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Revitalizing traditional Ethnoveterinary practices in rural communities in Targhaw valley, District Bajaur

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Plant-based products play a crucial biological role in combating specific pathogenic organisms and have been recognized as a significant source of modern drugs. In developing countries, rural communities often rely on traditional herbal medical systems due to both a strong belief in their efficacy and limited access to allopathic medicines. Consequently, ethnomedicinal knowledge becomes invaluable in sustaining community-based approaches within this medical framework. This study was conducted in an unexplored, remote tribal area of Pakistan to explore and document the existing ethnomedicinal knowledge related to local flora. Information was gathered through semi-structured questionnaires administered to community members and local herbalists. Use reports (URs) were tallied for each species and subjected to analysis using Linear Regression, establishing a relationship between the number of URs per family and the number of plant species per family. A total of 63 medicinal plant species were identified, spanning 57 genera and 43 families. The most frequently employed plant families in ethnomedicine were Solanaceae (5 species) and Moraceae (4 species). Notably, *Berberis lyceum* ranked highest in URs (32 URs), followed by *Withania somnifera* (30 URs), *Allium sativum* (28 URs), *Zanthoxylum armatum* (26 URs), and *Dodonaea viscosa* (24 URs). Throughout the study, 31 groups of health conditions were documented, with a focus on treating gastrointestinal problems using medicinal plants. Powder emerged as the predominant method for drug preparation and administration, while leaves (35% of plants) were the most frequently utilized plant parts in ethnomedicinal recipes. Traditional knowledge, however, faces the risk of extinction, primarily because younger generations are not actively engaging in the learning and preservation of this valuable information. Therefore, urgent efforts are needed to subject the investigated taxa to phytochemical and pharmacological tests, validating the traditional knowledge before it is lost

Keywords: Folk knowledge, Indigenous communities, Livestock diseases Use value, Relative frequency of citation

INTRODUCTION

Plant resources have played a vital role in human society throughout history. According to the World Health Organization (WHO), approximately 80% of the population in the developing world relies on traditional herbal medicines (Alves and Rosa, 2005). In these developing nations, traditional medicines serve as a cost-effective and alternative primary health care source [Bannerman et al.1983), driven by factors such as the absence of modern health facilities, the effectiveness of traditional remedies, cultural priorities, and personal choices (Plotkin et al.1992). The use of traditional herbal medicines is also on the rise in developed countries. For example, in China, traditional herbal preparations make up 30–50% of total drug consumption. Similarly, in countries like Nigeria, Ghana, Zambia, and Mali, herbal medicines are the preferred choice for treating high malarial fever in 60% of affected children. In Ethiopia, approximately 80% of the population turns to traditional medicines due to the cultural trust in healers, the

relatively lower cost of traditional medicines, and limited access to modern drugs (Kebede et al .2006). Ethnobotanical surveys that document ancestral knowledge can bridge existing gaps in discovering effective drugs (Heinrich *et al.* 2006). Pakistan, with its diverse climatic zones and unique biodiversity, boasts around 6000 plant species, of which 400–600 are considered medicinally important (Ali, 2008). Numerous studies in the country have highlighted the medicinal uses of plant resources (Aziz et al. 2017). The transfer of folk knowledge on traditional herbal remedies typically occurs orally from one generation to the next (Mahmood et al. 2011). However, with vertical transfer, the risk of knowledge elimination increases in parallel, posing a significant threat that needs addressing for preservation. Over the last few decades, there has been a notable surge in scientific and commercial interest in plant-based herbal products across the country, driven by their cultural acceptance and economic potential (Sher et al. 2015). With diverse cultures and various languages spoken predominantly in rural and remote areas, people in these regions have limited access to healthcare services, prompting the utilization of traditional herbal medicines (Chaudhry et al. 2006). District Bajaur, a remote tribal area in Pakistan, is rich in diverse and significant medicinal plants. However, the area's traditional practices have been significantly impacted by modernization and exposure to pharmaceuticals. The ethnomedicinal knowledge in the region is at risk of extinction as older community members, the main bearers of this knowledge, pass away, and the younger generation shows little interest in preserving it. Despite possessing ample traditional knowledge, herbal practitioners in the area are often reluctant to share it with other community members. Thus, the present study was undertaken with the objectives of documenting the traditional knowledge of the study area, preserving it through published literature, and sharing it with communities globally.

MATERIALS AND METHODS

Study area

Bajaur, with its headquarters in Khar, is the FATA agency holding the smallest geographical area, covering a total land area of 1290 km2. It shares a significant 52 km border with Afghanistan, a matter of great importance for both Pakistan and the surrounding region. The research site is positioned at an elevation of 1126 meters above sea level, situated between latitudes 34°–30° and 34°–58°, as well as longitudes 71°–11° and 71°–30°. The socioeconomic status of the indigenous community is diverse and relatively modest, with limited income sources primarily stemming from agriculture and some trade/business activities. The majority of the population engages in farming, while others work as government servants, run small-scale businesses, or are employed on a daily wage basis. Some locals work in Gulf States, supporting their families through remittances. Owning domestic animals is a sign of better socioeconomic conditions for a tribe or family. The Agency has a limited number of secondary schools and only three government colleges. Although there are public health dispensaries to some extent, those residing in remote hilly areas have limited or no access to allopathic medicines. The local communities prefer traditional herbal therapies over modern pharmaceuticals, driven by strong cultural beliefs and faith in herbal medicines prepared by local traditional healers known as Hakims. Traditional knowledge about herbal recipes is confined to these Hakims and other elder community members. The socioeconomic status of indigenous communities could see improvement if the cultivation and sustainable use of medicinal plants are promoted and encouraged in the area.

Field Survey and Data Collection

Between May and August 2016, a field survey was conducted to collect ethnomedicinal data. Prior to data collection, regular field visits were made to establish and acknowledge the support of the indigenous communities. In May, local informants were identified for interviews, and the recording of ethnomedicinal data took place over the subsequent three months. As a resident of the study area, Mr. Umar Din visited various sites and held meetings with local community representatives to explain the purpose of the study. Data was gathered from community members through semi-structured interviews, meetings, and group discussions at various public places, following the procedure outlined by Martin (1995). A total of 45 local key respondents, including 35 males and 10 females from various age groups, were selected using the snowball sampling technique (Table 1). The selection excluded young female community members from interviews, except for some elder females, due to cultural limitations. Respondents were chosen based on their high reputation for ethnomedicinal knowledge. To validate traditional knowledge, continuous relationships were maintained with local people throughout the survey. All interviews with local people were conducted in the local language, "Pashto." The study objectives were shared with survey participants to gain trust and consent. After data collection, survey results were reviewed with the informants to rectify any errors or omissions.

Preservation and taxonomical verifications of plant species

Medicinal plants, gathered during field excursions, were recognized by Dr. Mohammad Adil at the Department of Botany, Qurtaba university of science and technology Peshawar, Pakistan. Subsequently, the plants underwent a drying process in shaded conditions, followed by treatment with 1% HgCl2, pressing, and

mounting on herbarium sheets. Each herbarium sheet received a voucher name and number and was submitted to the department for future reference. To ensure accurate nomenclature and classification, the World Flora Online (www.worldfloraonline.org) was used for each plant taxon.

Data analysis

The data collected in the survey underwent regression analysis, specifically examining the relationship between Use Reports (URs) and the number of species per family, utilizing SPSS version 16 (Moerman and selectivity, 1979).

RESULTS

Traditional Lifestyles and Herbal Medicine

The rural communities in District Bajaur exhibit a distinct cultural identity and belief system, with a traditional lifestyle that involves the use of herbal medicines. This lifestyle connects them closely to natural resources, setting them apart from other cultures in the country. It is a universal phenomenon for each community worldwide to have unique philosophies, beliefs, attitudes, cultures, and economic statuses. These fundamental factors contribute to the diverse practices of traditional medicines (Čančarević et al. 2013). The utilization pattern of medicinal plants within a specific community is an integral part of its cultural traditional knowledge, passed down from one generation to the next, representing a heritage. While past studies have often focused on the use of medicinal plants within a single culture or ethnic group, there has been a growing recognition of the intercultural importance of medicinal flora across different ethnic groups globally (Gairola et al. 2014). This comparative approach is crucial for identifying cross-cultural variations and guiding future research on medicinal plants (Aziz et al. 2017). The current study is a significant addition to the preservation of folk ethnomedicinal knowledge about plants and the effectiveness of their derived products in an area that has not been extensively explored previously. The findings reveal that individuals with lower levels of education are more adept at using traditional therapies than their more educated counterparts. Additionally, herbal practitioners possess a substantial amount of ethnomedicinal knowledge, while the elderly only hold a fraction of this knowledge. Unfortunately, traditional knowledge in the area is under the threat of extinction due to the gradual introduction of allopathic medicines, the modernization trend, and exposure to the technological era. The younger generation, in particular, shows little interest in herbal therapies and leans more toward allopathic medicines, mirroring trends found in other studies (Pieroni et al. 2017). The imminent loss of ethnomedicinal knowledge underscores the need for proactive measures to address this issue. Without intervention, the transfer of this knowledge within and across communities is at risk of declining and eventually becoming extinct in the near future, a concern echoed in similar studies (Bussmann and Sharon, 2006). In the study area, most Hakims (traditional healers) employ the Unani or Ayurvedic systems of traditional medication for treating various diseases. These Hakims, usually belonging to the local community, possess a deeper understanding of patients' backgrounds, which aids in the treatment process. Diagnosis typically involves assessing symptoms and pulse examination. While the Hakims interviewed were mostly male, only a few were qualified professionals. The local community believes that the effectiveness of consultations with these herbalists depends largely on personal experiences with the practitioners. However, the introduction of modern pharmaceuticals has led to a shift toward allopathic medicines, bringing about cultural changes and significantly reducing local reliance on traditional medicines, as also noted by Adnan *et al*. (Adnan et al. 2014).

Analyzing Ethnobotanical Quantities and preparation of Herbal Remedies.

The study area documented a total of 63 medicinal plant species from 57 genera and 43 families, utilized for treating various human diseases (Table 2). The majority of the reported plant species were affiliated with the Solanaceae family (5 species; URs: 59), followed by Moraceae (5 species; URs = 52), Rutaceae (4 species; URs = 68), Poaceae (3 species; URs = 14), Rutaceae (3 species; URs = 558), Pinaceae (2 species; URs = 11), Mimmoceae (2 species; URs = 19), and Lamiaceae (2 species; URs = 21). The prevalence and acceptance of a particular plant family may be linked to the presence of active phytochemicals effective in specific pathological conditions. Additionally, the choice of using a specific family may be influenced by its dominance in the geographical area and familiarity among the local population. Out of the reported 63 medicinal plants, herbaceous (47%) life form was predominantly employed in drug preparation. The most commonly utilized plant parts were leaves (35%), followed by seeds (10%) and fruits (16%) (Fig. 2). The use of herbaceous life forms and leaves in ethnomedicinal recipes aligns with findings from several studies (Tugume *et al.* 2016). Leaves and aerial plant parts are active in autotrophy and metabolism and can be easily collected (González et al. 2010).

Table 2: Plant Taxonomy, common name, habit, parts use, traditional uses and use value

Taxon	Family	Common name	Habit	Parts used	Traditional Uses	URs
Justicia adhatoda L.	Acanthaceae	Baikar	Shrub	Leaves	Fever, Dehydration and Dysentery	6
Foeniculum vulgare Mill.	Apicaceae	Kaga	Herb	Seed	Weakness and anorexia	12
Sonchus asper (L.)Hill	Asteraceae	Shodapi	Herb	Leaves and Stem	Galactagogue	10
Carthamus oxycantha M.bieb		Kareza	Herb	Seed	Use for Ulcers	7
Nerium oleander L.	Apocynaceae	Ghandary	Shrub	Leaves	For Ulcers in animals	13
Calotropis procera (Aiton) Draynd		Spalmi	Shrub	Fruit	Externally for Infection	17
Allium sativum L.	Alliaceae	Ooga	Herb	Bulb	For Vermifuge, and Increase fertility rate	28
Allium cepa. L		Piaz	Herb	Bulb	Give for infection in digestive system	19
Pistacia chinensis Bunge.	Anarcardiaceae	Shaniae	Tree	Leaves	Leaves juice give for Coughing	14
Amaranthus viridis L.	Amaranthacea	Ghnhr	Herb	Whole plant	Paste is prepared from whole plant use for weakness in cattle	9
Brassica campestris L.	Brassiceae	Shrshm	Herb	Oil	Use for Helminthiasis	11
Berberis lyceum Royle	Berberidaceae	Kwary	Shrub	Root	Root is given for jaundice and cooling	32
Citrullus colocythis (L.) Schard	Cucrbitaceae	Sqahendwana	Herb	Fruit	Fruit is given for abdominal pain	9
Chenopodium album L.	Chenopodiaceae	Sarmy	Herb	Whole plant	Whole plant is given for anthelmintic	12
Opuntia littoralis (Englem.) cockerel	Cactacaeae	Zoqm	Herb	Whole plant	Whole plant powder is uses for treatment dermal problems	17
Convolvulus arvensis L.	Convolvulaceae	Pervaty	Herb	Root	Roots given for Cooling	14
Cannabis sativa L.	Cannabaceae	Bhang	Herb	Leaves	Leaves use for removing of external parasite	10
Cyperus rotunds L.	Cyperaceae	Deela	Herb	Rhizome/ Root	Rhizome/root is given for anthelmintic and diarrhea	6
Mallotus philippensis (Lam.)	Euphorbiaceae	Kambela	Tree	Stem	Whole plant gives for liver fluke	11
Dalbergia sisso Roxb'.	Fabaceae	Shwa	Tree	Leaves	Leaves is use for diarrhea	8
Juglans regia L.	Juglandaceae	Ghwaz	Tree	Bark	Use for gastric disorder	5
Otostigia limbata (Benth.) Boiss	Lamiaceae	Spin azghy	Shrub	Whole plant	For removing internal body wounds	9
Mentha longifolia (L.)		Inaly	Herb	Aerial parts	Use for diarrhea	17
Ajuga bracteosa Wall ex Benth		Gooti	Herb	Whole plant	Whole plant use for abdominal pain	4
Polygonatum verticillatum (L.)All	Lilliaceae	Noor alam	Herb	Root	Rhizome use for increasing milk	9
Punica granatum L.	Lythraceae	Anar	Shrub	Fruit	Fruit use for diarrhea and constipation	11
Morus nigra L.	Moraceae	Toor toot	Tree	Fruit	Ripened fruit for the increase of milk production	9
Ficus carica L.		Inzer	Tree	Leaves	Leaves given for retain of placenta	14
Morus alba L.		Spin toot	Tree	Leaves	Leaves use for diaphoretic, vermifuge	8
Broussonetia papyrifera (L.)L Her.ex vent		Gul toot	Tree	Leaves	For increase milk production leaves are given	6
Grewia optiva J.R.Drumnn.exBenth	Malvaceae	Pastawany	Tree	Leaves	Leaves give for increase milk production, placental emission and helminthiasis	15
Melia azedarach L.	Meliaceae	Toora shandai	Tree	Leaves	Leaves are uses as for gas trouble and abdominal pain	11
Myrtus cumminis L.	Myrtaceae	Manru	Shrub	Leaves	Leaves give for milk correction	8
Acacia modesta Wall.	Mimmoceae	Palosa	Tree	Bark	Bark is boiled in water use for dysentery and weakness	13
Acacia nilotica (L.) Delile		Kekr	Tree	Bark	Bark boil is given orally for pain killer	6
Peganum hamala L.	Nitrariaceae	Spelany	Herb	Seed	Seed gives for eye disorder and milk production	4
Olea europea L.	Oleaceae	Khuna	Tree	Oil	Oil use externally for broken bones and inflamed areas	16
Platanus orientalis L.	Plantaceae	Chenar	Tree	Bark	Bark is boiled and give for coughing	8
Pinus roxburghii Sarg.	Pinaceae	Nakhtr	Tree	Latex	Latex gives for allergies and infection	4

Cedrus deodara (Roxb.exD.Don)G.Don		Ranzra/deodar	Tree	Oil	Oil from this plant is use for anti-inflammatory activity	7
Oryza sativa L.	Poaceae	Chawl	Herb	Seed	Seed mix with flour give for weakness and respiratory infection	5
Zea mays L.		Jowar	Herb	Inflorescence	Inflorescence is given for Diarrhea, dysentery and intestinal worms	3
Hordaeum vulgare L.		Werbashe	Herb	Seed	For removal of worm's seed are uses	6
Trigonella foenum-graecum L.	Papilionaceae	Malkhvazy	Herb	Seed	Seed use for against gastric disorder	11
Papver somniferum L.	Papaveraceae	Afum/doda	Herb	Fruit	Fruit use for vaginal prolapse and cough	16
Rumex dentatus L.	Polygonaceae	Shlkhy	Herb	Leaves	For digestive problems leaves are used	9
Zanthoxylum armatum DC.	Rutaceae	Dambara	Shrub	Seed	For antipyretic, Urinary track infection and mouth disease seed are used	26
Citrus medica L.		Narang	Tree	Fruit	Extract obtains from fruit for wound healing	18
Citrus lemon (L.) osbeck		Lembu	Tree	Juice	Juice obtains from fruit use for uterine prolapse and mastitis	11
Ziziphus jujuba Mill.	Rhamnaceae	Baira	Tree	Leaves and Fruit	Leaves and fruits give orally for removal of worms and also uses as Diuretic	13
Prunus persica (L.)stokes	Rosaceae	Shftalu	Tree	Leaves	Leaves give orally for worm treatment in wounds	8
Verbascum thapsus L.	Scrophurlariance	Kharghwg	Herb	Leaves	Leaves and flower give orally for Diarrhea, skin diseases and wound healing	9
*Dodonaea viscosa (L.)*Jacqq	Sapindaceae	Ghwrasky	Shrub	Leaves	Leaves give orally for digestive and respiratory problem in clave	24
Monotheca buxifolia (Falc.)A.D.	Sapotaceae	Gwrgwra	Tree	Leaves	Leaves give orally for treatment of milk	19
Salix tetrasperma Roxb.	Saliacaea	Wala	Tree	Bark	Bark boil in water give orally for cough and internal body infections	15
Withania somnifera (L.) Dunal	Solanaceae	Kotilal	Tree	Root	Root and leaves with paste give orally for milk production, fertility and antipyretic	30
Nicotiana tobaccum L.		Tambaku	Herb	Leaves	Leaves through soothing method for removing ticks	9
Dathura stramonium L.		Bathura	Herb	Leaves	Leaves give orally for increase body temperature	2
Capsicun annum L.		Marchaki	Herb	Fruit	Fruit gives orally for pain kill and abdominal pain	6
Solanum surrattense Burm.F		Maraghuni	Herb	Fruit	Fruit give orally for abdominal pain and stomach swelling	12
Urtica dioca Linn.	Urticaceae	Sezunki	Herb	Root	Root and leaves are given orally for contusion	6

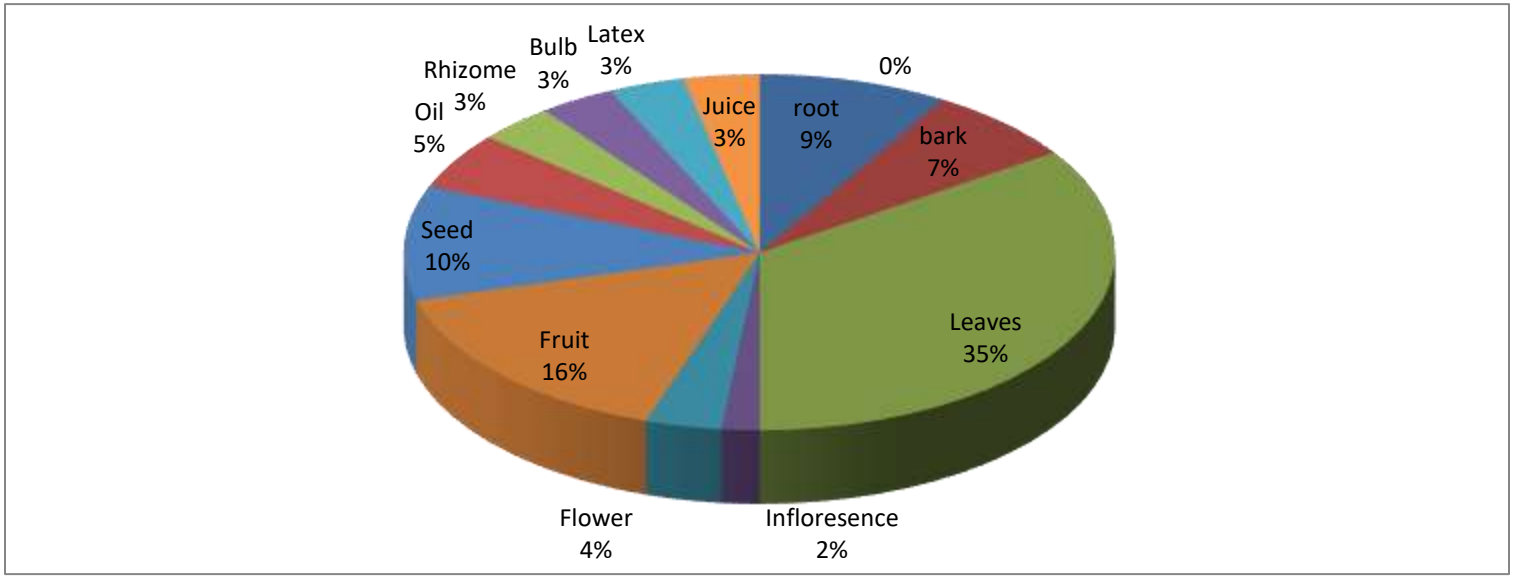

Figure 2: Classification of plants based on their parts used.

However, Traditional Chinese Medicines (TCM) often highlight roots as the dominant part in recipe preparation (Wesołowska et al. 2015). The composition of a particular ethnomedicine varies, and phytopharmacological screening of all plant parts is essential to validate local traditional knowledge and discover new compounds for modern allopathic medicines. Various methods of drug preparation and administration were documented in the study, employed by local herbalists. For oral use, plant powder was mainly ingested with water or as a decoction, with juice extraction being a rare practice. These findings parallel previous studies (Ridvan et al. 2015). On the other hand, paste and ground herbs were extensively used to treat dermal diseases. Decoction was also reported as a widely accepted form of herbal medicine administration in other studies (Scherrer et al. 2005). The reported medicinal plants were employed for treating various health conditions and diseases. Most remedies were based on the single application of a plant due to palatability, non-toxicity, and high efficacy (Tugume et al. 2016). Some remedies involved a combination of two or more plants for maximum therapeutic effect (synergism). A total of 19 groups of health conditions were recorded based on symptoms. Local herbalists typically diagnose ailments based on symptoms and signs without using modern laboratory techniques. The highest number of plants was used for gastrointestinal issues (30 species), followed by galactagogue (16 species), wound healing (10 species), respiratory disorders (6 species), and dermatological concerns (5 species). These results align with previous findings from various parts of the country (Bibi et al. 2014; Khan et al. 2014), where gastrointestinal complaints were commonly reported. The prevalence of digestive disorders in the study area may be attributed to the ingestion of contaminated foods and toxic materials resulting from past armed conflicts. Additionally, the lack of proper sanitation, limited access to clean water, and inhalation of fuel wood smoke may contribute to gastric problems. Gastrointestinal disorders are prevalent globally, leading to the use of numerous medicinal plants by different cultures (Nasab et al. 2014).

Traditional ethnoveterinary ailment classification

In the study area, a total of 30 plants were identified for the treatment of gastrointestinal problems, with the highest number of use reports (74) recorded (Table 3). Gastrointestinal issues, encompassing abdominal pain, diarrhea, and digestive problems, are considered the most prevalent disease category in domestic animals. These health issues are easily recognizable by respondents, likely contributing to the high incidence of the gastric problem category in our study and in others. Various ailments were classified into 10 groups, including weakness, gastrointestinal, galactagogue, reproductive, respiratory disorders, abdominal pain, fever, infection, cooling, and miscellaneous. The miscellaneous category encompassed medical conditions that were not fully described by the interviewees, such as eye problems and broken bones. The highest Fic values were observed for cooling (0.93), followed by respiratory disorders (0.85), abdominal pain (0.84), reproductive ailments (0.80), galactagogue (0.76), and fever (0.75) (Table 3). Fic value serves as an indicator of the local people's consensus on a specific plant species and the efficacy of a particular taxon (Teklehaymanot and Giday, 2007). According to Sharma et al. (Sharma et al.2012), a Fic value of 1 signifies that the local population is actively exchanging views, ideas, and information about traditional medications, while a Fic value of 0 indicates the opposite. In the current study, Fic values ranged between 0.71 and 0.95 for various livestock ailments (Table 3), indicating strong consensus among the local population regarding traditional herbal therapies. Similarly high levels of consensus on traditional animal therapies have been reported in previous research studies in other areas. For example, reported Fic values for reproductive disorders were 1.00 and 0.89 (Parthiban *et al.* 2015), for gastric problems were 0.90, 0.70, 0.92, 0.95, and 0.94 (Ali-Shtayeh et al. 2016), for galactagogue were 0.83 and 0.50 (Ali-Shtayeh et al. 2016), and for wound healing were 0.40 and 0.45 (Lulekal et al. 2014). Heinrich et al. (Heinrich et al. 1998) suggest that high Fic values can serve as a tool to target plants for the isolation of biologically active components. In our study, most livestock ailments were reported to be seasonal and epidemic, often attributed to changes in fodder. Additionally, the concept of hot and cold foods is prevalent in preventing animal diseases, with local residents adjusting the relative fodder in different seasons to minimize the chances of various health problems in cattle.

Table 3: Informant cesus factor

Category of diseases	Number of use report	Number of taxa used	ICF
Gastrointestinal	74	21	0.73
Galactagogue	26	7	0.76
Reproductive	6	2	0.80
Respiratory disorders	14	3	0.85
Fever	5	2	0.75
Abdominal pain	20	4	0.84
Miscellaneous	55	13	0.78
Infection	19	4	0.83
Weakness	8	3	0.71
Cooling	21	2	0.95

Risks to the indigenous Vegetation and Conservation Perspectives

During the field survey, certain crucial plants were observed to be under significant anthropogenic pressure. For instance, *Withania somnifera* was identified as endangered in its natural habitats due to excessive harvesting driven by economic incentives for the local population. The local residents attributed the deterioration of the natural habitats of medicinal plants to activities such as fuel wood collection, road and home construction, uncontrolled fires, fodder collection, and overgrazing. The intensity of these activities varied across different locations, and there was a lack of awareness among people regarding the conservation of medicinal plants. In addition to the mentioned threats, the armed conflict in the area over the past decade posed a serious concern for the preservation of medicinal flora. The use of explosive materials in the region resulted in contamination of several plants with corrosive substances. Notably, no conservation strategies have been implemented in the study area to prevent the overexploitation of wild species.

Nevertheless, some plants are being cultivated and marketed by local farmers, including *Melia azedarach* and *Dalbergia sisso*. This local initiative by indigenous communities to derive economic benefits from the local flora may stimulate interest in the conservation and regulation of the local flora to protect threatened species (Balemie and Kebebew , 2006).

Biodiversity Challenges

It is a common occurrence that natural resources, including plants, are susceptible to threats in their natural habitats due to rapid human intervention and the destruction of these resources. The collection of medicinal plants for ethnic practices and other anthropogenic activities not only damages Indigenous flora but also poses a threat to traditional knowledge. UNESCO has emphasized the importance of documenting and preserving traditional knowledge, particularly in South Asia, including Pakistan and India. Despite ongoing efforts, they are not sufficient for conserving the traditional knowledge that has persisted for centuries, potentially leading to valuable discoveries in the modern healthcare system. The current study examines the local perception of Indigenous communities regarding the threats faced by ecological resources, especially medicinal plants. Lack of awareness is identified as a major threat to plant resource conservation. Factors such as the timing of collection, processing, storage, and herbal preparations are crucial steps to consider for both economic returns and conservation. Primarily, local healers are involved in medicinal plant collection. A study in the Swat region of Pakistan has demonstrated that proper harvesting of wild medicinal plants can yield higher economic returns compared to standard cash crops (Sher et al. 2016). Other studies support these results, indicating significant potential for improving the harvesting, storage, use, preparation, and marketing of herbal products as a source of income (Aziz et al. 2016). In the remote areas of the study region, local inhabitants derive substantial economic benefits from forest products, a pattern observed in other mountainous communities in northern Pakistan (Ahmad *et al.* 2015). Several threats to medicinal plant resources in the study area include deforestation, heavy grazing pressure, uncontrolled collection of fodder, and other non-timber forest products by local people and traders. Studies have reported a decline in the number of medicinal plants due to overexploitation and environmental degradation (Hussain et al. 2006). Thus, there is an urgent need to manage and design the overall grazing system to promote the sustainable regeneration and protection of medicinal plants. Based on the observations and findings of the current investigation, proper management steps should be taken with active participation from Indigenous communities to conserve this precious flora. It is also crucial to raise awareness among local people about the market value and sustainable harvesting of medicinal plants. Rapid modernization and urbanization pose a threat not only to the degradation of plant species but also to the associated folk knowledge. Therefore, we strongly recommend the inclusion of ethnobotany as a subject in the curriculum to help students recognize endangered and medicinally important species in their respective regions. Additionally, incentives may be provided to farmers for cultivating medicinal plants on marginal lands and home gardens.

CONCLUSIONS

This research has played a crucial role in safeguarding traditional knowledge from a remote region where folk wisdom is rapidly diminishing due to various factors, including swift modernization. The custodians of traditional knowledge are predominantly local herbalists and elder community members. The study identified a total of 63 medicinal plant species belonging to 43 families, with Solanaceae and Moraceae being the most frequently utilized plant families in the study area. Notably, species like *Berberis lyceum* and *Withania somnifera* have the highest number of use reports and are extensively employed by the local population. While certain medicinal plants have undergone phytochemical screening and pharmacological testing, the traditional uses of a considerable number of plants still await validation. Therefore, our study emphasizes the imperative need for phytochemical, pharmacological, microbiological, toxicological, preclinical, and clinical investigations to ensure the safety and efficacy of the reported medicinal taxa. Additionally, our research sheds light on the various threats faced by the local flora, including deforestation, heavy grazing, and overexploitation, which are undermining the prospects of

sustainability. Consequently, it is essential to formulate and implement robust conservation strategies for the sustainable utilization of medicinal flora and the preservation of traditional knowledge.

Supplementary materials
Not applicable

Author contributions
Conceptualization, M.A. and AMKH; methodology, U,D., software, IUH.; validation, G.R. and AHK.; formal analysis, A.Q., S.I, S.A.I, M.N, N.U.H, F.U, H.M and A.A.S.; investigation, U.D.; data curation, AMHK writing-original draft preparation, A.M.H.K.; writing-review and editing, M.A. and A.M.H.K.; supervision, M.A. authors have read and agreed to the published version of the manuscript.

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Data Availability Statement
All of the data is included in the article/Supplementary Material.

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Conflict of interest
The authors declared that present study was performed in absence of any conflict of interest.

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