Ethnoveterinary utilization of medicinal plants in Ghamot National Park Western Himalayas of Azad Jammu and Kashmir, Pakistan

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Research

Abstract

Background: The local communities in Pakistan possess extensive traditional knowledge about indigenous medicinal plants, which has been passed down through generations for centuries. However, this invaluable ethnic knowledge is currently facing a threat to its preservation. In Pakistan, research on medicinal plants predominantly centers on documenting the local flora and its applications. The indigenous population, with ancestral wisdom, holds traditional insights into the uses of regional plants. Ethno-veterinary medicine encompasses the collective beliefs, expertise, techniques, and customs within communities concerning animal welfare, particularly prominent in rural settings where it serves as a primary approach to livestock treatment. This study aims to address the existing knowledge gap by documenting ethno-veterinary knowledge from this untapped area. The specific objectives are focused on recording the essential ethno-veterinary applications of local plant species by mountain populations in treating livestock ailments and disorders.

Methods: Data regarding the use of ethno-medicinal plants for treating livestock ailments were gathered through a semi-structured questionnaire, one-on-one interviews, and group discussions. From 2022 to 2023, we interviewed 124 individuals about 28 plant species, with the majority of ethno-veterinary data coming from respondents in the 40–69 age groups. The frequency of citation was determined to assess how often a specific plant species was mentioned for treating veterinary diseases. Additionally, the Use Value (UV) for each species was computed using UV = FC/N.

Results: The research identified 28 medicinal plants from 22 different plant families used for treating 23 distinct livestock ailments. These plants comprised 21 herbs (75% of the total), 5 shrubs (17.85%), and 2 trees (7.14%). The dominant plant family was Asteraceae (3sp.). Roots (46%) were the primary plant part used in medicines, and paste (19 sp.) was the most common herbal formulation method. Most medicinal plants (8) were employed to cure digestive system diseases such as dysentery and indigestion. A comparison of the collected medicinal plants and related indigenous medicinal knowledge was made with previously published work on surrounding areas.

Conclusion: This study assumes a vital role in preserving indigenous plant-based knowledge from potential oblivion and introduces new ethno-veterinary applications in the region. Further investigations involving phytochemical and pharmacological assessments are necessary to isolate active compounds and evaluate plant efficacy against specific veterinary diseases, both in vitro and in vivo. Comprehensive toxicological studies are also imperative to ensure the safe and secure utilization of documented ethno-medicines.

Keywords: Ethno-veterinary, Medicinal plants, Western Himalayas, Ghamot National Park

Background

In Pakistan, a substantial majority (60.78%) of the population resides in rural areas, grappling with challenges such as poverty, illiteracy, limited healthcare awareness, and restricted access to quality services (Popovic *et al.* 2016). The healthcare system, divided into public and private sectors, contends with issues like underutilization, political interference, shortages in human resources, and insufficient facilities (Gwalwanshi *et al.* 2014, Popovic *et al.* 2016). The private sector, comprising recognized and unrecognized healthcare entities, is often preferred by the local population due to its accessibility, affordability, and societal influence, especially for conditions like depression, epilepsy, infertility, and psychosomatic troubles (Jan *et al.* 2019).

Medicinal plant research in Pakistan primarily concentrates on documenting ethnic values, capitalizing on the extensive traditional knowledge passed down through generations (Popovic *et al.* 2016). Nevertheless, this knowledge is under the threat of diminishing interest among younger generations (Popovic *et al.* 2016). The Western Himalayan Mountains of the Kashmir region, characterized by rich biodiversity, host a mosaic of diverse niches and habitats (Alam *et al.* 2011, Hamayun *et al.* 2006). The agro-pastoral semi-nomadic lifestyle of rural mountain communities in Kashmir, relying on livestock rearing and subsistence agriculture, further underscores the importance of indigenous knowledge (Sher & Hussain 2011).

This invaluable indigenous knowledge, pivotal for ethno-veterinary practices, faces the risk of erosion amidst rapid socioeconomic changes, environmental shifts, and technological advancements (Jan *et al.* 2020). While existing research extensively covers ethno-medicinal applications for human health (Alam *et al.* 2011, Ahmed *et al.* 2015, Forman & Birdson 2013), a substantial knowledge gap persists concerning ethno-veterinary applications of local herbs in the Kashmir region (Bhatia *et al.* 2014, Shah *et al.* 2016).

Despite limited studies on indigenous ethno-veterinary practices in various parts of Pakistan (Farooq *et al.* 2019, Mangestu *et al.* 2008, Shah *et al.* 2016), the western Himalayan mountain region of Kashmir has remained largely unexplored due to its remoteness, harsh climatic conditions, and rugged terrain. The present study aims to address this knowledge gap by documenting ethno-veterinary knowledge from this unexplored area, with specific objectives focused on recording the essential ethno-veterinary applications of local plant species used by the mountain populations in treating livestock ailments and disorders. This study will help familiarize the local and surrounding communities with the novel medicinal uses of already known medicinal plants as well as newly reported medicinal plants.

Materials and Methods

Study area

Ghamot National Park (GNP) is situated in the upper Neelum valley, a part of the inner Himalayas, positioned 170 km north of Muzaffarabad, the capital of Azad Jammu and Kashmir. The designated area encompasses the Sharda Range, specifically Sharda Forest Division's Surgan block compartments numbered 16 and 17, covering a total expanse of 27,271 hectares (67,388 acres). Originally declared as a Game Reserve on July 28, 1982, under the AJK Wildlife Act 1975, this region was subsequently upgraded to a National Park (GNP) through a government notification (no SJ-F-O-02(14)/08-1212/2004) dated April 15, 2004. The primary objective of this designation is to ensure sustainable conservation and management of the area's natural resources, with active participation from local communities. The study area is positioned between latitude 35° 24 N and longitude 73° 57 E, spanning an elevation from 2439 to 4949 meters above sea level. GNP is located on the periphery of Surgan Nullah, approximately 25 km away from Sharda. To its west lies the Kaghan Valley in NWFP, while to the east is Indian-occupied Jammu & Kashmir. The National Park encompasses two forest compartments, namely 16 and 17, falling within the Sharda Forest Range (Baig 2012, GoAJ&K 2018, Jahangeer *et al.* 2023, Khan *et al.* 2010, Qamar *et al.* 2005, Qamar *et al.* 2008) (Figure 1).

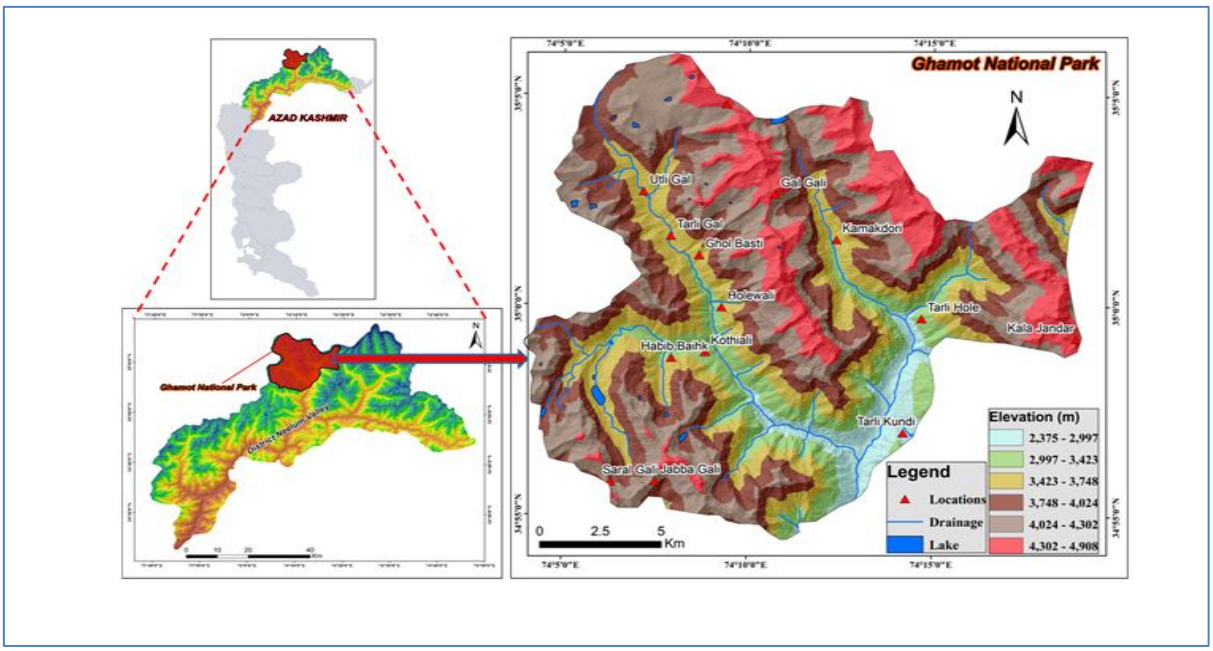

Figure 1. Location map of study area

Topography

The research area encompasses mountainous terrain characterized by sheer and irregular topography, fragile geology, and a climate marked by snowfall and rainfall. It is nestled within deep valleys and high ridges, featuring slopes that are exceptionally steep, reaching up to 100% incline at numerous sites and extending for hundreds of meters. The region experiences common occurrences of landslides and glacier slides due to loose rocks, steep slopes, inadequate land use practices, diminished vegetation, and substantial rainfall. Dotted throughout the area are 25 freshwater springs, and it is traversed by four perennial streams, Hula Bhaik, Sora, Kali Jander, and Saralfed by cold and clear water originating from the melting snow on mountain peaks. These streams converge to form Surgan Nullah, and upon reaching the union council Sharda, it joins the Neelum River (Jahangeer *et al.* 2023, Qamar *et al.* 2005) (Figure 2).

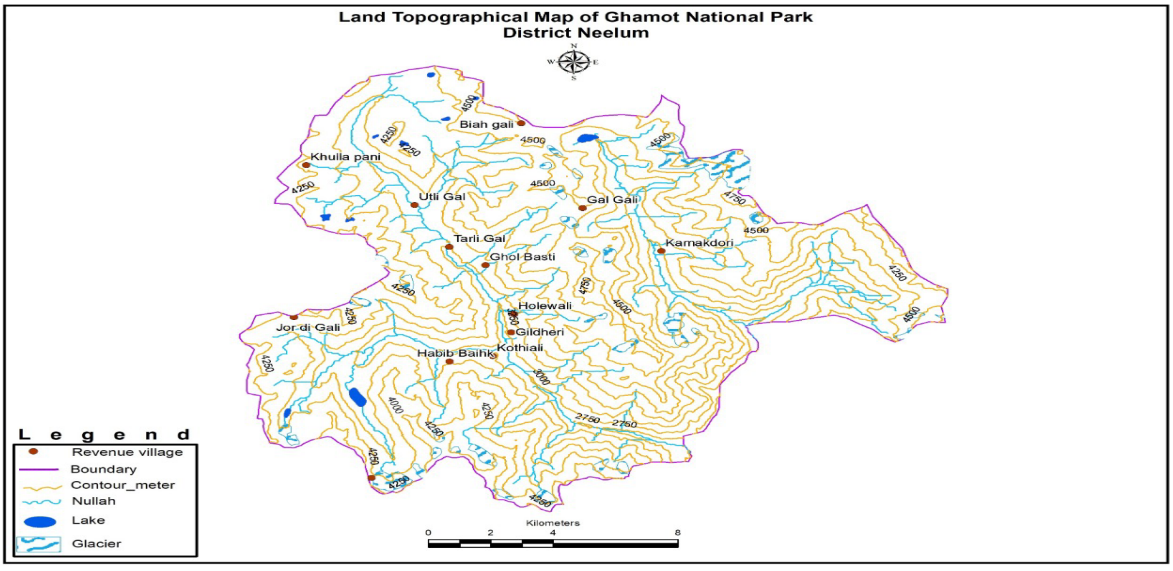

Figure 2. Land Topographical map of study area

Climate

The Neelum Valley region is situated within the climatic zone of sub-tropical highlands. While the climate in the area fluctuates with altitude, the forested regions generally encompass moist temperate forests, dry temperate forests, sub-alpine scrub, and alpine pastures. Winters are characterized by extremely cold temperatures and heavy snowfall; with high peaks retaining their snow cover until June or even longer, including glaciers. Summers bring a pleasant and cool climate.

Despite some rainfall during the summer, the majority of precipitation occurs in the form of snowfall during the winter season. Meteorological data for the Neelum Valley is not available from the Pakistan Meteorological Department. Instead, data from the nearby Muzaffarabad district is utilized as a representative, recognizing that Muzaffarabad is at significantly lower elevations than the lowest point in the study area. The recorded average rainfall in Muzaffarabad from 2017-2019 is 1529.86 mm. Monthly daytime temperatures in Muzaffarabad vary from 9°C in January to 29°C in June and July, while the yearly daytime temperature fluctuates between 18°C and 24°C (Jahangeer *et al.* 2023, Qamar *et al.* 2005, Qamar *et al.* 2008).

Indicator Flora

In previous studies (Jahangeer *et al.* 2023, Ishtiaq *et al.* 2013, Qamar *et al.* 2010) conducted in the Neelum Valley, findings indicated the presence of seven gymnosperm species, 404 angiosperm species, 46 grass species, 33 fern species, and 14 fungi species. The forest working plan for the Sharda forest range offers a comprehensive description of the various forest types within the study area. Noteworthy wildlife species identified include Cedrus deodara, Pinus willichiana, Abies pindrow, Picea smithiana, Aesculus indica, Vibernum nervosum, Sassurea lappa, and Pyrus pashia (Ahmad *et al.* 2017, Qamar *et al.* 2005) (Figure 3).

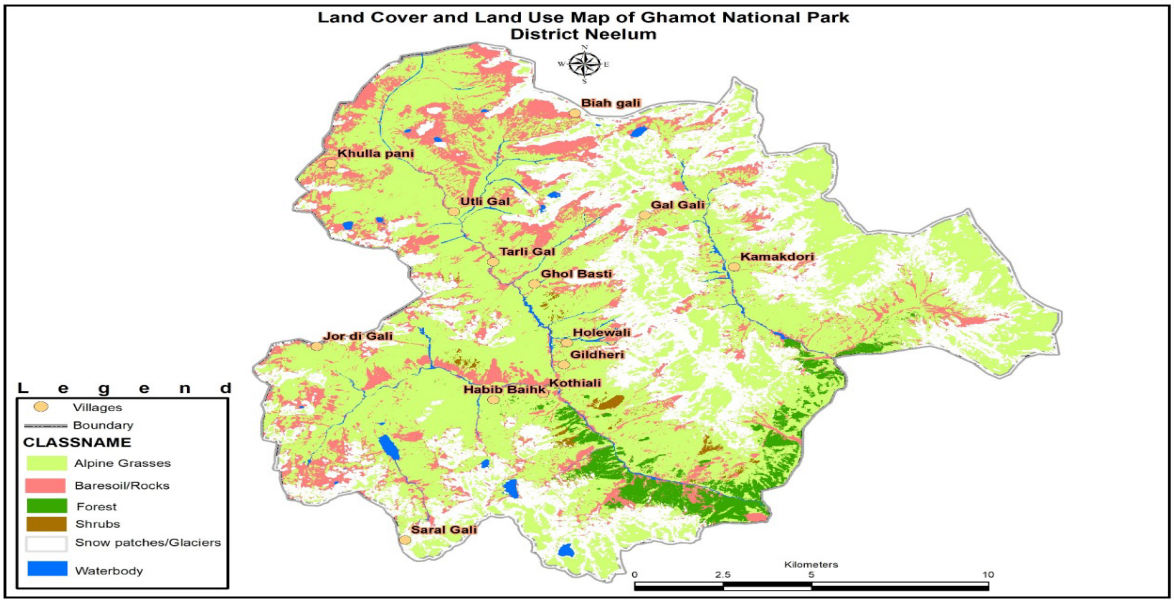

Figure 3. Land cover and land use map of study area

Indicator Wildlife Species

The study area is strategically located at the convergence of three renowned mountain systems, namely the Hindu Kush, Karakorum, and Himalaya. Serving as a natural boundary for environmental zones within these mountainous regions, this distinctive arrangement contributes to a rich floral and faunal biodiversity. In addition to hosting numerous economically significant plant and animal species, the study area serves as a habitat for rare and globally valuable wildlife. A prior study (Qamar *et al.* 2005) reported the presence of 12 mammals, 35 bird species, including notable wildlife species such as the Snow leopard (Uncia uncia), Common leopard (Panthera pardus), Himalayan ibex (Capra ibex), Musk deer (Moschus chrysogaster), Black Bear (Ursus thibetanus), Brown Bear (Ursus arctos), Monal pheasant (Lophophorus impejanus), and Himalayan Griffon Vulture (Gyps himalayensis) (Abbas *et al.* 2014, Ali *et al.* 2018, Jahangeer *et al.* 2023, Khan *et al.* 2010, Khan *et al.* 2012, Nawaz 2007).

Socio-economic situation

Seven settlements, comprising a total population of approximately 61, 31, and 734 households with an average household size of 8.13, rely on the natural resources within the study area, as reported in the District Census Report of 2017. The male-to-female ratio stands at 49:51, and the entire population is uniformly Muslim, with an overall literacy rate of 17 percent. Ethnic diversity characterizes the community, including groups such as Butt, Loan, Sayyed, Mir, Khawaja, Mughal, Minhas, Chaudhry, Swati, Raja, and Kayani (DCR 2017). The challenging environmental conditions prompt dependent settlements to gravitate towards forested areas, ensuring easy access to grazing lands and forest resources. The local economy hinges on livestock rearing and agriculture, with livestock serving household needs for milk, meat, and wool. Surplus animals and their products are sold for income generation. Cultural and linguistic diversity prevails, with Hindko, Kashmiri, Gojri, Shina, and Pashtu being commonly spoken languages (Jahangeer *et al.* 2023).

The area grapples with low-standard and limited healthcare facilities, as seven out of eight settlements lack basic health services. Surgan village hosts the sole Basic Health Unit (BHU), and the absence of first aid facilities becomes critical, particularly during winter when heavy snowfall blocks roads. Residents often travel to Sharda, Kel, Athmuqum, or Muzaffarabad for serious health issues, presenting life-threatening challenges due to inadequate healthcare (Jahangeer *et al.* 2023, Khan *et al.* 2022).

Limited livelihood opportunities exist in Neelum Valley, especially for pastoralists in the mountainous region of Azad Jammu & Kashmir (AJ&K) and farmers in highly fertile lands. Livestock rearing, a centuries-old tradition plays a vital role in providing farmyard manure, rural transport, and a source of milk and meat. Livestock also contributes to local entertainment through sports like polo and holds a significant position in the rural economy, offering income and employment to smallholder farmers and individuals in impoverished communities (Jahangeer *et al.* 2019). The use of easily accessible ethno-veterinary medicinal plants proves cost-effective for treating various diseases. Due to the inadequacies of modern veterinary health systems, residents often resort to traditional ethno-veterinary practices, and economic constraints limit access to allopathic drugs, resulting in diminished livestock production and financial losses. The promotion of ethno-veterinary medicines as alternative treatments empowers individuals to utilize local remedies, potentially alleviating poverty by enhancing livestock well-being (Rafique *et al.* 2021).

Data Collection

Ethics statement

The data collection adhered to the Code of Ethics of the International Society of Ethnobiology (2008), available at http://ethnobiology.net/code-of-ethics/. Given that the focus of data collection was on animals, individuals closely interacting with the animals became the primary targets. Informants in the localities where data was collected received comprehensive briefings about the research's purpose, and verbal consent was obtained due to the prevalent illiteracy among most informants, making written consent impractical.

For the gathering and documentation of demographic information, well-informed individuals from the relevant area were engaged in interviews and group discussions, employing standardized questionnaires developed for this specific purpose. Ethno-veterinary information was collected during extensive field visits in 2022–2023, utilizing pre-planned questionnaires as standardized data collection protocols (Martin *et al.* 2004, Ocvirk *et al.* 2013). Although Institutional Review Board (IRB) permission was not mandatory for data collection, formal verbal approval from respondents was obtained at each locality.

The methods employed in this study aimed to extract valuable information on the ethno-veterinary uses of medicinal plants among the natives of the Kashmir Himalaya, following established procedures (Martin *et al.* 2004, Ocvirk *et al.* 2013). Field surveys covered various localities, including Ghomat village, Kundi, Kaly Jander, Habib Bahak, and Kamakhodari. Interviews primarily involved elderly and experienced members of tribes, locally referred to as 'Budhair' (aged), typically above the age of forty. The surveyed population included farmers, shepherds, pastoralists, traditional healers, gardeners, shopkeepers, and plant collectors possessing knowledge of veterinary practices. During interviews, plant specimens were presented for authentication of information related to preparation methods, usage, and dosage of each medicinal plant species. Cross-verification of information across different localities was conducted to enhance accuracy (Figure 4).

Plants identification Preservation and herbarium deposition

Specimens were predominantly gathered from the wild, and no specific permits or permissions were required for collection. The majority of the collection took place on public land, which is state property, obviating the need for formal permission from the forest department. In instances where data collection extended to private lands, verbal consent was obtained from the landowners before initiating the collection at each site. Each specimen of medicinal plants, collected from various localities, was assigned a unique collection number for future reference and complemented by checklists for inventory purposes.

The collected plant specimens underwent processing at the Herbarium Department of Botany, University of Azad Jammu & Kashmir in Muzaffarabad. Subsequently, these specimens were identified with the assistance of available literature (Aziz *et al.* 2018, Dilshad *et al.* 2010, Nasir *et al.* 1970). The appropriately processed plant specimens were then deposited in the Herbarium Department of Botany at the University of Azad Jammu & Kashmir, Muzaffarabad (Nasir *et al.* 1970).

Figure 4. Questionnaire, plant collection and identification survey in study area

Data analysis

To evaluate the prominence of specific plant species in treating veterinary diseases within traditional medicinal practices, we calculated the frequency of citation (FC) to determine how often a particular plant species was referenced in comparison to all plant mentions. The relative frequency of citation (RFC) was computed using the formula RFC = FC/N, where FC stands for the number of informants reporting the use of a specific plant species, and N represents the total number of informants in the study (Hoareau 1999). RFC is essentially the citations for a particular species divided by the total citations for all species (MS Awan *et al.* 2023). The frequency of citation for a specific species is then expressed as (Number of citations for that species/Number of citations for all species) x 100.

Additionally, we calculated the Use Value (UV) measure to assess the importance and significance of individual plant species in traditional medicinal practices. The formula used for UV is UV = FC/N, where FC is the frequency of citation for a specific species divided by the total number of informants (N) participating in the study. To determine the relative importance of each species, the formula UVs = XUVi Ni was employed, where 'UVi' represents the use value for a given species among participating informants, and 'Ni' represents the sum of informants (Rafique Khan 2021).

Results and Discussion

In the study area, which encompasses a total of 8 villages with a combined population of 61, 31, and 734 households averaging 8.13 individuals per household, field visits revealed that all permanent settlements are medium-sized. The settlements vary in size from 30 to 90 households, with Surgan Bakwali and Ghamot having larger populations ranging from 115 to 155 households. The average household size varies across villages, with Samgam Mali having the maximum of 9.68 individuals and Ghamot having the minimum of 5.95 individuals. Surgan Bakwali recorded the highest human population (2344; 38.23%), while Kundi had the lowest (108; 1.76%). The female population (3,103; 50.61%) outweighed the male population (3,028; 49.38%), resulting in an average female-to-male ratio of 51:49 in the study area (Jahangeer *et al.* 2023).

Due to the relatively smaller population (61, 31) and study area (27,271 ha), a total of 124 participants were interviewed, including local residents, nomadic Gujjar Bakarwal, and herbalists. Among these participants, the majority (n = 80; 64.5%) were male, and the minority (n=44; 34.48%) were female. This gender distribution reflects cultural norms that limit female participation, with older women being the primary participants in rituals on celebration days. The categorization of respondents into age brackets revealed that a majority (n = 96; 77.41%) belonged to the older age group (41 and above), while a smaller number (n=28; 22.58%) were in the younger age group (25 to 40). There was a noticeable decline in traditional knowledge among informants aged 25 to 40, potentially influenced by modern lifestyle preferences and a smaller number of informants above 70 years of age. Moreover, a decrease in traditional knowledge was observed with a higher literacy rate, aligning with the trend of educated individuals favoring modern healthcare over traditional systems. The decline in the popularity of plant-based therapies for various disorders was particularly evident among the younger generation, while older

respondents, belonging to the elderly age group, retained more ancestral knowledge often passed down through oral tradition. The Nomadic and Pastoral Gujjar Bakarwal Tribes migrate to GNP during the summer season, staying within the park from mid-June to October. They graze their livestock on alpine pastures within the park during the summer and use forested areas as stopover sites on their way to the park. Each Bakarwal family unit, or 'dera,' typically consists of 2-3 brothers or cousins, along with their wives and children. According to discussions held with Bakarwal tribes in August 2022, each dera may have an average herd size ranging from 50-250 animals, primarily sheep and goats. Additionally, deras own horses, donkeys, and shepherding dogs. During field visits and community discussions, the nomadic Gujjar tribes shared substantial knowledge of ethno-veterinary medicine in the study area. This knowledge among the nomads may be linked to their lifestyle, including seasonal migrations to the study area, remoteness, and the limited availability of resources in high mountain regions such as allopathic medicine (Jahangeer *et al.* 2023) (Table 1).

Table 1. Demographic data of the individuals who took part in interviews within Ghamot National Park

Indicator	**Respondent**	
Gender	**Number**	**Percentage**
Male	80	64.5
Female	44	35.48
Age in years		
20-35	28	22.58
36-51	43	34.67
Above 55	53	42.74
Profession		
Farmer	63	50.80
Herbalist	4	3.22
Nomads	53	42.74
Educationist	4	3.22
Education		
Illiterate	44	35.48
Primary-middle (1-8)	37	29.83
Matriculation (9-10)	26	20.96
Intermediate (11-12)	11	8.87
Bachelors (13-16)	4	3.22
Higher education	2	1.61

Taxonomic distribution and growth form of medicinal plants

In our present study, we identified 28 medicinal plants belonging to 22 different plant families, utilized for treating 27 distinct livestock ailments, as detailed in Table 2. These plants comprised 21 herbs (75% of the total), 5 shrubs (17.85%), and 2 trees (7.14%). The prevalence of herbs in the medicinal plant inventory may be attributed to their better adaptability to the climate and geography of the research area. Herbs, being more potent and fast-growing compared to shrubs or trees often have an advantage. Their easy availability and diverse bioactive compounds contribute to their adaptability to various climatic conditions. Moreover, herbs typically exhibit a higher concentration of bioactive compounds and greater medicinal efficacy than shrubs and trees, especially in high-altitude regions characterized by a more herbaceous flora (Haq *et al.* 2022, Haq & Singh 2020, Malik *et al.* 2019, Shah & Rahim 2017).

Examining the plant families associated with these medicinal species, Asteraceae emerged as the most prominent, contributing 3 different species. It was followed by Alliaceae (2 species), Polygonaceae (2 species), Apiaceae (2 species), and Berberidaceae (2 species). The remaining 17 plant families each had one species associated with them (as listed in Table 2). The widespread distribution of these families in the study area likely contributes to their dominance. Asteraceae, being the most prevalent family in Pakistan, holds a significant presence in the study area. Its dominance is supported by various studies in both the study area and surrounding regions. Similarly, the prevalence of Polygonaceae, Apiaceae, and Berberidaceae families may be attributed to suitable habitats, favorable environmental conditions for their growth, and increased interactions of local communities with these plants. Consequently, the traditional usage of these species is well-known among the inhabitants (Abbas *et al.* 2017, Bhatia *et al.* 2014, Farooq *et al.* 2019, Rafique *et al.* 2021).

Parts of the plant used the method of preparation, and the categories of use

The data obtained from participants revealed the utilization of various plant parts in the preparation of remedies. Notably, roots were the most frequently used (constituting 46%), followed by leaves (17.85%), aerial parts (10.71%), seeds (10%), resins (7.14%), and fruits (3.57%) in the context of veterinary treatments.

The dominant use of roots in herbal recipes, reported in other studies from surrounding areas (Malik *et al.* 2019, Rashid *et al.* 2015), raises conservation concerns as it may not be sustainable for the survival of plants (Bibi *et al.* 2022). Leaves, the second most frequently used plant part (17.85%), align with findings from neighboring areas (Malik *et al.* 2019, Rashid *et al.* 2015, Rafique *et al.* 2021). Leaves, being the primary photosynthetic organ and rich in metabolites, are commonly employed in herbal medicines, and their sustainable use has fewer negative consequences for plants (Rafique *et al.* 2021, Zahoor *et al.* 2017, Bano *et al.* 2014). The use of aerial parts, seeds, fruits, and resins in herbal medicine may be attributed to ease of collection, availability, and the presence of diverse chemical constituents (Ahmad *et al.* 2016, Rafique Khan *et al.* 2021). The frequent use of fruit in herbal recipes is associated with the high proportion of bioactive compounds found in fruits, which often serve as storage organs in plants (Abidin *et al.* 2022, Malik *et al.* 2019, Rashid *et al.* 2015, Rafique *et al.* 2021).

The primary methods for preparing these remedies included mashing them in their raw state (in 19 species), cooking (in 15 species), making decoctions (in 3 species), and using them in powdered or resin form (one species each). The dominant mode of administration was a paste, consistent with results from surrounding areas (Ishtiaq *et al.* 2015, Hassan *et al.* 2019). The mountainous terrain of the study area contributes to a higher incidence of external wounds and injuries, making herbal paste medications more popular, especially for physical trauma and skin problems (Akhtar *et al.* 2013). the second most common method of administration was a powder, aligning with findings from neighboring areas (Butt *et al.* 2015, Rafique *et al.*2021). Decoction was the third most common medication preparation technique, likely due to its simplicity and effectiveness (Malik *et al.* 2019, Ullah *et al.* 2014). These findings were consistent with similar studies (Khan *et al.* 2019, Kayani *et al.* 2015).

Key informants identified 23 major therapeutic applications for these plants, including dysentery, indigestion, internal heat, tonics, milk production, joint pain, post-delivery care, anti-salt treatments, uterus prolapse, goat pox, wound healing, repeat breeding, goat pox, nephritis, strangles, constipation, and cough. The administration of medicinal plant remedies was primarily through oral and topical means, with topical consumption (57%) being the most commonly used route, followed by oral consumption (43%). This prevalence of topical application is in line with other studies (Rashid *et al.* 2018, Wali *et al.* 2021), with topical use considered ideal for treating conditions such as skin disorders, joint pains, wounds, and muscular pains, while oral use is preferred for internal disorders (Hussain *et al.* 2022, Khan *et al.* 2019, Kayani *et al.* 2015, Tariq *et al.* 2014).

The utilization of indigenous plant species for ethno-veterinary purposes holds paramount importance in the lives of Himalayan mountain communities within the Kashmir region. Livestock farming serves as a linchpin in the local economy, offering vital support for livelihoods. Among semi-nomadic populations, there exists a preference for traditional ethno-medicine over conventional allopathic remedies due to its cost-effectiveness and easy accessibility (Tariq *et al.* 2014).

Our research uncovered the extensive use of a substantial number of locally abundant plants, totaling 39 different species (detailed in Table 2), by local communities to uphold the health of their livestock. These medicinal plant species, employed in livestock care, flourish in diverse habitats ranging from valley plains to temperate mountain forests and alpine pastures, covering a broad altitudinal range from 2400 to 4400 meters (Azam *et al.* 2012, Murad *et al.* 2014). Intriguingly, our observations revealed that older population groups, especially females, possess a more profound understanding of ethno-botanical knowledge. This is ascribed to their deeper engagement in traditional agro-pastoral lifestyles compared to the younger generation (Heinrich *et al.* 2009).

Table 2. The arrangement of medicinal plants based on their taxonomy their medicinal uses and Part used for Ethno-veterinary

Voucher Number	Botanical name	Local name	Family	Habit	Animals treated	Animal disease	Part used	In the form of
5133	*Allium cepa* L.	Piaaz	Alliaceae	Herb	All types of cattle	Abdominal pain	Bulb	Crushed paste
5134	*Allium sativum* L.	Thoam	Alliaceae	Herb	Cows	To increase body heat Pregnant cows	Rhizome	Rrhizome mixed with flour
5135	*Ajuga bracteosa* Wall. ex Benth.	Jan-e-Adam	Lamiaceae	Herbs	Cattle	internal heat	Roots	Uncooked roots
5136	*Aesculus indica* (Wall. ex Camb.) Hook.f.	Bunkahoor	Hippocastanaceae	Tree	Horse, cattle	Tonic, indigestion/warm effect	Fruits	Mashed
5137	*Angelica cyclocarpa* (Norman) Cannon	Choora	Apiaceae	Shrub	Cattle	indigestion	Roots	Uncooked roots
5138	*Aconogonon molle* (D. Don) H. Hara	Chukroo	Polygonacea	Herb	Lamb	Cure dysentery	Roots	Boiled roots
5139	*Arnebia benthamii* (Wall. ex G. Don) I.M.Johnst.	Gaw-Zuban	Boraginaceae	Herb	Goat/horse	Joint pain	Rhizome	Mashed Powder
5140	*Berberis lycium*	Sunmbloo	Berberidaceae	Shrub	Cattle	Internal injuries and for body warmth	Roots	Boiled roots used
5141	*Brassica compestris* L.	Sarson	Brassicaceae	Herb	Goat	Flatulence	Seeds (oil)	Oil
5142	*Bistorta amplexicaulis* var.	Maslon	Polygonaceae	Herb	feeble cattle	Tonic	Roots	Cooked roots
5143	*Berberis aitchisonii* Ahrendt	Sumbaloo	Berberidaceae	Shrub	Cattle	Wound healing	Roots	Mashed powder
5144	*Bupleurum candollei* Wall. ex DC	Kali-Boti	Apiaceae	Herb	Goat	Increase Milk production	Roots	Mash powder mixed with flour
5145	*Cedrus deodara* (Roxb. ex D.Don) G.Don	Pluddaar	Pinaceae	Tree	All cattle	Skin Wound healing	Resin	Resin
5146	*Chenopodium* album L.	Bathwaa	Chenopodiaceae	Herb	cow	Dysentery	Leaf	Uncooked leaf
5147	*Dipsacus inermis* Wall. ex Roxb.	Pilhaa	Dipsaceae	Herb	Cattle	Post-delivery treatment in cattle	Roots	Mashed and cooked

5148	*Dryopteris wallichiana* (Spreng.) Hylander,	Kunjii	Dryopteridaceae	Herb	Cattle	Indigestion, purgative	Young shoots	Young shoots are cooked as pot herbs
5149	*Euphorbia wallichii* Hook.f.	Harvi	Euphorbiaceae	Herb	Buffalos	Against worms, as cathartic, purgative and diaphoretic.	Latex	Latex
5150	*Hylotelephium ewersii* (Ledeb.)H. Ohba	Lonslooni	Crassulaceae	Herb	goats and sheep	Effects of over dozed salts	Whole plant	Whole mashed uncooked
5151	*Helianthus annuus* L.	Gul-e-Aftab	Asteraceae	Shrub	cattle	Tonic to the general weakness.	Seed	Crushed seed (Powder)
5152	*Phaseolus lunatus* Linn.	Moothi	Papilionaceae		Goat	Goat Pox	Seeds	Boiled in water
5153	*Rheum webbianum* Royle	Chotyal	Polygonaceae	Herb	Cattle.	Indigestion and constipation	Roots	Mashed roots
5154	*Saussurea lappa* (Dcne.) Sch. Costus (Falc. Lipsch.)	Kutth	Asteraceae	Herb	sheep and goats	Expel worms and also believed as tonic	Roots	Crushed roots
5155	*Saussurea costus* (Falc.) Lipsch).	Kutth	Asteraceae	Herb	cattle	Release of placenta after birth	Roots	Powder
5156	*Trigonella foenumgraecum* Linn.	Sinjii	Fabaceae	Herb	Cattle	Cure prolapse of uterus	Leaf	Leaf
5157	*Urtica dioica* L.	Kairi	Urticaceae	Herb	Cattle	Set into heat cycle Repeat Breeding	Leaves	Leaves
5158/5559	*Verbascum thapsus* L.	Gadikan	Saxifragaceae	Herb	Cattle	Relieve pain in case of injury Increase milk secretion	Leaves	Leaves are cooked and added to soups
5160	*Viburnum cotinifolium* D.Don.	Ukloon	Caprifoliaceae	Shrub	horses and buffalos	To cure constipations	Tips of the plants	Tip of plant

Relative frequency of citation and use value

For assessing the local significance of each plant, we employed the Use Value (UV) metric, as proposed by Phillips and Gentry (Haq *et al.* 2022). It's important to note that low UV values for medicinal plants don't necessarily indicate lower importance; rather, they may signal a risk to the knowledge associated with these plants or a limited availability of the specific medicinal plant (Shinwari *et al.* 2017).

In our present study, *Viburnum cotinifolium* exhibited the highest UV (0.33), while *Verbascum thapsus* had the lowest use value (0.04) (Table 3). Consistent with our findings, Khan *et al.* (2020) also reported *Viburnum cotinifolium* as a high UV medicinal plant and *Verbascum thapsus* with the lowest UV in Neelum valley. The elevated UV of medicinal plants in the study region can be attributed to their widespread distribution, and local communities are well-acquainted with their medicinal uses (Adnan *et al.* 2014). A higher use value suggests greater importance of the particular plant species. However, it's essential to note that UV alone doesn't distinguish whether a plant is used for a single or multiple ailments (Ahmad *et al.* 2016). Additionally, we computed the Relative Frequency of Citation (RFC) for the medicinal plants, with values ranging from 37 to 7.32 (as displayed in Table 3). *Viburnum cotinifolium* had the highest RFC (7.32), followed by *Verbascum thapsus* (6.61) and *Verbascum thapsus* (6.43). Conversely, *Dryopteris wallichiana* had the lowest RFC (0.89) (as shown in Table 3). The prevalence of *Viburnum cotinifolium* in higher reaches may explain its high RFC, as it is a well-known medicinal plant commonly used for treating various diseases (Kayani *et al.* 2014). RFC indicates the popularity of a specific plant species in an area based on its relative use. Furthermore, it reflects the efficacy and wide-ranging usage of plants with minimal or no side effects (Hussain *et al.* 2018). Our findings align with a previous study (Khan *et al.* 2020, Munir *et al.* 2022). Evaluating and demonstrating the pharmacological activity of ethnomedicinal species with high UVs and RFCs values is crucial (Yaseen 2019). While plants with low UVs are indeed important (Amjad *et al.* 2017), their low values suggest that locals may not be aware of their benefits, hindering the dissemination of information to potential users (Table 3).

Table 3. Relative frequency of citation and use value of plants in Ghamot National Park

Scientific name	FC	UV	RFC
Allium cepa L.	27	0.21	4.28
Allium sativum.	7	0.06	1.25
Ajuga bracteosa	9	0.07	1.61
Aesculus indica	9	0.07	1.61
Angelica cyclocarpa	13	0.10	2.32
Aconogonon molle	12	0.10	2.14
Arnebia benthamii	16	0.13	2.86
Berberis lycium	18	0.14	3.21
Brassica compestris	28	0.22	5.0
Bistorta amplexicaulis	20	0.16	3.57
Berberis aitchisonii Ahrendt	13	0.10	2.32
Bupleurum candollei	19	0.15	3.39
Cedrus deodara	15	0.12	2.68
Chenopodium	25	0.20	4.46
Dipsacus inermis.	14	0.11	2.50
Dryopteris wallichiana	5	0.04	0.89
Euphorbia wallichii.	6	0.05	1.07
Hylotelephium ewersii	7	0.06	1.25
Helianthus annuus	11	0.09	1.96
Phaseolus lunatus	18	0.14	3.21
Rheum webbianum	6	0.05	1.07
Saussurea lappa	7	0.06	1.25
Saussurea costus.	6	0.05	1.07
Trigonella foenumgraecum	12	0.10	2.14
Urtica dioica	6	0.05	1.07
Verbascum thapsus .	5	0.04	6.61
Viburnum cotinifolium	37	0.29	7.32

Conclusion

The findings from this research clearly underscore the rich floristic and cultural diversity in the study area, contributing to the local population's extensive Ethno-veterinary knowledge. Given the predominantly mountainous and remote nature of the study area, coupled with a lack of modern health facilities, the reliance on medicinal plants by the local community becomes evident. This study primarily emphasizes the significant indigenous Ethno-veterinary knowledge intertwined with the local medicinal flora.

It is noteworthy that this invaluable indigenous Ethno-veterinary knowledge is at risk of extinction, with waning interest from the younger generation. The local population traditionally passes down this wealth of knowledge orally, a practice that significantly contributes to the loss of such valuable information across generations. Through our survey, we meticulously documented 28 medicinal plant species from 22 families, along with their associated indigenous Ethno-veterinary knowledge. Asteraceae emerged as the most dominant plant family, comprising 3 species. Roots, accounting for 46%, stood out as the most frequently used plant part in medicinal formulations, with herbal pastes (utilized in 19 species) being the predominant method of preparation. Notably, a majority of the medicinal plants (18 species) were employed in treating digestive system ailments, such as dysentery and indigestion. The older age group, particularly those above 40, played a substantial role in sharing this knowledge. Preserving this traditional knowledge for future generations, safeguarding it by making it publicly accessible, and utilizing it as a foundation for further research and conservation initiatives are critical aspects highlighted in this documentation. To authenticate this indigenous knowledge, we recommend future investigations in phytochemistry and pharmacology, as these plants hold potential for the discovery of new drugs. Additionally, rigorous toxicological examinations are imperative to ensure the safe and secure utilization of the documented ethno-medicines.

Declarations

List of abbreviations: RFC= relative frequency of citation, UV= use value, FC= Frequency of Citation

Ethics approval and consent to participate: Code of ethics of International Society of Ethnobiology (2008) was followed during data collection (http://ethnobiology.net/code-of-ethics/). As the data collection was about the animals, therefore, the people who were in close interaction with the animals were targeted. After complete briefings to the informants about the purpose of this research work, verbal consents were taken from all the localities from where the data was collected. As most of the informants were illiterate and it was not possible to take written consent from them**.**

Information was obtained from the participants. All informants were orally consented.

Consent for publication: Oral permission was given from all persons shown in figures to have their images published.

Availability of data and materials: The data used to support the findings of this study are available from the corresponding author upon request.

Competing interests: We declare that there is no conflict of interest.

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Authors' contributions: MJ and MS designed the study; MJ, MSA conducted the fieldwork, RIM, MMS,UA and AS conducted the main statistical analysis; MJ wrote the manuscript; all authors read, corrected, and approved the manuscript.

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