Indigenous knowledge and conservation status of wild plants collected from Garyaum, North Waziristan, Pakistan

Irfan Ali Shah, Tanvir Burni, Lal Badshah and Noor Ul Uza

Correspondence

Irfan Ali Shah, Tanvir Burni, Lal Badshah and Noor Ul Uza*

Department of Botany, University of Peshawar, Pakistan.

*Corresponding Author: noorbotany123@gmail.com

Ethnobotany Research and Applications 25:40 (2023) - http://dx.doi.org/10.32859/era.25.40.1-17
Manuscript received: 10/02/2023 – Revised manuscript received: 14/03/2023 - Published: 16/03/2023

Research

Abstract

Background: People still use plant-based medicine for their basic healthcare requirements despite having easy access to contemporary medications. Individuals are more dependent on natural remedies, especially in rural areas. In Garyaum, North Waziristan, Pakistan, this study intends to investigate the key native plants utilized in medicine and their applications for treating various illnesses.

Objectives: The objectives of this study was to: (1) conduct a systematic examination of the wild plants utilized by the inhabitants of the study area; (2) collect indigenous knowledge concerning wild plants; (3) assess species with considerable cultural importance to the Garyaum inhabitants; and (4) document the conservation status of the collected plants in study area.

Methods: Ethnobotanical data based on sociodemographic characteristics were collected using the protocol of (Martin 1995). Techniques included direct led field walks, focus groups, and semi-structured interviews. 95 participants including 81 men and 14 women were interviewed. Quantitative approaches, such as relative frequency citation (RFC), use value (UV), and fidelity level (FL) were also conducted.

Results: The participants reported a total of 66 plant species, belonging to 49 genera and 28 families. Of the total reported plants, 47 were fodder species, 35 were medicinal species, 14 were timber species, 20 were fuel species, 11 were fruits species, 7 was vegetable species, 2 were condiment species, 9 were thatching species, 3 were ornamental species while 3 were poisonous in nature. The current findings revealed 45 species (68.18 %) as vulnerable, 9 species (13.63 %) as rare, 8 species (12.12 %) as endangered and 4 species (6.06 %) was found infrequent. None of the species was ranked in the dominant category (IUCN 2001) which clearly described the unpleasant situation of the local flora.

Conclusion: It is concluded that local people still rely on plant-based medication for their basic medical requirements. The vast majority of the species are utilized as fuel, wood, and fodder. In addition, plant diversity is diminishing as a result of many anthropogenic influences, infrastructural expansion, and climate change as well. Hence, proper identification and cultivation of significant medicinal and aromatic plants, as well as appropriate conservation and management techniques, are urgently needed in the research region. And the value of floral diversity and conservation must be entrenched in local inhabitants' children.

Keywords: Conservation status, Endangered species, Garyaum, Indigenous knowledge, Quantitative ethnobotany.

Background

Indigenous traditional knowledge has been used to generate a number of commonly used items, including herbal treatments for human and animal health. Additionally, indigenous knowledge advances research in a number of areas connected to the utilization of plant-based therapies in the creation of contemporary medicine (Megersa and Woldetsadik 2022). Finding natural remedies for use as medicine was extremely difficult for early humans (Kassa *et al.* 2020). It is extremely likely that early humans frequently ate poisonous plants in search of sustenance, yet they were nevertheless able to learn about herbal remedies. The use of traditional medicine is linked in numerous nations to extensive indigenous knowledge that dates back to very early periods (Wendimu *et al.* 2021). For the development of new medications and for the treatment or prevention of various illnesses and associated infectious symptoms, knowledge of plant-based ethnomedicine or traditional medicine, as well as its derivatives, is essential. Ethnomedicine is often passed down orally by members of a society (Ahmed and Hughes 2022). It is extremely old and comprises all of the knowledge, abilities, and procedures whether explicable or not that are based on the theories, beliefs, and experiences unique to various cultures. These methods are used to maintain health as well as to prevent, diagnose, treat, or improve physical and mental illnesses (Achour *et al.* 2022).

Many ethnic communities rely on natural resources, including medicinal plants, according to the global community. The use of plants as traditional therapeutics provides a viable alternative in healthcare in developing countries, particularly for rural populations. In recent decades, the study of therapeutic plants using qualitative research methods has become an important tool. Herbal treatments have a long history in East Asia and are thought to have few side effects and high efficacy (Ali *et al.* 2022). It is feared that the expanding era, advancements in contemporary agriculture and industry, and urbanization would more or less have an impact on the village community's ability to meet fundamental demands. The ease of access to remote and mountainous locations brought about by globalization has the potential to alter how rural communities use different plants for their everyday requirements. The transmission of local knowledge from the elder generation may be impeded and even decline as a result of modernization (Ghanimi *et al.* 2022).

Various studies have been conducted both within and outside the country and it was found that the knowledge of medicinal plants is fading as a result of the younger generation's disinterest. Furthermore, because traditional knowledge is passed down orally from generation to generation, basic facts such as plant parts used, methods of preparing and administering the remedy, ailments cured, and so on may be lost during the transfer process. Documenting medicinal plants is critical for preserving indigenous knowledge (Hussain *et al.* 2022). Consequently, it is anticipated that an ethnobotanical study will contribute to the cultural sustainability of plant use. Local knowledge from the community also advances science and technology (Arsyad 2018) and offers scientific methods that can be expanded further for long-term sustainable purposes (Cao *et al.* 2020).

Other researchers such as (Mengistu and Bekele 2021; Shah and Hussain 2021; Woldemariam *et al.* 2021; Zakariya *et al.* 2021; Birjees *et al.* 2022; Ishtiaq *et al.* 2022; Telli *et al.* 2022; Dastagir *et al.* 2022; Jan *et al.* 2022) studied ethnobotany and conservation status of plants from their study areas and stressed that local communities of the proposed areas lack life facilities; they depend on traditional uses of plants for various purposes.

The review of literature revealed that no research has been done on any part of the plant resources in Garyaum, North Waziristan Pakistan. Because there are no written records on medicinal plants due to the passing of knowledgeable elders without passing on traditional skills to other family members, many plant species and accompanying indigenous knowledge are also vanishing. Also due to urbanization, modernization of traditions, industrialization, fast food temptation, deforestation, and a lack of interest among the younger generation, the use of plants and the knowledge linked with them is disappearing. Therefore, it is essential to preserve this priceless ancient knowledge before it disappears. The objectives of the current study are to conduct a systematic examination of the wild plants utilized by the inhabitants of the study area; collect indigenous knowledge concerning wild plants; assess species with considerable cultural importance to the Garyaum inhabitants; document the conservation status of the collected plants in study area. Due to its isolation and preservation of traditions, we hypothesized Garyaum that would exhibit pronounced variations in plant use compared to other regions of Pakistan. The current research will help with the phytoecological analysis of the selected area and the examination of the region's bioresources, guiding conservationists and managers in the implementation of their plans and activities. It also fits within the scope of a monograph.

Materials and Methods

Description of study area

North Waziristan is located in the northernmost mountainous region of Pakistan. It is around the same size as Rhode Island in the United States. It borders Kurram district in the north, South Waziristan district in the south, Bannu in the east, and Afghanistan in the west. According to the most recent Pakistani census, which was conducted in 1998, it has 361,246 residents. The population has significantly increased since then, though, and is likely closer to 492,608 currently. According to reports, the average literacy rate in 1998 was about 17.5% (women's literacy is estimated to be under 3%). North Waziristan is divided into three sections (Miranshah, Mirali and Razmak). Nine Tehsils separate these three divisions further (Ghulam khan, Shewa, Datta khel, Spinwam, Dossali, Razmak, Garyaum, Miranshah, and Mirali Tehsil). Garyaum is a hilly and cold area and located between 32° 19′ 12.85″ North latitudes and 69° 57′ 24.56″ East longitudes. Its height above sea level ranges from 1220 to 1830 meters (Major 1927). It is probably the most underdeveloped of the nine Tehsils with a few roads and one high school for boy. There is no girls school in the whole Tehsil. The girls are seen grazing goats, instead of going to schools. The area is inhabited mainly by Madikhel and Shogi subtribes. Large join families live either in one house (locally known as Kot) or inadjacent houses. Most houses (Kots) have a fort like structure. Every section in a village has a mosque and a common sitting place. (Figure 1). The common dress of men comprises shirt, trousers, waist coats, turban and chappal. The women wear a long shirt known as "Staar Khaat" with trousers. A married woman wears colored trousers while, an unmarried girl wears simple trousers. The average temperature in June and July ranges from (20 to 28) and (22 to 32 degrees Celsius), respectively. July is the hottest month in Garyaum. The winter season begins in November and lasts through February. The minimum and highest temperature in January ranges from -1 to 13 degrees Celsius. Coldest months are December and January. March is the pleasant season (Shah et al 2023) (Figure 1).

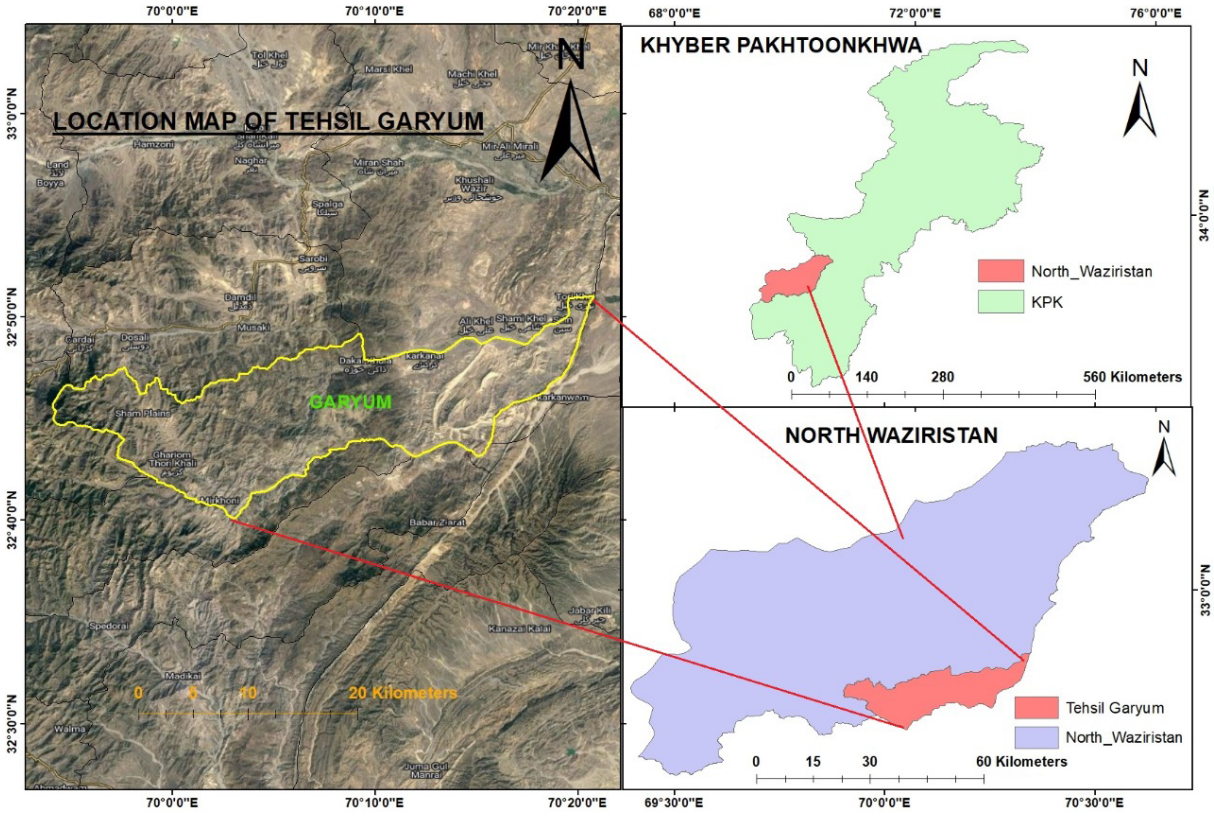

Figure 1. Map of Garyaum, North Waziristan, Pakistan.

Ethnobotanical surveys, plant collection and identification

Ethnobotanical surveys (4 Times) were conducted from 2017-2019 to explore the local uses of wild plants of Garyaum. Plant samples were collected, correctly dried, conserved after being inspected in the field, and identified by taxonomist Ghulam Jailani (Lecturer in Botany at Department of Botany, University of Peshawar) with the help of flora of Pakistan (http://www.efloras.org/flora) and the plant list (http://www.theplantlist.org/) was used for the nomenclature of plant species (Nasir & Ali 1971-1995). Voucher numbers were assigned to the specimens and mounted on herbarium sheets for future documentation at Department of Botany, University of Peshawar, Pakistan.

Ethnobotanical and socio-demographic data

Ethnobotanical data based on sociodemographic characteristics were collected using the protocol of (Martin 1995). Techniques included direct led field walks, focus groups, and semi-structured interviews (Figure 2) (Shah *et al.* 2023). 81 men and 14 women out of 95 participants were interviewed. The age of the majority of the participants ranged from 42 to 65. The necessary data included local names, locality, and therapeutic values. Few participants had the chance to finish elementary or secondary education. Practitioners of traditional medicine, farmers, midwives who attend traditional births, herbalists, and nomads were among the respondents' main lines of work (Table 1).

ETHNO-BOTANICAL SURVEY PROFORMA

- Thesis title: _____
- Botanical Name: _____
- Date: _____
- Sheet No.: _____
- Participant: _____
- Habit: _____
- Habitat: _____
- Altitude: _____
- Traditional uses of plant locally: _____
- Part used: _____
- Is it favorite food of livestock: _____ Yes/ No
- Then name of the livestock: _____ Sheep, Goat, Cow etc.
- Is it cure for cure of human ailments: _____ Yes/ No
- If Yes, then for which disease: _____
- Mode of preparation: _____
- Status of plant: _____ common, rare, endangered, vulnerable.
- Name of the researcher: _____

Figure 2. Ethnobotanical Survey Proforma.

Table 1. Demographic information of the participants.

Variable	Total number of participants	Category	Number	%
Gender	95	Male	81	85.2
		Female	14	14.7
Age		23-30	18	18.9
		30-42	23	24.2
		42-65	54	56.8
Education level		Illiterate	53	55.7
		Primary	17	18
		Middle	25	26.3
Profession		Practitioners	12	12.6
		farmers	37	38.9
		midwives	14	14.7
		herbalists	22	23.1
		nomads	10	10.5

Quantitative data analysis

The selection of therapeutic plants for additional phytochemical and pharmacological research is made possible by quantitative ethnobotanical analysis. The following indices were used to statistically examine the collected data.

Use Value

The UV of a plant species is used to assess its relative importance i.e.; it considers its potential for usage (Ferreira *et al.* 2009). It is measured as:

$$UV = UVi/Ni$$

Where "Ni" is the total number of respondents and "UVi" is the frequency of citations for each species across all respondents.

Fidelity Level

The Fidelity Level is the proportion of respondents who acknowledged using particular plant species to treat a particular disease in the study location (Idm'hand *et al.* 2020). The FL is calculated as:

$$FL\ (\%) = (Np/N) \times 100$$

Where "Np" denotes the precise number of citations for a given illness and "N" denotes the overall number of informants who brought up a particular species when discussing any condition.

Relative Frequency of Citation

Relative Frequency Citation (RFC) is used to report the valley's highest medicinal plants, which is consumed for the cure of various disorders (Idm'hand *et al.* 2020).

$$RFC = FC/N\ (0 < RFC < 1)$$

Where "FC" is the frequency of citation and "N'' is the number of respondents reporting the use of species.

Conservation classes of plants

Plants were categorized into various conservation classes using (IUCN 2001) criteria as mentioned in (Table 2).

Table 2. Conservation classes of plants.

Numbers	**Denotes**
a) Plant availability	
1:	Very rare
2:	Rare
3:	Occasional
4:	Abundant
b) Collection	
0:	More than 1000 kg/year
1:	Consumed from 500-1000 kg/ year
2:	Consumed from 200-500 kg/year
3:	Consumed from 100-200 kg/year
c) Growth	
0:	Re-growth in more 3 years
1:	Re-growth in 3 years
2:	Re-growth in 2 years
3:	Re-growth in 1 year
4:	Re-growth in a season
d) Part Used	
0:	Whole plant/roots
1:	Bark
2:	Fruits/seeds
3:	Flowers
4:	Latex/Gum/Leaves
e) Total Scores	
1:	0-4 Endangered
2:	5-8 Vulnerable
3:	9-12 Rare
4:	13-14 Infrequent
5:	15-16 Dominant

Results and Discussion

Qualitative ethnobotany

In the current study, 66 plant species, belonging to 49 genera and 28 families were reported. Of the total reported plants, 47 were fodder species, 35 were medicinal species, 14 were timber species, 20 were fuel species, 11 were fruits species, 7 were vegetable species, 2 were condiment species, 9 were thatching species, 3 were ornamental species while 3 were poisonous in nature. Most of the reported plants were regularly used as firewood, medicinal, grazing and for timber purposes. *Quercus incana* and *Q. dialata* were used as a timber. *Juglans regia, Melia azadarch*, *Acacia modesta* and *Morus* species were mostly used as a fuel because there was no natural gas in the study area (Figures 3-4), Table 3. Acharya *et al.* (2022); Bibi *et al.* (2022); Al-Robai *et al.* (2022); Jan *et al.* (2021); Jan *et al.* (2022) reported similar results.

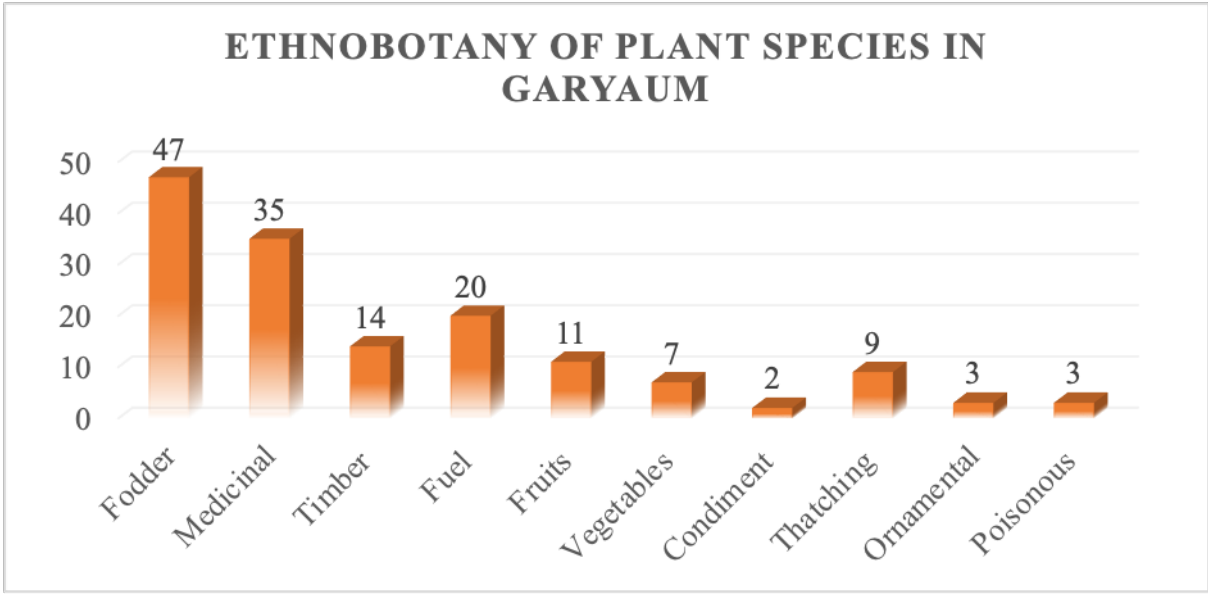

Figure 3. Ethnobotanical profile of collected plants in Garyaum, North Waziristan, Pakistan.

Quantitative ethnobotany

Use Value (UV)

Use value (UV) is an index widely used to quantify the relative importance of useful plants. It combines the frequency with which a species is mentioned with the number of uses mentioned per species and is often used to highlight prominent species of interest (Fatima *et al.* 2017). In the current study, UV was reported in the range of 0.13 to 0.95. The highest UV was documented for *Cucurbita maxima* (0.95) followed by *Cucumis sativus* (0.93 %), *Morus alba* (0.89), *M. nigra* (0.88) and lowest for *Poterium sanguisorba* (0.13). According to the current findings, *Cucurbita maxima* (0.96) was the most commonly used species, because of its therapeutic and nutraceutical significance (Table 3). It showed that traditional knowledge about these medicinal plants is limited, medicinal plants with the lowest UV do not necessarily suggest that they are not valuable medically (Shopo *et al.* 2022). The results are comparable with the findings of (Rahman *et al.* 2016; Hussain *et al.* 2018; Khomsi *et al.* 2022; Souilah *et al.* 2022; Birjees *et al.* 2022; Karpavičienė 2022), who stressed that the plants with high UV have high medicinal value and can be employed for drug discovery.

Fidelity Level (FL)

Fidelity level is an important index that highlights the medicinal plants with maximum curative properties. It is used to determine the most preferred species used in the treatment of a particular ailment as more than one plant species are used in the treatment in the same category (Cheng *et al.* 2022). FL was reported from 19.2 to 91.8 %. The plant species with highest fidelity level were *Juglans regia* (91.8) followed by *Ajuga parviflora* (89.8), *Cleome Ariana* (80.2) and *Mentha arvensis* (79.8) (Table 3). The maximum FL revealed the choice of informants to cure the specific disease (Karaköse 2022). The highest FL denotes the availability, distribution, and detailed information about the curative properties, and dosage of a plant. The lowest FL was calculated for *C. nummularius* and *P. orientalis* (19.2) (Table 3).

Ali *et al.* (2022); Jan *et al.* (2022); Bibi *et al.* (2022); Srinivasan *et al.* (2022); Acharya *et al.* (2022) and Hussain *et al.* (2022) observed similar findings. The plant species used in the treatment of a single disease have fidelity levels of 100 % when compared to those used in the management of multiple diseases. The plant species that are extensively *used by the indigenous inhabitants have maximum FL values than those that are rarely used (Chebaibi et al. 2022).*

Figure 4. A-C: Trees cutting for Timber wood, D: Trees cutting for Fuel wood, E-F: Heavy grazing.

Relative Frequency of Citation (RFC)

The Value of RFC ranged from 0.01 % to 0.14 %. The maximum RFC was shown by *Mentha arvensis* (0.14 %) followed by *M. longifolia*, *M. spicata* and *Momordica charantia* (0.12 %). RFC values represent the relative popularity of individual species in study area according to their use. The significant values of these species confirmed that they are used for many disorders including pyrosis, vomiting, gastric pain, hypertension, against cold, intestinal bloating, against worms, gastric pain; it also facilitates digestion. The minimum RFC value (0.01 %) was documented for *Scabiosa olivieri* and *Phlomis stewertii* (Table 3). The relative frequency of citations reveals how well-versed the tribes were in the therapeutic benefits of particular plant species. Additionally, it indicates use and effectiveness with few side effects (Hussain *et al.* 2018). (Mlilo and Sibanda 2022; Bai *et al.* 2022; Mohamed *et al.* 2022; Haq *et al.* 2022; Munir *et al.* 2022) supported the present findings.

Table 3. Ethnobotanical profile of wild plants of Garyaum, North Waziristan, Pakistan.

Family	Species	Voucher NO	Altitude (m)	Habit	F	M	Ti	Fu	Fr	Ve	C	Th	O	P	RFC	UV	FL
Capparidaceae	*Cleome ariana* Hedge & Lamond	Shah.Bot.01 (UOP)	4000	H	+	+	-	-	-	+	-	-	-	-	0.04	0.40	80.2
	Cleome brachycarpa (Forssk.) Vahl. ex Dc.	Shah.Bot.02 (UOP)	4000	H	+	-	-	-	-	-	-	-	-	-	0.03	0.50	60.2
Convolvulaceae	*Convolvulus arvensis* L.	Shah.Bot.03 (UOP)	4018	H	+	-	-	-	-	-	-	-	-	-	0.10	0.71	70.8
	Ipomea purpurea L.	Shah.Bot.04 (UOP)	4102	H	+	+	-	-	+	-	-	-	-	-	0.03	0.23	56.2
Cucurbitaceae	*Cucurbita maxima* Duch. ex Lam.	Shah.Bot.05 (UOP)	4108	C	+	-	-	-	-	-	-	-	-	-	0.11	0.95	40.9
	Cucumis sativus L.	Shah.Bot.06 (UOP)	4100	C	+	+	-	-	-	+	-	-	-	-	0.02	0.93	49.7
	Momordica charantia L.	Shah.Bot.07 (UOP)	4000	C	-	+	-	-	-	-	-	-	-	-	0.12	0.45	20.3
Dipsaceceae	*Scabiosa candollei* Dc.	Shah.Bot.08 (UOP)	4020	H	+	-	-	-	-	-	-	-	+	-	0.04	0.40	43.7
	Scabiosa olivieri Coult. Mem. Dips.	Shah.Bot.09 (UOP)	4020	H	+	-	-	-	-	-	-	-	-	-	0.01	0.66	29.8
Ebenaceae	*Luffa cylindrical* L.	Shah.Bot.10 (UOP)	4310	C	-	-	+	+	+	-	-	-	-	-	0.03	0.78	30.7
Euphorbiaceae	*Chrozophora tinctoria* (L.) A. Juss.	Shah.Bot.11 (UOP)	4000	H	-	-	-	-	-	-	-	-	-	+	0.04	0.51	73.8
	Euphorbia indica Lam.	Shah.Bot.12 (UOP)	4205	H	-	-	-	-	-	-	-	-	-	+	0.04	0.60	56.2
Fabaceae	*Acacia modesta* Wall.	Shah.Bot.34 (UOP)	4050	T	+	-	+	+	-	-	-	+	-	-	0.02	0.46	30.2
	Astragalus anisacanthus Boiss	Shah.Bot.48 (UOP)	5800	H	+	-	-	-	-	-	-	-	-	-	0.02	0.52	59.8
	Astragalus corrugata Bertol	Shah.Bot.49 (UOP)	5300	H	+	-	-	+	-	-	-	-	-	-	0.02	0.43	45.9
	Astragalus hemsleyi Aitch & Baker	Shah.Bot.50 (UOP)	5300	H	+	-	-	-	-	-	-	-	-	-	0.03	0.26	50.6
	Astragalus psilocentros Fisch.	Shah.Bot.51 (UOP)	5300	H	+	+	-	+	-	-	-	-	-	-	0.05	0.59	66
	Astragalus strobilifers Royle ex. Benth.	Shah.Bot.52 (UOP)	5300	H	+	+	-	-	-	-	-	-	-	-	0.04	0.36	46
Fagaceae	*Quercus incana* Roxb.	Shah.Bot.13 (UOP)	4407	T	+	-	+	+	-	-	-	+	-	-	0.03	0.45	65.5
	Quercus dialata Royle	Shah.Bot.14 (UOP)	4109	T	+	-	+	+	-	-	-	+	-	-	0.02	0.51	25.9
Fumaraceae	*Fumaria indica* (Hausskn.) Pugsley	Shah.Bot.15 (UOP)	4400	H	+	+	-	-	-	-	-	-	-	-	0.05	0.62	72.3

Gentianaceae	*Erodium cicutarium* (L.) L. Her. ex Aiton.	Shah.Bot.16 (UOP)	5300	H	+	-	-	-	-	-	-	-	-	-	0.03	0.38	35.5
	Gentianodes lowndesii (Blatt.) Omer, Ali & Qaiser	Shah.Bot.17 (UOP)	5305	H	-	+	-	-	-	-	-	-	-	-	0.04	0.25	62.5
Geraniaceae	*Geranium colinum* Stephan ex Willd.	Shah.Bot.18 (UOP)	4250	H	-	+	-	-	-	-	-	-	-	-	0.02	0.69	45.6
	Geranium rotundifolium L.	Shah.Bot.19 (UOP)	4247	H	+	-	-	-	-	-	-	-	-	-	0.03	0.48	65.7
Juglandaceae	*Juglans regia* L.	Shah.Bot.20 (UOP)	4305	T	+	+	+	+	+	-	-	-	-	-	0.05	0.49	91.8
Lamiaceae	*Ajuga parviflora* Benth.	Shah.Bot.21 (UOP)	4408	H	-	+	-	-	-	-	-	-	-	-	0.02	0.68	89.8
	Eremosta chyssuperba Royle. ex Benth.	Shah.Bot.22 (UOP)	5400	H	+	-	-	-	-	-	-	-	-	-	0.06	0.71	20.2
	Eremosta chysthyrsiflora Benth.	Shah.Bot.23 (UOP)	5200	H	+	-	-	-	-	-	-	-	-	-	0.05	0.45	56.7
	Eremosta chysvicaryi Benth. Ex Hook.f.	Shah.Bot.24 (UOP)	5200	H	+	+	-	-	-	-	-	-	-	-	0.05	0.63	69.4
	Isodon rugosus (Wall.ex Benth) Codd.	Shah.Bot.25 (UOP)	4000	S	-	+	-	-	+	-	-	-	-	-	0.03	0.28	50.7
	Marrubium vulgare L.	Shah.Bot.26 (UOP)	4134	H	+	+	-	-	-	-	-	-	-	-	0.02	0.61	68.2
	Mentha arvensis L.	Shah.Bot.27 (UOP)	4500	H	+	+	-	-	-	+	+	-	-	-	0.14	0.63	79.8
	Mentha longifolia (L.)	Shah.Bot.28 (UOP)	4430	H	+	+	-	-	-	+	-	-	-	-	0.12	0.66	57.4
	Mentha spicata L.	Shah.Bot.29 (UOP)	4420	H	+	+	-	-	-	+	-	-	-	-	0.12	0.29	75.1
	Nepeta sp Roth.	Shah.Bot.30 (UOP)	4405	H	+	+	-	-	-	-	-	-	-	-	0.05	0.49	25.9
	Phlomis stewertii Hook. f.	Shah.Bot.31 (UOP)	5500	H	+	-	-	-	-	-	-	-	-	-	0.01	0.55	60.6
Malvaceae	*Malva neglecta* Waller.	Shah.Bot.32 (UOP)	4000	H	-	+	-	-	-	+	+	-	-	-	0.04	0.65	50.6
Meliaceae	*Melia azadarch* L.	Shah.Bot.33 (UOP)	4000	T	+	-	+	+	-	-	-	+	-	-	0.05	0.59	56.1
Moraceae	*Ficus carica* L.	Shah.Bot.35 (UOP)	4400	T	+	+	+	+	+	-	-	-	-	-	0.02	0.50	56
	Morus alba L.	Shah.Bot.36 (UOP)	4100	T	+	-	+	+	+	-	-	+	-	-	0.10	0.89	69.8
	Morus nigra L.	Shah.Bot.37 (UOP)	4100	T	+	-	+	+	+	-	-	+	-	-	0.09	0.88	25.9
	Morus laevigata Wall. ex Brandis	Shah.Bot.38 (UOP)	4000	T	+	-	+	+	+	-	-	+	-	-	0.09	0.86	66.1
Nyctaginaceae	*Mirabilis jalapa* L.	Shah.Bot.39 (UOP)	4000	H	-	-	-	-	-	-	-	-	+	-	0.04	0.60	62.1

Oleaceae	*Fraxinus xanthoxyloides* (G. Don) Wall. ex A. DC.	Shah.Bot.40 (UOP)	4001	T	+	+	-	+	-	-	-	-	-	-	0.02	0.47	70
	Olea europea L.	Shah.Bot.41 (UOP)	4500	T	+	+	+	+	+	-	-	+	-	-	0.02	0.49	56
Onargaceae	*Epiloium hirsutum* L.	Shah.Bot.42 (UOP)	4300	H	+	+	-	-	-	-	-	-	-	+	0.06	0.52	52.5
	Oenothera rosea L. Hert. ex Aiton	Shah.Bot.43 (UOP)	4080	H	-	+	-	-	-	-	-	-	-	-	0.04	0.86	76.3
Oxalidaceae	*Oxalis corniculata* L.	Shah.Bot.44 (UOP)	4030	H	+	+	+	+	-	-	-	-	-	-	0.03	0.23	51
Papavaraceae	*Hypecom pendulum* L.	Shah.Bot.45 (UOP)	4000	H	+	-	-	-	-	-	-	-	-	-	0.05	0.30	40.6
	Onobrychus tavernievifolia Stock ex Boiss.	Shah.Bot.46 (UOP)	5400	H	+	-	-	-	-	-	-	-	-	-	0.05	0.78	28
	Papaver Dubium L.	Shah.Bot.47 (UOP)	5400	H	-	+	-	-	-	-	-	-	-	-	0.04	0.49	25.1
Plantaginaceae	*Digitalis purpurea* L.	Shah.Bot.53 (UOP)	4306	H	-	+	-	-	-	-	-	-	-	-	0.07	0.45	36
	Plantago lanceolata L.	Shah.Bot.54 (UOP)	5100	H	+	-	-	-	-	-	-	-	-	-	0.10	0.15	25.1
Platanaceae	*Platanus orientalis* L.	Shah.Bot.55 (UOP)	5100	T	+	+	+	+	-	-	-	+	+	-	0.07	0.28	19.8
Plumbaginaceae	*Acantholimon* spp.	Shah.Bot.56 (UOP)	5050	S	+	-	-	+	-	-	-	-	-	-	0.06	0.21	30.2
Paulowniaceae	*Paulownia tomentosa* (Thunb.) Steud.	Shah.Bot.57 (UOP)	5000	T	-	-	+	+	-	-	-	-	-	-	0.02	0.27	76
Polygonaceae	*Adonis aestivalis* L.	Shah.Bot.58 (UOP)	4000	H	+	+	-	-	-	-	-	-	-	-	0.04	0.59	20.5
	Persicaria hydropiper (L.) Delarbre	Shah.Bot.59 (UOP)	4000	H	-	+	-	-	-	-	-	-	-	-	0.04	0.52	35.9
	Persicaria maculosa Grey.	Shah.Bot.60 (UOP)	4000	H	-	+	-	-	-	-	-	-	-	-	0.03	0.73	55.1
	Rumex crispus L.	Shah.Bot.61 (UOP)	5010	H	+	-	-	-	-	+	-	-	-	-	0.04	0.34	20.6
Rosaceae	*Cotoneaster nummularius* C.A.	Shah.Bot.62 (UOP)	4000	S	-	+	-	+	+	-	-	-	-	-	0.05	0.49	19.8
	Fragaria nubicola (Hook. f.) Lindl.	Shah.Bot.64(UOP)	4000	H	-	+	-	-	-	-	-	-	-	-	0.02	0.58	70.5
	Poterium sanguisorba L.	Shah.Bot.65 (UOP)	4008	H	-	+	-	-	-	-	-	-	-	-	0.04	0.13	53.2
	Prunus armeniaca L.	Shah.Bot.66 (UOP)	4019	T	+	-	-	+	+	-	-	-	-	-	0.03	0.61	20.2

Table 4. Ranking of plant species using IUCN criteria for conservation status of plants.

Family	Species	Availability	Collection	Part used	Growth	Total score	Conservation status
Capparidaceae	*Cleome ariana* Hedge & Lamond	1	1	0	1	3	E
	Cleome brachycarpa (Forssk.) Vahl. ex Dc.	1	2	0	1	4	E
Convolvulaceae	*Convolvulus arvensis* L.	3	2	4	4	13	I
	Ipomea purpurea L.	3	3	4	4	14	I
Cucurbitaceae	*Cucurbita maxima* Duch. ex Lam.	1	1	2	4	8	V
	Cucumis sativus L.	1	2	1	4	8	V
	Momordica charantia L.	2	1	1	4	8	V
Dipsaceceae	*Scabiosa candollei* Dc.	1	2	2	3	8	V
	Scabiosa olivieri Coult. Mem. Dips.	2	1	2	3	8	V
Ebenaceae	*Luffa cylindrical* L.	2	0	3	3	8	V
Euphorbiaceae	*Chrozophora tinctoria* (L.) A. Juss.	2	3	4	4	13	I
	Euphorbia indica Lam.	3	3	4	4	14	I
Fabaceae	*Acacia modesta* Wall.	2	0	0	1	3	E
	Astragalus anisacanthus Boiss	0	0	0	3	3	E
	Astragalus corrugates Bertol	0	0	0	3	3	E
	Astragalus hemsleyi Aitch & Baker	2	2	0	3	7	V
	Astragalus psilocentros Fisch.	2	2	0	3	7	V
	Astragalus strobilifers Royle ex. Benth.	2	3	0	3	8	V
Fagaceae	*Quercus incana* Roxb.	3	1	4	3	11	R
	Quercus dialata Royle	3	1	4	3	11	R
Fumaraceae	*Fumaria indica* (Hausskn.) Pugsley	2	1	0	3	7	V
Gentianaceae	*Erodium cicutarium* (L.) L. Her. ex Aiton.	1	3	0	3	7	V
	Gentianodes lowndesii (Blatt.) Omer, Ali & Qaiser	1	3	0	3	7	V
Geraniaceae	*Geranium colinum* Stephan ex Willd.	0	3	0	3	6	V
	Geranium rotundifolium L.	0	3	0	3	6	V

Juglandaceae	*Juglans regia* L.	3	0	2	3	8	V
Lamiaceae	*Ajuga parviflora* Benth.	2	2	0	4	8	V
	Eremosta chyssuperba Royle. ex Benth.	1	2	0	3	6	V
	Eremosta chysthyrsiflora Benth.	1	2	0	4	7	V
	Eremosta chysvicaryi Benth. Ex Hook.f.	1	2	0	4	7	V
	Isodon rugosus (Wall.ex Benth) Codd.	2	2	0	4	8	V
	Marrubium vulgare L.	2	2	0	2	6	V
	Mentha arvensis L.	3	1	0	4	8	V
	Mentha longifolia (L.)	3	1	0	4	8	V
	Mentha spicata L.	3	1	0	4	8	V
	Nepeta sp Roth.	2	1	0	3	6	V
	Phlomis stewertii Hook. f.	2	2	2	4	10	R
Malvaceae	*Malva neglecta* Waller.	2	2	0	3	7	V
Meliaceae	*Melia azadarch* L.	1	2	1	3	7	V
Moraceae	*Ficus carica* L.	2	0	2	3	7	V
	Morus alba L.	1	0	2	2	5	V
	Morus nigra L.	1	0	2	2	5	V
	Morus laevigata Wall. ex Brandis	1	0	2	2	5	V
Nyctaginaceae	*Mirabilis jalapa* L.	2	2	0	3	7	V
Oleaceae	*Fraxinus xanthoxyloides* (G. Don) Wall. ex A. DC.	1	0	2	2	5	V
	Olea europea L.	1	0	2	2	5	V
Onargaceae	*Epilobium hirsutum* L.	2	2	4	4	12	R
	Oenothera rosea L. Hert. ex Aiton	2	2	3	4	11	R
Oxalidaceae	*Oxalis corniculata* L.	3	2	4	4	13	R
Papavaraceae	*Hypecom pendulum* L.	3	2	3	4	12	R
	Onobrychus tavernievifolia Stock ex Boiss.	2	1	0	3	6	V
	Papaver dubium L.	3	0	2	4	9	R

	Acacia modesta Wall.	2	0	0	1	3	E
Plantaginaceae	*Digitalis purpurea* L.	2	3	0	3	8	V
	Plantago lanceolata L.	2	3	0	3	8	V
Platanaceae	*Platanus orientalis* L.	0	0	1	3	4	E
Plumbaginaceae	*Acantholimon spp Boiss.*	2	2	0	3	7	V
Paulowniaceae	*Paulownia tomentosa* (Thunb.) Steud.	0	2	0	0	2	E
Polygonaceae	*Adonis aestivalis* L.	1	3	0	3	7	V
	Persicaria hydropiper (L.) Delarbre	0	1	0	3	4	V
	Persicaria maculosa Grey.	1	2	0	3	6	V
	Rumex crispus L.	2	2	4	4	12	R
Rosaceae	*Cotoneaster nummularius* C.A.	1	1	0	2	4	E
	Fragaria nubicola (Hook. f.) Lindl.	2	2	0	4	8	V
	Poterium sanguisorba L.	2	0	0	4	6	V
	Prunus armeniaca L.	2	1	0	2	5	V

Conservation status of the flora

Based on conservation status, the documented plants were classified in 5 classes i.e., dominant, infrequent, rare, vulnerable and endangered. It was noticed that each species has confined to a specific habitat. The current findings revealed 45 species (68.18 %) as vulnerable, 9 species (13.63 %) as rare, 8 species (12.12 %) as endangered and 4 species (6.06 %) was found infrequent. None of the species was ranked in the dominant category (IUCN 2001) which clearly described the unpleasant situation of the local flora (Table 4 & Figure 3-4). These plants are used in various forms by local people like these are as source of ethnobotanical applications. The continuous and incessant cutting or usage by the indigenous communities causes loss of the many of these herbaceous taxa from the study area. The decline in the population size of these species was due to its small population, over harvesting, and grazing, urbanization, adverse climatic conditions, and marble mining. The results are comparable to Ali et al (2018); Shaltout and Bedair (2022); Qin *et al.* (2022). It was noticed that the inhabitants of the area relay on natural sources firstly due to lack of resources and secondly due to high cost of mark product. This represents key factor that will cause natural flora degradation in the study area. Many species like *Cleome ariana, C. brachycarpa, Acacia modesta, Astragalus anisacanthus, A. corrugates, Paulownia tomentosa*, *Platanus orientalis* and *Cotoneaster nummularius* are declared as endangered. Similar results were reported by Dastagir *et al.* (2022) and proposed that these species are near to extinction from the study area which demands urgent need to conserve these valuable plants.
Gender-restricted harvesting, mouth harvesting, night harvesting, and naked harvesting were common among them (Wanjohi *et al.* 2020).

Research revealed that the adoption of technical training for the young generation as a means of preserving traditional medicine knowledge was conspicuously absent. As a result, there is no dependable method of preserving indigenous medicinal knowledge in the study area (Farooq *et al.* 2019).

To determine the nutritional and medicinal value of the flora, elemental, phytochemical, and close studies should be performed. It is crucial to protect the species of medicinal plants for the next generations since major medicinal species are on the verge of extinction due to overexploitation. To reduce strain on the flora, local residents should intensify the farming of medicinal plants that are in danger of extinction. The current research yielded a wealth of knowledge fit for directing future action. To expand regional applications of plant resources in the coming years will be helpful to taxonomists, ecologists, pharmacologists, and other public and commercial organizations.

Novelty of the study

It is the first ever survey in Garyaum, North Waziristan, Pakistan as a total to the best of our knowledge. It will serve as a foundation for subsequent study in the field of pharmacology, biology, ethnobotany and phyto-chemistry.

Conclusion

The research revealed a high level of indigenous knowledge transfer through spiritualism and dreaming, both of which are underutilized in traditional medicine knowledge transfer and conservation. Tough peer learning was also mentioned, but due to fear of competition among herbalists, it is likely to become minimal as the herbal medicine industry becomes more commercialized. However, deforestation, grazing, and widespread medicinal plant extraction are man-made risks to medicinal species. These elements might be harmful to taxa that are phyto-medicinal as well as the information that goes with them. Medicinal plant species with high UV index should be subjected to phytochemical and pharmaceutical analysis to identify their active components for drug extraction. These species should also be prioritized for conservation as their preferred uses may threaten their populations due to overexploitation. The research is only a preliminary survey, but it could offer a valuable literary contribution for regional scholars, environmentalists, and decision-makers.

Declarations

Abbreviations: C, Condiments; F, Fodder; FL, Fidelity Level; Fr, Fruit; Fu, Fuel wood; H, Herb; M, Medicinal; O, Ornamental; P, Poisonous; RFC, Relative Frequency of Citation; T, Tree; Ti, Timber; Th. Thatching; S, Shrub; UV, Use Value; Ve, Vegetables; V, vulnerable; R, rare; E, endangered; I, infrequent.

Ethical approval and consent to participate: All interviewees consented.

Availability of data: The data used in this work are available in the manuscript.

Conflict of interest: The authors declare that there is no conflict of interest.

Funding: No funding.

Authors' contributions: IAS, L and TB designed the study; IAS conducted the fieldwork, NUU, IAS conducted the main statistical analysis; NUU wrote the manuscript, NUU revised the data analysis and the manuscript; all authors read, corrected, and approved the manuscript.

Literature cited

Acharya M, Divakar MS, Malabadi RB, Chalannavar RK. 2022. An ethnobotanical survey of medicinal plants used by the" NALIKE" community in the Bantwala taluk of Dakshina Kannada District, Karnataka, India. Plant Science Today 9(2):461-8.

Achour S, Chebaibi M, Essabouni H, Bourhia M, Ouahmane L, Mohammad SA, Aboul-Soud M, Giesy JP. 2022. Ethnobotanical study of medicinal plants used as therapeutic agents to manage diseases of humans. Evidence-Based Complementary and Alternative Medicine 15(23):1-31.

Ali A, Badshah L, Hussain F. 2018. Ethnobotanical appraisal and conservation status of medicinal plants in Hindukush Range, District Swat, Pakistan. Journal of Herbs, Spices & Medicinal Plants 24(4):332-55.

Ali M, Yar, P, Salman K, Hussain W, Hussain K, Hussain G, Bussmann RW. 2022. Land use and land cover modification and its impact on biodiversity and the ecosystem services in District Kurram, Pakistan. BLACPMA 21:365-388.

Al-Robai SA, Ahmed AA, Mohamed HA, Ahmed AA, Zabin SA, Alghamdi AA. 2022. Qualitative and Quantitative Ethnobotanical Survey in Al Baha Province, Southwestern Saudi Arabia. Diversity 14(10):867.

Arsyad M. 2018. Studi etnobotanitumbuhan obatoleh masyarakat Desa Sidorejo Kecamatan Tamban Kabupaten Barito Kuala J Insan Farmasi Indonesia1 (1): 85-95.

Bai Y, Zhang Q, He X, Wang H, Li W, Zhu J, Meng Y, Long C. 2022. An ethnobotanical study on medicinal plants of Shexian dryland stone terraced system in northern China. Journal of Ethnobiology and Ethnomedicine 18(1):1-40.

Bibi F, Abbas Z, Harun N, Perveen B, Bussmann RW. 2022. Indigenous knowledge and quantitative ethnobotany of the Tanawal area, Lesser Western Himalayas, Pakistan. Plos One 17(2):263604.

Birjees M, Ahmad M, Zafar M, Nawaz S, Jehanzeb S, Ullah F, Zaman W. 2022. Traditional knowledge of wild medicinal plants used by the inhabitants of Garam Chashma valley, district Chitral, Pakistan. Acta Ecologica Sinica 42(2):19-33.

Cao Y, Li R, Zhou S, SongL, Quan R, Hu H. 2020. Ethnobotanical study on wild edible plants used by three trans-boundary ethnic groups in Jiangcheng County, Pu'er, Southwest China. Journal of Ethnobiology and Ethnomedicine 16: 66. DOI: 10.1186/s13002-020-00420-1.

Chebaibi M, Bousta D, Bourhia M, Baammi S, Salamatullah AM, Nafidi HA, Hoummani H, Achour S. 2022. Ethnobotanical study of medicinal plants used against COVID-19. Evidence-based Complementary & Alternative Medicine 2(2):4-8.

Cheng Z, Lu X, Lin F, Naeem A, Long C. 2022. Ethnobotanical study on wild edible plants used by Dulong people in northwestern Yunnan, China. Journal of Ethnobiology and Ethnomedicine 18(1):1-21.

Dastagir G, Jan SA, Uza NU, Ahmad I, Bussmann RW. 2022. Traditional knowledge and diversity of medicinal plants in Hindukush range, Tehsil Mastuj, Chitral, Pakistan: An ethnobotany survey. Ethnobotany Research and Applications 29(24):1-9.

El Khomsi M, Dandani Y, Chaachouay N, Hmouni D. 2022. Ethnobotanical study of plants used for medicinal, cosmetic, and food purposes in the region of Moulay Yacoub, Northeast of Morocco. Journal of Pharmacy & Pharmacognosy Research 10:13-29.

Farooq A, Amjad MS, Ahmad K, Altaf M, Umair M, Abbasi MA. 2019. Ethnomedicinal knowledge of the rural communities of Dhirkot, Azad Jammu and Kashmir, Pakistan. Journal of Ethnobiology and Ethnomedicine 15:45.

Fatima A, Ahmad M, Zafar M, Yaseen G, Khan MPZ, Butt MA, Sultana S. 2017. Ethnopharmacological relevance of medicinal plants used for the treatment of oral diseases in Central Punjab-Pakistan. Journal of Herbal Medicine 9:4-7.

Ferreira FS, Brito SV, Ribeiro SC, Almeido WO, Alves RRN. 2009. Zootherapeutics utilized by residents of the community Poco Dantas, Crato-CE, Brazil. Journal of Ethnobiology and Ethnomedicine 5:21.

Ghanimi R, Ouhammou A, Ahouach A, Cherkaoui M. 2022. Ethnobotanical study on wild edible plants traditionally used by Messiwa people, Morocco. Journal of Ethnobiology and Ethnomedicine 18:16-19.

Haq A, Badshah L, Ali A, Ullah A, Khan SM, Ullah I. 2022. Ethnobotanical study of medicinal plants of Pashat Valley, Bajaur, along Pakistan-Afghanistan border: a mountainous region of the Hindu Kush Range. Nordic Journal of Botany 2:35-80.

Hussain S, Hussain W, Nawaz A, Badshah L, Ali A, Ullah S, Ali M, Hussain H, Bussmann RW. 2022. Quantitative ethnomedicinal study of indigenous knowledge on medicinal plants used by the tribal communities of Central Kurram, Khyber Pakhtunkhwa, Pakistan. Ethnobotany Research and Applications 15(23):1-31.

Hussain W, Badshah L, Ullah M, Ali M, Ali A, Hussain F. 2018. Quantitative study of medicinal plants used by the communities residing in Koh-e-Safaid Range, northern Pakistani-Afghan borders. Journal of Ethnobiology and Ethnomedicine 14(1):1-8.

Idm'hand E, Msanda F, Cherifi K. 2020. Ethnobotanical study and biodiversity of medicinal plants used in the Tarfaya Province, Morocco. Acta Ecologica Sinica 40(2):134-144.

Ishtiaq M, Khanum H, Hussain I, Parveen A, Maqbool M, Thind S, Hussain T, Azeem M, Shabir F, Elansary HO. 2022. Ethnobotanical inventory and medicinal perspectives of herbal flora of Shiwalik mountainous range of District Bhimber, Azad Jammu and Kashmir, Pakistan. Plos one, 17(3):26-28.

Jan M, Khare RK, Mir TA. 2021. Medicinal plants used during pregnancy and childbirth in Baramulla District of Jammu and Kashmir, India. Ethnobotany Research and Applications 22:1-9.

Jan M, Mir TA, Jan HA, Khare RK. 2022. Medicinal plants diversity and their uses for gynecological disorders of District Baramulla, Jammu and Kashmir, India. Vegetos 35(2):438-52.

Karaköse M. 2022. An ethnobotanical study of medicinal plants in Güce district, north-eastern Turkey. Plant Diversity 3:7-10.

Karpavičienė B. 2022. Traditional Uses of Medicinal Plants in South-Western Part of Lithuania. Plants 11(16):2093.

Kassa Z, Asfaw Z, Demissew S. 2020. An ethnobotanical study of medicinal plants in Sheka Zone of Southern Nations nationalities and peoples regional state, Ethiopia. Journal of Ethnobiology and Ethnomedicine 6:7-9.

Major AD. 1927. Notes on a tour through Waziristan. Journal of the Royal Army Medical Corps 49(2):143-151.

Megersa M. Woldetsadik S. 2022. Ethnobotanical study of medicinal plants used by local communities of Damot Woyde District, Wolaita zone, southern Ethiopia. Nusantara Bioscience 14(1).

Mengistu M, Bekele F. 2021. Traditional medicinal plants species belonging to fabaceae family in Ethiopia: A systematic review. International Journal of Plant Biology 12:8473.

Mlilo S, Sibanda S. 2022. An ethnobotanical survey of the medicinal plants used in the treatment of cancer in some parts of Matebeleland, Zimbabwe. South African Journal of Botany 146:401-8.

Mohamed A, Karima S, Nadia O. 2022. The use of medicinal plants against cancer: An ethnobotanical study in the Beni Mellal-Khenifra Region in Morocco. European Journal of Integrative Medicine 52:102137.

Munir M, Sadia S, Khan A, Rahim BZ, Gagosh Nayyar B, Ahmad KS, Khan AM, Fatima I, Qureshi R. Ethnobotanical study of Mandi Ahmad Abad, District Okara, Pakistan. Plos one 17(4):265125.

Nasir A, Hughes K. 2022. Role of ethno-phytomedicine knowledge in healthcare of COVID-19: advances in traditional phytomedicine perspective. Beni-Suef University Journal of Basic and Applied Sciences 11(1):1-7.

Qin F, Xue T, Yang X, Zhang W, Wu J, Huang Y, Khan G, Yu S. 2022. Conservation status of threatened land plants in China and priority sites for better conservation targets: distribution patterns and conservation gap analysis. Biodiversity and Conservation 31(8-9):2063-82.

Rahman U, Ijaz F, Iqbal Z. 2016. A novel survey of the ethno medicinal knowledge of dental problems in Manoor valley (Northern Himalaya), Pakistan. Journal of Ethnopharmacology 194:877-894.

Shah SM, Hussain F. 2021. Weed diversity in Maize fields of Mastuj valley, Hindukush range, Pakistan. Pure and Applied Biology 5(4):1044-50.

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 18(25):1-8.

Shaltout K, Bedair H. 2022. Diversity, distribution and regional conservation status of the Egyptian tree flora. African Journal of Ecology 60(4):1155-83.

Shopo B, Mapaya RJ, Maroyi A. 2022. Ethnobotanical study of medicinal plants traditionally used in Gokwe South District, Zimbabwe. South African Journal of Botany 149:29-48.

Souilah N, Miara MD, Bendif H, Medjroubi K, Snorek J. 2022. Traditional ethnobotanical knowledge on medicinal plants used by the populations in Central Russikada (Northeastern Algeria). Journal of Herbs, Spices & Medicinal Plants 28(1):15-35.

Srinivasan P, Subramaniyan V, Gk T, Krishnasamy K, Jeyalachagan S, Palani M. 2022. A survey on medicinal plant knowledge among the indigenous communities (Tamilians) in the delta regions of Tamil Nadu, India. Journal of Herbs, Spices & Medicinal Plants 28(1):36-72.

Tefera BN, Kim YD. 2019. Ethnobotanical study of medicinal plants used as antimalarial and repellent by Sidama people of Hawassa Zuria district, Southern Ethiopia. Journal of Complementary Medicine Research 10(1):13-13.

Telli A, Chedad A, Sadine SE. 2022. Ethnobotanical study of medicinal plants used for scorpion sting envenoming treatments in Algerian Septentrional Sahara. International Journal of Environmental Studies 2(3):1-23.

Wanjohi BK, Njenga EW, Sudoi V, Kipkore WK, Moore HL, Davies MIJ. 2020. Ecological knowledge of indigenous plants among the Marakwet Community (Embobut Basin), Elgeyo Marakwet County (Kenya). Ethnobotany Research and Applications 20:3-8.

Wendimu A, Tekalign W, Asfaw B. 2021. A survey of traditional medicinal plants used to treat common human and livestock ailments from Diguna Fango District, Wolaita, Southern Ethiopia. Nordic Journal of Botany 39:5-10.

Woldemariam G, Demissew S, Asfaw A. 2021. An ethnobotanical study of traditional medicinal plants used for human ailments in Yem ethnic group, south Ethiopia. Ethnobotany Research and Applications 22:1-15.

Zakariya AM, Adamu A, Nuhu A, Kiri IZ. 2021. Assessment of indigenous knowledge on medicinal plants used in the management of malaria in Kafin Hausa, north. western Nigeria. Ethnobotany Research and Applications 22.