Ethnobotanical applications of medicinal plants in the alpine flora of Marukh and Asogaha Nallah, Haramosh Valley, District Gilgit, Pakistan

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Ethnobotany Research and Applications 27:45 (2024) - http://dx.doi.org/10.32859/era.27.45.1-24
Manuscript received: 20/06/2024 - Revised manuscript received: 10/10/2024 - Published: 10/10/2024

Research

Abstract

Background: This study, conducted from 2022 to 2024, explores the floristic diversity and ethno-medicinal significance of Haramosh Valley in the Karakoram Range. The region, renowned for its rich landscapes and traditional knowledge, confronts threats like deforestation. The primary objective is to document and conserve unique plant species and indigenous medicinal practices.

Method: Field studies encompassed plant specimen collection, herbarium mounting, and identification. Ethno-botanical data was obtained through interviews with 130 locals, including herbalists, housewives, and elders, using semi-structured questionnaires. Statistical indices such as Relative Frequency Citation (RFC), Use Value (UV), Fidelity Level (FL), and Informant Consensus Factor (ICF) were employed for data analysis. Scientific databases provided additional information.

Results: The results revealed that (65) alpine medicinal plant species in the Haramosh Valley were used to treat different illnesses. These species were organized into (51) genera and (32) families. The Asteraceae family became the most common, with (12) species and (9) genera. These plants were utilized as folk medicine in the study area and fell into the habit group. Perennial herbs are dominated by (42) species, followed by shrubs with (13) species, annual herbs with (5) species, and biennial herbs and trees with a single species each. The study offered some fascinating conclusions from the use of two quantitative data sets, UV and RFC, to investigate ethnomedical usage. Among the plant species examined, the ones with the highest RFC at (0.92) were *Pleurospermum candollei*, *Swertia cordata*, *Bergenia stracheyi*, *Mentha arvensis*, *Primula denticulata*, and *Primula macrophylla*, all of which had a (100%) FL, indicating their importance and frequency in the area.

Conclusion: This study enhances our understanding of the intricate relationship between the people of the Haramosh Valley and plant biodiversity. It emphasizes the ecological significance of the area and advocates for conservation efforts amid increasing environmental threats. Documented ethno-medicinal knowledge provides insights into local communities' traditional healing practices, underscoring the urgency of preserving both the ecological and cultural heritage of Haramosh Valley. Sustainable practices are crucial for the well-being of the local population and the unique biodiversity of the region.

Keywords: Ethno-botanical Significance, Medicinal Plant Species, Fidelity Level (FL), Informant Consensus Factor (IFC)

Background

The study of the direct relationship between plants and humans is a sub-disciplinary science, which is known as ethnobotany (Toneu 2017). Ethnobotany is essentially a study that explores the intricate connection between humans and plants (Hussain 2024). Between 35,000 and 70,000 plant species are employed in traditional folk medicine across the globe, underscoring the widespread dependence on natural remedies. This underscores the significant global role of plant-based healing within diverse cultural traditions (Khadim *et al.* 2024a). Over many years, people worldwide have engaged with their local plant life, gaining knowledge through repeated interactions, and understanding how to utilize plants for medicinal purposes (Prance 1991). Certain plants are utilized for medicine in their entirety, while others employ specific parts like leaves, seeds, and roots. Indigenous wisdom has delved into the medicinal use of plants, leveraging their diverse properties to treat various ailments (Eldeen *et al.* 2016).

Medicinal plants hold a crucial place in African communities, deeply rooted in their culture and traditions. Due to their perceived efficacy, accessibility, and affordability, rural African populations continue to depend on these plants for healthcare (Masondo *et al.* 2019). Evidence spanning ancient literature to modern scientific records corroborates that plants are the primary source of medicine for healthcare in developing Asian nations, based on traditional medicinal knowledge (Sheng-ji 2011). These plants are crucial reservoirs of therapeutic drugs, pivotal for the survival and welfare of tribal and ethnic communities (Rubab *et al.* 2020; Ishtiaq *et al.* 2020). These traditional medicinal plants, valued for their affordability, accessibility, and potential lack of res stance, are gaining popularity over modern healthcare in developing nations (Abouri *et al.* 2012; Chisamile *et al.* 2023).

Pakistan is home to over 6,000 types of blooming plants, with around 2,000 species having special significance in local cultures (Khadim *et al.* 2024a). In the early 1950s, over 84% of Pakistanis relied on traditional medicine for health cures, and this figure may have only marginally diminished since then (Goodman and Ghafoor 2011). There is a considerable gap in documenting Pakistan's herbaceous diversity; of the 5,700 plant species, only 400-600 are officially recognized for their medicinal benefits (Ikramullah *et al.* 2007). The Himalaya, Karakoram, and Hindu Kush mountains are home to 25,000 plant species, 10% of which have commercial or medical value, underscoring the importance of these regions in biodiversity conservation. About 70% to 80% of the native population in the Himalayas gets their traditional medicine from plants found in their natural surroundings. To maintain the long-term use of these therapeutic plants for future generations, it is imperative that these habitats have to be preserved (Khadim *et al.* 2024b, Bano *et al.* 2014).

Human activities, soil degradation, natural disasters, and climate fluctuations all pose threats to the survival of Gilgit-Baltistan's medicinal plants (Arshad *et al.* 2014; Arshad 2012). The significance of these medicinal plants to human health is undeniable, with nearly 75% of medications produced from plants of indigenous provenance, influencing both local populations and the worldwide pharmaceutical industry (Zareef *et al.* 2023). Indigenous populations' plant knowledge not only contributes to scientific understanding but also plays an important role in the conservation of varied species (Pradhan *et al.* 2020). Ethnobotanical research is critical for preserving unique traditions and avoiding the irreversible loss of significant cultural knowledge (Khadim *et al.* 2024a). Haramosh, situated in the Gilgit district north of the Indus River, offers valuable opportunities for ethnobotanical research due to its rich floral diversity and the presence of ancient civilizations among the local population (Abbas *et al.* 2023). (Ali *et al.* 2018) document plants such as *Ephedra gerardiana* and *Artemisia absinthium* in traditional remedies. (Khan and Ahmed 2020) describe the cultural roles of plants like *Juglans regia* and *Viburnum cotinifolium* (Abbas *et al*. 2023) emphasizes the need for conservation due to modern development threats, advocating for sustainable management to preserve both plant species and traditional knowledge. Additional studies (Abbas *et al.* 2018; Khan *et al* .2015) show that shrubs, representing 16% of species, are vital in folk medicine. Trees and subshrubs, though less prevalent (8% and 4%, respectively), are crucial for specific health conditions (Shah *et al*. 2023; Kadium *et al.* 2024) highlight the importance of understanding consumption patterns across habitats for informing conservation efforts. The area's abundant biodiversity faces significant challenges, including deforestation, overgrazing, forest land conversion to agriculture, development, and climate change (Chivian, 2002). Additionally, the oral transmission of indigenous knowledge exacerbates the depletion of flora and traditional wisdom, underscoring the urgent need for documentation (Khan *et al.* 2009). Marukh and Asogaha Nallah is rich in floral diversity and present significant potential for ethnobotanical discoveries. These areas are characterized by unique biodiversity and dense forest patches at elevations ranging from 2500 to 5000 meters. While the lower regions are mainly used for agriculture, the higher elevations feature alpine pastures and forested zones. The local climate varies significantly with the seasons, as the harsh winters bring heavy snowfall, and the summers are mild and pleasant. The local population suffers significant healthcare issues despite the region's abundance of botanical resources. The inhabitants, who have a semi-nomadic lifestyle due to their limited access to healthcare, mostly rely on medicinal plants to treat a variety of illnesses. Beyond medical care, they also rely on natural resources for food, fuel, housing, and fodder.

The lack of historical documentation of traditional medicinal practices in this particular area highlights a critical gap in ethnobotanical knowledge, underscoring the need for thorough investigation and the preservation of this invaluable traditional knowledge.

This study aims to chronicle the ethnobotanical knowledge connected to medicinal plants, with a focus on alpine species, in the Marukh and Asogaha Nallah of the Haramosh Valley. The approach takes into account the issues of supporting sustainable management and maintaining traditional knowledge. The project seeks to provide crucial insights into traditional medicinal practices in this hitherto unexplored area by discovering and documenting indigenous expertise regarding the healing effects of these plants. Preserving this important knowledge, improving our comprehension of ethnobotany, and possibly helping to create novel pharmaceuticals and methods for biodiversity preservation are the ultimate objectives. In this hitherto unexplored field, the research attempts to offer critical insights into traditional medical practices by finding and documenting indigenous knowledge about the medicinal qualities of these plants. Protecting this priceless information, improving our knowledge of ethnobotany, and possibly helping to create new pharmaceuticals and conservation tactics for biodiversity are the ultimate objectives.

Materials and Methods

Study area

The study area of Haramosh valley is in Karakorum Range at the elevation of 2367m to 2637 m and 31°.01'.722" North latitude, 074°.32'.791" East longitude. The map of the study area is depicted in (Figure 1).

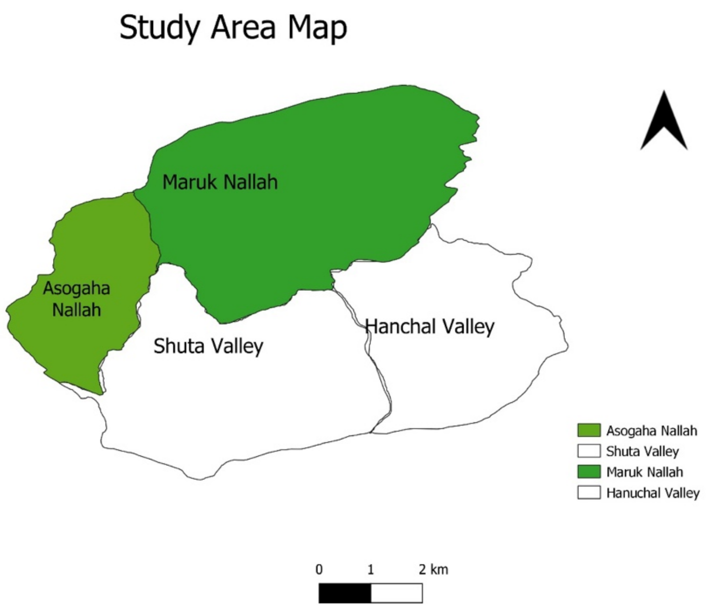

Figure 1. Study Area Map of Marukh and Asogaha Nallah

The valley is 4km away from Gilgit city and on the way to Skardu, Baltistan region. The region is well-known for its lush forests and high mountains decorated with valuable stones, lakes, beautiful meadows, and glaciers. It is home to a varied range of medicinal plants (Abbas *et al.* 2023). Gilgit-Baltistan stands out as the only place where the Hindu Kush, Karakoram, and Himalayan Mountain ranges converge. (Khan et al.2016). The three great mountain ranges met at the junction of the Indus and Gilgit rivers near Macpoon Das, which is in Haramosh valley Gilgit, at the 35°-37° North latitude and 72°75°East longitude (Abbas *et al.* 2019). The three great mountain ranges met at the junction of the Indus and Gilgit rivers near Macpoon Das, which is in Haramosh valley Gilgit, at the 35°-37° North latitude and 72°75°East longitude (Abbas *et al.* 2019).

Field surveys and data collection

A field survey was conducted from March 2022 to November 2024 in the Marukh and Asogaha Nallah regions to collect sample data randomly (karima *et al.* 2024; Zehra *et al.* 2024). Photographs of the plants were also taken with the assistance of a taxonomist during the field study, using tools such as cameras, twig cutters, trowels, newspapers, plant pressers, and polythene bags. Data was recorded in field notebooks and each specimen was tagged. The collected specimens underwent pressing, drying, and mounting onto herbarium sheets. Identification was conducted by comparing them with specimens housed in the Department of Plant Science at Karakoram International University, Gilgit. as well as with relevant literature. We also used the Flora of Pakistan for further identification (Ali & Qaiser, 1986). Scientific databases such as Google Scholar and PubMed were also used to obtain further information on plants in these areas.

Ethnobotanical data collection

Ethnomedicinal data was methodically documented through a series of open and semi-structured questionnaires, surveys, interviews, and attentive participant observations, engaging 130 local respondents. The socio-demographic profile of respondents encompassed elders, local herbalists (Hakeems), housewives, and professionals possessing traditional knowledge of ethnomedicinal plants.

The data were gathered through face-to-face interviews and the use of semi-structured questionnaires. The questionnaire consisted of two parts. The first part focused on gathering demographic information about the respondents, including gender, age, occupation, level of education, and their experience in using therapeutic plants. The second part of the questionnaire focused on recording specific details about the medicinal plants, including their common names, family names, the specific plant part used, methods of preparation, routes of administration, and the diseases they were known to treat. This comprehensive data collection process aims to compile information about the utilization of medicinal plants with an emphasis on local traditional knowledge and practices. Visual representation from collected data to identification is illustrated in (Figure 2).

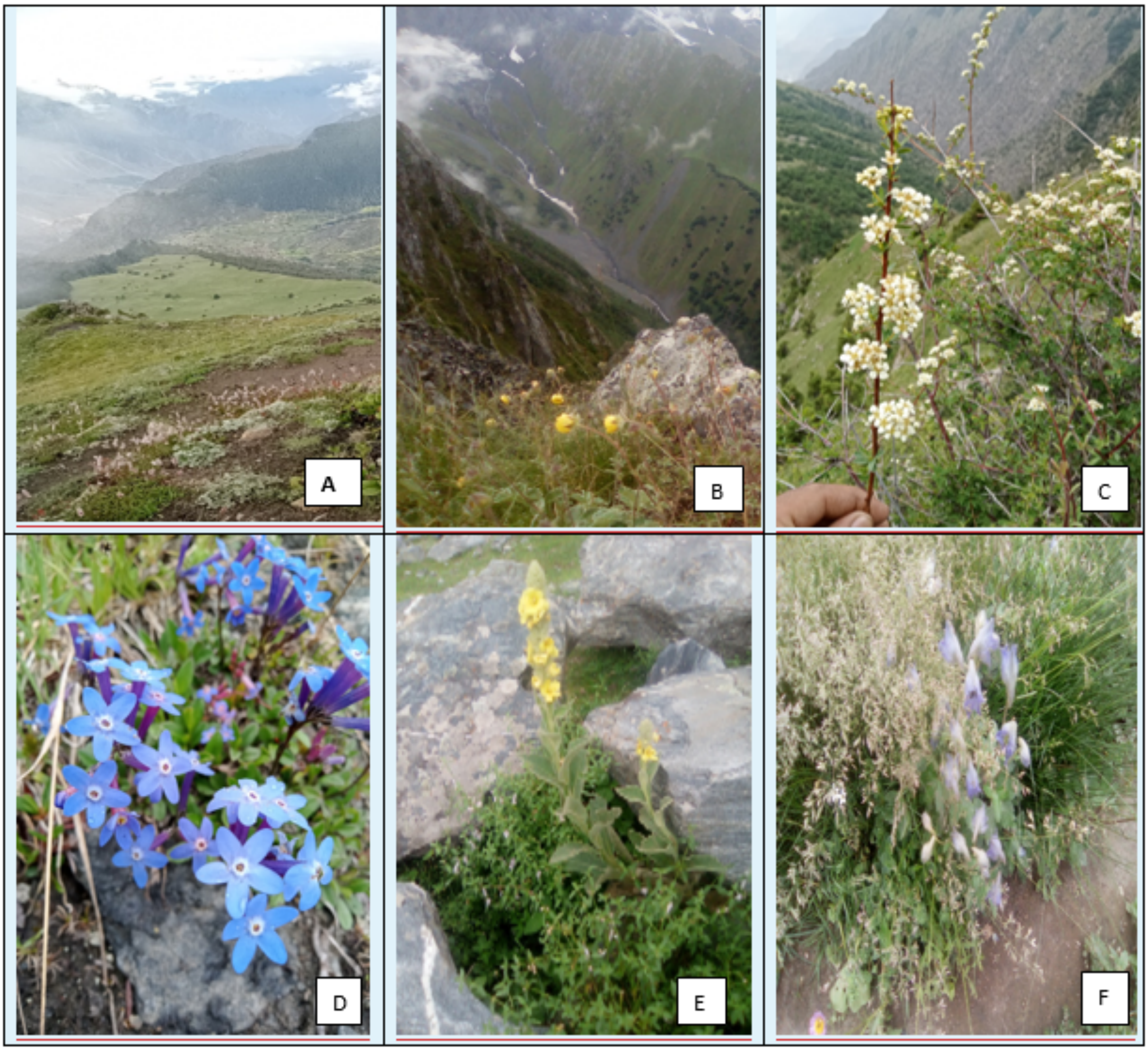

Figure 2. (A & B) Maruk and Asogaha Valley Haramosh, (C) *Spiraea canescens,* (D) *Gentianodes eumarginata,* (E) *Verbascum thapsus* and (F) *Delphinium brunonianum*.

Quantitative data analysis

The analysis of ethnobotanical data involved the utilization of different statistical indices, Relative frequency citation (RFC), Use Value (UV) and Fidelity Level (FL).

Relative Frequency of Citations (RFC)

Relative Frequency of Citations (RFC) was applied to gauge the significance of plant species mentioned by informants (Khadim *et al.* 2024b).

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

(0 < RFC < 1) It illustrates the importance of each species and is calculated by the Frequency of Citation (FC) which represents the count of informants reporting the use of a specific species, while 'N' stands for the total number of informants (Khadim *et al.* 2024b; Shah *et al.* 2023).

Use Value (UV)

The relative importance of each plant species was calculated by using the following equation.

$$\boldsymbol{UV = \frac{\sum Ui}{N}}$$

Where: ∑Ui= Total number of used reports of each medicinal plant; n = Sum of informants cited for a specific therapeutic plant (Khadim *et al.* 2024b).

Fidelity level (FL)

The Fidelity Level (FL) was utilized to assess the preference of a particular plant for treating respiratory diseases. A high FL indicates that the medicinal plant is extensively used for respiratory disorders, while a low FL suggests a low frequency of usage for this condition (Hussain, 2024). The FL index was calculated based on specific criteria to determine the level of preference for the plant in curing respiratory ailments (Rehman *et al.* 2023).

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

The Fidelity Level (FL) index was calculated by considering the number of respondents who mentioned a specific plant for the treatment of respiratory disorders (Np) and dividing it by the total number of respondents who mentioned that plant species for any ailment (N) (Leonti, 2022).

Informant Consensus Factor (FIC)

According to (Uddin & Hassan 2014) the purpose of the FIC (Informant Consent Factor) is to uphold the utilization of plant species following cultural beliefs, and health disorders are categorized into groups. Plants with a high FIC value are deemed more significant than those with a low ICF value (Hussain 2024). A high FIC indicates a greater number of reports from respondents regarding the use of plants to treat specific diseases. In the research analysis, a substantial IFC value of 0.96 was recorded for antiseptic purposes. The IFC value is computed using the following formula (Kayani *et al.* 2024):

$$\boldsymbol{IFC = \frac{Nur - 1}{Nur - Nt}}$$

Jaccard Similarity Index (JI)

In ethnobotany, the Jaccard similarity index (JI) can be a valuable tool for comparing the use of medicinal plants across different traditional medicinal practices or cultural contexts. For instance, researchers might use the JI to quantify the overlap in plant species used between two distinct communities or geographic regions. To apply this, they would identify two sets of data: one representing the medicinal plants used by one community or in one region, and the other representing those used by another. The formula for calculating (Kayani *et al.* 2015):

$$\mathbf{JI= C\ x}\ \boldsymbol{\frac{100}{a\ + b - c}}$$

Where: "a," the total number of plant species documented in the first community or area; "b," the total number of species documented in the second; and "c," the number of species common to both. This index helps in understanding the extent of shared ethnobotanical knowledge and practices, shedding light on cultural exchanges, the transmission of traditional knowledge, and the diversity of medicinal plant usage across different regions and cultures.

Demographic details

The current investigation encompassed interviews with 130 participants. Among them, 85 (65.38%) were male informants, while 45 (34.61%) were female informants. Regarding age distribution, 55 participants (42.3%) fell between the ages of 35 and 45, 45 participants (34.68%) were aged between 46 and 60, and 30 participants (23.07%) were in the 61 to 80 age range. In terms of literacy, 76 informants were literate, constituting 58.46% of the total, while (54) were illiterate, making up 41.53% of the total. The occupational breakdown of informants included (4) Hakium (Local herbalist), (24) farmers, (9) shepherds, (15) teachers, (17) housewives, (22) mid-level workers, and (39) primary-level workers, with detailed results presented in (Table 1).

Table 1. Demographic characteristics of the informants

Variables	Categories	No. of Individuals	%
Informants	Herbalist	3	2.3
	Common	127	97.6
Gender	Male	85	65.38
	Female	45	34.61
Age	35- 45	55	42.3
	46-60	45	34.68
	61-80	30	23.07
Educational Background	Literate	76	58.46
	Illiterate	54	41.53
Occupation	Hakium	4	3.07
	Farmers	24	18.46
	Shepharts	9	6.92
	Teachers	15	11.5
	Housewife	17	13.07
	Middle Level	22	16.92
	Primary Level	39	30

Results and Discussion

Diversity of medicinal plants

Table 2 illustrates the utilization of sixty-five (65) alpine medicinal plant species for treating various human ailments, encompassing approximately 18 different types of diseases and disorders. Among these families, Asteraceae was the most diverse with (12 species) spread across (9 genera). Lamiaceae and Rosaceae followed with (5 species) each, distributed among (4 genera). Families such as Boraginaceae, Brassiceae, and Polygonaceae contained (3 species) each. The remaining families had only a single species and genus (Figure 3).

Previous research has shown a strong reliance on medicinal plants from four important families: Lamiaceae, Apiaceae, Anacardiaceae, and Fabaceae (Khadim *et al.* 2024a). These families are common in Mediterranean countries, emphasizing their role in traditional medicine practices. Interestingly, 36 of these therapeutic plants can also be used as spices or food plants (Hussain *et al.* 2023). This is consistent with previous ethnobotanical studies, which identified the frequent practice of using food plants for medicinal purposes (Khan *et al.* 2018). Food plants are convenient medical solutions because they are widely available in households and local markets. Furthermore, the western High Atlas region's rich flora provides simple access to a wide variety of therapeutic herbs (Khadim *et al.* 2024b).

Furthermore, the results revealed a consistent pattern in the use of specific methods for administering medicinal plants, with decoction being a prevalent approach, especially for roots and aerial parts. This suggests a common practice of extracting bioactive compounds through boiling, reflecting a systematic approach in traditional medicine. Additionally, quantitative measures such as Relative Frequency of Citation (RFC), Use Value (UV), and Fidelity Level Percentage (FL%) provide insights into the significance of each plant species in local medicinal practices. These parameters aid in prioritizing species with higher citation frequencies, versatile applications, and cultural importance, forming a foundation for future ethnobotanical and pharmacological studies.

Table 2. Outlines medicinal plants in the Haramosh Valley and their diverse application and method for treatment of various ailments.

Family Name	***Species name***	**Vernacular name**	**Voucher No**	**Habit**	**Part used**	**Method of use**	**Folk Medicinal uses**	**RFC**	**UV**	**FL%**
Alliaceae	*Allium carolinianum* DC.	Paloon	HA-111	P.H	Aerial part	As a vegetable	to alleviate symptoms of diarrhea and improve digestion.	0.19	0.1	90%
Apiaceae	*Pleurospermum candollei* DC.	Potosen	HA-112	P.H	Aerial part	powder	Infertility	0.92	1	95%
Apiaceae	*Pleurospermum hookeri var. thomsonii* C.-B. Clarke	Not Know	HA-113	P.H	Root	Decoction	Respiratory conditions	0.1	0.5	60%
Apiaceae	*Pleurospermum stellatum* var. *lindleyanum* (Klotzsch) C.B.Clarke	Not Know	HA-114	P.H	The whole part	Decoction	Digestive disorders and promoting appetite	0.25	0.1	70%
Apiaceae	*Pleurospermum stylosum* C.B. Clarke	Shochi potosen	HA-115	P.H	Root	Decoction	Respiratory conditions and digestive disorders	0.34	0.2	85%
Asteraceae	*Aster alpinus* L.	Not Know	HA-116	P.H	Flower	Directly	Stomach pain	0.1	0.2	85%
Asteraceae	*Allardia glabra* Decne.	Shopti phoner	HA-117	P.H	Flower Head	Directly	Stomach pain and cessation of bleeding	0.35	0.7	90%
Asteraceae	*Anaphalis nepalensis* Spreng.	Kilpush phoner	HA-118	P.H	Aerial part	Decoction	Asthma	0.34	0.1	80%
Asteraceae	*Anaphalis virgata* Thomson ex C. B. Clarke,	Not Know	HA-119	P.H	Aerial part	Decoction	anti-inflammatory, analgesic, and antipyretic properties, Respiratory	0.1	0.4	80%
Asteraceae	*Aster peduncularis* Wall.ex Nees	Not Know	HA-120	P.H	Root	Decoction	fever and respiratory problems.	0.11	0.3	100 %
Asteraceae	*Cremanthodium decaisnei* C. B. Clarke	Not Know	HA-121	P.H	The whole part	Decoction	digestive disorders and respiratory ailments	0.12	0.4	95%
Asteraceae	*Saussurea candolleana* Wallich ex Schultz	Not Know	HA-122	P.H	Aerial part	Decoction	anti-inflammatory, analgesic, and immunomodulatory properties.	0.09	0.4	70%

Asteraceae	*Saussurea falconeri* Hook.f.	Not Know	HA-123	P.H	Root	Decoction	therapeutic effects, including anti-inflammatory and analgesic properties.	0.12	0.2	95%
Asteraceae	*Saussurea simpsoniana* Fielding & Gardner	Boshe phoner	HA-124	P.H	Flower	Decoction	cough and pneumonia.	0.85	0.3	80%
Asteraceae	*Solidago virga-aurea* L.	Not Know	HA-125	P.H	Aerial part	Herbal tea	diuretic, anti-inflammatory, and antimicrobial properties, urinary tract health.	0.42	0.2	80%
Asteraceae	*Tanacetum artemisioides* Schultz-Bip. ex-Hook. f.,	Zoon	HA-126	P.H	Aerial part	Directly	fever, cough, and pneumonia.	0.93	0.2	70%
Asteraceae	*Taraxacum officinale* F. H. Wiggers	Dandelion	HA-127	P.H	Root	Decoction	kidney problems.	0.35	0.3	95%
Balsaminaceae	*Impatiens edgeworthii* Hook. f.	Chati	HA-128	A.H	Flower	External	skin condition and wound healing.	0.46	0.5	75%
Berberidaceae	*Berberis orthobotrys* Bien.	Ishkeen	HA-129	S.H	Root	Powder	back pain, internal injuries, cuts to injuries, cuts and injuries to the skin.	0.68	0.2	95%
Betulaceae	*Betula utilis D.* Don	Joze	HA-130	T	Bark	Decocation	rheumatism and earache. Furthermore, gastric gas in the stomach.	0.84	1	95%
Boraginaceae	*Heliotropium crispum* Desf.	Not Know	HA-131	A.H	Aerial part	Decoction	diuretic, expectorant, and antispasmodic properties, respiratory and urinary tract health.	0.33	0.3	60%
Boraginaceae	*Myosotis alpestris ssp. alpestris* L.	Lozom lelo	HA-132	P.H	Flower	Direct	throat problems and throat infections	0.11	0.3	85%
Braginaceae	*Myosotis arvensis* Hill	Lelo	HA-133	P.H	Aerial part	Decoction	diuretic, expectorant, anti-expectorant anti-inflammatory properties, urinary, respiratory cough	0.46	0.2	100 %

							health, coughs and colds.			
Brassiceae	*Draba nemorosa* All.	Not Know	HA-134	A.H	The whole part	Decoction	diuretic, urinary, and urinary tract infections.	0.11	1	100 %
Brassiceae	*Sisymbrium irio* L.	Donger	HA-135	A.H	The whole part	Decoction	anti-inflammatory, analgesic, diuretic properties, digestive and respiratory health.	0.26	0.9	70%
Cannabaceae	*Cannabis sativa* L.	Thiochi	HA-136	A.H	Leaves	Decoction	skin allergies, nervous disorders, dysentery, neuralgia, gastrointestinal diseases, stomach ulcers, and pain relief.	0.51	0.2	80%
Cupressaceae	*Juniperus communis Thunb.*	Methari	HA-137	S.H		Decoction	kidney stones. Additionally, the smoking of the leaves is practiced warding off evil spirits from houses.	0.52	0.2	100 %
Cupressaceae	*Juniperus excelsa* Pursh	Cheli	HA-138	S.H		Decoction	abdominal pain relief, leaves burned with tobacco for snuff, and sacred leaves burned for protective smoke against evil spirits in houses	0.52	0.9	90%
Elaeagnaceae	*Hiphophae rhamnoides* L.	Boro	HA-139	S.H		Direct	stomach issues, cholesterol reduction, kidney stones, cancer, and irregular palpitations.	0.59	0.3	75%
Ericaceae	*Rhododendron anthropogon* D. Don	Thalachum	HA-140	S.H	leaves	Decoction	blood pressure, coughing, heart problems, and	0.52	0.3	75%

							maintaining blood sugar levels.			
Fabiaeae	*Astragalus membranaceus* Fisch. ex Bunge	Not Know	HA-141	S.H	Leaves	Directly	dietary supplements to enhance milk production in livestock.	0.6	0.1	95%
Gentiaceae	*Swertia cordata* (G.Don) Clarke	Not Know	HA-142	P.H	Leaves	Decoction	blood pressure and cardiac issues.	0.92	0.4	90%
Gentiaceae	*Gentiana tianschanica* Rupr. ex Kusn. i	Palamach	HA-143	P.H	Aerial part	Powder	stomach-related concerns, ascariasis (intestinal worm infection), hepatitis, blood pressure, and blood purification.	0.86	0.2	75%
Gentiaceae	*Gentianodes eumarginata* Omer	Shotay lilo	HA-144	P.H	Flower	Powder	fever and throat infections.	0.13	0.3	70%
Graminaceae	*Geranium pratense* L.	Khurat chachoo	HA-145	P.H		Paste	injuries. Additionally, stomach pain.	0.68	0.2	70%
Grossulariaceae	*Ribes alpestre* Decne.	Shomolo	HA-146	S.H	Fruit	direct,	jaundice, vomiting, and digestive problems, back pain, injuries, and knee pain	0.68	0.2	96%
Lamiaceae	*Mentha arvensis* L.	Pheleel	HA-147	P.H	Aerial part	Direct	stomach, aid in digestion, and combat seasonal diseases.	0.69	0.4	100 %
Lamiaceae	*Mentha longifolia* L.	Pheleel	HA-148	P.H	Aerial part	Direct	digestion, alleviate stomachaches, and regulate body temperature.	0.69	0.4	95%
Lamiaceae	*Mentha royleana* Benth.	Pheleel	HA-149	P.H	The whole part	Directly	blood pressure, enhance food digestion, and alleviate stomachache.	0.52	0.4	80%
Lamiaceae	*Salvia nubicola* Wall. ex Sweet,	Koropo	HA-150	P.H	Leaves	Decoction	cough, fever, asthma, and various respiratory ailments.	0.68	0.1	95%

Lamiceae	*Thymus linearis* Benth.	Tomoro	HA-151	P.H	Aerial part	Decoction	roundworms, relieves headaches, improves digestion, blood pressure, fights blood cancer, and reduces stress.	0.77	0.9	98%
Malvaceae	*Malva neglecta* Wallr.	Gangali Shanisha	HA-152	P.H	Aerial part	Decoction	constipation and digestive problems.	0.35	1	85%
Oleaceae	*Fraxinus hookeri* Wenzig	Kasunar	HA-153	T	Bark	Decoction	typhoid fever.	0.51	0.3	80%
Papaveraceae	*Papaver nudicaule* L.	Goshel phoner	HA-154	P.H	Flower	Decoction	Stomach	0.59	0.4	80%
Papillionaceae	*Sophora mollis* (Royle) Baker	Poshool	HA-155	S.H	Leaves	Paste	skin allergies and antiseptic substances.	0.75	0.3	85%
Pinaceae	*Picea smithiana* (Wall.) Boiss,	Kachul	HA-156	T	The whole part	as a fuel	animals, while the wood is employed in the production of furniture.	0.35	0.5	85%
Pinaceae	*Pinus wallichiana* A. B. Jackson	Chi	HA-157	T	Resin	Directly	blood clotting following a cut, specifically on the external surface of the skin.	0.52	0.5	60%
Polygonaceae	*Bistorta officinalis* Delarbre	Chumoi	HA-158	P.H	Bark	Direct	diarrhea, promote healthy respiration, and aid in digestion.	0.35	0.2	90%
Polygonaceae	*Rheum spiciforme* Royle,	Jaro chotal	HA-159	P.H	Bark	Decoction	therapeutic properties and local pain relief.	0.35	1	80%
Primulaceae	*Primula denticulata* Smith.	Heto lelo	HA-160	P.H	Aerial part	Powder	stomach ailments and is also believed to have benefits specifically for baby boys.	0.68	0.1	75%
Primulaceae	*Primula elliptica* Royle,	Lozum lelo	HA-161	P.H	The whole part	Decoction	anti-inflammatory, analgesic, and antipyretic properties, respiratory conditions, fever, and skin disorders.	0.67	0.2	94%

Primulaceae	*Primula macrophylla* D. Don, Prodr. Fl.	Shojo lelo	HA-162	P.H	Flower	Direct	eye allergies. Additionally, throat inflammation and tonsillitis.	0.68	0.3	65%
Ranunclaceae	*Delphinum brunonianum* Royle	Makhoti	HA-163	P.H	Flower	Decoction	cough and pneumonia symptoms, skin irritation, stomach issues, heart complications, breathing difficulties.	0.27	0.2	65%
Rosaceae	*Fragaria nubicola* (Hook.f.)	Gorus	HA-164	P.H		Direct	purifying blood and serving as a potent tonic.	0.5	0.1	96%
Rosaceae	*Potentilla anserina* L.	Not Know	HA-165	P.H	Flower	Powder	stomach pain, particularly in cases of a congenital heart defect known as a "hole in the heart."	0.35	0.6	70%
Rosaceae	*Potentilla dryadenthoides* L.	Darocho jaa	HA-166	S.H	Aerial part	Decoction	anti-inflammatory, digestive disorder-alleviating properties, wound healing, antimicrobial activity, and antioxidant effects.	0.45	0.1	65%
Rosaceae	*Rosa webbiana* Wall. ex-Royle, Ill.	Shighaya	HA-167	S.H		Decoction	digestive benefits, preparation of herbal tea.	0.68	0.2	60%
Rosaceae	*Spiraea canescens* D. Don, Prodr.	Dara	HA-168	S.H	Bark	Oil	The stem is utilized as a source for extracting oil that is specifically applied to treat infections caused by ringworm.	0.69	0.1	50%
Salicaceae	*Salix flabellaris* Andersson in Kung.	Brawo	HA-169	S.H	Bark	Decoction	anti-inflammatory, analgesic, and	0.58	0.1	95%

							antipyretic properties, and it is also used to relieve pain and reduce fever.			
Saxifergaceae	*Bergenia stracheyi* (Hook.f. & Thorns.)	Sapsar	HA-170	P.H	Leaves	Powder	cough, asthma, and back pain. Moreover, the dried leaves are employed in the preparation of tea.	0.92	0.1	96%
Saxifragaceae	*Saxifraga flagellaris* Willd. ex Sternb., Rev.Sax.	Kavali cher	HA-171	P.H	Aerial part	Decoction	diuretic, anti-inflammatory, and analgesic properties, and it is also employed to treat urinary tract disorders and as a general tonic.	0.68	0.5	90%
Scrophulariaceae	*Verbascum thapsis* L.	Masigood	HA-172	B.H	Aerial part	Decoction and paste	blood clotting and addresses lung bleeding, fever and asthma	0.68	0.2	80%
Thymelaceae	*Daphne mucronata* Royle,	Nirko	HA-173	S.H	Root	Decoction	treatment of diarrhea.	0.6	0.1	98%
Urticaceae	*Urtica dioica* L.	Jomi	HA-174	P.H	Aerial part	vegetable	injuries, skin problems, and diabetes. This plant is toxic and can induce skin irritation, especially with excessive dosage.	0.52	0.5	96%
Valerianaceae	*Valeriana officinalis* L.	Not Know	HA-175	P.H	Root	Powder	heart disease, as well as for alleviating symptoms of cough, asthma, and fever.	0.35	0.8	80%

Habit Distribution

The habitat distribution of the identified plant species reveals a dominance of perennial herbs, with 42 species identified. This indicates the adaptability of these plants to the stable environment of the study area, where they can grow and reproduce over multiple years. Shrubs (13 species), annual herbs (5 species), biennial herbs (1 species), and trees (4 species) also contribute to the botanical diversity of the area. The category of habit is illustrated in (Figure 4).

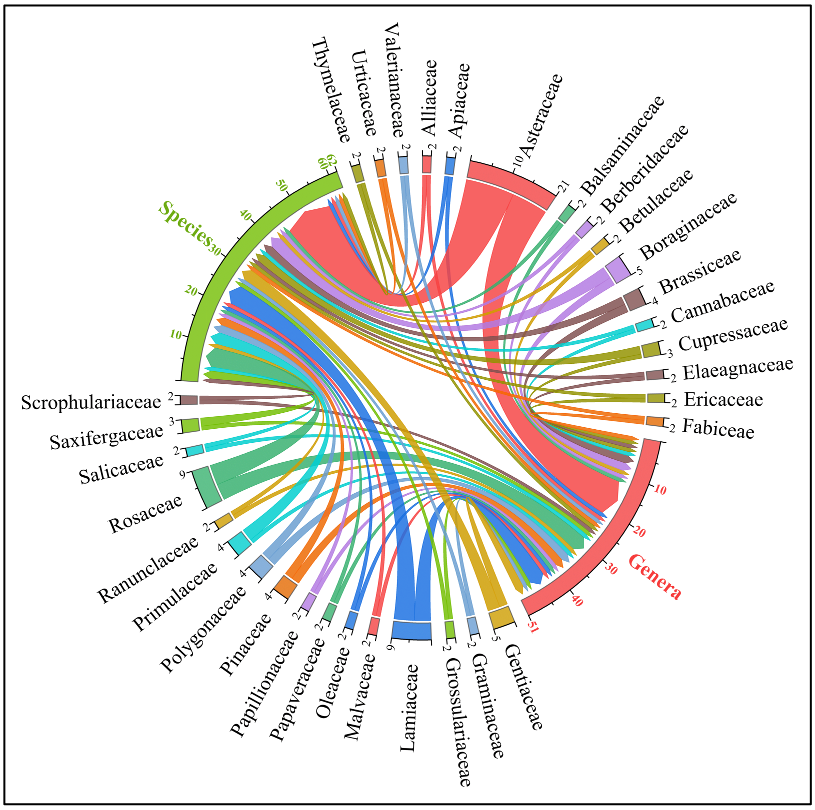

Figure 3. Families with number of genera and species in the study area

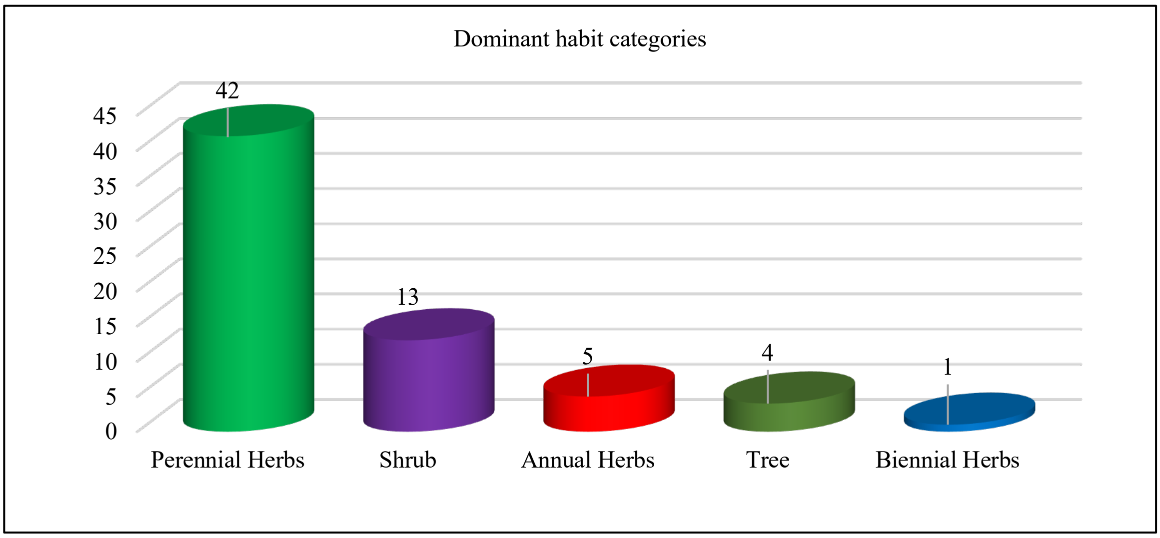

Figure 4. Habit categories of documented plants in the study area

Recent scholarly studies like (Bahadur *et al.* 2023; Guo *et al.* 2023), emphasizing the widespread use of herbs in traditional medicine, emphasizing their ecological benefit for biodiversity and cultural significance within communities. Herbs are valuable because they fulfill both ecological and medicinal functions. Furthermore, as noted by (Teklehaymanot 2009; Cooper *et al.* 2005), Shrubs play a major part in folk medicine, with 14 species (16%) in the studied field. Trees, accounting for around 8%, and subshrubs, accounting for 4%, play essential but specialized roles in addressing numerous health conditions (Shah *et al.* 2023). According to the current study, understanding the consumption patterns across habitat categories provides essential insights into local biological processes and informs conservation activities. (Kadium *et al.* 2024).

Understanding the utilization patterns of plant species across different habitat categories offers critical insights into local ecological dynamics. Our findings contribute to the existing body of knowledge by highlighting the ecological and medicinal importance of herbs, shrubs, trees, and sub-shrubs in the study area. This knowledge can guide conservation strategies aimed at preserving biodiversity and traditional medicinal practices.

Plant parts usage

In our research, we investigated how people in our study area utilize various parts of plants in their daily lives for medicinal purposes. Our findings reveal a diverse utilization pattern across different plant parts. The aerial parts, which include leaves, stems, and flowers, emerged as the most frequently used category, with (19 species) employing these components. Roots were also prominently utilized, with 8 species relying on them for medicinal benefits, followed closely by the whole plant, which is used in 7 species. Flowers were specifically targeted in 10 species, underscoring their medicinal significance, while leaves were similarly valued, and documented in 9 species. In contrast, bark and fruits were less commonly utilized, with 6 and 5 species, respectively, relying on these parts for their medicinal properties. Berries and other plant parts had minimal representation, each documented in only 1 species. This distribution underscores the richness and specificity of plant usage practices rooted in traditional knowledge within our studied community. Understanding these preferences provides crucial insights into the local application of medicinal plants, guiding sustainable harvesting practices and conservation efforts aimed at preserving both biodiversity and cultural heritage. The utilization of plant parts is illustrated in (Figure 5).

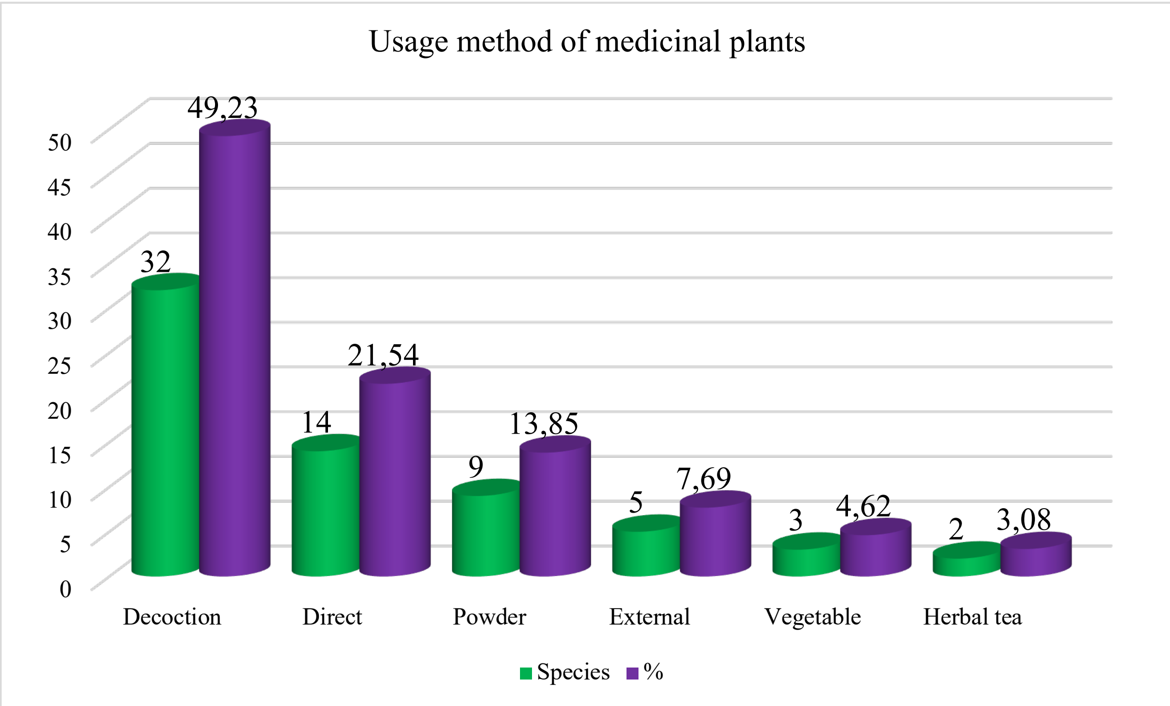

Figure 5. Method of usage of medicinal plants in the study area.

Recent literature continually highlights leaves as the most extensively used plant portion in traditional medicine, accounting for 34.4% of uses (Tahir *et al.* 2023). Studies by (Bahadur *et al.* 2023, Kayani *et al.* 2024) This discovery is supported by the fact that leaves contain a high concentration of bioactive chemicals like alkaloids and flavonoids, which are essential for their medicinal properties. Their ease of harvesting without hurting the plant leads to their sustained use in many medicinal forms like as extracts and teas (Abbas *et al.* 2018). In contrast, the rhizome, containing a mere 2.2%, stands as the least exploited portion, although it has the potential for distinct medicinal characteristics reliant on cultural preferences, geographical customs, or unique therapeutic effects connected with various species (Manzoor *et al.* 2023). This mismatch highlights the global diversity of traditional medical practices, stressing leaves' versatility as a resource and the contextual significance of rhizomes in traditional healing uses by (Khadim *et al.* 2024a).

Our findings add to the current body of knowledge by describing the precise plant parts used medicinally in the research area. Aerial parts and leaves are prominent in traditional medicine because of their ecological and cultural significance.

Understanding these preferences is critical for guiding sustainable harvesting techniques and conservation efforts to protect biodiversity and cultural heritage. By comparing our findings to earlier research, we highlight the relevance of leaves in traditional medicine, as well as the contextual value of other plant components, such as roots and rhizomes, in certain cultural settings.

Method of utilization

The study's findings highlight a diverse array of methods for utilizing plants in traditional medicinal practices, as detailed in (Figure 6). Decoction emerges as the most prevalent method, with (32 species) utilized in this form, indicating the common practice of boiling plant parts to extract medicinal compounds. Direct application follows closely, with (14 species) used directly, suggesting methods such as chewing or applying plant parts externally for immediate therapeutic effects. Powdered forms are also notable, with (9 species) employed, likely for ease of consumption or topical application in medicinal treatments. Furthermore, plants serve as vegetables in (3 species), demonstrating their dual role in diets and medicinal applications. Herbal teas are noted in (2 species), providing another common method for consuming medicinal plants, often targeting specific health benefits through infusion. External application of plant materials is observed in (5 species), indicating the use of extracts or preparations for topical treatments aimed at treating various conditions. This diverse range of utilization methods underscores the adaptability of plants in addressing cultural practices and diverse health needs within traditional medicine. Understanding and documenting these practices are essential for preserving traditional knowledge and informing sustainable practices in medicinal plant harvesting and conservation efforts.

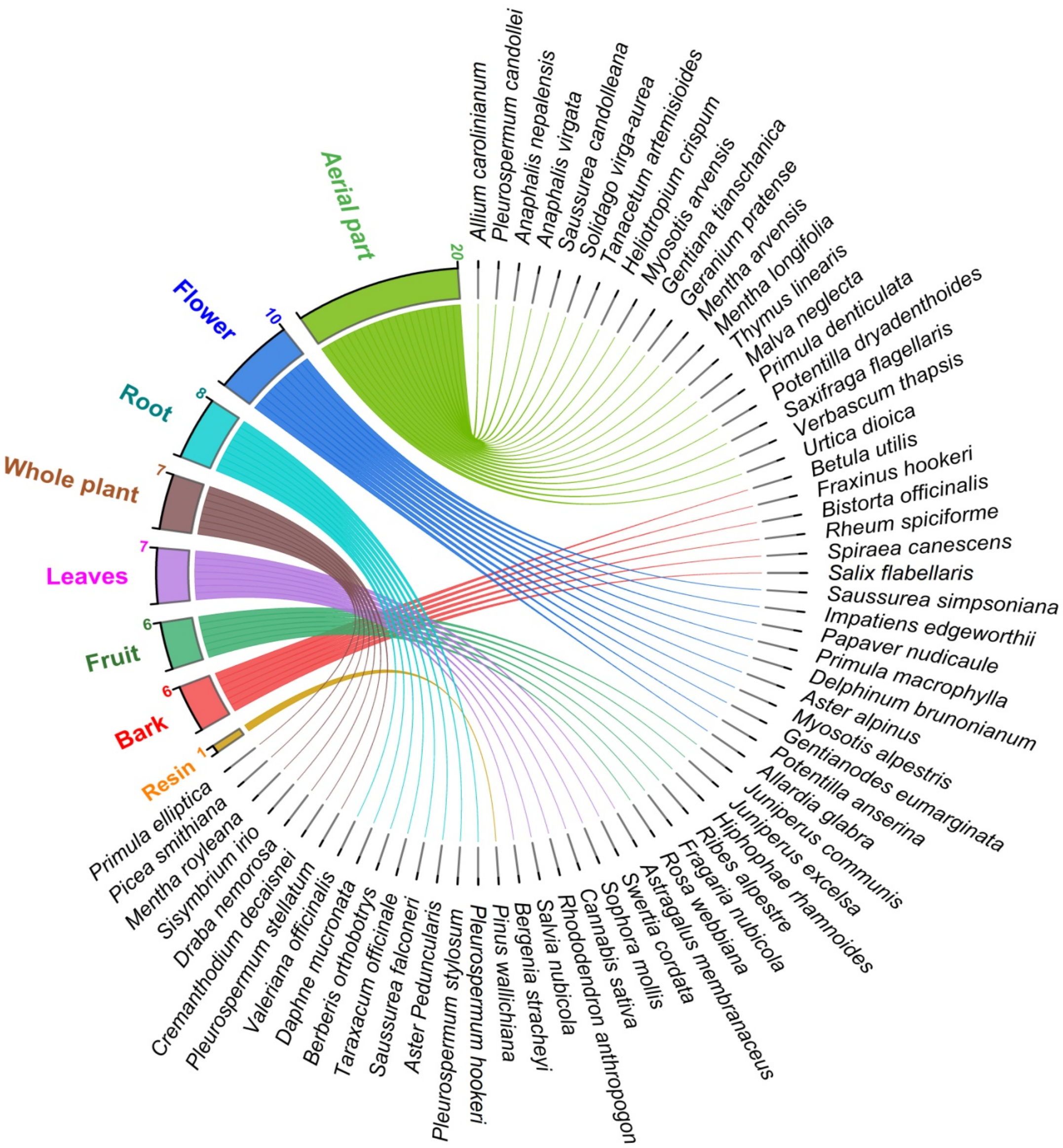

Figure 6. Plant parts were used ethnomedicinally for treating different diseases in the study area

Previous ethnobotanical research has used quantitative analysis to study the use of plant components in traditional medical practices, with oral administration and topical treatment emerging as the most prevalent strategies. This preference for oral treatments is consistent with other studies that highlight their effectiveness and cultural acceptance (Bahadur *et al.* 2023). A decoction is a popular approach, accounting for 63% of traditional medicinal applications, according to research conducted across Pakistan's many regions (Bahadur *et al.* 2023). It is the process of boiling plant materials to extract medicinal ingredients, which are then used to make teas and infusions (Tahir *et al*. 2023). For example, *Delphinium brunonianum* is used as a decoction to treat pneumonia and blended with oil to cure dandruff and increase hair health, reflecting local therapeutic traditions (Khadim *et al.* 2024b). Another example is *Thymus linearis* Benth, which is used as a decoction to treat illnesses such as high blood pressure and indigestion and is commonly drank as a post-meal tea to relieve coughs. In contrast, smoke or fumes are the least chosen approach, accounting for only 2% of applications (Hussain *et al.* 2023).

Our findings add to the current body of ethnobotanical knowledge by describing the specific ways of plant use for therapeutic purposes in the studied area. The prevalence of decoction is consistent with global norms and demonstrates its efficiency in extracting therapeutic ingredients. The variety of application methods, ranging from direct use to powdered forms, demonstrate traditional medicine's versatility and resourcefulness. Documenting these methods is critical for maintaining traditional knowledge and guiding sustainable medicinal plant collection and conservation initiatives. By comparing our findings to earlier research, we highlight the cultural and practical significance of these strategies in traditional medicine.

Ethnomedicinal applications in quantitative data

Relative Frequency Citation (RFC)

The investigation into ethnomedicinal applications utilizing quantitative metrics like Relative Frequency Citation (RFC) and Use Value (UV) has yielded significant findings, as summarized in (figure 7). Among the various plant species studied, *Thymus linearis* stands out with the highest RFC of 0.80, corroborating earlier research by (Khadim *et al.* 2024a). Similarly, *Pleurospermum candollei, Swertia cordata,* and *Bergenia stracheyi* exhibited the highest RFC at 0.92, consistent with findings reported by Abbas *et al.* (2022). Additionally, *Gentiana tianschanica* (RFC = 0.86), *Saussurea simpsoniana* (RFC = 0.85), and *Betula utilis* (RFC = 0.84reflecting a comparably reduced significance in Indigenous customs, as shown in Figure 7. These lower RFC scores suggest lower citation frequency in ethnomedicinal contexts, potentially due to factors like limited availability, less proven effectiveness, or cultural influences on usage.

A recent study found strong Relative Frequency of Citation (RFC) values for diverse plant species, highlighting their importance in ethnomedicinal practices (Awan *et al.* 2023). *Thymus linearis* had the highest RFC at 0.800, which is consistent with data from (Abbas *et al.* 2022), which show that it is widely used in treating problems such as cough, asthma, and digestive disorders, and is commonly made as a decoction or taken as green tea. *Delphinium brunonianum* followed with an RFC of (0.368), while *Hippophae rhamnoides* and *Allium fedtschenkoanum* both had RFC values of (0.563), indicating their importance in local medicinal traditions. Plants such as *Salix denticulata Andersson, Rhodiola wallichiana, and Tamarix arceuthoides* exhibited lower RFC values (0.056 to 0.069), indicating that they are less commonly cited, presumably due to limited availability or perceived efficacy (Pradhan *et al.* 2020). The frequent citation of specific plant species can be attributed to their accessibility, effectiveness, and minimal side effects, as emphasized in studies by (Kayani *et al.* 2015), and RFC serves as a critical measure in previous research, indicating the frequency with which these plants are referenced for medicinal purposes (Shah *et al.* 2023). Our results showed the importance of specific species in traditional medicine and offered a thorough understanding of the Relative Frequency of Citation (RFC) values for medicinal plants in the study area. *Pleurospermum candollei* has an RFC value of 0.80, whereas *Thymus linearis* has a score of 0.92. These species' high RFC ratings reflect their extensive use and cultural significance. This study adds to the body of knowledge by analyzing variables including efficacy, accessibility, and the least amount of side effects that affect RFC values. It also offers information about the long-term application and preservation of these therapeutic herbs.

Use Value (UV)

The Use Value (UV) metric serves as a crucial indicator of the significance of various plant species in indigenous practices, assigning values on a scale from (0 to 1), as detailed in Table 2. *Pleurospermum candollei* emerges with the highest UV value of (1.0), highlighting its paramount importance in traditional indigenous utilization. This underscores its widespread and profound role in local medicinal and cultural practices. Similarly, *Pleurospermum stylosum* follows closely with a substantial UV of (0.9), indicating significant value in indigenous traditions.

Verbascum thapsus and *Mentha arvensis* also hold notable UV values of (0.8) and (0.4), respectively, underscoring their considerable importance in indigenous applications. These values reflect their recognized efficacy and relevance in addressing various health needs within local communities. On the other hand, *Primula macrophylla, Astragalus membranaceus,* and *Fragaria nubicola* share the lowest UV values of (0.1), suggesting a relatively diminished role in indigenous practices compared to other species shown in (Figure 7).

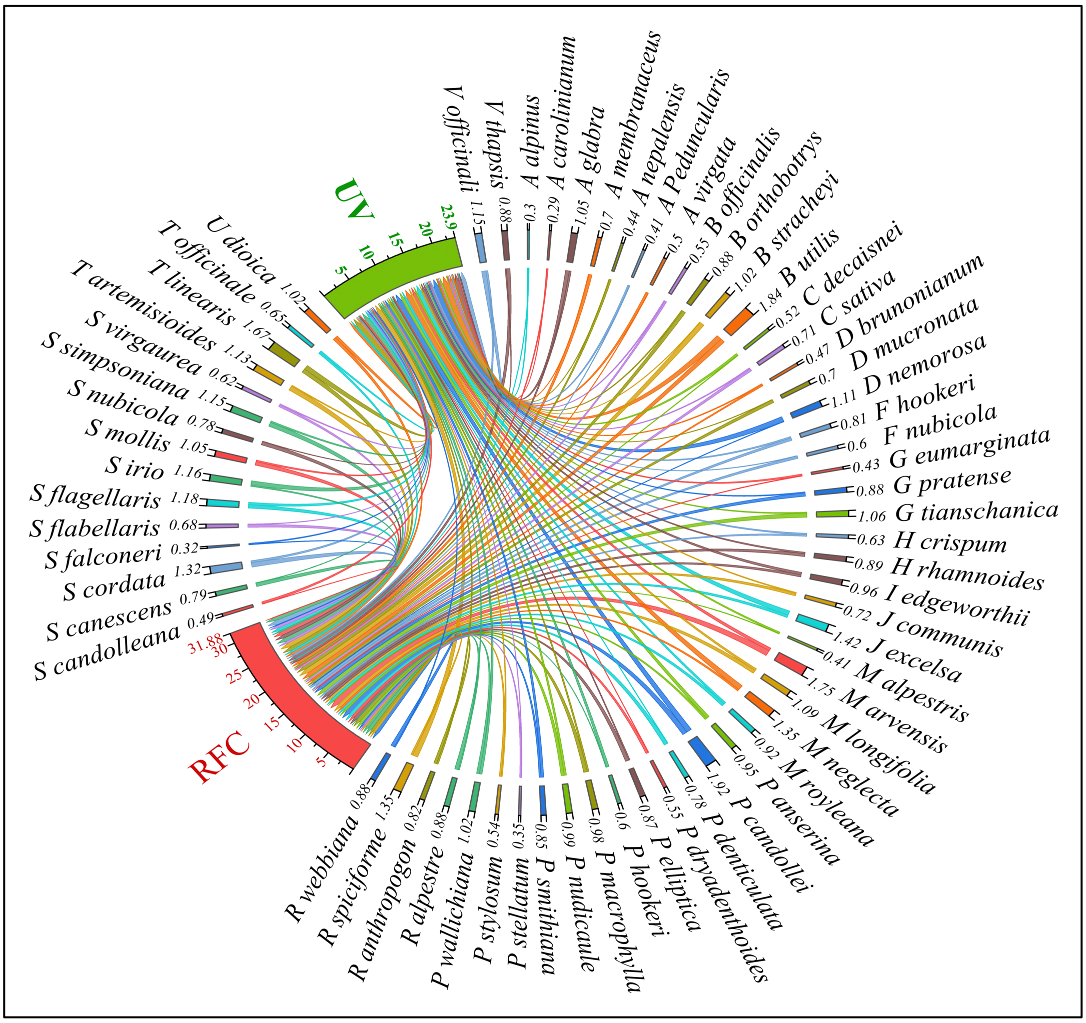

Figure 7. Reveals the Use Value (UV) and Relative Frequency of Citation (RFC) for medicinal plant species from the study area.

The Use Value (UV) metric, which has values ranging from 0 to 1, was used in recent research to emphasize the significance of different plants in traditional activities (Awan *et al*., 2023). According to Hussain et al. (2023), higher UV values denote greater significance, and lower values denote less importance. The plants with the greatest UV levels were *Delphinium brunonianum* (0.950), *Thymus linearis* (0.944), *Urtica dioica* (0.894), *Betula utilis* (0.788), and *Carum carvi* (0.750), highlighting their significance in traditional indigenous use. However, lower UV levels were found in *Bistorta affinis* (0.075), *Tanacetum artemisioides* (0.075), and *Tamarix arceuthoides* (0.081), suggesting that these plants are less common in native cultures (Khadim *et al.* 2024a; Bano *et al.* 2014). By closely examining UV values in a particular geographic area, our research makes a valuable contribution to our knowledge of how traditional societies prioritize the use of therapeutic plants. This study sheds light on the intricate connections between plant use and cultural traditions, offering important insights for the preservation of biodiversity and the creation of potent herbal remedies

Fidelity level (FL)

Our research results reveal that Fidelity Level (FL) is a critical metric in ethnobotany, providing insights into the prevalence of plant species across diverse cultural practices, as detailed in Table 2. *Primula denticulata, Mentha arvensis, and Primula macrophylla* each achieve an FL of 100%, highlighting their widespread significance in ethnobotanical literature and their consistent mention in traditional practices. Following closely, *Ribes alpestre* and *Fragaria nubicola* also demonstrate a high FL of 96%, underscoring their frequent citation in ethnobotanical contexts. Conversely, *Rosa webbiana, Heliotropium crispum,* and *Pleurospermum hookeri* share an FL of 60%, indicating a moderate presence in ethnobotanical literature. *Picea* *smithiana* shows an FL of 85%, indicating notable but less frequent citations, while *Bergenia stracheyi* maintains a high FL of 96%.

The significance of fidelity level (FL) in ethnobotany has been shown by earlier studies that revealed how different plant species can be used to treat common health issues (Kayani *et al*. 2014; Awan *et al*., 2023). *Thymus linearis*, for example, had the greatest FL at 97.5%, followed by *Allium fedtschenkoanum* (76.3%), *Hippophae rhamnoides* (81.3%), and *Delphinium brunonianum* (96.3%) (Bahadur *et al*. 2023). Due to their high FL, these plants are regarded as essential tools in traditional medicine, where they are used to treat ailments like gastrointestinal problems, asthma, and coughs. On the other hand, *Arnebia euchroma* low FL of 6.3% suggested that it was used more specifically in the treatment of lung problems and coughing (Jimenez-Arellanes *et al*. 2003). Further research validates FL's importance in comprehending the cultural significance and therapeutic potential of medicinal plants. (Hussain et al. 2019), for instance, point out that plants with high FL are frequently deeply ingrained in regional medicinal practices, indicating a long history of usage and confidence within the community. In a similar vein, (Khadim *et al.* 2024b) contend that FL represents both the frequency of use and the plant's perceived effectiveness in treating particular conditions. Other research, like Hussain *et al.* (2023), it found that high-FL plants are frequently given priority in conservation efforts because of their cultural and medical significance, which lends additional credence to this. Furthermore, the high FL of *Delphinium brunonianum* and *Thymus linearis* is consistent with the results of (Arshad *et al.* 2012), who indicated that both species are highly appreciated for comparable medicinal objectives in other countries. This uniformity among various geographic regions emphasizes how widely acknowledged the therapeutic benefits of these plants are. *Arnebia euchroma* comparatively low FL indicates restricted recognition or a smaller variety of applications; this pattern was also seen by *Awan et al.* (2023), who connected lower FL values to plants with more specialized or obscure uses. These findings collectively underscore the importance of documenting and preserving traditional knowledge associated with high-FL plants, as they represent vital components of cultural heritage and biodiversity. The study of FL not only provides insights into traditional healthcare systems but also guides the development of sustainable management and conservation strategies for these valuable plant resources.

Informant Consensus Factor (ICF)

Our research findings showed substantial informant consensus on the efficacy of specific plant species in treating various problems, with Informant Consensus Factor (ICF) values of 1 indicating unanimous agreement for ailments such as infertility, diarrhea, asthma, and others. Disorders such as respiratory and gastrointestinal troubles have a somewhat lower but considerable consensus (ICF 0.8-0.9), but anti-inflammatory effects have a lower consensus (ICF 0.7). These findings illustrate the reliability of traditional plant use for specific health concerns across cultural contexts, indicating subjects for further research to improve our understanding and use of medicinal plants. Table 3 depicts the deployment of the ICF. These findings illustrate the reliability of traditional plant use for specific health concerns across cultural contexts, indicating subjects for further research to improve our understanding and use of medicinal plants. Table 3 depicts the deployment of the ICF.

Table 3. Informant Consensus Factor (ICF) values plants species

Disorder	Nt	Nt %	Nur	Nur%	ICF
Infertility	1	1.6	20	3	1
Respiratory Disorder	8	13.1	50	7.4	0.9
Stomach Problem	12	19.7	60	8.9	0.8
Diarrhea	2	3.3	67	10	1
Asthma	3	4.9	70	10	1
Fever and Cough	7	11.5	90	13	0.9
Anti-inflammatory	5	8.2	15	2.2	0.7
Pneumonia	1	1.6	100	15	1
Kidney problem	2	3.3	34	5.1	1
Pain Killer	3	4.9	45	6.7	1
Anti-diuretic	1	1.6	30	4.5	1
Blood pressure	5	8.2	17	2.5	0.8
Anti-cancer	1	1.6	9	1.3	1
Anti-septic	1	1.6	7	1	1
Tonic	5	8.2	25	3.7	0.8
Allergy	1	1.6	6	0.9	1
Anti-Hepatitis	1	1.6	4	0.6	1
Skin problem	2	3.3	23	3.4	1

The term 'Nur' represents the count of use reports for each disease category, while 'Nt' signifies the cumulative number of species used in that category by all informants. The 'ICF,' or Informant Consensus Factor, quantifies this consensus among informants regarding the utilization of specific plant species for a given disease category.

In recent research, the Informant Consensus Factor (ICF) was used to assess informant agreement on plant species chosen for various diseases (Boro *et al.* 2023). Significant findings included a high ICF value of 0.91 for digestive system problems, demonstrating widespread agreement on the efficacy of specific plants (Panmei *et al.* 2019) conducted research in Manipur, northeast India. Similarly, plants are widely used for digestive disorders, suggesting a global trend in herbal remedies (Jimenez-Arellanes *et al.* 2003; Kayani *et al.* 2014; Bahadur *et al.* 2023). Pneumonia had a significant ICF value of 0.90, whereas cancer had the lowest ICF value of 0, owing to informant differences on plant selections for this category. Our contribution to the medical understanding of ICF includes a thorough examination of a specific cultural context, emphasizing the significance of traditional knowledge in herbal therapy. These findings verify the persistent dependence on specific plants in a variety of cultural situations, demonstrating the strength of traditional knowledge systems and their potential to inform current medicinal practices

Unveiling Cultural Beliefs and Practices

In Haramosh Valley, indigenous flora such as *Juniperus excelsa*, *Rhododendron hypenanthum*, *Pinus*, *Betula utilis*, *Delphinium brunonianum*, and *Spiraea canescens* are very culturally significant. *Juniperus excelsa* is valued for its scented branches, which are thought to improve household happiness and mental well-being. *Rhododendron hypenanthum* is grown for its beauty and symbolic value, as well as for its smell, which enhances daily living. Pinus passively observes traditional activities, indicating the valley's reliance on its natural environment. Betula utilis and *Delphinium brunonianum* are cherished as symbols of prosperity and good fortune. *Spiraea canescens*, with their medicinal and symbolic importance, contribute to the valley's cultural legacy by serving as essential components in rituals and beliefs. These plants not only contribute to local traditions but also improve the community's connection to its botanical past, demonstrating a harmonious interaction between nature and cultural identity in Haramosh Valley.

In a recent study, researchers investigated the deep cultural and mythical relationships between the Gilgit Baltistan population and particular indigenous plants (Abbas *et al.* 2016). For example, *Rhododendron hypenanthum* is prized in local houses for its aroma, which is thought to promote happiness and a happy environment. The Dayal population in Gilgit Baltistan receives spiritual insights by inhaling *Juniperus excelsa* leaf smoke, which reveals hidden mysteries and the influence of malicious spirits (Abbas *et al.* 2016). These findings are critical for community well-being, influencing customs and attitudes. Furthermore, the cultivation of *Rosa webbiana* and *Fragaria nubicola* is praised for adding beauty to the environment and delivering joy through their scented presence. Similarly, *Betula utilis* and *Delphinium brunonianum* are deeply embedded in the community's cultural fabric as symbols of prosperity and well-being. *Rosa webbiana* and *Fragaria nubicola* cultivation is recognized for its ability to enhance the attractiveness of its surroundings while also delivering joy with its scented presence. Similarly*,* *Betula utilis* and *Delphinium brunonianum* have significant cultural importance as symbols of prosperity and well-being.

Our research adds to our understanding of the complex cultural ties between plant species by offering a detailed picture of how these plants are intertwined with local practices and beliefs. This information is critical for maintaining cultural history and supporting the sustainable use of botanical resources, emphasizing the importance of traditional practices in modern ethnobotany.

The Jaccard Similarity Index (JI%)

Table 4 displays the Jaccard Similarity Index (JI%) for three study areas: Maruk Nallah, Haramosh Valley, and Haramosh and Bagrote Valley, concerning medicinal plant species. Plant species overlap varies according to the JI% values; the least comparable plant species are found in the Haramosh Valley (28.79%), followed by Maruk Nallah (36.84%), and Haramosh and Bagrote Valley (44.25%). These findings imply that although Maruk Nallah and Haramosh Valley preserve more rare species, Bagrote Valley and Haramosh Valley have a comparatively stronger interchange of ethnobotanical knowledge or similar environmental factors impacting plant use. The variations in JI% show how distinctive and varied each region's knowledge of medicinal plants is, and how these variations may be influenced by regional, cultural, and ecological factors. Because of their richness, these areas' traditional ethnobotanical practices should be preserved, and their medicinal plant usage should be further investigated.

Table 4. Jaccard Similarity Index JI% values

Study area	NRSAA	TSCBA	SEOOA	JI%	Citation
Haramosh Valley	20	19	65	28.79%	(Khan and Khatoo, 2004)
Haramosh and Bagrote Valley	98	50	65	44.25%	Khan and Khatoo, 2008
Maruk Nallah	65	35	65	36.84%	(Abbas et al.2019)

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

Utilizing the Jaccard Similarity Index (JI) in ethnobotanical research has shown to be a successful technique for measuring the extent of agreement between disparate study findings. The highest JI value of 23.24 recorded by (Uddin *et al.* 2013) serves as an example of this, showing a high degree of similarity with the ethnomedicinal plant species found in this investigation. These high JI values point to a notable overlap in the plant species used in traditional medicine, indicating regional or cultural similarities in ethnomedical practices. Studies with lower JI values, on the other hand, show a higher diversity in ethnomedicinal plant species and disclose particular regional or cultural practices. To illustrate the regional character of traditional medicinal knowledge, (Khan *et al*. 2016) conducted a study on ethnobotanical practices in northern Pakistan. Their findings revealed a JI of 0.45, indicating a different group of ethnomedicinal plants compared to other locations. In a similar vein, research carried out in Bangladesh by (Rahman *et al.* 2018) revealed a lower JI of 0.32, showing notable variations from the plant species found in other studies, even those from nearby nations (Rahman *et al*. 2018). This version highlights how crucial it is to conduct ethnobotanical surveys unique to a given area to fully document the range of knowledge about medicinal plants in that area. The variation in JI values across studies reflects the complex interplay between environmental, cultural, and historical factors influencing ethnomedicinal practices. For example, the study by (Sharma *et al.* 2020) in the Himalayan region showed a moderate JI of 7.18, highlighting both shared and unique ethnomedicinal practices compared to other Himalayan and sub-Himalayan studies (Sharma *et al*. 2020).

Overall, these comparisons underline the value of the Jaccard Similarity Index in ethnobotanical research for identifying both common and distinct elements of traditional medicinal knowledge across different regions. Future studies could benefit from incorporating JI analyses to further elucidate the relationships between ethnomedicinal practices and their geographical or cultural contexts.

Conclusion

The study revealed ethnic communities' great competence in comprehending the healing properties of wild medicinal plants. This unique traditional knowledge, which is essential for their healing techniques, has been passed down orally through centuries but lacks meaningful documentation. This study sought to document this traditional knowledge and practices. Our study emphasizes the importance of alpine medicinal plants in traditional medicine by showing their great diversity, consumption patterns across diverse plant sections, techniques of use, and ethnobotanical significance. The indices such as RFC, UV, FL, and ICF were used to validate the results. With 42 perennial herbs species, were the most prevalent habit group; shrubs (13 species), annual herbs (5 species), and trees (one species each) were the next most represented habit category. The significant ethnomedicinal usage of *Pleurospermum candollei, Swertia cordata, Bergenia stracheyi, Mentha arvensis, Primula denticulata*, and *Primula macrophylla* was highlighted by their high Relative Frequency of Citation (RFC) values (0.92) and 100% Fidelity Level. This study advances our grasp of traditional knowledge while also promoting biodiversity protection and the development of effective herbal treatments. This study scientifically documented the indigenous knowledge of medicinal plants and highlighted the necessary conservation measures to ensure their sustainable use by locals for ethnomedicine. In cooperation with the local government and communities, this study suggested that creating Community-Based Conservation Committees, holding workshops to increase capacity, starting public awareness campaigns, and creating incentive programs will ensure the sustainable utilization and conservation of these medicinally used plants. Future studies should investigate the sustainable use of the area's flora, the protection of these plants, and the evaluation and validation of their chemical composition for treating ailments.

Declarations

Abbreviations: UV (Use Value), RFC (Relative Frequency Citation), FL (Fidelity Level), ICF (Informant Consensus Factor), Nur' (count of use reports for each disease), Nt (the cumulative number of species used), H (Herb), Sh (Shrub), T (Tree).

Ethics Approval and Consent to Participate: Prior oral informed consent was obtained from all interviewees.

Consent for Publication: Individuals depicted in the images provided prior oral informed consent for the display of their images.

Author's contributions: Led by the adept management of primary author Hasnain Abbas, the research seamlessly navigated planning, data collection, specimen preparation, identification, results analysis, and manuscript production. In a supervisory role, Sher Wali Khan contributed to research design, aided in specimen identification, and facilitated results analysis. Actively involved in specimen collection, Heera Ali and Salim Khadim provided crucial support in pressing, mounting, and professional formatting. Together, their collaborative efforts ensured a comprehensive and well-executed study on the ethnobotanical inventory and indigenous therapeutic applications of wild medicinal plants in Haramosh Valley, Gilgit-Baltistan, Pakistan.
Conflicts of interest: The authors have no conflicts of interest to declare.
Funding: The study, titled " Ethnobotanical Applications of Medicinal Plants in the Alpine Flora of Marukh and Asogaha Nallah, Haramosh Valley, District Gilgit," was conducted without receiving any funding.

Acknowledgments

This research paper constitutes a vital component of Mr. Hasnain Abbas's MS/M.Phil. Thesis. I extend my sincere appreciation to all respondents for their active participation and valuable insights. My heartfelt acknowledgment goes to my parents, Mr. Mussayiab Hussain, and my dedicated students for their unwavering moral support and assistance in the meticulous collection and management of plant specimens. Special gratitude is reserved for Karakoram International University Gilgit, which fostered an optimal research environment.

Literature cited

Abbas H, Ali H, Khan SW, Hussain N, Haider T, Ismail M, Noor A, Khadim S, Haider S. 2023. Phytochemical Investigation of High Potential Medicinal Plants for Friendly Insect Pest Management at Heramosh, District Gilgit. Plant Protection, 7(3):535-544.

Abbas Q, Hussain A, Khan SW, Hussain A, Shinwari S, Hussain A, Ullah A, Zafar M, Ali K. 2019. Floristic diversity, ethnobotany, and traditional recipes of medicinal plants of Maruk Nallah, Haramosh Valley, District Gilgit, Gilgit Baltistan. Proceedings of the Pakistan Academy of Sciences: Part B 56(3B):97-112.

Abbas Q, Qureshi R Un A, Naqvi N, Khan SW, Hussain I. 2013. Floristic inventory and ethnobotanical study of the Naltar valley (Karakoram range), Gilgit, Pakistan. Pakistan Journal of Botany 45:269-277.

Abouri M, Mousadik AEl, Msanda F, Boubaker H, Saadi B, Cherifi K. 2012. An ethnobotanical survey of medicinal plants used in the Tata Province, Morocco. International Journal of Medicinal Plants Research 1(7):99-123.

Arshad Ali Shedayi. 2012. Ethnomedicinal uses of plant resources in Gilgit-Baltistan of Pakistan. Journal of Medicinal Plants Research 6(29):4540-4549.

Arshad AS, Ming X, Bibi G. 2014. Traditional medicinal uses of plants in Gilgit-Baltistan, Pakistan. Journal of Medicinal Plants Research 8(30):1-13.

Albuquerque UPDe, Hurrell JA. 2010. Recent Developments and Case Studies in Ethnobotany. Ethnobotany: one concept and many interpretations. SBEE/NUPEEA, pp.87-99.

Awan MS, Dar MEUI, Hussain K, Sabir S, Iqbal T, Mehmood A, Habib T. 2023. Ethnomedicinal utilization and conservation status of highland flora from Western Himalayas of Azad Jammu and Kashmir, Pakistan. Ethnobotany Research and Applications 26:1-20.

Begum F, Alam M, Mumtaz S, Ali M, Wafee S, Khan M Z, Ali K Hussain I, Khan A. 2019. Soil Quality Variation under Different Land Use Types in Haramosh Valley, Gilgit, Pakistan. International Journal of Economic and Environmental Geology 10(2) 32-37.

Bibi S, Sultana J, Sultana H, Naseem R. 2014. Ethnobotanical uses of medicinal plants in the highlands. Journal of Ethnopharmacology 155(1):352-361.

Boro M, Das B, Boro KK, Nath M, Buragohain P, Roy S, Sarma PJ, Kalita S, Nath N. 2023. Quantitative ethnobotany of medicinal plants used by the Bodo Community of Baksa District, Assam, India. Biodiversitas 24(6):3169-3182.

Bahadur S, Ahmad M, Zafar M, Begum N, Yaseen M, Ali M, Kumar T. 2023. Ethnomedicinal relevance of selected monocot taxa from different geographical regions of Pakistan. Ethnobotany Research and Applications 26:1-17.

Bano A, Ahmad M, Hadda TB, Saboor A, Sultana S, Zafar M, Khan MPZ, Arshad M, Ashraf MA. 2014a. Quantitative ethnomedicinal study of plants used in the skardu valley at high altitude of Karakoram-Himalayan range, Pakistan. Journal of Ethnobiology and Ethnomedicine 10(1):10-43.

Chisamile W A, Sonibare M A, Kamanula J F .2023. Ethnobotanical Study of Traditional Medicinal Plants Used for the Treatment of Infectious Diseases by Local Communities in Traditional Authority (T/A) Mbelwa, Mzimba District, Northern Region, Malawi. J 6(1): 115-139.

Chivian, E. 2002. Biodiversity: its importance to human health. Center for Health and the Global Environment, Harvard Medical School, Cambridge, MA 23, Pp 6-49

Coale A J. 1991. Excess female mortality and the balance of the sexes in the population. an estimate of the number of" missing females". The Population and Development Review 17(3):517-523.

Goodman SM, Ghafoor A. 2011. The ethnobotany of southern Balochistan, Pakistan: with particular reference to medicinal plants 31:1-84.

Hong L, Guo Z, Huang K, Wei S, Liu B, Meng S, Long C. 2015. Ethnobotanical study on medicinal plants used by Maonan people in China. Journal of Ethnobiology and Ethnomedicine 11(1):1-35.

Hussain N, Abbas H, Shahab-Ud-din, Ali H, Abbas A, Hussain S, Khadim S, Hussain S, Hussain W, Din S U, Razaq A. 2023. Assessment And In Vitro Control of Pomegranate Fruit Rot Disease in Gilgit District, Pakistan. Plant Protection 7(2):207-216.

Hussain S, Baig A A, Abbas H, Hussain W, Hussain N, Din SU. 2024. Exploring informed consent and the utilization of traditional medicinal plants in Roundu Valley, Gilgit Baltistan. Pure and Applied Biology 13(2):101-111.

Hussain S, Hamid A, Ahmad KS, Mehmood A, Nawaz F, Ahmed H. 2019. Quantitative ethnopharmacological profiling of medicinal shrubs used by indigenous communities of Rawalakot, District Poonch, Azad Jammu and Kashmir, Pakistan. Revista Brasileira de Farmacognosia 29(5):665-676.

Ikramullah K, Razzaq, Islam M. 2007. Ethnobotanic al studies of some medicinal and aromatic plants at higher altitudes of Pakistan. American Eurasian Journal of Agricultural and Environmental Science 2(5):470-473.

Ishtiaq S, Hanif U, Shaheen S, Bahadur S, Liaqat I, Awan UF, Shahid MG, Shuaib M, Zaman W, Meo M. 2020. Antioxidant potential and chemical characterization of bioactive compounds from a medicinal plant Colebrokea oppositifolia Sm. Anais da Academia Brasileira de Ciências 92(2): e20190387.

Jorge J S, Sousa P H P, de Albuquerque França, B R Santos R L, Freire E M X, Caliman A. 2023. Among flowers and thorns: birds associated with Encholirium spectabile, a keystone bromeliad in a Brazilian semi-arid region. Ornithology Research 31(2):93-102.

Jimenez-Arellanes A, Meckes M, Ramirez R, Torres J, Luna-Herrera J. 2003. Activity against multidrug-resistant Mycobacterium tuberculosis in Mexican plants used to treat respiratory diseases. Phytotherapy Research 17(8):903-908.

Karima, Hyder S, Khadim S, Zehra N, Shahnaz, Zeshan, Ali R, Abbass A. 2024. Analyzing phytoecological significance of floral biodiversity in Rahim Abad, District Gilgit, Pakistan. International Journal of Agriculture and Biology 31(4):235–242.

Khadim S, Hyder S, Zuhra T, Abbas H.2024a. Ethnobotanical inventory and indigenous therapeutic applications of wild medicinal plants in Parishing valley. Ethnobotany Research and Application 28(32):1-26.

Khadim S, Hyder S, Shedayi AA, Zuhra T, Abbas H. 2024b. Ethnobotanical applications of medicinal plants of family Asteraceae in Allah Wali Lake Gutumsar, District Astore, Gilgit-Baltistan, Pakistan. Ethnobotany Research and Applications 29(16):1-17.

Khan B, Abdukadir A, Qureshi R, Mustafa G. 2011. Medicinal Uses of Plants by The Inhabitants Of Khunjerab National Park, Gilgit, Pakistan. Pakistan Journal of Botany 43(5):2301-2310.

Khan K, Erum A, Ahmad B, Akram M, Anwar M, Junaid A, Saleem U. 2009. Ethnobotanical Studies From Northern Areas of Pakistan. National Library of Medicine 21(1):52-57.

Khan SW, Khatoon S. 2008. Ethnobotanical studies on some useful herbs of Haramosh and Bugrote valleys in Gilgit, northern areas of Pakistan. Pakistan Journal of Botany 40(1):20-43.

Khan S W, Khatoon S, Abbas Q, Raza G, Hussain A. 2016. Inventory of the alpine flora of Haramosh and Bagrote valleys (Karakoram range) district Gilgit, Gilgit-Baltistan, Pakistan. Pakistan Journal of Botany 48(4):1559-1572.

Khan S W, Khatoon S, Hussain A, Abbas H, Ali H. 2018. Inventorying and monitoring of alpine specific genera and species of Haramosh and Bagraote valleys, (Karakoram range) Gilgit-Baltistan, Pakistan. Pakistan Journal of Agricultural Sciences 55(3):595-601.

Khan MA, Ullah N, Ahmad M. 2016. Ethnobotanical studies of medicinal plants used by indigenous communities in northern Pakistan. Journal of Ethnopharmacology 189:139-150.

Kayani S, Ahmad M, Sultana S, Khan Shinwari Z, Zafar M, Yaseen G, Hussain M, Bibi T. 2015. Ethnobotany of medicinal plants among the communities of Alpine and Sub-alpine regions of Pakistan. Journal of Ethnopharmacology 164:186-202.

Leonti M. 2022. The relevance of quantitative ethnobotanical indices for ethnopharmacology and ethnobotany. Journal of Ethnopharmacology 288:115008.

Malik K, Ahmad M, Zafar M, Ullah R, Mahmood H. M, Parveen B, Rashid,N, Sultana S, Shah S N, Lubna. 2019. An ethnobotanical study of medicinal plants used to treat skin diseases in northern Pakistan. BMC Complementary and Alternative Medicine 19(1):1-38

Masondo N A, Stafford G. I, Aremu A O, Makunga NP. 2019. South African Journal of Botany Acetylcholinesterase inhibitors from southern African plants.An overview of ethnobotanical , pharmacological potential and phytochemical research including and beyond Alzheimer ' s disease treatment. South African Journal of Botany 120:39-64.

Pan SY, Zhou SF, Gao SH, Yu ZL, Zhang SF, Tang MK, Sun JN, Ma DL, Han YF, Fong WF. 2013. New perspectives on how to discover drugs from herbal medicines. CAM's outstanding contribution to modern therapeutics. Evidence-Based Complementary and Alternative Medicine.

Pesek T, Cal M, Cal V, Fini N, Minty C, Dunham P, Sanchez P, Poveda L, Arnason J. 2006. Rapid ethnobotanical survey of the Maya mountains range in southern Belize, Central America: a pilot study. Trees Life Journal 10(1):1-12.

Pradhan SP, Chaudhary RP, Sigdel S, Pandey BP. 2020. Ethnobotanical knowledge of Khandadevi and Gokulganga rural municipality of Ramechhap district of Nepal. Ethnobotany Research and Applications 20:1-32.

Qureshi R A, Ghufran M A, Sultana K N, Ashraf M, Khan A G. 2006. Ethnobotanical Studies of Medicinal Plants of Gilgit District and Surrounding Areas. Ethnobotany Research and Applications 5:115-122.

Rahman M, Hossain MB, Islam MT. 2018. A comparative study of ethnomedicinal plants used by different ethnic groups in Bangladesh. Asian Pacific Journal of Tropical Biomedicine 8(2):135-144.

Rehman S, Iqbal Z, Qureshi R, Shah G M. 2023. Quantitative ethnobotanical study of medicinal plants used by the indigenous communities of Shawal Valley, District North Waziristan, Pakistan. Ethnobotany Research and Applications 25(5):1-24.

Rubab S, Rizwani GH, Bahadur S, Shah M, Alsamadany H, Alzahrani Y, Alghamdi SA, Anwar Y, Shuaib M, Shah AA, Muhammad I. 2020. Neuropharmacological potential of various morphological parts of Camellia sinensis L. Saudi Journal of Biological Sciences 27(1):567-573.

Shengji P, Sheng-ji P. 2011. Ethnobotanical Approaches of Traditional Medicine Studies. Some Experiences From Asia Ethnobotanical Approaches of Traditional Medicinel Studies. 0209 (May).

Shaheen H, Aziz S, Nasar S, Waheed M, Manzoor M, Siddiqui MH, Alamri S, Haq SM, Bussmann RW. 2023. Distribution patterns of alpine flora for long-term monitoring of global change along a wide elevational gradient in the Western Himalayas. Global Ecology and Conservation 48: e02702

Shah IA, Burni T, Badshah L, Uza NU, Bussmann RW. 2023. Quantitative ethnobotanical study and conservation status of herbal flora of Koh-e-Suleman range, Razmak valley, North Waziristan, Pakistan. Ethnobotany Research and Applications 25:1-18.

Sharm R, Kumar A, Singh V. 2020. Ethnobotanical practices in the Himalayan region: A comparative analysis using the Jaccard Similarity Index. Journal of Ethnobiology and Ethnomedicine 16(1):42.

Tahir M, Asnake H, Beyene T, Van Damme P, Mohammed A. 2023. Ethnobotanical study of medicinal plants in Asagirt District, Northeastern Ethiopia. Tropical Medicine and Health 51(1):1-13.

Zareef H, Sarim FM, Qureshi R. 2023. Quantitative ethno-gynecological survey of traditional medicinal plants from Punjab province, Pakistan. Ethnobotany Research and Applications 26:1-20.

Zehra N, Hyder S, Khadim S, Zeeshan M, Ali R, Abbas A, Shahnaz, Karima. 2024. The phytoclimatic spectrum of weed flora of Nomal valley, District Gilgit, Gilgit-Baltistan, Pakistan. International Journal of Agriculture and Biology 32(2):136–144