Ethnobotanical inventory and traditional medicinal applications of the flora in Kutwal Haramosh Valley, District Gilgit, Pakistan

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Research

Abstract

Background: In the Kutwal Valley Haramosh region, traditional ethnomedical knowledge and local flora are at risk due to the rise of modern medicine and rapid land conversion. Thus, the current study aims to document and explore the cultural significance of medicinal plants, emphasizing the urgent need for conservation efforts.

Methods: We used semi-structured questionnaires to gather information from residents and interviewed farmers, shepherds, and elderly individuals who have traditional knowledge.

Results: The study identified 91 plant species across 40 families in the local area, with Asteraceae being the predominant family, represented by 13 species. Herbs constituted 76% of the species, primarily utilizing aerial parts (29 species) and roots (20 species) in medicinal preparations, often consumed directly (35 species) or through decoction (22 species). The highest use values (1), relative frequency citation (0.9), and fidelity levels (100%) were observed for *Saussurea simpsoniana*, *Tanacetum falconeri, Berberis lyceum, Pleurospermum brunonis, Euphorbia cornigera,* and *Punica granatum*, indicating their paramount significance in traditional medicine. The highest Informant Consensus Factor values (1) were recorded for the community-based syndrome, immunity, stress, gastrointestinal issues, skin conditions, temperature regulation, headaches, blood disorders, infertility, and mental health. A strong positive correlation ($r = 0.7699$, $p < 0.0001$) between use values and relative frequency citation highlights the link between perceived medicinal value and local use.

Conclusion: The study emphasizes the need for conservation efforts amidst threats such as overgrazing, deforestation, overexploitation, and habitat loss, and suggests further phytochemical research to validate medicinal properties.

Keywords: Gilgit, Kutwal Haramosh, Ethnobotany, Medicinal plants, Conservation

Background

Ethnobotany explores the interaction between plants and humans (Din *et al.* 2024, Ummara *et al.* 2013, Abbas *et al.* 2017). Understanding this relationship is crucial, as plants are a vital source of energy and nutrition, provide essential construction materials, and play a critical role in traditional medicine systems (Salim *et al.* 2019). Ethnobotanical studies are necessary for safeguarding unique traditions and preserving invaluable cultural knowledge, particularly in developing regions (Kunwar & Bussmann 2008). Traditional knowledge is crucial for disease identification and healthcare practices. Integral to conventional medicine, plant species have deeply embedded themselves in the structure of human civilization for thousands of years. Insights about medicinal plants have significantly contributed to disease management and the discovery of life-saving drugs (Rahman *et al.* 2011). This folk wisdom, developed through trial and error, has been passed down through generations verbally (Jabeen *et al.* 2015). Approximately 75% of plant-based pharmaceuticals are derived from indigenous species, underscoring the essential role of medicinal plants in supporting human health (Zareef *et al.* 2023).

About 80% of the population in the developing world relies on herbal medication (Adnan *et al.* 2014). Globally, it is estimated that 35,000 to 70,000 plant species are used in folk medicine, demonstrating the extensive reliance on natural remedies (Khadim *et al.* 2024). Pakistan is home to approximately 600 species of flowering plants known for their medicinal properties, with around 500 of these species recognized for their national and global significance, as highlighted by various studies (Khadim *et al.* 2024, Salim *et al.* 2019, Jan *et al.* 2015). This widespread utilization underscores the importance of plant-based healing across diverse cultures and its continued significance in global healthcare systems (Khadim *et al.* 2024). Remarkably, around 84% of Pakistanis relied on traditional medicine in the 1950s, with a slight decline in use since then (Goodman and Ghafoor 2011).

Gilgit-Baltistan (GB) is a diverse region of Pakistan that boasts more than 3,000 plant species, many of which are used in traditional medicine. GB is predominantly rural, characterized by its mountainous terrain, where the local population relies largely on agriculture and livestock rearing for their livelihoods. In rural areas, traditional medicine is preferred for its effectiveness, low cost, cultural influence, and limited availability of alternative treatments (Bibi *et al.* 2014).

Recently, numerous ethnobotanical studies have been conducted across different regions of Gilgit-Baltistan. Notable studies include Khadim *et al.* (2024) in Parishing Valley Astore, Din *et al.* (2024) in Upper-Haramosh, (Abbas *et al.* 2014) in Naltar Valley, (Khan *et al.* 2018) in Bagrote and Haramosh valleys, (Shedayi & Gulshan 2012) in Ghizer, (Bano *et al.* 2014) in Skardu valley, (Abbas *et al.* 2017) in Shigar valley, and (Abbas *et al.* 2016) in Tormik valley, (Abbas *et al.* 2019) in Marukh Nallah Haramosh and (Noor *et al.* 2012, 2013 and 2014) in Astore Valley. However, the Kutwal Valley remains largely unexplored. Although a few clinics and dispensaries are available in nearby villages, the study area still lacks modern infrastructure and sufficient healthcare facilities, leading locals to rely on natural resources for their daily needs. Given these conditions and the predominantly mountainous terrain, we hypothesize that residents possess unique knowledge of medicinal plants that differs from that of surrounding regions. As traditional knowledge continues to decline, documenting this information is crucial for future generations. Therefore, this study aims to explore the cultural significance of medicinal plants in the Kutwal Valley, emphasizing their role in local healthcare practices and the preservation of traditional knowledge.

Materials and Methods

Study area

Kutwal Valley Haramosh 35°53'37"N 74°53'12"E is located in the eastern part of the Gilgit area at a distance of 45km from the main Gilgit city. It comprises seven villages: Shuta, Hanuchal, Sassi-Hurban, Dasso, Barchi, Khaltaro, and Jutial. The area encompasses four distinct ecological zones: alpine, subalpine, temperate dry mountain zone, and subtropical desert region (Abbas *et al.* 2014). The diversity of habitats such as grasslands, glaciers, forests, lakes, and mountain slopes, support a rich diversity of plants in the study area. The native people mostly rely on indigenous plants to meet their needs including treating ailments, preparing remedies, and supporting daily life (Khadim *et al.* 2024, Khan & Khatoon 2007, Abbas *et al.* 2014). Mani Glacier (11km), Baska Glacier (9km), Kutwal Lake, and Haramosh Peak (7409m) are the prominent features of this area. The study area Kutwal comprises various localities including Iskere 35°56’05.74” N, 74°52’09.49” E, Gadoi 35°53’47.33” N, 74°50’50.46” E, Baska 35°5’05.74” N, 74°52’09.49” E, Dooru 35°53’24.02” N, 74°51’24.35” E, Majaharai 35°53’56.33” N, 74°51’50.74” E, Buleejet 35°53’51.09” N, 74°52’27.52” E, and Khojid 35°53’57.45” N, 74°55’10.80” E (Fig. 1). The pastures are a great source for feeding cattle, goats, and sheep in the study area.

Data Collection

Field surveys were conducted multiple times from May 2022 to August 2023. During these visits, we carefully collected plant specimens through random sampling techniques from diverse locations within the study area, covering altitudes ranging from 2500m to a maximum of 4800m. Photographic proofs were systematically taken in the field (Khan *et al.* 2015, Zehra *et al.* 2024, Karima *et al.* 2024) and later the collected specimens were appropriately pressed, dried, mounted on standard herbarium sheets, and deposited in the Herbarium Department of Plant Sciences, Karakoram International University, Gilgit. Plant species were identified and classified using scientific nomenclature and according to their physiognomic characteristics (Khadim *et al.* 2024). The identification was done at the Herbarium of Plant Sciences, located at the main campus of Karakoram International University in Gilgit, utilizing the method described by Khan and Khatoon (2008). The E flora website (www.efloras.org) was also consulted for detailed descriptions and illustrations of plant species.

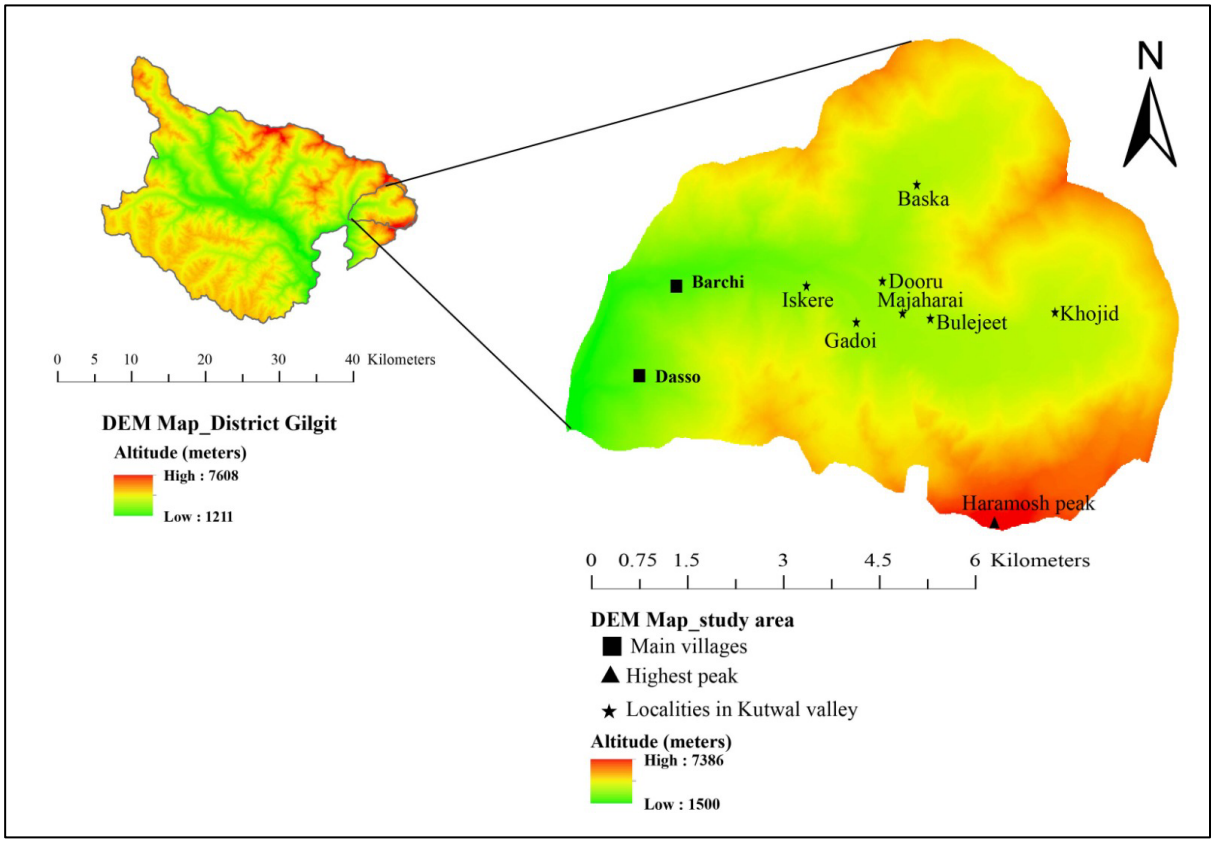


Figure 1. Map of the study area.

Ethnobotanical data collection

We gathered ethnomedicinal information using semi-structured questionnaires, surveys, interviews, and field walks, engaging with 110 locals, including 85 males and 25 females. Inclusion criteria: The informants had to be natives of the study area and were categorized by literacy level and age. Exclusion criteria included non-residents, those with insufficient literacy, and individuals outside the specified age range. These criteria ensured the data collected was relevant and representative of local traditional knowledge.

Data analysis

Quantitative data were analyzed using statistical tools to verify and measure the results. The following indices were used for ethnobotanical quantitative data.

Use value

Use values were calculated using the formula given by Shaheen *et al.* (2017) to determine the relative significance of medicinal plant species. The use values range from 0 to 1 and measure the importance of plant species in native practices. Higher values indicate greater significance, while lower values reflect lesser usage.

$$\mathbf{UV} = \frac{\mathbf{\Sigma Ui}}{\mathbf{N}}$$

Where, Ui = No. of use reports cited by each respondent, and ni = the total no. of respondents.

Pearson's correlation coefficient

Pearson's correlation coefficient was calculated using IBM SPSS Statistics 22 to assess the relationship between RFC and UV across all distinct species (Din *et al.* 2024).

Relative frequency citation

The Relative Frequency of Citation (RFC) indicates the local significance of each species. It is calculated by dividing the frequency of citation (Fc) by the total number of informants (N) involved in the survey.

The formula is

$$\mathbf{RFC} = \frac{\boldsymbol{FC}}{\boldsymbol{N}}$$

Fc denotes the number of informants who mentioned the species' use, and N is the total number of informants (Din *et al.* 2024).

Fidelity Level

It shows the percentage of informants claiming the given plant for the same major disease (Khadim *et al.* 2024). FL% was calculated using the method described by (Ch *et al.* 2013 and Ur *et al.* 2016).

$$\mathbf{FL\%} = \frac{\boldsymbol{Np}}{\boldsymbol{N}} \times \mathbf{100}$$

Where, Np = No. of respondents citing a plant species for a particular disease. And N = no. of respondents citing the plant for any disease.

Informant Consensus Factor

The Informant Consensus Factor (ICF) evaluates the reliability of ethnomedicinal information by measuring the level of agreement among informants about using plant species for various diseases. Using Heinrich's method (2000), ICF is calculated as

$$\mathbf{ICF} = \frac{(\boldsymbol{Nur} - \boldsymbol{Nt})}{\boldsymbol{Nt} - \mathbf{1}}$$

where 'Nur' is the number of use reports for each disease category and 'Nt' is the number of taxa used in that category. Values range from 0 to 1, with higher values indicating greater consensus on the use of specific species for diseases (Khadim *et al.* 2024).

Novelty index (Jaccard Index)

The novelty index, represented by the Jaccard Index (JI), was determined by contrasting recent findings with previously published studies from comparable regions. The formula used for this calculation is provided below:

$$\mathbf{JI} = \left[\frac{\boldsymbol{C}}{\boldsymbol{A} + \boldsymbol{B} - \boldsymbol{C}}\right] \times \mathbf{100}$$

In this formula, A represents the number of species in the current study area, B denotes the number of species in the published study area, and C indicates the number of species common to both areas A and B (Abbas *et al.* 2024 and Perveen *et al.* 2024).

Results

Demographic of respondents

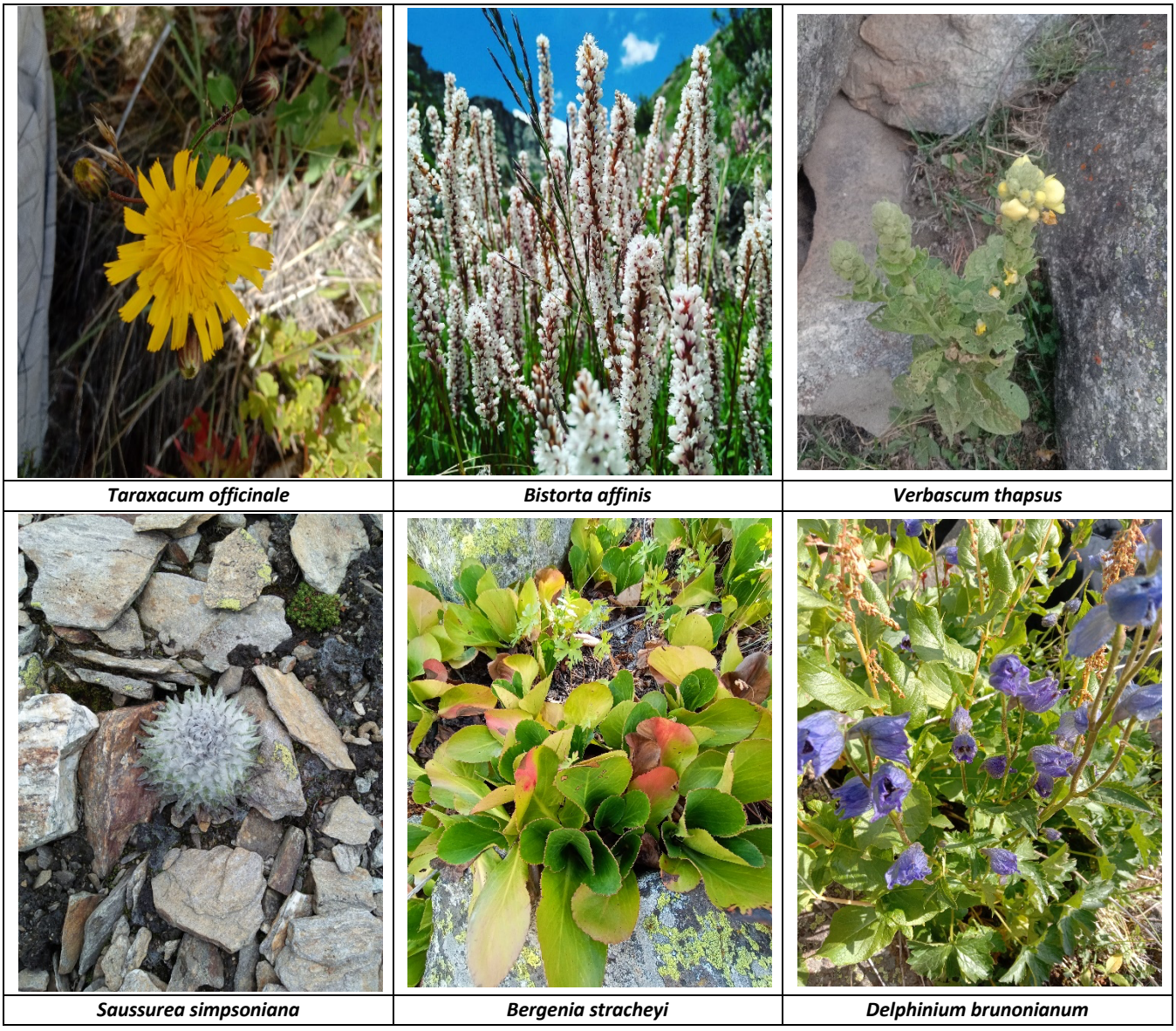
Table 1 presents the demographic distribution of the 110 informants, highlighting key variables such as gender, age, and occupation. Among the informants, 85 were male, and 25 were female. The age distribution indicated that 23% were under 40, 59% were between 41 and 60, and 18% were 60 or older. Regarding occupation, 34% were shepherds, 25% were farmers, 14% were teachers, and 27% fell into other categories like businessmen, laborers, students, and housewives.

Indigenous therapeutics applications of medicinal plants

Local people used 91 plant species from 40 families to treat various diseases. These plant species were used to treat 36 diseases and disorders. Details are listed in (Table 2). Some pictorial views of medicinal plants are depicted in (Fig. 2).

Table 1. Demographics of the informants.

Variables	Categories	No. of Individuals	%
Gender	Male	85	77
	Female	25	23
Age (years)	<40	25	23
	41-60	65	59
	60 >	20	18
Literacy Level	Teacher	15	14
	Farmer	28	25
	Shepherds	37	34
	Others	30	27



Taraxacum officinale | ***Bistorta affinis*** | ***Verbascum thapsus***

Saussurea simpsoniana | ***Bergenia stracheyi*** | ***Delphinium brunonianum***

Figure 2. Some medicinal plants in their wild habitats

Table 2. List of medicinal plants used in Kutwal Valley to treat different diseases.

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Amaryllidaceae	*Allium Carolinian DC*.	**813 -SS**	Khat-sha	Carolinian Onion	H	Aerial part	As vegetable	The aerial part of the plant is consumed as a vegetable for diarrhea and better digestion.	0.5	0.2	90%
Amaryllidaceae	*Allium cepa L*	**814 -SS**	Kashu	Common Onion	H	bulb, aerial parts	Juice extract, vegetable	The bulb is heated in ash, and then the juice is extracted and consumed for the sour throat. The shoot is cooked as a vegetable for better digestion.	0.5	0.1	95%
Amaryllidaceae	*Allium humile* Kunth	**815 -SS**	Kaa kashu	Dwarf Onion	H	Bulb	Paste, powder	The paste or powder of the bulb is used for back pain and injuries.	0.1	0.2	60%
Amaryllidaceae	*Allium victorialis* L	**816 -SS**	Toonch	Victory Onion	H	Leaves	As vegetable	The leaves are consumed as vegetables, while the extract of leaves is taken for stomachache.	0.2	0.4	70%
Anacardiaceae	*Pistacia khinjuk Stocks*	**817 -SS**	Khakao	Khinjuk Pistachio	H	Fruit	Direct	The fruit is directly consumed for asthma.	0.2	0.5	85%
Apiaceae	*Carum carvi L*	**818 -SS**	Felijzo	Caraway	H	Aerial part	Direct	The aerial part is directly consumed for good digestion.	0.1	0.1	90%
Apiaceae	*Ferula assa-foetida* L	**819 -SS**	Sup	Asafoetida	H	Root	powder form, paste	The root is taken in powder form for B.P., Back pain, tonsils, cough, and stomach. Paste is directly applied for the healing of injuries.	0.4	0.3	80%
Apiaceae	*Foeniculum vulgare Mill*	**820 -SS**	Badiyan	Fennel	H	leaves, seed	drink, decoction	The drink of leaves and decoction of seeds is used	0.3	0.4	80%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
								for stomach problems and constipation.			
Apiaceae	*Pleurospermum brunonis* Benth. ex C.B.Clarke	**821 -SS**	Mut chotal	Brunon's Pleurosper mum	H	Root	Powder, decoction	Powder or decoction of roots is used for treating constipation.	0.4	0.5	100%
Apiaceae	*Pleurospermum candollei* (DC.) Benth. ex C.B.Clarke	**822 -SS**	Posting	Candolle's Pleurosper mum	H	Root, aerial part	powder form, direct	The plant is dioecious and usually used for infertility cases. One who desires a son can consume a male plant and others who desire a daughter can consume a female plant. Either root powder or aerial part directly is used for this purpose and is also good for stomach problems.	0.4	0.2	95%
Apiaceae	*Selinum Papyraceum* C.B.Clarke	**823 -SS**	Bata shachi	Papery Selinum	H	Root	Paste, powder		0.2	0.1	70%
Apiaceae	*Trachyspermum ammi* Sprague	**824 -SS**	Shoto	Ajwain	H	Aerial part	decoction	The decoction of the aerial part is taken for cold problems.	0.3	0.2	95%
Apiaceae	*Buniyum Persicum* L	**825 -SS**	Hayaoo	Black Cumin	H	Seed	decoction	The decoction of seeds is used for pneumonia and better digestion. It is also used as a spice.	0.7	0.5	85%
Asteraceae	*Anaphelis nepalensis* (Spreng.) Lehm. & Lindenb.	**826 -SS**	Kilpush	Nepal Everlasting	H	Aerial part	decoction	The decoction of the aerial part is used for Asthma.	0.2	0.1	80%
Asteraceae	*Arctium lappa* Kalm	**827 -SS**	Chero	Greater Burdock	H	Aerial part	Paste	The paste of the aerial part is used for skin diseases.	0.2	0.3	80%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Asteraceae	*Artemisia maritima* L	**828 -SS**	Zoon	Sea Wormwood	H	Leaves	Drink	The drink of leaves is used for dysentery and fever.	0.3	0.4	70%
Asteraceae	*Artemisia santolinifolia* Turcz. ex Besser	**829 -SS**	Gabojing	Santolina-leaved Mugwort	Sh	Leaves	**Drink**	The drink of leaves is used for fever, and ascariasis and is also good for stomachache.	0.5	0.3	95%
Asteraceae	*Artemisia scoporia* Stechm.	**830 -SS**	Jaanh	Redstem Wormwood	H	Root	Drink	The drink of roots is used for colds and pneumonia.	0.2	0.3	75%
Asteraceae	*Artemisia siversiana* Ehrh. ex Willd.	**831 -SS**	Kakamoch	Siversian Wormwood	H	Aerial part	direct, drink	The Aerial part is consumed directly or freshly drunk and is taken for diarrhea, abdominal pain, B.P, and Ascariasis.	1	0.9	95%
Asteraceae	*Carthamus tinctorius* L	**832 -SS**	Poong	Safflower	H	Flower	decoction	The flower decoction is used for stomachache, pneumonia, gastric problems, and cough.	0.3	0.2	95%
Asteraceae	*Cichorium intybus* L	**833 -SS**	Ishkanache	Chicory	H	Aerial part	Drink	The drink of aerial part is used for fever.	0.3	0.2	60%
Asteraceae	*Cousainia thomsonii* Müll. Hal.	**834 -SS**	Shachar kono	Thomson's Cousinia	H	leaves, root	drink, powder form	The drink of leaves and powder of roots is used for stomachache.	0.2	0.1	85%
Asteraceae	*Sassurea simpsonania* (Fielding & Gardner) Lipsch.	**835 -SS**	Booshi fonar	Simpson's Saussurea	H	Flower	decoction	The flower decoction is taken for cough and pneumonia.	1	0.9	100%
Asteraceae	*Tanacetum falconeri* Hook.f.	**836 -SS**	Paloyo zoon	Falconer's Tansy	H	Aerial part	Drink	The-decoction of the aerial part is used for digestive purposes and Ascariasis.	0.9	0.8	100%
Asteraceae	*Taraxacum officinale* F.H.Wigg.	**837 -SS**	Dado/ Lagin	Dandelion	H	Root	decoction	The decoction of roots is used for Kidney problems.	0.2	0.1	70%
Asteraceae	*Xanthium strumarium* L	**838 -SS**	Chuno Chero	Rough Cocklebur	H	Aerial part	Paste	The paste of the aerial part is used for skin diseases.	0.2	0.3	80%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Berberidaceae	*Berberis lyceum* C.K.Schneid.	**839 -SS**	Ishkeen	Indian Barberry	H	Root	powder	The root powder is taken with milk or water directly for back pain, and internal injuries. The powder is also used for external cuts and injuries.	0.9	0.8	100%
Brassicaceae	*Lepidium sativum L*	**840 -SS**	Zaachik	Garden Cress	H	Seed	decoction	The decoction of seeds is used for abdominal pain. The seeds are placed in the eyes to remove dust and particles.	0.3	0.5	90%
Capparaceae	*Capparis spinosa* L.	**841 -SS**	Kabir	Caper Bush	H	Root, fruit	drink, as a vegetable, paste	The drink of roots is taken for knee pain and swelling. The fruit is consumed as a vegetable and the paste is applied for a skin disease (Badii).	0.3	0.1	75%
Chenopodiaceae	*Kochia prostrata* (L.) Schrad.	**842 -SS**	Ass	Prostrate Summer Cypress	Sh	Twigs	Brush	Twigs of the plant are used as toothbrushes.	0.1	0.1	75%
Cupresaceae	*Juniperus excelsa* Pursh	**843 -SS**	Chilli	Greek Juniper	T	Leaves	Fume	The fume of leaves is used for evil repulsion. The seeds are used for asthma.	0.4	0.3	95%
Eleagnaceae	*Eleagnus angustifolia L*	**844 -SS**	Gonair	Russian Olive	T	Fruit	Direct	The fruit is consumed directly for cough and cold.	0.2	0.1	90%
Eleagnaceae	*Hippophae rhamnoides* L.	**845 -SS**	Buro	Sea Buckthorn	Sh	Fruit	Direct	The fruit of the plant is consumed directly for stomach, kidney stones, and cancer.	0.3	0.2	75%
Ephedraceae	*Ephedra gerardiana* Wall. ex Stapf	**846 -SS**	Soom	Gerard's Joint-fir	Sh	Aerial part	Drink	The drink of the aerial part is used for cold. It is also	0.2	0.2	70%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
								consumed with milk for backache.			
Ephedraceae	*Ephedra intermedia* Schrenk & C.A.Mey.	**847 -SS**	Shai soom	Intermediate Joint-fir	Sh	Aerial part	Drink	The drink of the aerial part is used for cold. It is also consumed with milk for backache.	0.2	0.3	70%
Ericaceae	*Rhododendron hypenanthum* Balf.f.	**848 -SS**	Talachum	Mountain Rose	Sh	Leaves	decoction	Decoction and drink are used for respiratory diseases and pneumonia.	0.4	0.5	96%
Euphorbiaceae	*Euphorbia cornigera* Boiss.	**849 -SS**	Fotan	Horned Spurge	H	Root, leaves	Direct	The milky liquid of plant leaves is slightly consumed to treat constipation.	0.4	0.3	100%
Euphorbiaceae	*Euphorbia micractina* Boiss.	**850 -SS**	Darli noori	Tiny Spurge	H	Roots	decoction	The decoction of roots is good for Ascariasis.	0.4	0.4	95%
Fumariaceae	*Corydalis govaniana* Wall.	**851 -SS**	Ferran	Govan's Corydalis	H	Root, aerial part	decoction	The root decoction is used for hair elongation. It is also effective for fever.	0.1	0.5	80%
Gentianaceae	*Gentiana tianschanica* Rupr.	**852 -SS**	Palamas	Meadow Crane's-bill	H	Aerial part	powder	The aerial part of the plant is taken in powder form for the stomach, Ascariasis, Hepatitis, B.P, and blood purification.	0.9	0.9	95%
Geraniaceae	*Geranium pratense L*	**853 -SS**	Korat kacho	Alpine Currant	H	Aerial part, Flower	paste, drink	The aerial part of plant paste is applied to injuries. The drink of flowers is used for stomach pain.	1	0.9	98%
Grossulariaceae	*Ribes alpestre* L.	**854 -SS**	Shongloo	Himalayan Currant	Sh	Fruit, Root	direct, powder	The fruit is consumed directly for vomiting and digestive problems, while, root powder/decoction is used for back pain, injuries, and knee pain.	0.3	0.4	85%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Grossulariaceae	*Ribes himalense* Royle ex Decne.	**855 -SS**	Mehr shatoo	English Walnut	Sh	Fruit	Direct	The fruit is consumed directly for pneumonia, fever, and blood pressure. and stomach.	0.4	0.3	80%
Juglandaceae	*Juglans regia L*	**856 -SS**	Acho	Field Mint	T	Seed	direct, oil	The seeds are consumed directly for heart diseases, sore throat, and inflammatory diseases. The seed oil is used as a tonic.	0.3	0.6	80%
Lamiaceae	*Mentha arvensis* L	**857 -SS**	Podina	Horse Mint or Wild Mint	H	Aerial part	direct, drink	The plant is either consumed directly or drunk and is used for stomach, well digestion, and seasonal diseases.	0.5	0.4	85%
Lamiaceae	*Mentha longifolia* L.	**858 -SS**	Fileel	Sweet Basil	H	Aerial part	Direct	The Aerial part is consumed directly or juice is taken to improve digestion, for stomach-ache, and temperature maintenance.	0.5	0.3	85%
Lamiaceae	*Ocimum basilicum* Schumach. & Thonn.	**859 -SS**	Gasmalli	Sweet Basil	H	Seed	decoction	The decoction of seeds is used to treat Asthma.	0.2	0.5	60%
Lamiaceae	*Thymus linearis* Benth.	**860 -SS**	Tumoro	Linear Thyme	H	Aerial part	decoction	The decoction of the Aerial part is used for headaches, digestion, BP, blood cancer, and stress.	1	0.9	90%
Linaceae	*Linum usitissimum* Willd.	**861 -SS**	Homan	Flax	H	leaves, seed	Direct	The decoction of leaves and seeds is used for constipation and stomachache.	0.1	0.2	80%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Moraceae	*Ficus carica* L.	**862 -SS**	Faag	Common Fig	T	Fruit	direct, dry fruit	The fruit is freshly consumed or as dry fruit for heart diseases.	0.2	0.4	75%
Moraceae	*Morus alba* L	**863 -SS**	Shaimroch	White Mulberry	T	Fruit	direct, dry fruit	The fruit is consumed directly or as dry fruit for digestive purposes and as a tonic.	0.3	0.4	94%
Oleaceae	*Fraxinus xanthoxyloides* subsp. *excelsior*	**864 -SS**	Kasunar	Himalayan Ash	T	Bark	decoction	The decoction of the bark is used for diuretics.	0.2	0.1	65%
Papaveraceae	*Papaver nudicaule* L	**865 -SS**	Goshal	Iceland Poppy	H	Flower, Aerial part	decoction	The decoction of flowers or aerial part is used for stomach problems.	0.1	0.2	65%
Papilionaceae	*Hedysarum falconeri* Baker	**866 -SS**	Halaksoor	Falconer's Sweetvetch	H	Root	Direct	The roots are taken directly for loss of appetite and also improve digestion.	0.6	0.3	96%
Papilionaceae	*Pisum sativum* L	**867 -SS**	Khokoon	Garden Pea	H	Seed	direct, decoction	The seed is directly consumed and the decoction of seeds is used for kidney stones.	0.1	0.4	70%
Papilionaceae	*Trigonella foenum-graceum* unr. gladiata (Steven ex M.Bieb.) Asch. & Graebn.	**868 -SS**	Ishkar kooch	Fenugreek	H	Aerial part	Paste	The paste of the aerial part is used for injuries.	0.2	0.3	65%
Papilionaceae	*Vicia faba L*	**869 -SS**	Bukak	Fava Bean	H	Seeds	Direct	The seeds are consumed directly for digestive diseases, stomach, and hepatitis.	0.1	0.3	60%
Poaceae	*Hordeum vulgare* L	**870 -SS**	Yoo	Barley	H	Seeds	Flour	The flour of grains is used for bread making and is good for cancer, and the stomach.	0.1	0.1	95%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Podophyllaceae	*Podophyllum emodi* Wall. ex Hook.f. & Thomson	**871 -SS**	Ichai marooch	Himalayan Mayapple	H	Fruit	Direct	The fruit of the plant is consumed directly for the stomach, blood cancer, and also for digestive disorders.	0.5	0.3	96%
Polygonaceae	*Bistorta affinis* Greene.	**872 -SS**	Chingoi	Himalayan Bistort	H	Seeds	Direct	The seeds are consumed directly for Diarrhea, good respiration, and the stomach.	0.2	0.3	90%
Polygonaceae	*Oxyria digyna* Hill	**873 -SS**	Churkii char	Mountain Sorrel	H	Aerial part	Direct	The drink of the whole aerial part is used for fever.	0.1	0.2	80%
Polygonaceae	*Rheum emodi* Wall.	**874 -SS**	Jaro chotal	Himalayan Rhubarb	H	Aerial part	Drink	The juice of the aerial part is used for stomach, blood diseases, and back pain.	0.5	0.3	98%
Polygonaceae	*Rheum webbianum* Royle	**875 -SS**	Chotal	Webb's Rhubarb	H	Aerial part	Direct	The shoot is directly consumed for skin cancer. The head/flower of the plant is consumed directly for diarrhea.	0.8	0.6	96%
Polygonaceae	*Rumex hastatus* D.Don	**876 -SS**	Churkuii	Hastate-leaved Dock	H	Root	Decoction	The decoction of roots is used for blood cancer and abdominal pain.	0.4	0.5	80%
Polygonaceae	*Rumex nepalensis* Spreng.	**877 -SS**	Ubabal	Nepal Dock	H	Root	drink, paste	Drink of roots is made for digestion and stomach-ache. The root paste is good for a skin allergy (locally called 'Jazii').	0.2	0.5	70%
Primulaceae	*Primula denticulata Wight*	**878 -SS**	Achio lilo	Drumstick Primrose	H	Flower	Direct	The powder of flower pollen is applied directly for eye allergy.	0.3	0.4	80%
Primulaceae	*Primula macrophylla* D.Don	**879 -SS**	Achio lilo	Large-leaved Primrose	H	Flower	Direct	The powder of flower pollen is applied directly for eye allergy.	0.3	0.2	80%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Punicaceae	*Punica granatum* L.	**880 -SS**	Dano (churko)	Pomegranate	T	Fruit	Direct	The fruit is consumed directly for strong immunity and as a tonic for weakness.	0.2	0.4	100%
Pyrolaceae	*Pyrola rotundifolia* L.	**881 -SS**	Achio lilo	Round-leaved Wintergreen	H	Flower	direct, paste	Powder of the flower is used for eye problems, and paste is applied directly for Sore throat.	0.1	0.2	60%
Rannunculaceae	*Aconitum heterophyllum* Wall. ex Royle	**882 -SS**	Patrees	Atis	H	Root	direct, powder	The root is either taken directly or in powder form for constipation.	0.3	0.1	80%
Rannunculaceae	*Aconitum violaceum* Jacquem. ex Stapf	**883 -SS**	Patrees	Violet Aconite	H	Root	Powder	The powder of roots is used for constipation and typhoid.	0.2	0.1	80%
Rannunculaceae	*Actaea spicata* L	**884 -SS**	Ichai jach	Baneberry	H	Fruit	Direct	The fruit is taken directly for asthma.	0.3	0.3	50%
Rannunculaceae	*Delphinium brunonianum* Royle	**885 -SS**	Makhoti	Musk Larkspur	H	Flower	Decoction	The flower decoction is taken for cough and pneumonia.	1	0.7	98%
Rosaceae	*Alchimella ypsilotoma* Rothm.	**886 -SS**	Schillas	Notched Lady's Mantle	H	Leaves	Decoction	The decoction of leaves is used for Abdominal pain	0.1	0.2	50%
Rosaceae	*Fragaria nubicola Lindl*.	**887 -SS**	Goroose	Himalayan Wild Strawberry	H	Fruit	Direct	The fruit is consumed directly for blood purification and as a powerful tonic.	0.2	0.1	85%
Rosaceae	*Prunus amygdalus* Stokes	**888 -SS**	Badam	Almond	T	Seed	Direct. Dry fruit	The seed is consumed as a dry fruit for a healthy body. It is believed that the seed can boost the function of our Brain.	0.4	0.6	95%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Rosaceae	*Prunus armeniaca* Chevall.	**889 -SS**	Juee	Apricot	T	Seed, fruit	direct, seed oil	The seeds are either consumed directly or seed oil is used as a tonic. The dry fruit is used for cough and better respiration at high altitudes.	0.5	0.4	95%
Rosaceae	*Prunus jacquemonti* (M.R.Hend.) Whitmore	**890 -SS**	Tonal	Jacquemont 's Cherry	Sh	Fruit	Direct	The fruit is directly and freshly consumed for diarrhea.	0.3	0.4	84%
Rosaceae	*Rosa webbiana* Wall. ex Royle	**891 -SS**	Shingai	Webb's Rose	Sh	Fruit, Bark	direct, decoction	The fruit is consumed directly for digestive purposes, while the bark decoction is used for making herbal tea.	0.2	0.5	75%
Rosaceae	*Rubus irritans* Focke	**892 -SS**	Ichajaah	Irritant Bramble	Sh	Fruit	Direct	The fruit is directly consumed for B.P.	0.3	0.2	85%
Salicaceae	*Salix alba* L	**893 -SS**	Braow	White Willow	T	Leaves	Drink	The drink of leaves is taken for fever and abdominal pain.	0.1	0.1	78%
Saxifragaceae	*Bergenia stracheyi* (Hook.f. & Thomson) Engl.	**894 -SS**	Sapsar	Strachey's Bergenia	H	Root	Powder	Powder of the roots is taken directly or with milk for Back pain. While it’s directly applied on injuries.	0.8	0.7	96%
Saxifragaceae	*Saxifraga stenophylla* Royle	**895 -SS**	Kaveli char	Narrow-leaved Saxifrage	H	Aerial part	Powder	The powder of the aerial part is used for hair elongation.	0.2	0.1	75%
Scrophulariaceae	*Verbascum thapsus* L	**896 -SS**	Masigood	Great Mullein	H	Aerial part, Leaves	decoction, paste	The paste of the aerial part is used for blood clotting, while the decoction of leaves is used for fever and asthma.	0.3	0.4	75%

Family Name	Botanical name	Voucher Number	Local name	English Name	Habitat	Part used	Usage Method	Medicinal uses	UV	RFC	FL%
Solanaceae	*Nicotiana tabacum* L	**897 -SS**	Tamako	Tobacco	H	Leaves	direct, paste	Leaves are either applied directly or paste is applied on the abdomen for Ascariasis.	0.1	0.4	70%
Solanaceae	*Physcoclaina praealta* Lodd. ex Sweet	**898 -SS**	Phaphang	High Ground Cherry	H	Aerial part	Fume	The fume of the aerial part is used to remove teeth worms.	0.2	0.4	90%
Solanaceae	*Solanum nigrum* Tausch ex Dunal	**899 -SS**	Gabilii (kini)	Black Nightshade	H	Fruit	Direct	The fruit is directly consumed for diuretic and Typhoid.	0.2	0.2	65%
Urticaceae	*Urtica dioca* subsp.*chamaedryoides*	**900 -SS**	Jami	Small Nettle	H	Aerial part, Roots	as vegetable, paste	The whole aerial part is consumed as a vegetable for good digestion. The root paste is applied to injuries.	0.9	0.8	90%
Vitaceae	*Vitis vinifera* L	**901 -SS**	Jach	Grape Vine	T	Fruit	Direct	The fruit is directly taken for blood filtration, as a tonic, and for dyspepsia.	0.3	0.4	85%
Zygophyllaceae	*Peganum harmala* L	**902 -SS**	Ispandur	Syrian Rue	H	Aerial part	Fume	The fume of the aerial part is used for evil repulsion and is considered disease-resistant.	0.6	0.5	95%
Zygophyllaceae	*Tribulus teriestris* var. terrestris	**903 -SS**	Sheaoo kono	Puncture Vine or Caltrop	H	Fruit	Drink	The fruit drink is used as a diuretic.	0.1	0.2	70%

Where, H = Herb, Sh = Shrub, T = Tree, UV = Use values, RFC Relative frequency citation, FL% = Fidelity level %

Plant habits and dominant families used in medication

Out of the 91 medicinal plants used in the study area, herbs were dominant 69 (76 %), followed by shrubs 11 (12%), and trees 11 (12%) as in (Fig. 3). Asteraceae was the most dominant family contributing 13 species, followed by Apiaceae 7, Rosaceae 7, Polygonaceae 6, and Papilionaceae 4 species. Details are shown in (Fig. 4).

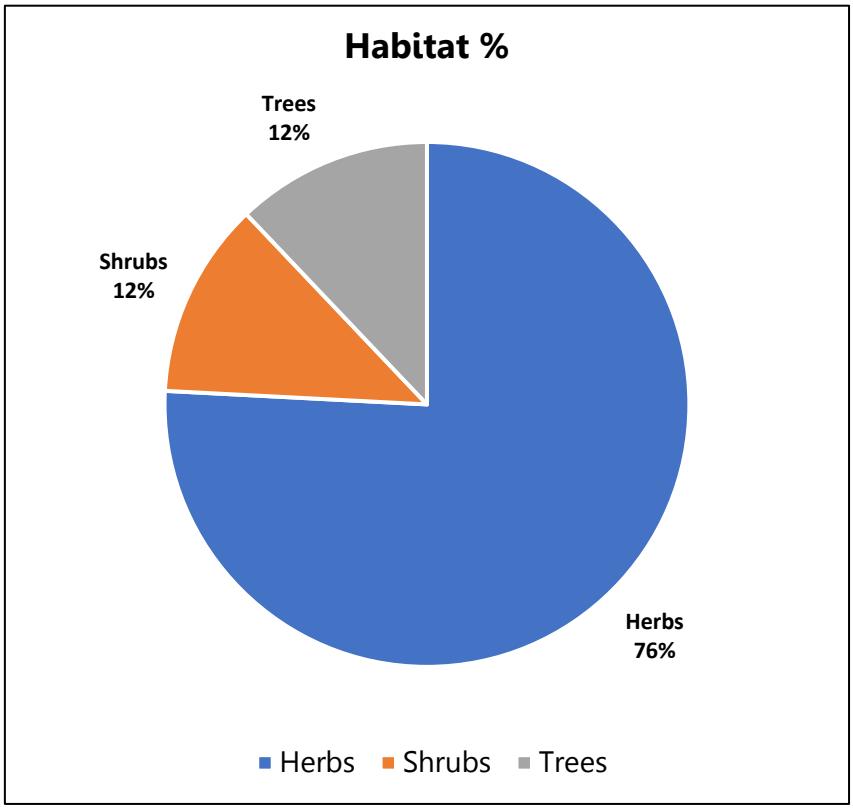


Figure 3. Shows habitat percentages of recorded plant species from the study area.

Plant parts and usage method

Different parts of plants were used in medicine preparations, mostly aerial parts were utilized with a frequency of (29), followed by roots of 20 species, fruits had 18 species, while the other parts of the plants were also used for treating different diseases depicted in (Fig. 5). The dominant usage method was direct consumption in 35 species, decoction form 22, drink 15, and paste 13, rest of the methods are depicted in (

).

Use values

Our results indicated that *Sassurea simpsonania, Geranium pratense, Artemisia siversiana, Thymus linearis, Delphinium brunonianum,* and *Gentiana tianschanica* exhibited the highest use value (1) indicating the frequent usage of these species by local people (Table 2).

Relative Frequency citation

Plants with higher RFC were commonly used by locals and nomads for various ailments, highlighting their importance in community health practices. The results revealed that *Sassurea simpsonania, Geranium pratense, Artemisia siversiana, Thymus linearis,* and *Delphinium brunonianum* showed higher RFC values (0.9), the most commonly cited plant species (Table 2).

Pearson's correlation coefficient

Pearson's correlation coefficient was calculated to determine the relationship between RFC and UV across all distinct species. The analysis revealed a positive correlation, indicating that species cited more frequently by informants generally have higher use values, and vice versa. A strong correlation coefficient (r = 0.7699*) with a significant *p*-value (< 0.05, $p < 0.0001$) was observed (Table 3).

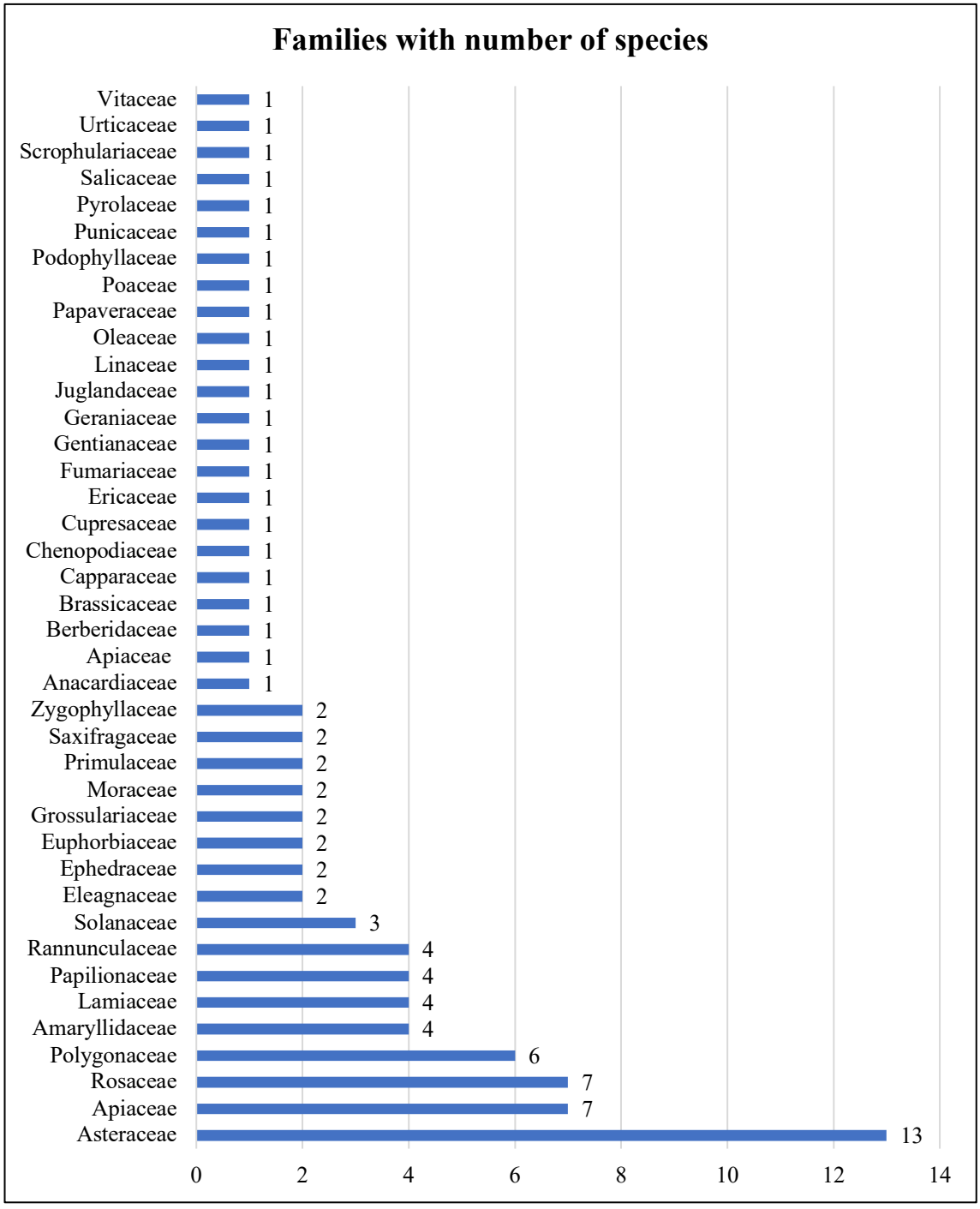


Figure 4. Families used in medical practice in the study area

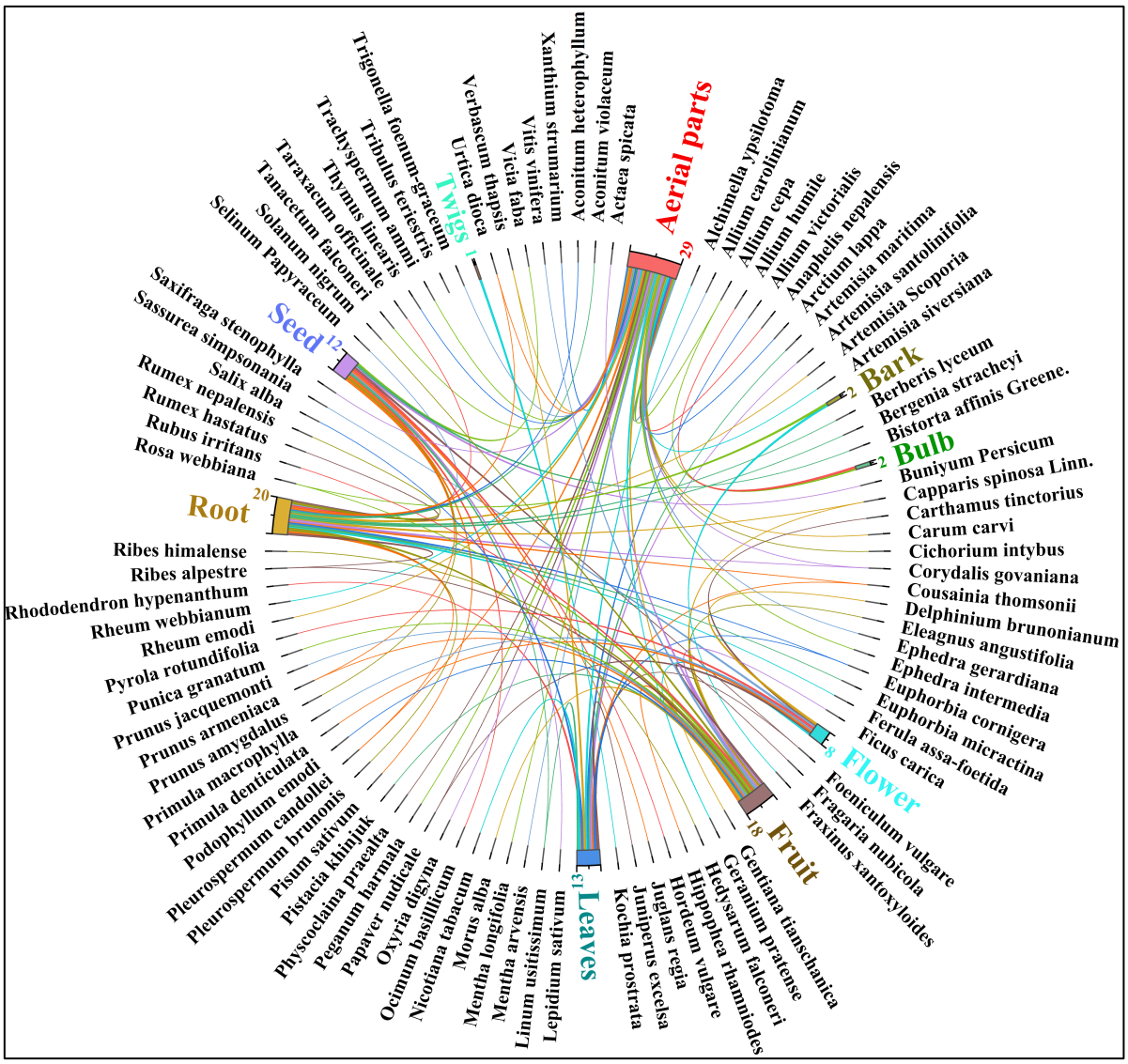


Figure 5. Different parts of plants were used to treat the different diseases.

Fidelity level

Table 2 shows the effectiveness of cited plant species in treating specific ailments, with FL ranging from 50% to 100%. The highest frequency of use (100%) was observed for *Sassurea simpsoniana, Tanacetum falconeri, Berberis lyceum, Pleurospermum brunonis, Euphorbia cornigera,* and *Punica granatum*, highlighting their significance and effectiveness for certain diseases.

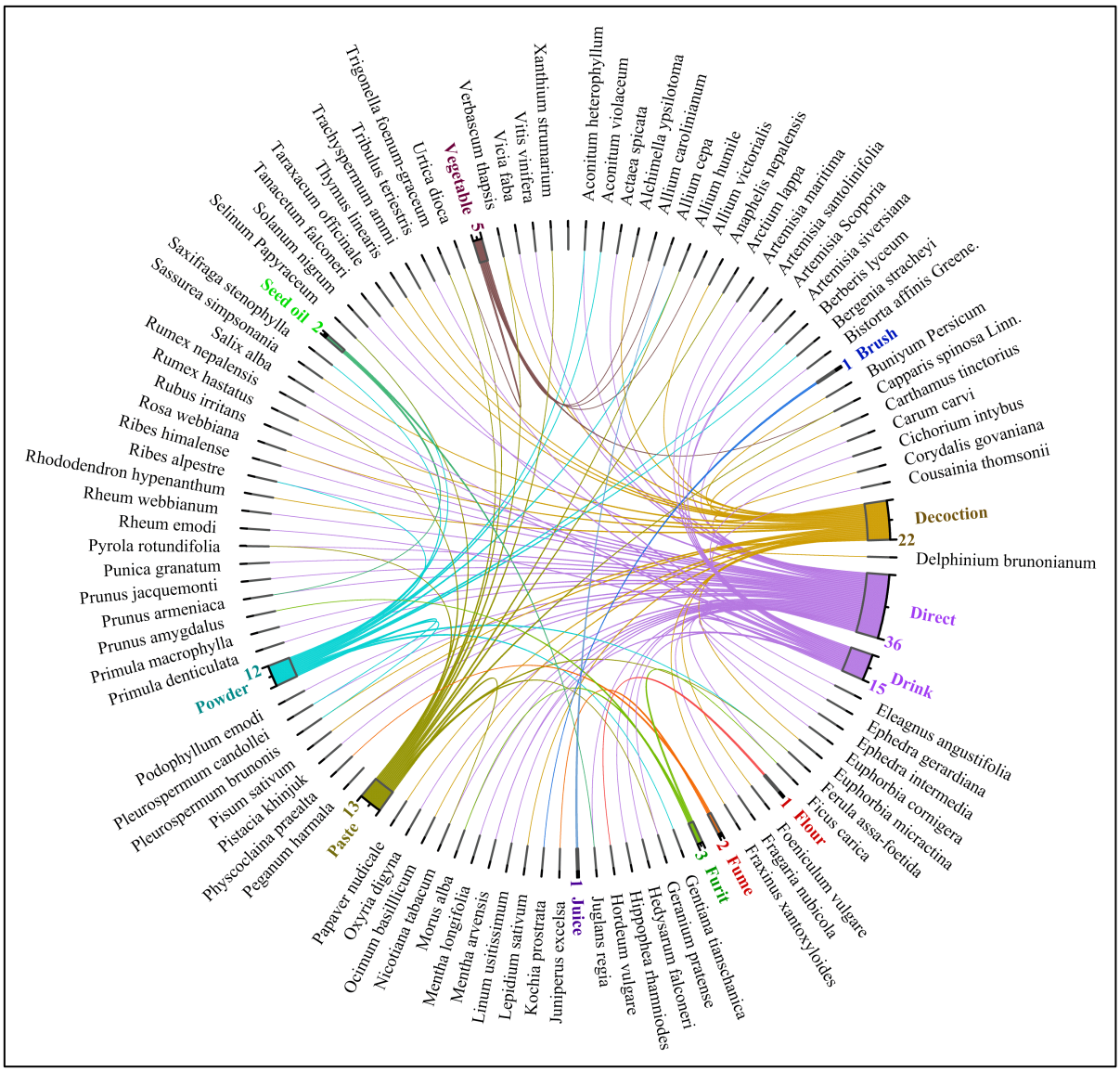


Figure 6. Usage method of medicinal plant species in the study area.

Table 3. A descriptive analysis of Pearson's correlation coefficient for UV and RFC.

Pearson Correlations			
		UV	RFC
UV	Pearson Corr.	1	0.7699
RFC	Pearson Corr.	0.7699	1
	p-value	<0.0001	

Informant consensus factor

To evaluate the consensus among informants regarding the selection of plant species for various ailments, the study calculated the ICF, revealing a significant range from 0 to 1. Across the study area, 91 plants were utilized to treat 36 different types of diseases (Table 4). The highest ICF values (1) were notably found for community-based syndrome, immunity, stress, vomiting, skin cancer, Stomach problems, tonsillitis, temperature maintenance, headache, blood clotting, infertility cases, brain health and memory, and respiratory problems. Specifically, 39 species were identified for treating stomach problems.

Table 4. Informant consensus factor for different disease categories

Disease Category	Nur	Nt	Nur-Nt	Nur-1	ICF= (Nur-Nt)/(Nur-1)
community-based syndrome	16	3	13	15	1
Immunity	64	8	56	63	1

Stress	8	1	7	7	1
Vomiting	5	1	4	4	1
Skin cancer	2	1	1	1	1
Stomach problems	209	39	170	208	1
Tonsilitis	11	1	10	10	1
Temp. maintenance	3	1	2	2	1
Headache	13	1	12	12	1
Blood clotting	3	1	2	2	1
Infertility cases	3	1	2	2	1
Brain health and memory	3	1	2	2	1
Respiratory problems	204	25	179	203	1
Urine problems	36	3	33	35	0.9
Inflammation	13	2	11	12	0.9
Heart problems	11	2	9	10	0.9
Fever	56	8	48	55	0.9
Cold	32	5	27	31	0.9
Blood purification	21	4	17	20	0.9
Teeth problems	13	3	10	12	0.8
Knee pain	7	2	5	6	0.8
Kidney stone	17	4	13	16	0.8
Skin diseases	22	5	17	21	0.8
Typhoid	5	2	3	4	0.8
Hair disorder	5	2	3	4	0.8
Abdominal pain	15	5	10	14	0.7
Constipation	18	6	12	17	0.7
Back pain	23	8	15	22	0.7
Eye problems	9	4	5	8	0.6
Diarrhea	13	6	7	12	0.6
Injuries	16	9	7	15	0.5
Blood cancer	4	3	1	3	0.3
Blood pressure	8	6	2	7	0.3
Cancer	8	6	2	7	0.3
Ascariasis	7	6	1	6	0.2
Hepatitis	2	2	0	1	0.0

Legends: Nur Number of use reports, Nt number of taxa, ICF informant consensus factor

Novelty index (Jaccard Index)

To identify new contributions, the results of this study were compared with existing ethnobotanical literature. The Jaccard Index (JI) was employed to calculate the similarity index. This research documented 91 medicinal plant species, cross-referenced with four published studies from neighboring regions of Gilgit-Baltistan, having similar climatic and geographic conditions. The areas include Astore Parishing Valley, Haramosh and Bagrote Valley, Haramosh Valley, and Maruk Nallah. The highest similarity was observed in Haramosh and Bagrote Valley, with a Jaccard Index of 48.81% depicted in (Table 5).

Table 5. Jaccard index (Novelty index) of the medicinal flora.

Areas	**NRSAA**	**TSCBA**	**SEOOA**	**JI**	**Citation**
Astore Parishing Valley	90	27	91	17.53	(Khadim et al. 2024)
Haramosh and Bagrote Valley	98	62	91	48.81	Khan and Khatoo, 2008
Haramosh Valley	20	19	91	20.65	(Khan and Khatoo, 2004)
Maruk Nallah	65	45	91	40.54	(Abbas et al. 2019)

NRSAA: Number of Recorded Species in the Aligned Areas, TSCBA: Total Species Common in Both Areas, SEOOA: Species Enlisted Only in Our Study Area, JI Jaccard index

Discussion

The Kutwal Haramosh Valley harbors a wealth of ethnomedicinal knowledge, orally transmitted through generations, showcasing the community's dependence on native plants for healthcare. However, this tradition, deeply connected to the valley's rich biodiversity, faces threats from migration, land conversion, and modern healthcare influences, highlighting the need for its preservation. From the study area, 91 plant species were documented, which are used, for treating various diseases. The study was somehow in agreement with (Khadim *et al.* 2024, Khan *et al.* 2016, and Ali *et al.* 2016) as the results of the studies revealed that herbs were dominant, while the Asteraceae family was the most prevalent, with Hemicryptophytes being the dominant life form. This similarity could be attributed to identical topographic conditions, elevation gradients, and climatic factors in both of the study areas but our research does not align with the life form of the Sheik Malton Town district Mardan conducted by Khan *et al.* (2013). The dominance of therophytes over hemicryptophytes is likely driven by shorter growing seasons, severe winter conditions, and increased environmental stress at higher elevations. Reduced soil moisture and intensified solar radiation in exposed, rocky terrains further favor therophyte adaptation in their research area. The unique topography, soil composition, altitude, and microclimatic variations in our research area create favorable conditions that sustain hemicryptophytic species; in contrast, these factors differ from those in other regions. The different floristic composition, influenced by these environmental factors and more moderate seasonal extremes, allows hemicryptophytes to thrive in areas where therophytes might otherwise dominate.

About 80% of the population of the developing world relies on herbal medication (Khadim *et al.* 2024, Adnan *et al.* 2014, Senkoro *et al.* 2020). Kutwal Haramosh has rich traditions, the documented plant species were used to treat different diseases like stomach problems, respiratory diseases, skin diseases, eye problems, cancer, and other serious diseases. Hong *et al.* (2015) conducted an ethnobotanical survey in Maonan Valley China and documented 368 plants for various diseases. Similarly, Abbas *et al.* (2014), and Khan & Khatoon (2007), (2008) conducted ethnobotanical studies and documented 83, 48, and 98 plant species respectively with almost similar medicinal uses.

For reliability and gauge, we employed UV to measure the importance of plants in Indigenous practices on a scale from 0 to 1. Higher UV values indicate greater significance, while lower values reflect lesser importance. The UV highlights the importance of plant species based on their frequent use by the community. Our results showed that *Sassurea simpsonania*, *Geranium pratense, Artemisia siversiana, Thymus linearis*, *Delphinium brunonianum*, and Gentiana tianschanica hold the highest UV (1), reflecting their critical role in local ethnobotany. Comparing these values with studies like Hong *et al.* (2015) and Khan & Khatoon (2008) underscores their significant cultural and medicinal relevance in the Kutwal Haramosh Valley. This high UV further emphasizes their central role in traditional healthcare and their potential for broader pharmacological research.

The RFC is used to quantify how frequently a plant species is cited by informants, offering insight into its cultural importance and perceived efficacy in traditional medicine. It helps researchers identify key plants that are central to local healthcare practices. In our study, *Sassurea simpsonania, Geranium pratense, Artemisia sieversiana, Thymus linearis,* and *Delphinium brunonianum* exhibited high RFC values of 0.9, indicating their widespread recognition and trusted use for treating ailments. Comparisons with similar ethnobotanical regions, such as those studied by Abbas *et al.* (2014) and Khan & Khatoon (2008), would provide a more comprehensive understanding of the importance placed on these species. This underscores the importance of these plants in local health traditions and suggests the need for further research into their pharmacological potential.

Our study identified *Sassurea simpsonania, Tanacetum falconeri, Berberis lyceum, Pleurospermum brunonis, Euphorbia cornigera,* and *Punica granatum* as the most significant species in terms of usage and fidelity. These plants are globally recognized for their therapeutic benefits, backed by solid scientific evidence. The high-fidelity levels indicate that these species are frequently cited within local communities, making them trusted and preferred treatments for specific ailments. This traditional knowledge underscores the importance of these species for conservation and developing effective herbal remedies. Integrating this wisdom with modern science is crucial to preserving these valuable species and fully harnessing their medicinal potential (Hussain *et al.* 2019, Awan *et al.* 2023, Khadim *et al.* 2024). Certain species were commonly used in the study area to treat diseases, although all species have therapeutic value. Literature further supports the high value of these particular species (Abbas *et al.* 2014, Khan & Khatoon 2008, Abbas *et al.* 2019).

Pearson's correlation coefficient revealed a strong positive relationship (r = 0.7699) between RFC and UV, with a highly significant *p*-value ($p < 0.0001$). It demonstrated that high RFC values are associated with high UV values across all plant species. This strong correlation demonstrates that species frequently cited by informants were considered more valuable in

traditional practices. The statistical significance of this result emphasizes the reliability of the association, confirming that plants with higher use values played a pivotal role in local ethnobotanical knowledge and cultural traditions. Due to the strength of this relationship, it is essential to prioritize these species in conservation strategies, as they contribute to biodiversity and are integral to cultural heritage. Moreover, understanding these key species can improve sustainable resource management, helping preserve culturally and ecologically important plants for future generations. The importance of this correlation lies in its ability to guide targeted conservation efforts, protecting species that are both ecologically vital and culturally irreplaceable (Bano *et al.* 2014). More or less similar results have been observed in studies conducted worldwide (Amjad *et al.* 2017).

The ICF was calculated to assess agreement among informants on plant use for various ailments (Khadim *et al.* 2024), with the highest ICF value of 1 recorded for the disease categories like community-based syndromes, immunity, stress, vomiting, skin cancer, stomach problems, tonsillitis, headaches, and respiratory issues. This unanimous consensus highlights the deep trust in traditional medicinal plants for addressing key health concerns in the region. Stomach problems had the highest number of use reports (209) with 39 taxa used for the treatment, followed by respiratory issues with 204 reports and 25 taxa. The prevalence of these ailments may be linked to local dietary habits and environmental factors, such as the cold, dry climate. These high ICF values underline the community's strong reliance on ethnomedicine, emphasizing the need to preserve and explore the pharmacological potential of these traditional remedies. The results are aligned with the studies like Khadim *et al.* (2024) and Abbas *et al.* (2024).

The data reveals varying levels of species overlap between the current study and previous research, as measured by the Jaccard Index (JI). The highest similarity is observed in Haramosh and Bagrote Valley, with a JI of 48.81%, suggesting that nearly half of the species are shared between the current study (98 species) and the previous one (62 species) (Khan and Khatoo, 2008). This indicates relatively stable vegetation and consistent environmental factors over time. Maruk Nallah shows moderate overlap with a JI of 40.54% (Abbas *et al.* 2019), while Haramosh Valley exhibits lower similarity at 20.65%, despite similar species counts, suggesting possible ecological changes or species turnover (Khan and Khatoo, 2004). The lowest JI, 17%, is recorded for Astore Parishing Valley, indicating significant changes in species composition, potentially due to new species colonization or environmental shifts (Khadim *et al.* 2024). These findings highlight the varying degrees of biodiversity stability across the valleys and underscore the importance of ongoing monitoring to track changes in species diversity and ecological dynamics. Understanding these patterns is crucial for conservation efforts, ecosystem management, and ensuring the sustainability of biodiversity in the region.

As our planet faces an unprecedented loss of biodiversity, conserving plant diversity is especially important (Jan *et al.* 2014). Overgrazing, deforestation, and habitat loss from human activities significantly impact local flora, affecting ethnobotanical knowledge and traditional practices in Kutwal Valley as seen in many other regions. Overgrazing reduces vegetation, limits plant diversity, and disrupts ecological balance, while deforestation from logging and land conversion destroys critical habitats, leading to a decline in biodiversity. Habitat loss from agricultural expansion and urban development further fragments plant habitats, impacting their ability to thrive. These changes significantly affect local flora, eroding ethnobotanical knowledge and traditional practices as medicinal and culturally significant plants become scarcer (Arshad Ali Shedayi 2012, Arshad *et al.* 2014). To address these challenges, it is essential to adopt sustainable land management practices, such as controlled grazing, reforestation, and habitat conservation while integrating traditional knowledge with modern conservation strategies to preserve plant diversity and cultural heritage (Kunwar & Bussmann 2008).
Conclusion

Conclusion

This research illuminates the profound depth of ethnomedicinal knowledge influenced by local communities in the Kutwal Valley Haramosh region, highlighting their intricate understanding of plant-based medicinal applications. Although this invaluable knowledge has been passed down verbally through generations, it remains inadequately documented. The study systematically records and analyzes traditional practices, offering detailed insights into the medicinal use of 91 plant species, with a notable emphasis on the Asteraceae family and key species such as *Saussurea simpsoniana* and *Tanacetum falconeri*. These species are crucial in traditional medicine for addressing various ailments, as reflected by their high UV, RFC, and FL values, and strong ICF. The high prevalence of stomach and respiratory problems in the study area is largely due to the region's harsh climatic conditions, such as cold temperatures and high altitude, which intensify gastrointestinal and respiratory issues. These same environmental factors also influence the region's biodiversity, as in the Jaccard Index (JI). The JI calculated shows that species overlap varies across valleys, with the highest JI observed in Haramosh and Bagrote Valley

(48.81%) and the lowest in Astore Parishing Valley (17%). These findings are essential for informing conservation strategies and efforts to maintain ecosystem resilience in this challenging environment. Additionally, the traditional diet and lifestyle factors contribute to these health problems. As modern pharmaceuticals and rapid land conversion pose significant threats to this rich heritage, the research underscores the urgent need for rigorous investigations into the medicinal properties of these plants and the development of robust conservation strategies. This study is a crucial step in documenting and preserving traditional knowledge and serves as a call to action for continued research and conservation efforts to protect these invaluable natural resources for future generations.

The study recommends

Further research should urgently address the impact of climate change on plant biodiversity and develop comprehensive conservation strategies to mitigate biodiversity loss and prevent mass extinction. Implementing both ex-situ and in-situ conservation measures for local flora is critical, alongside evaluating the effects of land use and land cover changes on biodiversity. Additionally, to scientifically validate and enhance indigenous ethnomedicinal knowledge, it is imperative to conduct rigorous phytochemical studies and pre-clinical trials. These measures will preserve traditional medicinal practices and their efficacy while protecting plant diversity in the face of changing environmental and anthropogenic pressures.

Declarations

List of abbreviations: SPSS = Statistical Package for the Social Sciences, r = Pearson correlation coefficient, UV = use value; RFC = relative frequency citation, FL = fidelity level, Nur = number of use reports, Nt = Number of taxa, ICF = informant consensus factor, H = Herb, Sh = Shrub, T = Tree. NRSAA: Number of Recorded Species in the Aligned Areas, TSCBA: Total Species Common in Both Areas, SEOOA: Species Enlisted Only in Our Study Area, JI Jaccard index

Ethics approval and consent to participate: All interviewees gave their personal prior informed consent. The study complies with the Nagoya Protocol under the Convention on Biological Diversity, ensuring fair and equitable benefit-sharing.

Consent for publication: Not applicable

Availability of data and materials: Not applicable

Competing interests: The authors declare that there is no conflict of interest

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Author contributions: SBD is the first author to conduct all research parts, QA, design the research SK, data analysis, and develop the manuscript till approval of the final draft. TZ and MAI assisted in modifying the manuscript. SBD, SK, PA, and HA scheduling field surveys, specimen collection, identification, and collecting ethnomedicinal information.

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