including population, gender, age, ethnicity, economy, and occupation (Kutal *et al.* 2021). In our study the lowest amount of information was given by informants under the age of 45. In many ethnobotanical studies, deteriorating indigenous knowledge has been attributed to increased urbanization and a lack of measures to document indigenous information, highlighting the knowledge gap between the older and younger generations in terms of knowledge transfer. (Haq *et al.* 2023b) reported the same outcome. Some of the informants had attended elementary education (28.13%), secondary education (11.72%), and higher education (7.03%), but a significant portion of the informants (53.13%) were illiterate. Herders (23.44%) made up the majority of those who held traditional knowledge followed by skilled/semi-skilled workers (22.66%), Cultivator/agricultural laborer (16.61%), housewives (14.06%), traditional healers (13.28), shopkeepers (6.25%), and government employees (3.91%). The majority of the time that herders spend in

the forests with their cattle and without access to medical services explains why they had the greatest levels of traditional knowledge.

Table 1. Demography of the respondents from the study area.

Variable	Categories	Number of Persons	Percentage
Informant category	Traditional healer	17	13.28
	Other local participants	111	86.72
Gender	Male	71	55.47
	Female	57	44.53
Age group	25-45 years	27	21.09
	46-65 years	55	42.97
	Above 65	46	35.94
Education Level	Illiterate	68	53.13
	Primary education	36	28.13
	Secondary education	15	11.72
	Higher education	9	7.03
Profession	Traditional healers	17	13.28
	Skilled/semi-skilled worker	29	22.66
	Cultivator/agricultural laborer	21	16.41
	Herders	30	23.44
	Housewives	18	14.06
	Shopkeepers	8	6.25
	Govt. Employees	5	3.91
Religion	Islam	128	100

Medicinal plant species used

In the current study a total of 72 medicinal plants, belonging to 41 families were documented as used by the indigenous people of Kashmir Himalayas. The number of plant species identified in the research area was comparably higher than in previous ethnobotanical studies conducted in other Himalayan regions. Haq *et al.* (2023b) reported 46 species from high-altitude areas of Kashmir Himalayas, Sher *et al.* (2020) reported 53 plants from District Swat, Pakistan, Barreda *et al.*(2015) reported 53 plants from Monpa tribe in Eastern Himalayas; Kumar Rana *et al.* (2015) reported 42 species from Sikles area of Nepal and Gurung and Rajbhandary (2017) reported 66 species from Kathmandu Nepal. This indicates that the area is an excellent reservoir of plant species of medicinal value. According to (Mir *et al.* 2021) high diversity of medicinal plants is attributed to good vegetation cover which in turn implies their significant role in plant-based traditional medicine in meeting basic primary healthcare needs.

Medicinal Plant Diversity

In this study, a total of 72 wild medicinal plant species from 41 families were reported. Among them, there were two pteridophytes, two gymnosperms, and the rest 68 angiosperm species (Table 2). Asteraceae has the greatest number of species in the family distribution, (N-9) followed by Lamiaceae with (N-6), Polygonaceae with (N-5), Ranunculaceae with (N-4), Apiaceae and Rosaceae with (N-3 each), and Boraginaceae, Saxifragaceae, Pinaceae, Liliaceae, Caryophyllaceae, Geraniaceae, and Asparagaceae with (N-2 each) (figure 2). While only one species is present in each of the (N-28) monotypic groups. In several biomes, especially in open habitat environments, Asteraceae were shown to be predominate (Khoja *et al.,* 2022a). According to several research (Khoja *et al.*2022a; Haq *et al.* 2023c), the Asteraceae was also the most significant or practical family in the areas bordering the Pakistani and Kashmir Himalayas. Asteraceae was also noted as a dominating family in the Highlands of Gasa District, Bhutan, by (Dorji *et al.* 2017), and from western Himalayas (Khoja *et al.* 2022; Haq *et al.* 2023). Plants of the Asteraceae, Lamiaceae, and Ranunculaceae are renowned for being a rich source of medicinal goods used to cure a variety of illnesses because of their alkaloids, sterols, flavonoids, and glycosides (Raghuvanshi *et al.* 2021; Wali *et al.* 2021). The abundance of these groups in the study area's flora is another factor contributing to their domination. In addition, a number of researchers (Sher *et al.* 2020; Muhammad *et al.* 2021) claim that the members of these families contain a lot of beneficial bioactive chemicals. The family Asteraceae adapts to arid, dry settings quickly and easily due to vast ecological amplitude (Haq *et al*. 2021). According to Pala *et al.* (2019), Lamiaceae is the dominant family in the Eastern Himalaya, which is consistent with our findings.

Table 2. List of medicinal plant species, local name, life form, part used; preparation/administration, diseases treated, other ethnobiological uses, Nativity, FC, RFC and UV from the Kashmir Himalayas.

Botanical name Voucher No/ Code	Family	Local name	Life from	Part used	Preparation/ Administration	Diseases treated	Other ethnobotanical uses	Nativity Native (N) / Exotic (E)	FC	RFC	UV
Acorus calamus L. 4119-KASH (Aco. cal)	Acoraceae	Vai	Herb	Tuber	Fresh or dried tubers are taken orally for 2-3 days twice a day. Tubers are chewed for 2-3 days early in the morning.	Stomach pain, Diarrhea, Anthelminthic, cough and throat pain	---------	Native	48	0.38	0.44
Amaranthus dubius Mart. ex Thell 7101-KASH (Ama. dub)	Amaranthaceae	Krey	Herb	Seeds	Dried seeds are cooked along with maize floor and dhesi ghee and taken orally for 2-3 days	Paralysis, joint pain	Tinder leaves are cooked as vegetable	Exotic	44	0.34	0.33
Allium sativum L. 8118-KASH (All. sat)	Amaryllidaceae	Jungle rohan	Herb	Tuber	Dried tubers are semi-roosted and eaten orally thrice a day for 5-10 days	High blood pressure, Heart diseases	Tubers are used as spice	Exotic	56	0.44	0.47
Angelica glauca Edgew. 4111-KASH (Ang. gla)	Apiaceae	Choud	Herb	Roots	Dried roots are mixed with sugar or honey and taken orally	Abdominal pain, Stomach cramps	Roots are used as spice	Native	42	0.33	0.41
Elwendia persica (Boiss.) Pimenov & Kljukov (Bun. per)	Apiaceae	Jungli zeeur	Herb	Seeds	Fresh or roosted seeds are taken along with honey for 5-8 days early in the morning	Abdominal pain, respiratory disorders, joint pain, heart diseases	Seeds are used as spice	Native	38	0.30	0.36
Selinum vaginatum C.B.Clarke 3811-KASH (Sel. vag)	Apiaceae	Budjeath	Herb	Roots	Dried root powder is mixed with sugar and taken orally early in the morning	Abdominal pain, stomach cramps	---------	Native	62	0.48	0.41
Arisaema jacquemontii Blume 7095-KASH (Ari. jac)	Araceae	Sarfe-makai	Herb	Tuber	Poultice of tubers is applied topically	Burns, skin rashes	---------	Native	21	0.16	0.24
Polygonatum cirrhifolium (Wall.) Royle 4229-KASH (Pol. cir)	Asparagaceae	Salapmesri	Herb	Tuber	Fresh or dried tubers are taken orally for 4-6 days twice a day	Leukorrhea	Tubers are eaten fresh	Native	38	0.30	0.33
Polygonatum verticillatum (L.) All. 4230-KASH (Pol. ver)	Asparagaceae	Salapmesri	Herb	Tuber	Fresh or dried tubers are taken orally for 4-6 days twice a day	Leukorrhea, Stomach pain	Tubers are eaten fresh	Native	39	0.30	0.38

Achillea millefolium L. 4097-KASH (Ach. mil)	Asteraceae	Phale-gass	Herb	Leaves	Fresh leaves are chewed, paste is applied topically, infusion of leaves is taken orally	Toothache, wound healing, diuretic	Aerial parts are used as fodder	Native	32	0.25	0.3
Artemisia absinthium L. 4020-KASH (Art. abs)	Asteraceae	Tethwa n	Herb	Whole plant	Dried leaves are taken along with sugar early in the morning for 1-2 days, leaves are fried and applied topically	Abdominal pain, Stomach cramps, Anthelminthic, factures	---------	Native	68	0.53	0.65
Cichorium intybus Linn. 7115-KASH (Cic. int)	Asteraceae	Kaw-hand	Herb	Whole plant	Infusion of roots is taken early in the morning, leaves are fried and applied topically for 12 hrs for 2-3 days	Typhoid, Arthritis, bone fracture	Tinder leaves are cooked as vegetable	Exotic	47	0.37	0.45
Dolomiaea costus (Falc.) Lipsch. 4211-KASH (Sau. cos)	Asteraceae	Kuth	Herb	Roots	Decoction collected from roots is used to cook rice which is taken for 2-3 days thrice a day	Joint pain, bone fracture	---------	Native	52	0.41	0.48
Dolomiaea macrocephala DC. ex Royle 4090-KASH (Jur. dol)	Asteraceae	Gogul-doop	Herb	Roots, Leaves	Paste of roots is applied topically, tea made up,offrom roots is taken orally for 1-3 days	Burns, cough and cold, abdominal pain	Leaves are used to make herbal tea	Native	48	0.38	0.45
Erigeron canadensis L 4116-KASH (Con. can)	Asteraceae	Shalut	Herb	Leaves	Infusion extract from leaves are taken for 3-4 days	Indigestion, diarrhea and dysentery	Aerial parts are used as fodder	Exotic	18	0.14	0.2
Inula racemosa Hook. f. 8122-KASH (Inu. rac)	Asteraceae	Poshkar-mool	Herb	Roots	Decoction of roots is taken orally twice a day	Cough and cold	Aerial parts are used as fodder	Native	25	0.20	0.22
Ligularia jacquemontiana (Decne.) M.A. Rau 4214-KASH (Lig. jac)	Asteraceae	Musth ma	Herb	Roots	Dried roots are taken empty stomach for 2-3 days	Abdominal pain, anthelminthic, stomach cramps	Aerial parts are used as fodder	Native	26	0.20	0.27
Taraxacum officinalis (L.) Weber ex F.H.Wigg 6259-KASH (Tar. off)	Asteraceae	Heand	Herb	Whole plant	Dried leaves are fried and applied topically,topically; infusion of whole plant is taken orally for 2-3 days	Bone fracture, stomach cramps, diuretic	Tinder leaves are cooked as vegetable	Exotic	75	0.59	0.52
Berberis lycium Royle 4102-KASH (Ber. lyc)	Berberidaceae	Kawdac h	Shrub	Roots	Decoction extracted from roots is used to cook rice which is taken orally for 2-3 days twice a day, decoction of roots is taken orally	Joint pain, Arthritis, blood purifier, diabetes	Firewood, fruits are edible, fruits are used to make ink	Native	34	0.27	0.32
Betula utilis D.Don 4015-KASH (Bet. uti)	Betulaceae	Burz	Tree	bark	Powder of bark is applied topically on effected portions	Burns	Whole tree is used as firewood, stem is used to make glass.	Native	29	0.22	0.31

Arnebia benthamii Wall. ex G.Don 4096-KASH (Arn. ben)	Boraginaceae	Khazaban	Herb	Roots, Leaves	Decoction extracted from roots is used to cook rice, herbal tea made of leaves is taken for 2-3 days	Joint pain, cough and cold, dry throat, fever	Leaves are used to make herbal tea	Native	78	0.61	0.55
Cynoglossum glochidiatum Wall. ex Benth. 4083-KASH (Cyn. glo)	Boraginaceae	Chuir	Herb	Roots	Poultice of fresh roots is applied topically	Wound healing	Aerial part is used as fodder	Native	24	0.19	0.23
Capsella bursa-pastoris L. 4250-KASH (Cap. bur)	Brassicaceae	Kralmound	Herb	Leaves	Infusion extract from leaves are taken for 3-5 days	Dysentery, fever	Tinder leaves are cooked as vegetable	Native	29	0.22	0.4
Herniaria hirsuta L. 6241-KASH (Her. hir)	Caryophyllaceae	Chikal	Herb	Whole plant	Dried whole plant is crushed into powder and fried along with egg and eaten twice a day	Dizziness	---------	Native	27	0.21	0.29
Silene coronaria Desr. 4229-KASH (Sil. cor)	Caryophyllaceae	Chok-dawa	Herb	Leaves	Fresh or dried leaves are boiled and applied topically after cooling	Burns	---------	Native	38	0.30	0.32
Colchicum luteum Baker 6254-KASH (Col. lut)	Colchiaceae	Yerkiposh	Herb	Tuber	Decoction extracted from roots is taken orally along with sugar	Joint pain, cough and cold	---------	Native	32	0.25	0.28
Rhodiola fastigiata (Hook. f. et Thomson) Hu 4091-KASH (Rho. fas)	Crassulaceae	Julab-di-dawa	Herb	Roots	Dried root powder is mixed with water and taken orally	Diarrhea	---------	Native	19	0.15	0.2
Dioscorea deltoidea Wall. ex Griseb. 6237-KASH (Dio. del)	Dioscoreaceae	Single-mingle	Herb	Roots	Decoction of roots is used to cook rice which is taken for 2-3 days twice a day. Fresh roots are eaten raw	Joint pain, Arthritis, snake bite	Aerial parts are used as fodder	Native	20	0.16	0.23
Diplazium maximum (D.Don) C. Chr. 7105-KASH (Dip. max)	Dryopteridaceae	Longud	Fern	Young frond	Young fronds are dried and crushed into powder later cooked as vegetable	Anthelminthic	Young fronds are cooked as vegetable	Native	49	0.38	0.38
Euphorbia wallichii Hook.f. 4216-KASH (Eup. wal)	Euphorbiaceae	Herib	Herb	Latex	Latex extracted by cutting leaves or stem is applied topically	Foot corm, skin infections	---------	Native	37	0.30	0.36
Astragalus grahamianus Benth. 7102-KASH (Ast. gra)	Fabaceae		Herb	Roots	Dried roots are applied on effected portion	Toothache	---------	Native	25	0.19	0.25

Trigonella foenum-graecum L. 4248-KASH (Tri. foe)	Fabaceae	Meath	Herb	Seeds	Dried seeds are crushed into powder and mixed with egg white and applied topically for 5-10 days	Bone fracture	Seeds are used as spice	Exotic	60	0.47	0.48
Geranium pratense L. 4098-KASH (Ger. pre)	Geraniaceae	Ratanjogh	Herb	Roots	Decoction extracted from roots is used to cook rice which is taken orally for 2-3 days twice a day	Joint pain, Arthritis	Roots are used to make herbal tea	Native	38	0.30	0.36
Geranium wallichianum Oliv. 4112-KASH (Ger. wal)	Geraniaceae	Ratangogh	Herb	Roots	Decoction extracted from roots is used to cook rice which is taken orally for 2-3 days twice a day	Joint pain, Arthritis	Roots are used to make herbal tea	Native	51	0.40	0.47
Hypericum perforatum L. 4089-KASH (Hyp. per)	Hypericaceae	Chai-kul	Herb	Leaves	Infusion extracted from leaves is taken orally thrice a day for 2-3 days	Fever, Diarrhea, Snake bite, wounds.	Roots are used to make herbal tea	Native	31	0.24	0.35
Juglans regia L. 7113-KASH (Jug. reg)	Juglandaceae	Doon	Tree	Bark, Fruits	Oil extracted from seeds is applied topically for 10-15 days, bark is applied topically	Arthritis, toothache	Stem and branches are used as firewood and timber, fresh fruits are edible	Native	66	0.52	0.5
Ajuga parviflora Benth 4095-KASH (Aju. par)	Lamiaceae	Jain-adam	Herb	Leaves	Infusion of leaves are taken orally for 2-3 days twice a day, paste of leaves is applied topically	Abdominal pain, Anthelminthic, wound healing,throat pain	Aerial parts are used as fodder	Native	48	0.38	0.45
Isodon rugosus (Wall.) Codd. 6257-KASH (Iso. rug)	Lamiaceae	Suliye-kath	Shrub	Leaves	Infusion of leaves is used to wash foot, herbal tea is taken twice a day	Foot fever, diarrhea, Blood pressure, toothache	Whole plant is used as firewood	Native	30	0.23	0.28
Nepeta cataria L. 4093-KASH (Nep. cat)	Lamiaceae	Gand-soi	Herb	Roots, leaves	Poultice of roots is applied topically. Infusion of leaves is taken orally for 2-4 days	Skin irritations, blood pressure, cold, fever	Aerial parts are used as fodder	Native	20	0.16	0.22
Prunella vulgaris L. 4254-KASH (Pru. vul)	Lamiaceae	Kalyuth	Herb	Whole plant	Infusion of leaves is taken orally as well as used to take bath and wash foot	Fever, sore throat, cough and cold, foot fever	Leaves are used to make herbal tea,tea; aerial part is used as fodder	Native	52	0.41	0.53
Thymus linearis Benth 4107-KASH (Thy. lin)	Lamiaceae	Javind	Herb	Leaves	Herbal tea made up of leaves is taken twice a day from 3-5 days	Abdominal pain, constipations, Improve digestion	Leaves are used to make herbal tea	Native	49	0.38	0.46
Fritillaria roylei Hook. 6238-KASH (Fri. roy)	Liliaceae	Sheet-khar	Herb	Tuber	Dried tubers are eaten early in the morning for 2-4 days	Abdominal pain, Stomach cramps, Anthelminthic	---------	Native	60	0.47	0.44
Lilium polyphyllum D.Don 6236-KASH (Lil. pol)	Liliaceae	Pland	Herb	Tuber	Fresh or dried tubers are taken orally for 2-3 days twice a day	Abdominal bloating, stomach cramps	Aerial parts are used as fodder	Native	34	0.27	0.3

Lavatera cashmeriana Camb. 4099-KASH (Lav. cas)	Malvaceae	Jungli-souchal	Herb	Flowers	Dried flowers are used to make jam which is taken mostly in winters	Cough and cold	Flowers are used to make jam/Khambeer	Native	25	0.20	0.27
Trillium govanianum Wall. ex D.Don 6230-KASH (Tri. gov)	Melanthiaceae	Tripatri	Herb	Tuber	Decoction of roots is taken orally twice a day	Inflammation, joint pain	Tinder leaves are cooked as vegetable	Native	20	0.16	0.3
Ficus carica L. 4088-KASH (Fic. car)	Moraceae	Anjeer	Tree	Fruits, Latex	Infusion of dried fruits is taken early in the morning for 3-5 days, latex extracted by cutting leaves is applied on infected portions	Constipation, Piles, urinary bladder problems, Skin diseases,	Whole plant is used as firewood, fruits are eaten fresh	Native	48	0.38	0.46
Dactylorhiza hatagirea (D. Don) Soó (Dac. hat)	Orchidaceae	Salapingri	Herb	Tubers	Piece of rhizome is chewed to cure. Paste of rhizome is used in	Stomachache, headache and burn.	Aerial parts are used as fodder	Native	48	0.38	0.35
Oxalis corniculata L. 4113-KASH (Oxa. cor)	Oxalidaceae	Chok-chrey	Herb	Whole plant	Whole plant infusion is taken orally for 2-3 days	Abdominal pain, diarrhea	Tinder leaves are cooked as vegetable	Native	34	0.27	0.24
Cedrus deodara (Roxb.) G.Don 4228-KASH (Ced. deo)	Pinaceae	Deodar	Tree	Oil	Oil extracted from dried wood is applied topically	Wound healing, toothache	Whole tree is used as firewood and timber	Native	68	0.53	0.51
Pinus wallichiana A. B. Jacks 4227-KASH (Pin. wal)	Pinaceae	Kayur	Tree	Latex	Fresh latex collected from stem is applied topically for 2-3 days	Wound healing, Cracked heels	Stem and branches are used as firewood, stem is used as timber	Native	64	0.50	0.55
Plantago lanceolata L. 6249-KASH (Pla. lan)	Plantaginaceae	Gull	Herb	Leaves	Infusion of leaves is taken orally	Cough and cold, Toothache, dysentery	Tinder leaves are cooked as vegetable	Native	26	0.20	0.27
Bistorta amplexicaulis (D.Don) Greene 4108-KASH (Bis. amp)	Polygonaceae	Manchrey-chai	Herb	Roots	Herbal tea made up of roots is taken orally up to 5 days twice a day	Fever, Inflammation	Roots are used to make herbal tea	Native	30	0.23	0.3
Koenigia rumicifolia (Royle ex Bab.) T.M.Schust. & Reveal (Aco. rum)	Polygonaceae	Safed-abij	Herb	Roots	Decoction extracted from roots is used to cook rice	Joint pain, Arthritis, inflammation	Aerial parts are used as fodder	Native	42	0.33	0.4
Rheum spiciforme Royle (Rhe. spi)	Polygonaceae	Chitola	Herb	Roots	Paste of roots is applied topically, decoction collected from roots is used to cook rice which is taken for 2-3 days thrice a day .decoction of the shoot portion is taken orally.	Wound healing, burns, joint pain, dysentery and intestinal problems	Tinder leaves are cooked as vegetable.	Native	61	0.48	0.55

Rheum webbianum Royle 4212-KASH (Rhe. web)	Polygonaceae	Pambchalan	Herb	Roots	Paste of roots is applied topically, decoction collected from roots is used to cook rice which is taken for 2-3 days thrice a day	Wound healing, burns, joint pain	Tinder leaves are cooked as vegetable.	Native	69	0.54	0.59
Rumex nepalensis Spreng. 7084-KASH (Rum. nep)	Polygonaceae	Abij	Herb	Roots	Decoction collected from roots is used to cook rice which is taken for 2-3 days thrice a day	Joint pain, Arthritis, inflammation	Tinder leaves are cooked as vegetable.	Native	57	0.45	0.52
Adinatum capillus-veneris L. 4115-KASH (Adi. cap)	Pteridaceae	Guether	Fern	Leaves	Infusion extract from leaves are taken for 3-5 days. Decoction of leaves is taken early in the morning.	Bleeding of nose, diabetes, jaundice	Mature fronds are used as toothpick	Native	24	0.19	0.22
Aconitum chasmanthum Stapf ex Holmes (Aco. cha)	Ranunculaceae	Mohand	Herb	Tuber, flowers	Dry tuber is applied externally in a small quantity. Dried flowers are used to make jam which is taken mostly in winters	Toothache, asthma	Flowers are used to make jam/Khambeer	Native	30	0.23	0.27
Aconitum heterophyllum Wall. ex Royle 4049-KASH (Aco. het)	Ranunculaceae	Patris	Herb	Tuber, Seeds	Dry tubers are eaten along with sugar for 2-4 days empty stomach, poultice of seeds is applied externally	Abdominal pain, Anthelminthic, Tonsillitis	Flowers are used to make jam/Khambeer	Native	55	0.43	0.54
Actaea spicata var acuminata H.Hara 6242-KASH (Act. spi)	Ranunculaceae	Jungle brand	Herb	Roots	Poultice of roots is applied topically	Joint pain, Inflammation	---------	Native	29	0.25	0.28
Delphinium cashmerianum Royle. 6243-KASH (Del. cas)	Ranunculaceae	Moori	Herb	Roots	Dried roots are placed inside glass bottle filled with honey and buried in soil for 6 months.	Asthma	Flowers are used to make jam	Native	29	0.23	0.29
Cydonia oblonga Mill. 6231-KASH (Cyd. obl)	Rosaceae	Bumbchount	Tree	Fruits, leaves	Infusion of fruits is taken for 2-6 days twice a day, paste of leaves is applied topically.	Asthma, cough and cold, burns	Fruits are eaten fresh, whole plant is used as firewood	Exotic	35	0.27	0.35
Fragaria nubicola Lindl. ex Lacaita 4087-KASH (Fra. nub)	Rosaceae	Ringrish	Herb	Roots	Herbal tea made up of roots is taken orally, paste of roots is applied topically	fever, wound healing	Fruits are eaten fresh; roots are used to make herbal tea	Native	33	0.26	0.33
Rosa webbiana Wall. ex Royle 6245-KASH (Ros. web)	Rosaceae	Jungli-poash	Shrub	Flowers	Dried flowers are used to make jam which is taken mostly in winters	Cough and cold	Flowers are used to make jam/Khambeer, flowers are used in decoration	Native	24	0.19	0.24
Galium aparine L. 6248-KASH (Gal. apa)	Rubiaceae	Thap-gass	Herb	Whole plant	Poultice made up of whole plant is applied topically	Wound healing	Aerial parts are used as fodder	Native	22	0.17	0.23

Skimmia anquetilia N.P. Taylor & Airy Shaw 4120-KASH (Ski. anq)	Rutaceae	Nair-pan	Shrub	Leaves	Infusion of leaves is taken orally for 2-4 days early in the morning	Asthma, stomach cramps	Whole plant is used as firewood,	Native	28	0.22	0.29
Salix alba L. 7086-KASH (Sal. alb)	Saliaceae	Veer	Tree	Leaves	Infusion of leaves is taken orally, it is also used to wash foot, paste of leaves is applied topically	Abdominal pain, Foot fever, boils	Aerial parts are used as fodder, stem and branches are used as firewood; branches are used to make wooden buckets.	Exotic	30	0.23	0.38
Bergenia ciliata (Haw.) Sternb. 4213-KASH (Ber. cil)	Saxifragaceae	Palfort	Herb	Roots	Decoction extracted from roots is used to cook rice which is taken orally for 2-3 days twice a day, fresh or dried root are crushed and applied topically	Liver diseases, wound healing, joint pain	Roots are used to make herbal tea	Native	43	0.34	0.45
Bergenia stracheyi (Hook.f. & Thomson) Engl. (Ber. str)	Saxifragaceae	Butpewa	Herb	Roots	Decoction extracted from roots is used to cook rice which is taken orally for 2-3 days twice a day, fresh or dried root are crushed and taken along with water	Wound healing, joint pain, urinary tract troubles	Roots are used to make herbal tea	Native	41	0.32	0.4
Verbascum thapsus L 4242-KASH (Ver. tha)	Scrophulariaceae	Buder-tund	Herb	Whole plant	Dried whole plant is crushed into powder and mixed with mustard oil and applied topically, decoction of leaves is taken orally for 2-3 days	Burns, stomach cramps	Dried stem is used as firewood	Native	24	0.19	0.27
Urtica dioica L. 4219-KASH (Uri. dio)	Urticaceae	Soi	Herb	Roots	Decoction extracted from roots is used to cook rice, which is taken orally, paste of roots is applied topically. decoction is taken orally	Joint pain, Asthma, arthritis, wound healing and fever	Tinder leaves are cooked as vegetable	Native	43	0.34	0.42
Viola odorata L. 4238-KASH (Vio. odo)	Violaceae	Vanposh	Herb	Flowers	Dried flowers are used to make jam which is taken mostly in winters. Paste of leaves is applied topically	Cough and cold, jaundice and wound healing	Flowers are used to make jam/Khambeer	Exotic	28	0.22	0.34

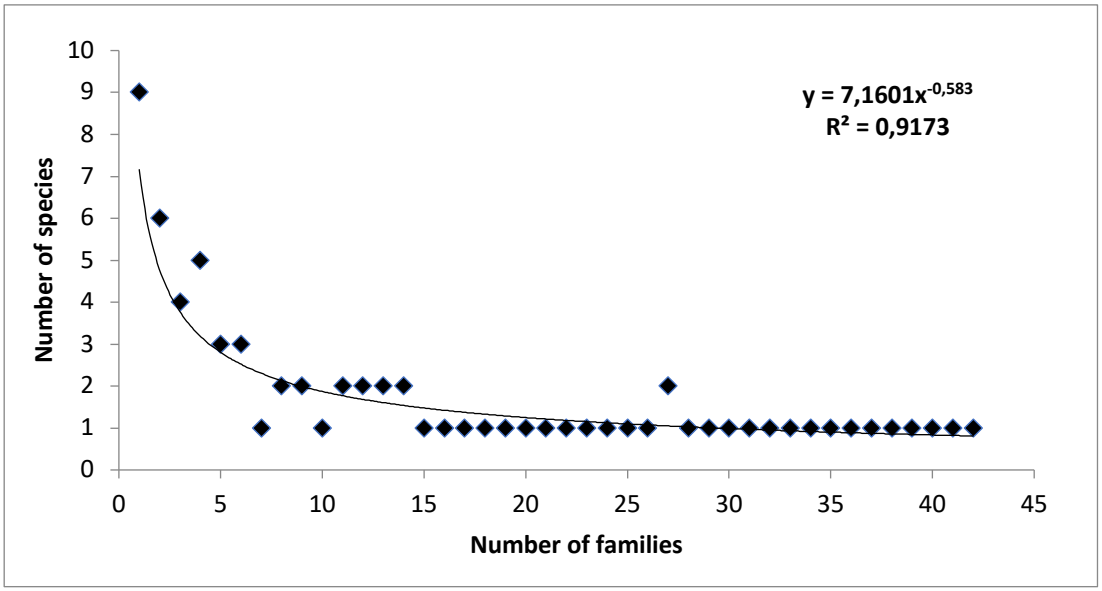


Figure 2. Species family relationship of the vegetation in the Kashmir Himalaya

Life form and Part Used

Herbs made up (N-58, 82%) of the total species reported, followed by trees (N-10, 10%), shrubs (N-4, 5%), and ferns (N-2, 3%) and then trees (N-10, 10%) (Table 2). Other studies from the Kashmir Himalayas (Haq *et al.* 2023a, 2023b; Khoja *et al.* 2023; Aadil *et al.* 2021) have found distribution patterns in many life forms that are similar to this one. Since the study sites are in higher elevation ranges where there is a greater diversity of herbs than there is of trees and shrubs, this could be one explanation for why herbs predominate. However, using shrubs for medicinal purposes is less widespread than using trees (Khoja *et al.* 2022a). Actually, according to (Haq *et al.*2023c), the study area has the greatest concentration of plants. The use of herbs may be owing to their high concentration of bioactive chemicals (Aadil and Andrabi 2021) and the fact that they have more potent therapeutic properties than other types of plants (Abdullah and Andrabi 2021).

Participants used a wide variety of plant parts, including roots, leaves, seeds, young fronds, fruits, stem-latex, bark, oil, flowers, whole plants, and tubers, of the species that have been identified. With (N-27, 34%) of usage, roots were the most widely used part of the plant. This was followed by leaves (N-16, 20%), tubers (N-11, 14%), whole plants (N-5, 9% each), seeds (N-5, 6%), latex, fruits, and flowers (N-3, 4% each), bark (N-2, 3%), wood, and young fronds (N-1, 1% each). (Figure 3). According to research (Yousuf *et al.* 2020), roots frequently have higher amounts of bioactive chemicals than other plant components. The leaves and entire plants were regularly used while dealing with herbaceous species. However, the removal of the entire plant, the removal of the roots, or the excessive use of fruits or seeds as medicines may result in a fall in plant populations; for this reason, leaves are frequently employed more frequently in herbal treatments. There are several uses and sections of one plant that are used in multiple ways among the kinds of plants that have been recorded, demonstrating the extensive knowledge of regional medicinal herbs. But in addition to over-collection, we also found that over-grazing, deforestation, and soil erosion are major contributors to the decline in the number of economically important and therapeutic plants in the study area.

Method of Preparation, and Administration of Medicinal Plants

The most popular methods for preparations included using raw materials, drying plants, powdering the material, and boiling it to make a decoction, tea, or infusion. In the biplot, PC1 and PC2 explained 43.9 percent of the plant preparations. Eleven clusters of disease categories based on species presence/absence can be seen there: Infusion, raw, decoction, paste, poultice, fried, herbal tea, jam, roasted, oil, and boiled (Figure 4). Numerous ethnobotanists, such as (Khoja *et al.* 2022a) from the Kashmir Himalayas, (Emiru *et al.* 2011) from Northern Ethiopia, and (Uniya *et al.* 2006) from tribal areasin the Western Himalaya, reported similar findings. According to the responders, some medicinal plant species should be harvested at a particular time or on a particular day because of their great medicinal value. *Rumex nepalensis*, for instance, should be collected from a location away from water streams, and species with potent medicinal properties like *Rheum webbianum, Saussurea costa, Bergenia ciliata, Arnebia benthamii*, *Aconitum heterophyllum*, and *Jurinea dolomiaea* should only be collected in the months of September and October. Depending on the plant's components, more than one preparation technique may be utilized to make a given remedy. Fruits and other latex extracts were obtained by cutting fleshy plant parts like those of *Ficus carica* and *Euphorbia wallichii.* Collection and stored in glass bottles was done to extract active ingredients and to increase the shelf life of herbal remedies.

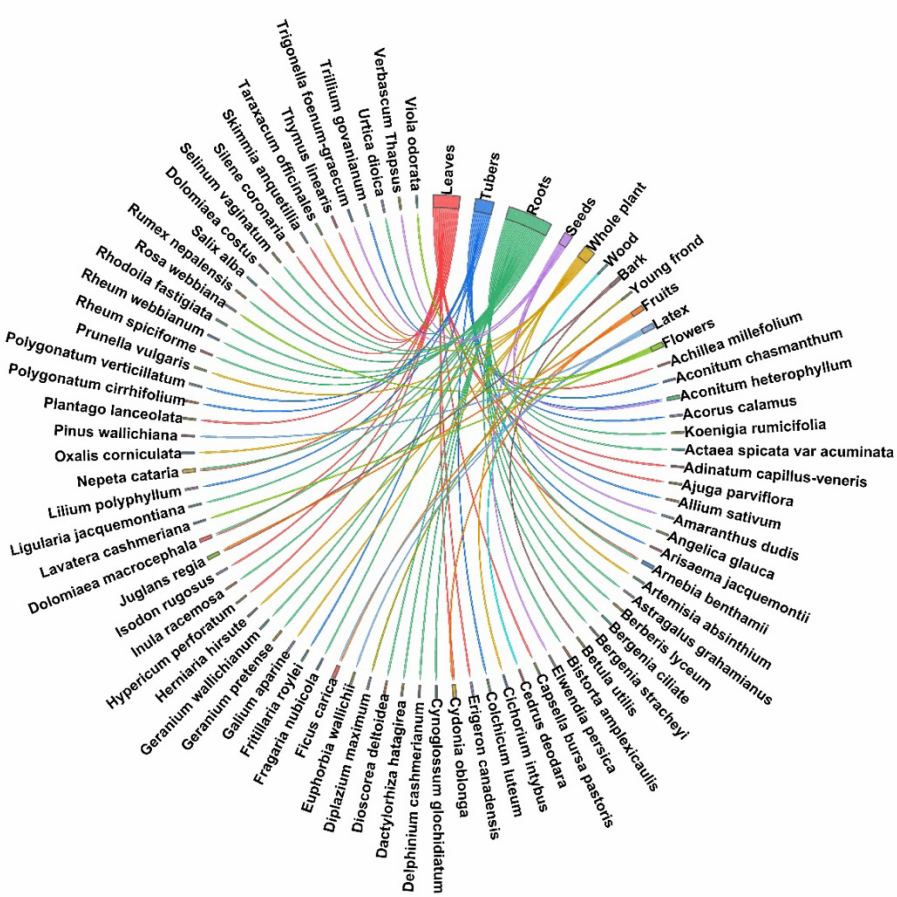


Figure 3. Distribution of plant species in various plant part categories used in the region. The direction of the lines depicts which plant species is linked with which part used and thickness of each bar indicates the degree of parts used in each category.

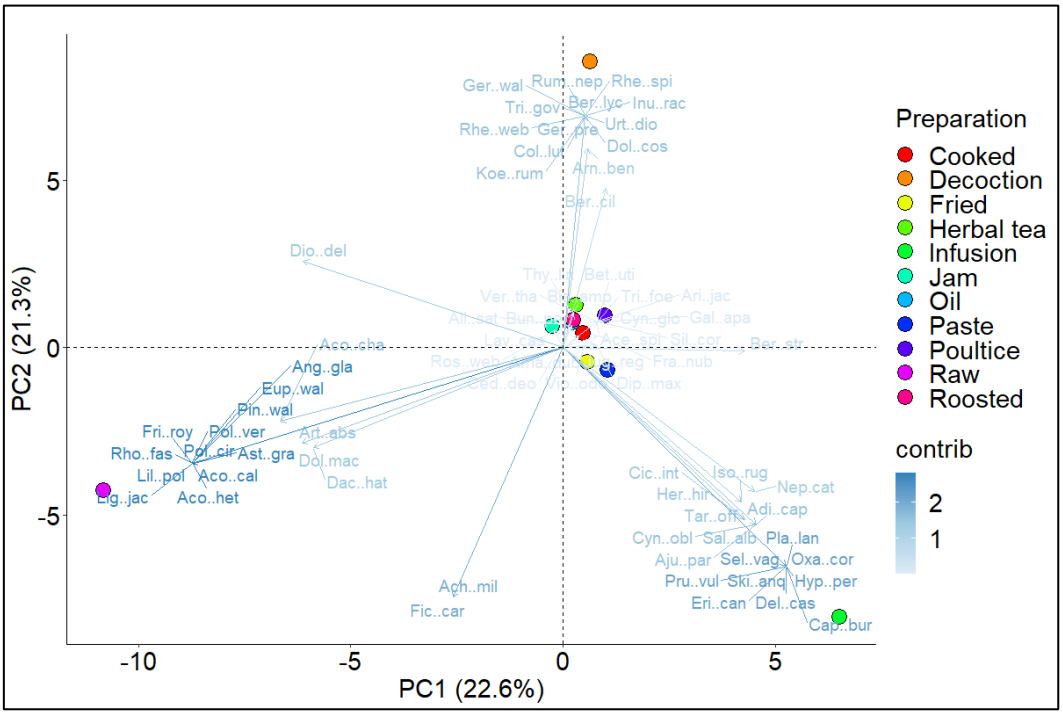


Figure 4. Different methods used for medicinal preparations.

Ailments treated

The majority of species (N-29, 21%) were used to cure gastrointestinal and hepatobiliary conditions, followed by dermatological conditions (N-26, 19%) and musculoskeletal conditions (N-23, 17%), for a total of 38 ailments (Fig. 5, Table 2). The results could be explained by the fact that gastrointestinal and hepatobiliary disorders are frequent in these regions as a result of poor sanitation, malnutrition, and a lack of clean water. Similar findings were found by researchers from Pakistan (Tariq *et al.* 2015) and Northern Nigeria (Abdul Rahman 2021), Pakistan (Wali *et al.* 2021) and Northern Himalaya (Farooq *et al.* 2019; Amjad *et al.* 2017) from distinct ethnic groups. Treatment of digestive disorders is one of the most widespread use of plants in medicine (Simsek *et al.* 2004).

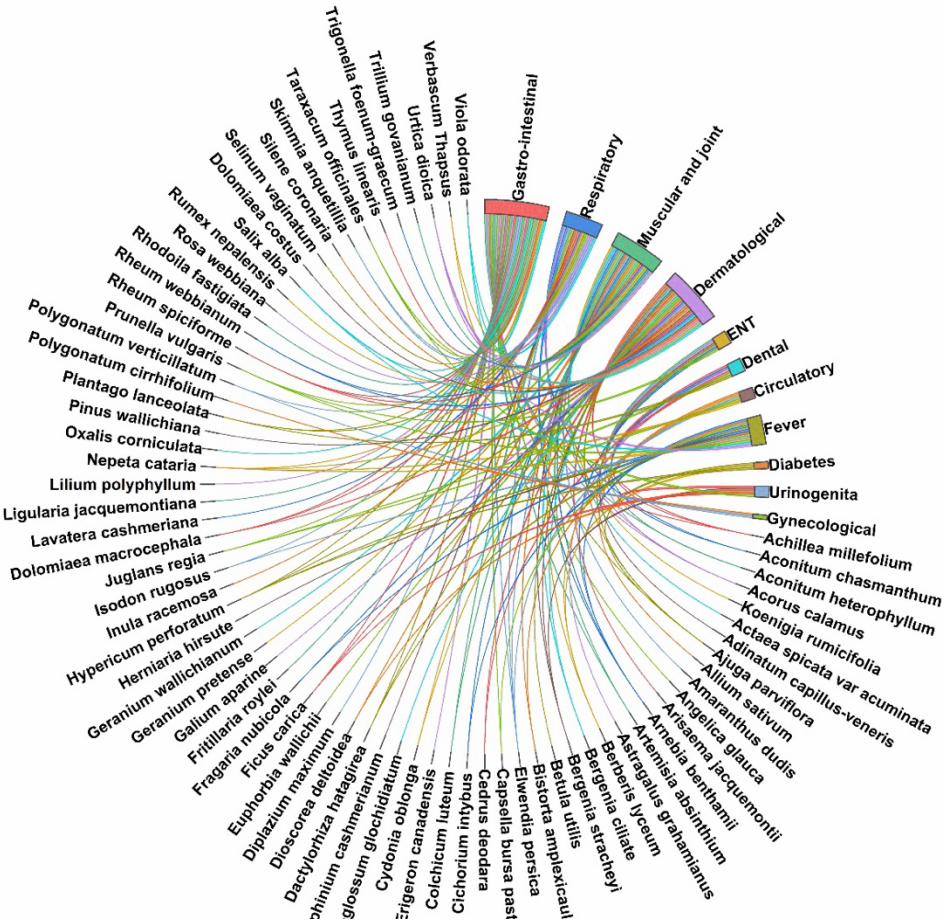


Figure 5. Distribution of plant species used in various disease categories in the region. The direction of the lines depicts which plant species is linked with which disease and thickness of each bar indicates the degree of plants used to treated disease in each category.

Traditional use categories

The majority of plants were used for medicinal purposes (N-72, 53%), followed by fodder and vegetables (N-13, 10%), herbal tea and firewood (N-10, 7%), jam and food (N-5, 4%), spice (N-4, 3%) and timber (N-3, 2%) (Table 2). This shows that the resources from medicinal plants are important in many dimensions of life for people who live in distant places, notably for of meeting their basic needs for food, housing, livelihoods, and healthcare. The area is suitable for use as a cattle rangeland, as evidenced by the second biggest use of plants in the research area: as fodder. The local population of Kashmir's burn a lot of fuelwood to heat both their homes and their animal shelters, especially during the chilly winter months. Combining extensive grazing with overharvesting of wood for medicine and fuel has resulted in open, degraded forests. Additionally, 59 plant species that are used as (Food; wild edible fruits, vegetables, salad, jam, herbal tea), fodder, fuelwood, timber and cultural uses were found during the survey; however, these species have showed a decreasing tendency in recent years due to overexploitation. Similar findings were also observed by several other studies from different Himalayan locations, including the high-altitude Trans Himalaya (Haq *et al.* 2023b), Kashmir Himalayas (Khoja et al. 2022c), and District Reasi (Haq and Singh 2020). People frequently choose to utilize traditional medicine due to its accessibility, affordability, and perceived lack of side effects, perceived lack of complexity in administration, and the increasing importance of medicinal plants frequently used in folk medicine (Kasole *et al.* 2019).

Quantitative Analysis

Use Value (UV)

The UV indices of the species observed in this study ranged from 0.20 to 0.65 (Table 2). The highest UV index was recorded for *Artemisia absinthium* (0.65), *Rheum webbianum* (0.59), *Arnebia benthamii, Pinus wallichiana*, and *Rheum spiciforme* (0.55 each), *Aconitum heterophyllum* (0.54 each), *Taraxacum* and *Rumex nepalensis* (0.52 each), while the lowest UV index was recorded for *Rhodoila fastigiata* (0.20) (Table 2). An insight of how a species is used can be gained from the use value calculation. Species with higher UV levels are usually well-known and preferred due to their reputation as natural treatments with less adverse effects (Ojha *et al.* 2020). The medicinal plants in the study area with high UV levels were generally widely known in the region (Farooq *et al.* 2019; Amjad *et al.* 2020). According to Haq *et al.* (2021) lactones and terpenoids (such as trans-thujone, terpinene, 1,4-terpeniol, myrcene, bornyl acetate, cadinene camphene, trans-sabinyl acetate, guaiazulene, chamazulene, camphor, and linalool) are the major phytochemicals reported from these species. The presence of diterpene alkaloids and flavonoids in the roots of *Aconitum heterophyllum* makes it effective in treating various gastrointestinal diseases (Wink 2015).

Relative frequency citation (RFC) and Frequency of Citation (FC)

According to the results, *Arnebia benthamii* (0.61), *Taraxacum officinale*(0.59), *Rheum webbianum* (0.54), *Artemisia absinthium* and *Cedrus deodara* (0.53 each), *Juglans regia* (0.50), and *Fritillaria roylei* (0.49), were the most cited and, therefore, best-known medicinal plants in the study area (Table 2).According to (Malik et al. 2016) terpenoids, flavonoids ,saponins, tannins, polyphenols, alkaloids, anthraquinones and cardiac glycosides are the major phytochemicals reported from *Arnebia benthamii.* The major phytochemicals present in different parts of the plants of *Taraxacum officinale* include carotenoids, flavonoids such as quercetin, chrysoeriol and luteolin-7-glucoside, phenolic acids such as caffeic acid, chlorogenic acid and chicoric acid, polysaccharides (inulin), sesquiterpene lactones (taraxinic acid, ixerin D), sterols (taraxasterol, β-sitosterol, stigmasterol) and triterpenes *(*Di Napoli, and Zucchetti 2021).

Informant Consensus Factor (ICF)

The ICF index is used to assess how well informants agree on how to treat ailments, and the diseases cure in this study was classified down into 11 categories. The ICF value ranged from 0.93 to 0.99. The disease categories with the lowest ICF were Urinogenita (0.93), followed by Gynecological disorders (0.99), Muscular and joint diseases (0.98), ENT diseases and Circulatory system diseases (0.97), Gastro-intestinal and hepatobiliary, Dental disorders and Dermatological disorders (0.96), Respiratory diseases, Fever, and Diabetes (0.95) (Table 3). IFC values were generally high for the majority of the diseases in our investigation, indicating that most informants tended to concur on the use of specific plant species. When compared to other disease categories, we regularly noticed in the study region that informants who utilized plants to treat muscular and joint and digestive diseases had the highest ICF. According to (Heinrich *et al.*1998), high values suggest the local population's high reliance on medicinal plants found in the area, while low values show a lack of consistency in the informant's knowledge. According to (Heinrich *et al.* 2009: Aadil & Andrabi 2021a) and Andrea- Cetto and Heinrich (2011), ICF values are typically impacted by the number of informants and are more important when calculated for uses reported by numerous informants.

Table 3. Informant consensus on the use of medicinal plants.

Disease categories	Number of plant taxa employed (nt)	Number of use reports (nur)	ICF
Gastro-intestinal and hepatobiliary	29	778	0.96
Respiratory diseases	17	346	0.95
Muscular and joint diseases	23	899	0.98
Dermatological disorders	26	565	0.96
ENT diseases	6	199	0.97
Dental disorders	6	127	0.96
Circulatory system diseases	5	120	0.97
Fever	13	225	0.95
Diabetes	3	39	0.95
Urinogenital disorders	5	60	0.93
Gynecological disorders	2	80	0.99

Exotic medicinal plants

Approximately (N-64, 89%) of the 72-plant species surveyed were native to Asia or the Himalayas, while (N-8, 11.11%) were introduced and partly invasive (Haq *et al.* 2023c).*Allium sativum*, *Cydonia oblonga*, *Salix alba*, and *Trigonella foenum-graecum* are only a few of the reported species that were grown in fields and gardens. Some invasive species included *Amaranthus dubius*, *Cichorium intybus*, *Erigeron canadensis*, *Taraxacum* and *Viola odorata* (Table 2). *Pinus wallichiana, Cedrus deodara*, *Ficus carica*, *Trillium govanianum*, *Ajuga parviflora, Bergenia ciliata, Rosa webbiana, Thymus linearis*, and *Juglans regia* are examples of natural species that ought to be introduced into forests.

Sustainability of medicinal plants

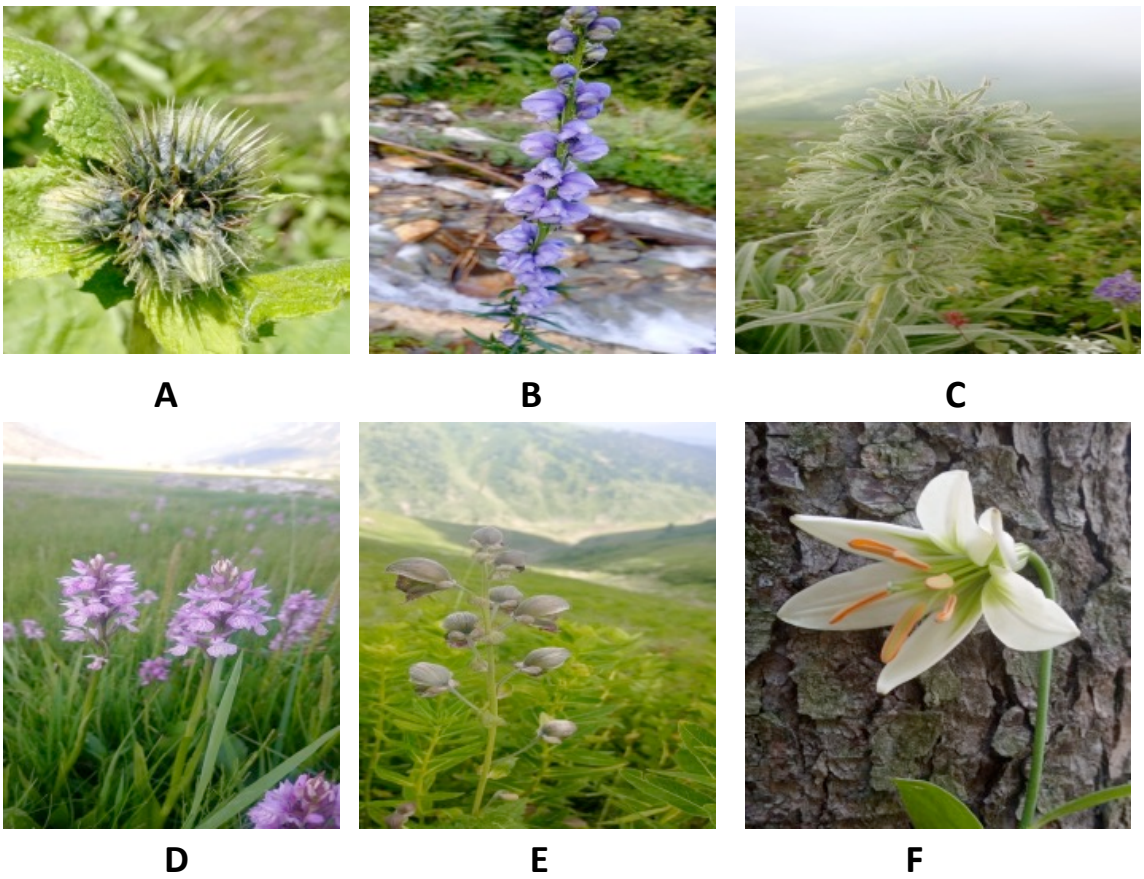
More than 83% of respondents reported that the number of wild medicinal plants were declining, while 17% reported being unaware of the trend and the remaining respondents reporting that the situation with regard to medicinal plants remained stable. The majority of the informants (44%) noted that the primary factor contributing to the decline in the natural population was unsustainable harvesting, especially premature collection to satisfy commercial demand. The second main cause of the decline in the wild population of medicinal plants was habitat destruction, particularly deforestation and habitat fragmentation. Climate change, construction of roads and improper forest management were three additional causes highlighted by the respondents. The Kashmir Himalayas are also under threat from overexploitation, an increase in harvesters, indiscriminate collecting, unchecked deforestation, and habitat damage. The availability of plants is greatly influenced by their multiple biological traits, including habitat specificity, distribution range, population size, species diversity, growth rate, and reproductive system (Wagh & Jain 2013; Chen *et al.* 2016). The overharvesting of roots, leaves, and tubers should be kept to a minimum because they are essential to the life cycle of plants. As Taylor et al. (2005) also noted, there is a need for quantitative estimation of threatened species and such species demand rapid action for conservation. Various conservation agencies categorize some of the species according to their threat levels and conservation status. A total of 14 plants were clearly threatened, for instance, *Aconitum heterophyllum* Wall. ex Royle and *Aconitum chasmanthum* Stapf ex Holmes(Ranunculaceae), *Dolomiaea macrocephala* DC. ex Royle, *Inula racemosa* Hook. f. and *Dolomiaea costus* (Falc.) Lipsch; (Asteraceae), *Arnebia benthamii* Wall. ex G.Don; (Boraginaceae)*Fritillaria roylei* Hook., and *Lilium polyphyllum* D.Don (Liliaceae),*Colchicum luteum* Baker (Colchicaceae), *Dactylorhiza hatagirea* (D.Don) Soo. (Orchidaceae) and *Dioscorea deltoidea* Wall. ex Griseb. (Dioscoreaceae)(Photoplate 1).These species are classified in the Appendix I & II category of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) as well as the Red List category of the International Union for Conservation of Nature (IUCN) (Table 4). These species require greater conservation effort than other species. The protection of medicinal plants also entails the conservation of plant biodiversity due to the vast diversity of medicinal plants (Hamilton 2004). As a result, the decisions and plans should be made appropriately.

Table 4. Medicinal plants included in International Union for Conservation of Nature (IUCN) and International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Botanical Name	**IUCN**	**CITES**
Aconitum chasmanthum Stapf ex Holmes	Critically endangered	
Aconitum heterophyllum Wall. ex Royle	Endangered	Appendix II
Angelica glauca Edgew.	Endangered	
Arnebia benthamii Wall. ex G.Don	Endangered	
Colchicum luteum Baker		Appendix II
Dactylorhiza hatagirea (D.Don) Soo	Endangered	
Dioscorea deltoidea Wall. ex Griseb.		Appendix II
Dolomiaea costus (Falc.) Lipsch.	Critically endangered	Appendix II
Dolomiaea macrocephala DC. ex Royle	Vulnerable	
Fritillaria roylei Hook.	Endangered	
Inula racemosa Hook. f.	Vulnerable	
Lilium polyphyllum D.Don	Critically endangered	
Rheum webbianum Royle	Vulnerable	
Trillium govanianum Wall. ex D.Don	Endangered	

Conclusion

According to the study's findings, locals continue to favor native plants because of their affordability and accessibility. In order to preserve the medical plants in this research area, severe grazing, indiscriminate collection and the destruction of medicinal plants should be reduced or regulated in the region, and the priceless knowledge of medicinal plants should be passed on to future generations before it is irretrievably lost. Urgent action is required to encourage the transmission of traditional knowledge. In order to maintain functioning ecosystems and the health of its inhabitants, it is necessary to reduce the factors that endanger biodiversity. Forest management strategies need to ensure that prospective threats (such as forest fragmentation and the invasion of exotic species) are dealt with before they become issues. Additionally, the majority of programs for species recovery should concentrate on regulating the regrown of native species in forests in human-modified settings.



Photoplate 1**.** Some of the plant species listed in CITES and IUCN red list: (A) *Dolomiaea costus* (Falc.) Lipsch. (B) *Aconitum chasmanthum* Stapf ex Holmes (C) *Arnebia benthamii* Wall. ex G.Don (D) *Dactylorhiza hatagirea* (D.Don) Soo. (E) *Aconitum heterophyllum* Wall. ex Royle (F) *Lilium polyphyllum* D.Don

Declarations

Abbreviations: Food and agriculture organization (FAO)**;** World health organisation (WHO)**;** International Plant Name Index (IPNI); Number of plant taxa (N)**;** International Union for Conservation of Nature (IUCN) **;** International Trade in Endangered Species of Wild Fauna and Flora (CITES)

Ethics approval and consent to participate*:* The ethical guidelines for the survey of rural and indigenous communities provided by International Society of Ethnobiology (available online: www.ethnobiology.net/whatwe-do/coreprograms/ise-ethics-program/code-of-ethics) were carefully followed. Prior to interviews, formal verbal consent (regarding data collection and publication) of each participant was taken. The PRA (Participatory rural appraisal) approach mentioned in the Kyoto Protocol (2017) was applied with the consent of the informant. In addition, formal consent from the University of Okara Ethical Review Committee was also taken (consent number UOERCC#124).

Consent for publication*:* Not applicable.

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

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Authors' contributions: A.A.K, and **S.M.H.** designed and supervised the entire study, **A.A.K.** conducted field surveys and collected data. **A.A.K., M.W., S.M.H.** and **R.W.B.** contributed in data arrangement, presentation and analysis. **A.A.K,** and **M.W** played role in statistical interpretation of data and also wrote the first draft of the manuscript along with **S.M.H.** and **M.M**. Later **M.W. and R.W.B** incorporated scientific input revised the manuscript.

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