Quantitative ethnobotanical study and conservation status of herbal flora of Koh-e-Suleman range, Razmak valley, North Waziristan, Pakistan

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Research

Abstract

Background: The present work was intended to explore the quantitative ethnobotany and conservation status of flora of Koh-e-Suleman range, Razmak valley, North Waziristan, Pakistan. For the first time, significant traditional knowledge of the uses of reported flora was documented.

Objective: The aim of the present study was to: (i) elucidate local populations' traditional knowledge of indigenous plants used for various purposes (ii) compile ethnomedicinal data using quantitative analyses for in-depth pharmacological evaluation of medicinal plants. (iii) evaluate the reported flora's conservation status.

Methods: Ethnobotanical data were analyzed using quantitative tools, i.e., Relative frequency citation (RFC), use value (UV), and fidelity level (FL).

Results: 102 participants including 75 men and 27 women were interviewed. The participants reported a total of 68 plant species, belonging to 57 genera and 19 families. There was 1 family of pteridophytes (1 species), 1 family of gymnosperms (4 species) and 63 species belonging to 17 families of angiosperms. Of the total reported plants, 38 were fodder species, 37 were medicinal species, 5 were timber species, 9 were fuel species, 8 were fruits species, 1 was vegetable species, 5 were condiment species, 2 were thatching species, 9 were ornamental species while none of the species was poisonous in nature. Conservation status revealed that 49 species (72.05 %) were vulnerable, 12 species (17.64 %) were rare, 6 species (8.82 %) were endangered, and 1 species (1.47 %) was found infrequent.

Conclusion: The current study showed the majority of the species were used as fuel wood, medicines, and fodder. As most plant species have significant curative properties, a rotational and moderate grazing system is required to conserve the plants. Local residents must inculcate in their children the importance of floral diversity and conservation.

Keywords: Anthropogenic activities, Conservation status, Endangered species, Quantitative ethnobotany, Razmak valley.

Background

The term "ethnobotany" refers to the study of interrelations between human beings and plants. It focuses on how plants have been used, accomplished and perceived in human societies and includes plants used for food, medicinal, rituals, social life and others (Jan *et al.* 2020; Usman *et al.* 2022)**.** It helps us to use plants for many purposes such as wealth, food, fuel, medicine and timber (Assen *et al.* 2021). Thousands of the peoples in developing countries depend upon various plant products. Other than medicinal uses, the plant species are also playing a significant role in the economic position of the local people (Dastagir *et al.* 2022; Hussain *et al.* 2022)**.** All plant species have particular micro habitats where they live and complete their life cycles. Species diverge with fluctuation in habitats and environmental factors (da Silva and Zank 2022).

Today, ethnobotanical research can be a reliable and preferred route to drug discovery, as well as plays an important role in biodiversity conservation (Shah and Hussain 2021). The indigenous peoples of a given geographical area are associated with nature and rely on plants as a primary source of remedy for various physical ailments (Idm'hand *et al.* 2020), it demonstrates the urgent need for an extensive ethnobotanical survey to understand the judicious utilization of raw materials while also preparing an inventory for it. Alamgeer *et al.* (2013) reported that medicinal plants from Batkhela, District Malakand were used for the treatment of various diseases like high blood pressure, diarrhea, and diabetes. It was claimed that ethnobotanical knowledge is corroborating to be helpful for drug discovery in the wake of effective searching from biodiversity. Ilyas *et al.* (2013) investigated 209 plants, majority of the species were used as medicine, fodder and forage, firewood, wild fruits, vegetables, ornamental plants and ethnoveterinary purpose. Other researchers such as (Farooq *et al.* 2012; Ahmad at el. 2014; Khan and Musharaf 2015; Abbas *et al.* 2016; Ali at el. 2017; Hussain at el. 2018; Mengistu and Bekele 2021; Woldemariam *et al.* 2021; Shah *et al.* 2022) also reported similar results 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.

Plants conservation plays a significant role to protect the habitat and other natural resources of an area. It is necessary because without plants, life is impossible (Bano *et al.* 2018). Plant diversity of Pakistan is under severe threats due to natural disasters and other anthropogenic activities. Human being is totally depending on plants for food, shelter, fuel wood, medicine, timber and other material essential for our daily life. Plants resources are vanishing at an alarming rate due to various factors such as over population, pollution, deforestation, alien species, various disease, climatic changes, and natural disaster (Bibi *et al.* 2015). Areas rich in biodiversity, with a high frequency of endemic species and which have a high extent of environmental dilapidation, were theorized as a Biodiversity Hotspots (Ali *et al.* 2017). The loss of biodiversity characterizes one of the most persistent environmental challenges (Ali *et al.* 2018). In the preceding eight years, 49 countries round the world have devoted to reinstating 150 million ha of ruined and deforested land by 2020 and 350 million ha by 2030 to protect the valuable biodiversity (Bakht *et al.* 2018).

The literature review showed that there is no work has been done on any aspect (including ethnobotanical study) of plants resources of Razmak valley, North Waziristan, Pakistan. Therefore, the present study endeavored to highlight the ethnobotanical properties and conservation of the plants of the selected area. The current findings fall within the range of a monograph and will contribute to the phytoecological analysis of Razmak and to the consideration of bio-resources of the location, thus directing conservationists and managers in the execution of their programs and activities.

The current study aimed at: 1. documenting the ethnomedicinal important flora and utilization of medicinal plants, 2. to assess the conservation status of medicinal plants. We hypothesized that Razmak valley, due to its remoteness and maintenance of traditions would show distinct differences in plant use in comparison to other areas of Pakistan.

Materials and Methods

Description of study area

North Waziristan is the Northern mountainous region of Pakistan. It has an area of 4,707 km^2. Now it is a district of Khyber Pakhtunkhwa province. In North it shares a border with Kurram district, in South with South Waziristan district, in East with Bannu and in West it shares a border with Afghanistan. It consists of three sub-divisions (Miranshah, Mirali and Razmak). These three divisions are further divided in to nine Tehsils (Ghulam khan, Shewa, Datta khel, Spinwam, Dossali, Razmak, Gharyum, Miranshah, and Mirali Tehsil). Razmak is one of the sub-divisions of North Waziristan. It lies between 32°/41/22 North latitudes, 69°/50/31 East longitudes. Its height varies from 6000 to 11000 ft from the sea level. It is located on the South of Miranshah and on the boundary of North Waziristan and South Waziristan (Figure 1). The main tribes in North Waziristan are Wazir and Dawar. The Dawar tribes are preferred

to government services while Wazir tribes prefer to transport businesses. The local people are mostly farmers. They rear cattle and earn their income through farming (Major 1927).

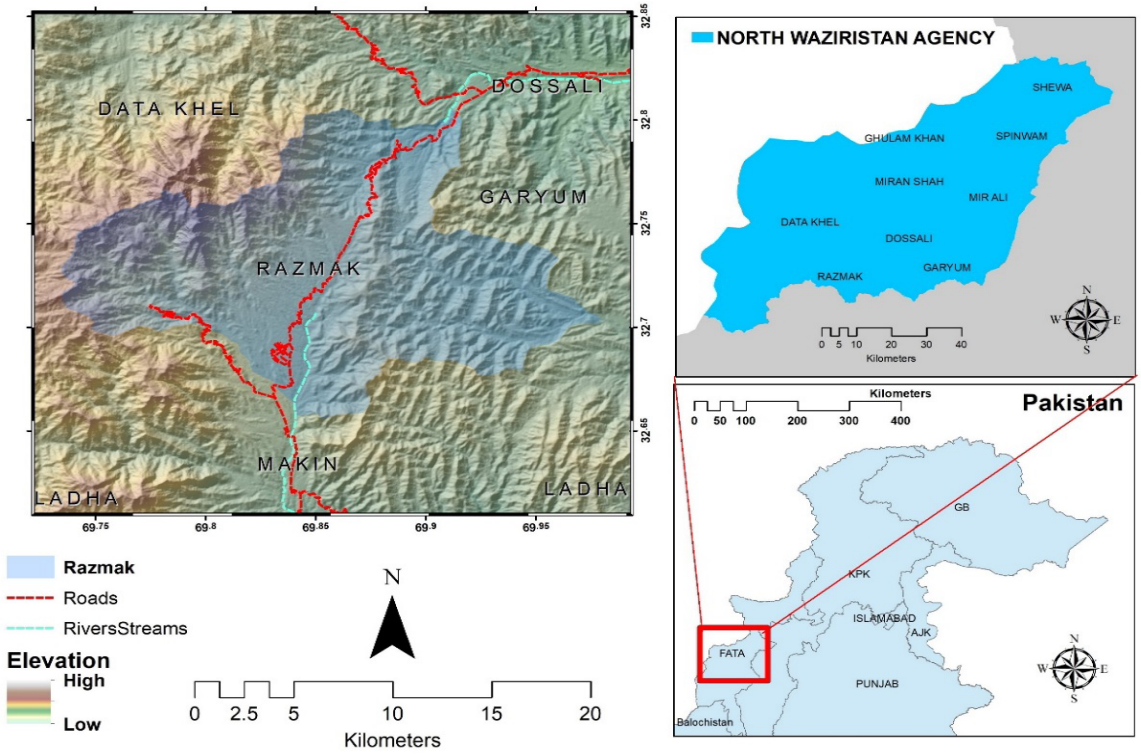

Figure 1. Map of research zone (Razmak valley).

Geo-Climate of research zone

The climate of area is varying because of different altitudes. In summer season it is awesome but in winter it is cold. The duration of summer season is 5 months, from May till until September. June is ordinarily the hottest month. The base and noteworthy temperature during the time of June is 18 ̊c to 31 ̊c respectively (Khalid *et al.* 2022). Winter season starts from the month of October and continues until April. The minimum and maximum temperatures during the month of January are -2 ̊c to 10 ̊c respectively. December, January, and February are coldest months. Precipitation is low aside from in the Razmak zone where precipitation is higher than other area of North Waziristan. The cultivated area of North Waziristan is only 4 % of the total geographic area whereas, the remaining 96 % area is non-cultivated. This puts pressure on the available agricultural land and creates a great problem for the local people. Geographically, the mountains are bounded by Suleiman range on south and Koh-e-safid on North. The area has been clarified as the place where there are high and troublesome slopes. The high mountains and slopes structure divide it between Afghanistan and Pakistan. The height of the North Waziristan slopes varies from (4900- 11000) ft from the sea level. The important ranges in Waziristan hills are Alexandra, Shawal and Shoidar (Lieutenant-Colonel 1925). There are some notable rivers such as Khaisor Kurrum, Tochi, Shaktoi and Kaito rivers (Figure 1). The literacy rate of this area is low, although there are many schools. Schools are usually owned and managed by the local elders and have been granted to them and are being funded by the government as a bribe. The interest of education in the general population is evident and most of the youth understand the importance of education. However, nowadays there are many people who are studying and getting education in many colleges and universities of Pakistan and these people also have much talent. There is only one Government Hospital in Tehsil Razmak.

Plant collection and identification

Ethnobotanical surveys were carried out during the year 2017-2019 to investigate the local uses of plants. Plant samples were observed in the field, collected, dried and preserved properly. The plant samples were identified by taxonomist Ghulam Jailani (Lecturer in Botany, at Department of Botany, University of Peshawar, Pakistan) with the help of flora of Pakistan (Nasir and Ali 1971-1995). Names of the plants were checked in Google and flora of

Pakistan. Voucher numbers were given and mounted on herbarium sheets for future record at Department of Botany, University of Peshawar, Pakistan.

Ethnobotanical and socio-demographic data

Ethnobotanical data collection procedures were used to collect information on ethnobotany of plants and socio-demographic features (Martin 1995). Semi-structured interviews (Figure 2), focus group discussions, and direct guided field walks were used as techniques (Wali *et al.* 2021; Jan *et al.* 2020). One hundred two participants including 75 men and 27 women were interviewed (Figure 1). Each respondent was interviewed separately to provide information on socio-demography (gender, age, and educational level). The majority of those who took part in this study were between the ages of 40 and 60. Few respondents had the opportunity to complete primary or secondary school. Respondents included traditional medicine practitioners, farmers, traditional birth attendants, herbalists, and nomads. The vast majority of respondents were men. The women were confined to their homes because of cultural barriers. They were purdah-observing and must fulfil the traditional and religious obligations. Secondly, men were found to have more experience in terms of knowledge sharing than women. The proper place and time for discussion were established on the interest of the respondent to diminish the collapse with their work time.

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: _____

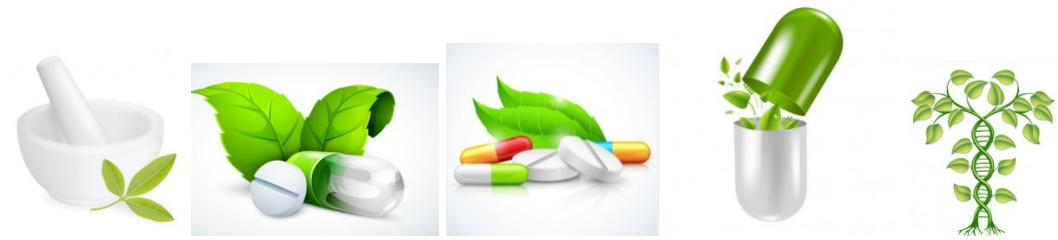

Figure 2. Ethnobotanical survey form

Statistical data analysis

The collected data was statistically analyzed using the following quantitative indices: Relative Frequency of Citation (RFC), Use Value (UV), and Fidelity Level (FL).

Relative Frequency of Citation

Relative Frequency Citation (RFC) was used to record the valley's highest therapeutic medicinal flora, which is consumed for the treatment of a variety of ailments.

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

It demonstrates the significance of each species and is determined by the frequency of citation FC, the number of respondents reporting the use of species divided by the total number of respondents (N) who participated in the survey as defined by (Vitalini *et al.* 2013).

Use Value

The use value of a plant species is used to determine its relative importance (Ferreira *et al.* 2009). It is calculated as:

$$UV = UVi/Ni$$

Where 'UVi' is the frequency of citations for species through all respondents and 'Ni' the number of respondents.

Fidelity Level

The percentage of respondents who mentioned the use of specific plant species to treat a specific disease in the research area is referred to as the Fidelity Level (Idm'hand *et al.* 2020). The FL index is calculated as follows:

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

Where "Np" is the specific Number of citations for a particular ailment, and 'N' is the total number of informants mentioned the species for any disease.

Conservation classes of plants

Plants were arranged into different conservation classes using IUCN (2001) criteria as given in Table 1.

Table 1. Conservation classes of plants.

Numbers	**Denotes**
a) Plants 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

The current study revealed 68 species belonging to 19 families were reported from the selected area. Of the total reported plants 38 were fodder species, 37 were medicinal species, 5 were timber species, 9 were fuel species, 8 were fruits species, 1 was vegetable species, 5 were condiment species, 2 were thatching species, 9 were ornamental species while none of the species were poisonous in nature. Most of the reported plants were regularly used as firewood, medicinal, grazing and for timber purposes. *Pinus walichiana* and *Pinus rouxburgii* were used as a timber. Most of the shrubs and trees are also used as a fuel because there was no light resources and natural gas in the study area (Figure¡ 3-4, Table 2-3). These results are consistent with other findings carried out by (Hu *et al.* 2020, Mir *et al.* 2021a, Mir *et al.* 2021b and Mir *et al.* 2022).

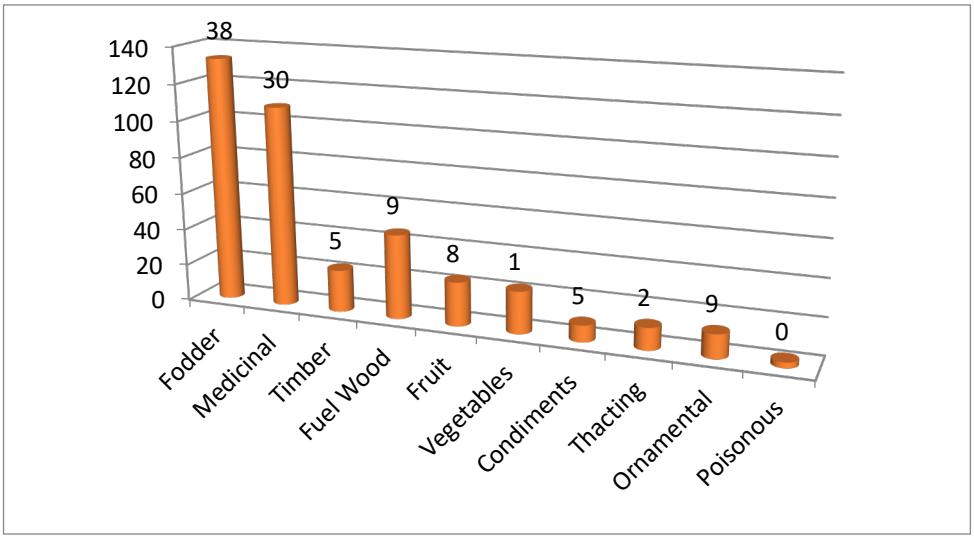

Figure 3. Economic significance of plants species in Razmak valley.

Figure 4. A-B: Tree cutting for timber and wood, C: Heavy grazing of *Quercus spp.* D: Tree cutting for fuelwood.

Table 2. Ethnobotanical profile of herbal flora of Koh-e-Suleman range, Razmak valley, North Waziristan, Pakistan.

Family	Species	Voucher NO	Altitude (m)	Habit	F	M	Ti	Fu	Fr	Ve	C	Th	O	P	RFC	UV	FL
Alliaceae	*Allium cepa* L.	Shah.Bot.07 (UOP)	2000	H	+	+	-	-	-	-	+	-	-	-	0.03	0.30	30.2
	Allium sativum L.	Shah.Bot.08 (UOP)	2000	H	+	+	-	-	-	-	+	-	-	-	0.01	0.50	30.2
Amaranthaceae	*Amaranthus hybridus* L.	Shah.Bot.20 (UOP)	2010	H	+	-	-	-	-	-	-	-	-	-	0.12	0.77	70.6
Apiaceae	*Coriandrum sativum* L.	Shah.Bot.21 (UOP)	2100	H	-	+	-	-	-	-	+	-	-	-	0.04	0.92	56
	Foeniculum vulgare Mill.	Shah.Bot.22 (UOP)	2100	H	+	+	-	-	-	-	-	-	-	-	0.01	0.90	45.9
	Torilis arvensis (Huds.) Link.	Shah.Bot.23 (UOP)	2100	H	+	+	-	-	-	-	-	-	-	-	0.04	0.23	49.8
Apocynaceae	*Vincetoxicum* spp. Medic	Shah.Bot.24 (UOP)	2000	H	-	+	-	-	-	-	-	-	-	-	0.04	0.45	30.3
Asteraceae	*Anthemis arvense* (L.) Scop.	Shah.Bot.25 (UOP)	2100	H	-	+	-	-	-	-	-	-	-	-	0.02	0.45	65.7
	Aster amellus L.	Shah.Bot.26 (UOP)	2300	H	+	+	-	-	-	-	-	-	-	-	0.03	0.48	49.8
	Aster subulatus (Colenso) Kuntze	Shah.Bot.27 (UOP)	2300	H	-	+	-	-	-	-	-	-	-	-	0.03	0.58	30.2
	Bidens pilosa L.	Shah.Bot.28 (UOP)	2200	H	-	+	-	-	-	-	-	-	-	-	0.04	0.69	56
	Calendula arvensis L.	Shah.Bot.29 (UOP)	2000	H	-	+	-	-	-	-	-	-	-	-	0.02	0.57	71.5
	Cichorium intybus L.	Shah.Bot.32 (UOP)	2400	H	+	-	-	-	-	-	-	-	-	-	0.05	0.41	65.1
	Cirsium arvense (L.) Scop.	Shah.Bot.30 (UOP)	2100	H	+	+	-	-	-	-	-	-	-	-	0.03	0.35	45.9
	Cirsium verutum (D. Don)	Shah.Bot.31 (UOP)	2400	H	+	-	-	-	-	-	-	-	-	-	0.05	0.46	73.3
	Cosmos bipinnatus Cav.	Shah.Bot.34 (UOP)	2310	H	-	-	-	-	-	-	-	-	+	-	0.02	0.34	30.5
	Cousinia buphthalmoides Regel	Shah.Bot.33 (UOP)	2300	H	+	-	-	-	-	-	-	-	-	-	0.04	0.22	67.5
	Echinops cornigerus DC.	Shah.Bot.35 (UOP)	2250	H	-	+	-	+	-	-	-	-	-	-	0.04	0.67	45.9
	Echinops echinatus Roxb.	Shah.Bot.36 (UOP)	2230	H	+	-	-	-	-	-	-	-	-	-	0.01	0.38	65.1
	Erigeron acris L.	Shah.Bot.37 (UOP)	2300	H	+	-	-	-	-	-	-	-	-	-	0.02	0.47	60.8
	Hertia intermedia (Boiss.) Kuntze	Shah.Bot.38 (UOP)	2400	S	+	+	-	-	-	-	-	-	-	-	0.05	0.58	49.8
	Helianthus annuus L.	Shah.Bot.39 (UOP)	2400	H	+	-	-	-	-	-	-	-	+	-	0.04	0.91	30.2
	Senecio chrysanthemoides DC.	Shah.Bot.40 (UOP)	2200	H	-	-	-	-	-	-	-	-	+	-	0.02	0.45	56
	Serratula pallida DC.	Shah.Bot.41 (UOP)	2200	H	+	+	-	-	-	-	-	-	-	-	0.02	0.67	39.4
	Sonchus oleraceus (L.) L.	Shah.Bot.42 (UOP)	2200	H	+	+	-	-	-	-	-	-	-	-	0.03	0.48	50
	Symphyotrichum graminifolium (Spreng.) G. L. Nesom	Shah.Bot.43 (UOP)	2100	H	+	-	-	-	-	-	-	-	-	-	0.05	0.67	48.2
	Tagetes erecta L.	Shah.Bot.44 (UOP)	2500	H	-	-	-	-	-	-	+	-	+	-	0.03	0.60	49.8
	Tagetes minuta L.	Shah.Bot.45 (UOP)	2430	H	+	-	-	-	-	-	-	-	+	-	0.02	0.65	57.7

	Tussilago farfara L.	Shah.Bot.46 (UOP)	2420	H	+	-	-	-	-	-	-	-	-	-	0.04	0.22	65.1
Balsaminaceae	*Impatiens edgeworthii* Hook. f.	Shah.Bot.47 (UOP)	2400	H	-	+	-	-	-	-	-	-	-	-	0.05	0.41	45.9
Berberidaceae	*Berberis lyceum* Royle	Shah.Bot.48 (UOP)	2500	S	+	+	-	+	-	-	-	-	-	-	0.02	0.35	70.6
Boraginaceae	*Arnebia griffithii* Boiss. Diagn.	Shah.Bot.53 (UOP)	2413	H	+	+	-	-	-	-	-	-	-	-	0.04	0.45	70.6
	Asperugo procumbens L.	Shah.Bot.54 (UOP)	2200	H	-	+	-	-	-	-	-	-	-	-	0.05	0.57	56
	Buglossoides arvensis (L.) John.	Shah.Bot.55 (UOP)	2250	H	-	+	-	-	+	-	-	-	-	-	0.03	0.41	30.2
	Cynoglossum lanceolatum Forssk.	Shah.Bot.56 (UOP)	2400	H	+	+	-	-	-	-	-	-	-	-	0.02	0.48	56
	Heliotropium europeaum L.	Shah.Bot.57 (UOP)	2500	H	+	-	-	-	-	-	-	-	-	-	0.03	0.56	49.8
	Nonnea edgeworthii DC.	Shah.Bot.58 (UOP)	2500	H	-	+	-	-	-	-	-	-	-	-	0.05	0.78	45.9
	Nonnea capsica (Willd.) G. Don.	Shah.Bot.59 (UOP)	2500	H	+	-	-	-	-	-	-	-	-	-	0.02	0.77	65.1
	Onosma hispida Wall. ex. G. Don	Shah.Bot.60 (UOP)	2500	H	+	+	-	-	-	-	-	-	-	-	0.02	0.63	65.1
	Trichodesma indicum (L.) R. Br.	Shah.Bot.61 (UOP)	2301	H	-	+	-	-	-	-	-	-	-	-	0.03	0.57	85
Brassicaceae	*Cardaria chalepensis* (L.) Hand. Mazz.	Shah.Bot.49 (UOP)	2200	S	-	+	-	-	-	-	-	-	-	-	0.05	0.48	56
	Isatis costata C. A. Mey.	Shah.Bot.50 (UOP)	2300	H	-	+	-	-	-	-	-	-	-	-	0.05	0.72	59.5
	Isatis minima Bunge	Shah.Bot.51 (UOP)	2180	H	-	+	-	-	-	-	-	-	-	-	0.03	0.96	78.3
	Lepidium pinnatifidum Ledb.	Shah.Bot.52 (UOP)	2230	H	+	-	-	-	-	-	-	-	-	-	0.03	0.33	81
Buddlejaceae	*Buddleja crispa* Benth.	Shah.Bot.62 (UOP)	2200	S	-	-	-	+	-	-	-	-	-	-	0.04	0.60	70.6
Cannabaceae	*Cannabis sativa* L.	Shah.Bot.63 (UOP)	2400	H	-	+	-	+	-	-	-	-	-	-	0.05	0.58	28
Caprifoliaceae	*Viburnum cotinifolium* D. Don.	Shah.Bot.66 (UOP)	2400	S	-	+	-	-	-	-	-	-	-	-	0.02	0.41	65.1
Capparidaceae	*Capparis decidua* (Forssk.) Edgew.	Shah.Bot.67 (UOP)	2415	S	+	+	-	+	-	-	-	-	-	-	0.03	0.63	82.1
	Capparis spinosa L.	Shah.Bot.68 (UOP)	2415	S	+	+	-	-	-	+	-	-	-	-	0.04	0.57	45.9
Caryophyllaceae	*Silene conoidea* L.	Shah.Bot.64 (UOP)	2500	H	+	+	-	-	+	-	-	-	-	-	0.01	0.48	56
	Stellaria media (L.) Vill.	Shah.Bot.65 (UOP)	2500	H	+	+	-	-	-	+	-	-	-	-	0.01	0.72	49.8
Iridaceae	*Iris germinica* L.	Shah.Bot.06(UOP)	2300	H	+	+	-	-	-	-	-	-	-	-	0.02	0.23	45.9
Pinaceae	*Cedrus deodara* (Roxb. ex D. Don) G. Don	Shah.Bot.02 (UOP)	2300	T	-	-	+	+	-	-	-	-	+	-	0.01	0.2	70.6
	Pinus geradiana Wall. ex D. Don	Shah.Bot.03(UOP)	2300	T	-	-	+	+	+	-	-	-	+	-	0.05	0.52	56

	Pinus roxburghii Sarg.	Shah.Bot.04(UOP)	2300	T	-	-	+	+	+	-	-	-	+	-	0.03	0.46	56
	Pinus wallichiana A. B. Jacks	Shah.Bot.05 (UOP)	2300	T	-	+	+	+	-	-	-	+	+	-	0.10	0.40	56
Poaceae	*Agrostis viridis* Gouan	Shah.Bot.09 (UOP)	2100	H	+	-	-	-	-	-	-	-	-	-	0.03	0.10	65.1
	Avena fatua L.	Shah.Bot.10 (UOP)	2100	H	+	-	-	-	-	-	-	-	-	-	0.07	0.23	49.8
	Bromus pectinatus Thunb.	Shah.Bot.11 (UOP)	2150	H	+	-	-	-	-	-	-	-	-	-	0.02	0.41	70.2
	Cynodon dactylon L.	Shah.Bot.12 (UOP)	2000	H	+	-	-	-	-	-	-	+	-	-	0.01	0.25	56
	Dactylis glomerata L.	Shah.Bot.13 (UOP)	2000	H	+	-	-	-	-	-	-	-	-	-	0.03	0.57	70.5
	Poa annua L.	Shah.Bot.14 (UOP)	2000	H	+	-	-	-	-	-	-	-	-	-	0.04	0.72	45.9
	Poa bulbosa L.	Shah.Bot.15 (UOP)	2000	H	+	-	-	-	-	-	-	-	-	-	0.02	0.23	35.1
	Polypogon monspeliensis (L.) Desf.	Shah.Bot.16 (UOP)	2010	H	+	-	-	-	-	-	-	-	-	-	0.02	0.34	70.6
	Triticum aestivum L.	Shah.Bot.17 (UOP)	2000	H	+	-	-	-	-	-	-	-	-	-	0.02	0.45	49.8
	Zea mays L.	Shah.Bot.18 (UOP)	2000	H	+	-	-	-	-	-	-	-	-	-	0.06	0.56	70.3
Pteridaceae	*Adiantum capillus-veneris* L.	Shah.Bot.01(UOP)	2000	H	+	-	-	-	-	-	-	-	-	-	0.01	0.11	83
Zingiberaceae	*Zingiber officinale* Roscoe	Shah.Bot.19 (UOP)	2011	H	-	+	+	-	-	+	+	-	-	-	0.03	0.61	30.2

Table 3. Part used and mode of preparation of medicinal plants of Koh-e-Suleman range, Razmak valley, North Waziristan, Pakistan.

Family	**Species**	**Habit**	**Part used**	**Mode of preparation**
Alliaceae	*Allium cepa* L.	H	Bulb	Onion Oil, Powder, Solution, Juice
	Allium sativum L.	H	Bulb	Extract, Tablets
Apiaceae	*Coriandrum sativum* L.	H	Fruits and leaves	Oil, Extract, Juice
	Foeniculum vulgare Mill.	H	Fruit	Salads and snacks, Stewed, Boiled, Grilled, Tea, Decoction
	Torilis arvensis (Huds.) Link.	H	Aerial parts	Extract
Apocynaceae	*Vincetoxicum* spp. Medic	H	Whole plant	Decoction
Asteraceae	*Anthemis arvense* (L.) Scop.	H	Fruit	Infusion
	Aster amellus L.	H	Root	Decoction
	Aster subulatus (Colenso) Kuntze	H	Root	Decoction
	Bidens pilosa L.	H	Whole plant	Extract
	Calendula arvensis L.	H	Leaves and flowers	Decoction
	Cirsium arvense (L.) Scop.	H	Root	Extract
	Echinops cornigerus DC.	H	Root's bark	Powder
	Hertia intermedia (Boiss.) Kuntze	S	Flowers	Extract
	Serratula pallida DC.	H	Aerial parts	Extract
	Sonchus oleraceus (L.) L.	H	Whole plant	In fresh form given to animals to increase milk
	Impatiens edgeworthii Hook. f.	H	Whole plant	Plant paste
Berberidaceae	*Berberis lyceum* Royle	S	Whole plant	Extract, Powder
Boraginaceae	*Arnebia griffithii* Boiss. Diagn.	H	Shoots	Dried form
	Asperugo procumbens L.	H	Whole plant	Extract
	Buglossoides arvensis (L.) John.	H	Leaves	Infusion
	Cynoglossum lanceolatum Forssk.	H	Whole plant	Powder
	Nonnea edgeworthii DC.	H	Aerial parts	Extract
	Onosma hispida Wall. ex. G. Don	H	Whole plant	Decoction
	Trichodesma indicum (L.) R. Br.	H	Whole plant	Extract
Brassicaceae	*Cardaria chalepensis* (L.) Hand. Mazz.	S	Whole plant	Extract
	Isatis costata C. A. Mey.	H	Whole plant	Extract

	Isatis minima Bunge	H	Whole plant	Extract
Cannabaceae	*Cannabis sativa* L.	H	Leaves and flowering tops	Decoction
Caprifoliaceae	*Viburnum cotinifolium* D. Don.	S	Fruit	Fresh fruits are eaten to cure stomach problems
Capparidaceae	*Capparis decidua* (Forssk.) Edgew.	S	Whole plant	Extract, Decoction
	Capparis spinosa L.	S	Whole plant	Extract, Decoction
Caryophyllaceae	*Silene conoidea* L.	H	Whole plant	Both fresh and dried form
	Stellaria media (L.) vill.	H	Whole plant	Dried powder
Iridaceae	*Iris germinica* L.	H	Roots	Dried powder
	Pinus wallichiana A. B. Jacks	T	Needles, Resin, Wood, Oleoresin	Oil
Zingiberaceae	*Zingiber officinale* Roscoe	H	Rhizome	Powder, Tea

Quantitative ethnobotany

Relative Frequency of Citation (RFC)

The Value of RFC ranged from 0.01 % to 0.12 %. Species with high RFC was *Amaranthus hybridus* (0.12 %) followed by *Pinus wallichiana* (0.10). The highest RFC value (0.12 %) *of A. hybridus* revealed that it is used for many ailments; pyrosis, vomiting, gastric pain, hypertension, against cold, intestinal bloating, against worms, gastric pain; it also facilitates digestion. The lowest RFC value (0.01 %) was documented for *Adiantum capillus-veneris., Cedrus deodara, Allium sativum, Cynodon dactylon, Foeniculum vulgare* and *Echinops echinatus* (Table 2). Similar findings have been reported in previous studies, where plants have been primarily used as source of medicines and other life sustenance materials (Bai *et al.* 2022; Haq *et al.* 2022). The relative frequency of citation indicates the tribes' familiarity with the medicinal properties of specific plant species. It also denotes accessibility and efficacy with minimal side effects (Kayani *et al.* 2015; Vitalini *et al.* 2013).

Use Value (UV)

The number of use reports mentioned by the respondent is referred to as the use value (UV). The use report indicates the medicinal property of a specific plant that is practiced in that ethnic community. The higher the use values of plant species, the greater the abundance and community reliance on a specific plant for treating various diseases. Plant species with high utility value are easily collected, and people are more familiar with the properties of plants that are rarely encountered (Kunwar *et al.* 2019).

In the current study, UV varied from 0.10 to 0.96. Maximum UV was calculated for *Isatis minima* (0.96) and lowest for *Agrostis viridis* (0.10). Significant values were documented for *Coriandrum sativum* (0.92), *Foeniculum vulgare* (0.90) and *Helianthus annuus* (0.91). According to the calculation made on the basis of the UV, *Isatis minima* (0.96) was the most frequently used by local informants with 96 use reports, because of its therapeutic significance and good variety (Table 2). Similar results were published by earlier studies (Rahman *et al.* 2016; Hussain *et al.* 2018; Khomsi *et al.* 2022), who illustrated how important quantitative techniques are in determining the importance of each species. The listed species have a high medicinal value and can be employed for drug discovery through analytical research, according to concordant findings in earlier works. Medicinal plants with the lowest UV do not mean that they are not medicinally important, but it is shown that the traditional knowledge about these medicinal plants is limited (Rahman *et al.* 2016). Therapeutic plants for which the use value (UV) is high due to their frequent distribution in the research area and the inhabitants are well known for their medicinal value (Mahmood *et al.* 2013).

Fidelity Level (FL)

FL was reported from 28 to 85 %. The plant species with highest fidelity level were *Trichodesma indicum* (85) followed by *Adiantum capillus-veneris* (83), *Capparis decidua* (82.1) and *Lepidium pinnatifidum* (81) (Table 2). The high FL of these plant species is due to their availability, distribution, and detailed information about their therapeutic uses, dosage, and recipes. The highest value of fidelity level (FL) determined the choice of informants to cure the specific disease (Bisi-Johnson *et al.* 2010). *Cannabis sativa* had the lowest value (28) recorded. Ali *et al.* (2022) and Hussain *et al.* (2022) reported similar results. According to Zakariya *et al.* (2021), 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. As a result, the findings of this study could serve as the foundation for further scientific validation of these medicinal plants.

Conservation status of the flora

The reported plants were categorized in 5 classes on the basis of conservation status i.e., endangered, vulnerable, rare, infrequent and dominant. It was noticed that each plant has restricted to a specific habitat. The current findings revealed 49 species (72.05 %) as vulnerable, 12 species (17.64 %) as rare, 6 species (8.82 %) as endangered and 1 species (1.47 %) 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). The Razmak flora is widely regarded as one of the most diverse, rich, and distinctive in the Koh-e-Suleman range. The abundance of medicinal plants emphasizes their diversity as well as their traditional uses. Previously, a large number of medicinal plants from neighboring areas were documented. Most herbal medicines were made from a single plant species. However, in traditional recipes similar to our study, more than one plant species was used in some cases (Tausha *et al.* 2018). To maintain biodiversity in the study area, medicinal plants with high UV exposure may require protection. However, project for the maintenance and conservation of flora and vegetation has been implemented in the study area thus far. Six plant species (*Bidens pilosa, Erigeron acris, Berberis lyceum, Buglossoides arvensis, Capparis decidua, C. spinose*) make up the research area critically endangered. The conservation status was determined and applied through direct field observation and information provided by local people (Ahmad *et al.* 2017). These species'

population size declined due to their small population, overharvesting and grazing, urbanization, adverse climatic conditions, and marble mining. The use of therapeutic plant species is growing, as is the demand for their harvesting. Overharvesting, urbanization, and marble mining have all contributed to the extinction of *Cedrus deodara* and *Pinus wallichiana*. The results are comparable to Ali et al (2018) and Ali et al (2022). It was also observed that due to lack of basic life facility, electric city and natural gas, the local communities totally depend on natural resources for timber, fuel and fodder purposes, made the plant resources endangered. Over browsing, unwanted harvesting and other human activities also declined the floral diversity of the valley (Figure 2). Many other workers also investigated conservation status of floral diversity from their research areas. Alamgeer *et al.* (2013) worked on conservation status of threatened endemic flora of Western Himalaya. They reported a total of 1965 species, of them 240 species were found to be threatened. Among them, 29 species were critically endangered followed by 55 species were endangered, 51 species were found vulnerable, and 26 species were found to be near threatened while, 272 species were found least concern category. They stressed that the basic reason is over grazing, uses as a source of medicine, timber wood, fuel wood and other anthropogenic activities. Bano *et al.* (2013); Khan *et al.* (2014); Ullah and Rashid (2014); Bakht *et al.* (2018) documented the conservation status of Azad Jammu and Kashmir, Himalayan, Region Poonch valley, Azad Kashmir, Mankial valley Hindukush Range, and Kalam valley. It was observed that majority of plants became extinct because of their high medicinal potential, over grazing, unwanted deforestation and other anthropogenic activities. This is also indicating that due to lack of basic life facilities, electric city and natural gas, the local communities totally depend on natural resources for timber, fuel and fodder purposes, made the plant resources endangered (Khan and Musharaf 2015).

The current findings showed that the local people are unaware of the knowledge about the significance of plant resources. They used plants traditionally for many purposes such as medicine, firewood, fodder and timber. For traditional uses of plants on large scale, deforestation have been observed in the Razmak valley. Due to over exploitation, important medicinal species are near to vanish therefore, it is significant to conserve the medicinal plants species for next generation. Further research work is needed to discourage alien invasive species and promote the plantation of native species. The current study discovered that there is no well-organized system for cultivating medicinal plants. This could be due to people's ignorance of medicinal uses, cultivation, seed collection, sowing, harvesting, collection, drying, storage, plant age, and marketing value of medicinal plants. The method of collecting medicinal plants is not scientific. These findings were supported by (Dastagir *et al.* 2022), who stated that the use of plant resources is also a source of income in Mastuj valley, in addition to meeting their various utilitarian needs. Plant collectors were frequently herders, shepherds, or other poor village dwellers. Overpopulation, agriculture, development work, habitat destruction, deforestation, and overgrazing were identified as the primary biotic stresses threatening phytodiversity. Conservation should thus be encouraged.

Novelty and future impacts

This study was compared with the findings of Qaisar *et al.* (2013), who studied the ethnobotany of medicinal plants used in Wazir and Daur tribes of North Waziristan, Pakistan. This study adds 14 new therapeutic plants (*Aster amellus, A. subulatus, Sonchus oleraceus, Impatiens edgeworthii, Arnebia griffithii, Serratula pallida, Silene conoidea, Stellaria media, Asperugo procumbens, Buglossoides arvensis, Cardaria chalepensis, Cynoglossum lanceolatum, Viburnum cotinifolium* and *Iris germinica*), which may provide baseline data for phytochemical and pharmacological screening for the detection of new drugs in future studies. The discovery of drugs from therapeutic plants links an interdisciplinary approach to joining ethnomedicinal, pharmacological, botanical, and natural methods. However, any medicinal plants in this study area are not subjected to detailed pharmacological screenings.

Conclusion

It served as a foundation for further pharmacological, biological, pharmacognostic, and phytochemical research. This study acclaims to control and monitor the flora of Razmak valley, North Waziristan under the respective authorities to favor the formation and regeneration of natural vegetation in its adjacent areas. It was also noticed that Razmak valley is under threat due to various anthropogenic activities for all sort of utilization of local plants resources. The flora is under pressure due to various anthropogenic activities such as over grazing and deforestation. Therefore, rotational and moderate grazing system is required to conserve the flora of the proposed area as most of the plant species have significant medicinal potential. Inhabitants of the proposed area must be bestowing with awareness regarding floral diversity and conservation. Further research work is needed to discourage alien invasive species and promote the plantation of native species. Farming of endangered medicinal plants should be fortified by the local inhabitants in order to terminate pressure on the flora. Elemental, phytochemical and proximate analyses of the flora should be carried out to appraise their nutritional and therapeutic value.

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
Alliaceae	*Allium cepa* L.	2	3	0	3	8	V
	Allium sativum L.	2	3	0	3	8	V
Amaranthaceae	*Amaranthus hybridus* L.	1	3	0	3	7	V
Apiaceae	*Coriandrum sativum* L.	2	3	0	3	8	V
	Foeniculum vulgare Mill.	2	3	0	3	8	V
	Torilis arvensis (Huds.) Link.	1	2	0	4	7	V
Apocynaceae	*Vincetoxicum* spp. Medic	2	1	0	3	6	V
Asteraceae	*Anthemis arvense* (L.) Scop.	1	3	0	3	7	V
	Aster amellus L.	2	3	0	3	8	V
	Aster subulatus (Colenso) Kuntze	2	3	0	3	8	V
	Bidens pilosa L.	0	1	0	3	4	E
	Calendula arvensis L.	1	3	0	3	7	V
	Cichorium intybus L.	2	2	4	3	11	R
	Cirsium arvense (L.) Scop.	2	3	0	3	8	V
	Cirsium verutum (D. Don)	2	3	0	3	8	V
	Cosmos bipinnatus Cav.	2	1	0	3	6	V
	Cousinia buphthalmoides Regel	0	3	0	3	6	V
	Echinops cornigerus DC.	2	2	0	1	5	V
	Echinops echinatus Roxb.	2	2	0	1	5	V
	Erigeron acris L.	0	1	0	3	4	E
	Hertia intermedia (Boiss.) Kuntze	2	2	0	3	7	V
	Helianthus annuus L.	3	2	2	3	10	R
	Senecio chrysanthemoides DC.	2	1	0	3	6	V
	Serratula pallida DC.	3	2	0	3	8	V
	Sonchus oleraceus (L.) L.	2	2	4	4	12	R
	Symphyotrichum graminifolium (Spreng.) G. L. Nesom	3	2	0	3	8	V
	Tagetes erecta L.	1	2	3	3	9	R
	Tagetes minuta L.	2	2	3	3	10	R
	Tussilago farfara L.	1	2	3	3	9	R
Balsaminaceae	*Impatiens edgeworthii* Hook. f.	2	3	3	4	12	R
Berberidaceae	*Berberis lyceum* Royle	3	0	0	1	4	E
Boraginaceae	*Arnebia griffithii* Boiss. Diagn.	2	2	0	3	7	V
	Asperugo procumbens L.	1	2	0	3	6	V
	Buglossoides arvensis (L.) John.	0	1	0	3	4	E
	Cynoglossum lanceolatum Forssk.	1	2	0	3	6	V
	Heliotropium europeaum L.	2	2	0	3	8	V

	Nonnea edgeworthii DC.	2	1	0	3	6	V
	Nonnea capsica (Willd.) G. Don.	2	2	0	3	8	V
	Onosma hispida Wall. ex. G. Don	1	3	0	3	7	V
	Trichodesma indicum (L.) R. Br.	2	2	0	3	7	V
Brassicaceae	*Cardaria chalepensis* (L.) Hand. Mazz.	2	3	0	3	8	V
	Isatis costata C. A. Mey.	1	2	0	3	6	V
	Isatis minima Bunge	2	3	0	3	8	V
	Lepidium pinnatifidum Ledb.	1	3	0	3	7	V
Buddlejaceae	*Buddleja crispa* Benth.	2	1	0	3	6	V
Cannabaceae	*Cannabis sativa* L.	3	0	4	3	10	R
Caprifoliaceae	*Viburnum cotinifolium* D. Don.	2	2	0	3	7	V
Capparidaceae	*Capparis decidua* (Forssk.) Edgew.	0	1	0	1	2	E
	Capparis spinosa L.	3	0	0	0	3	E
Caryophyllaceae	*Silene conoidea* L.	2	1	0	3	6	V
	Stellaria media (L.) Vill.	1	3	0	3	7	V
Iridaceae	*Iris germinica* L.	1	3	0	3	7	V
Pinaceae	*Cedrus deodara* (Roxb.) G. Don	3	2	0	0	5	V
	Pinus gerardiana Wall. ex D. Don	3	2	0	0	5	V
	Pinus roxburghii Sarg.	3	2	1	0	6	V
	Pinus wallichiana A B. Jacks	3	2	1	0	6	V
Poaceae	*Agrostis viridis* Gouan	1	2	0	4	7	V
	Avena fatua L.	3	2	0	4	9	R
	Bromus pectinatus Thunb.	2	2	0	3	7	V
	Cynodon dactylon L.	3	3	4	4	14	I
	Dactylis glomerata L.	1	3	0	3	7	V
	Poa annua L.	1	3	0	3	7	V
	Poa bulbosa L.	1	3	0	3	7	V
	Polypogon monspeliensis (L.) Desf.	3	2	0	4	9	R
	Triticum aestivum L.	3	1	2	3	9	R
	Zea mays L.	3	1	2	3	9	R
Pteridaceae	*Adiantum capillus-veneris* L.	1	3	1	3	8	V
Zingiberaceae	*Zingiber officinale* Roscoe	1	2	2	3	8	V

The present study created a treasure of information worthy of managing future progress of action. It will be useful to taxonomists, ecologists, pharmacologists and other government and private agencies to increase local uses of plants resources in the coming future.

Declarations

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

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