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Original Article

Exploring threatened traditional knowledge; ethnomedicinal studies of rare endemic flora from Lesser Himalayan region of Pakistan

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ABSTRACT

Himalayas are one among the world biodiversity hotspots harboring many endemic medicinal plants. Despite augmentation in the documentation of ethnopharmacological knowledge of medicinal plant species, information regarding endemic species is still underway. Current paper highlights the traditional medicinal uses of rare endemic and unexplored group of plants having potential for novel chemical constituents with effective pharmacological activities. In total, 142 informants (91 male and 51 female) including seventeen traditional healers were interviewed using semi-structured questionnaire, personal observations and group discussions. Interviews were taken in field or otherwise photographs were shown for identification. Females were interviewed indirectly through male family members. For data analysis, quantitative analytical approach was adopted using ethnopharmacological indices as Relative frequency of citations and Fidelity Level. In total, 38 endemic plant species belonging to nineteen families were utilized by the local inhabitants. Highest number of endemics was belonging to Ranunculaceae (7), followed by Gentianaceae and Rosaceae (4 each) with respect to number of species. Highest number of endemics was used in fever, wound healing, throat infection and tonic (4 species each). Root was the most widely used part (36.17%) in cure of diseases and the leading mode administered was decoction (25.49%). Highest use reports and RFC values were recorded for *Pimpinella stewartii* (58 citations, 0.41 RFC), *Caltha alba* var. *alba* (52 citations, 0.37 RFC). Endemic plant species considerably contribute toward ethnomedicinal knowledge and despite rarity, the communities prefer their utilization. Conservation of endemics is necessary for future availability to the local communities.

Introduction

Pakistan is among few countries having rich diversity of traditional knowledge (Akhtar et al., 2013). In case of plant utilization, from among 6000 reported vascular plant species; out of these, 600 taxa are utilized as ethnomedicines by local communities (Shinwari and Qaisar, 2011). The figure may be an underestimation of actual number, as most of areas are still unexplored (Ali, 2008; Rahman et al., 2018a) and this might be due to inaccessibility of researchers to far remote areas (Rahman et al., 2019a). About 80% of the human population depends on traditional medicinal remedies for their basic healthcare (Rahman et al., 2016a; Ijaz et al., 2017a), made from plants (Ijaz et al., 2017b) and minerals (Rahman et al., 2019b). Endemic plants are defined as plants confined to small geographic ranges characterized by low population size and habitat specificity (Kruckeberg and Rabinowitz, 1985). Flora of Pakistan contains sum 400 endemic plants; most of them are distributed in northern and north-western mountain ranges of the country (Ali and Qaiser, 1986). Little is known about their ethnobotany and traditional uses; however, some recent studies reveal their importance in local communities. *Delphenium nordagnii*, a species endemic to district Chitral (Pakistan) was utilized as hair tonic and it's over exploitation is the major threat (Ali and Qaiser, 2009). *Berberis orthobotyrs* ssp. *gilgitica*, a narrow endemic species of Gilgit area of the country was used to cure rheumatism (Alam, 2010). Many other researchers also reported endemics (*Aquilegia nivalis, Oto-*

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stegia limbata, Pimpinella stewartii) ranges (Kala, 2006; Hamayun et al., 2007; Ibrar and Hussain, 2009; Abbasi et al., 2010; Ahmad et al., 2012). All these reports merely represent 5% of the endemic flora of Pakistan. Loss of ethnomedicinal knowledge with the rapid disappearance of botanical resources is established phenomenon. Medicinal plant knowledge is most vulnerable in this regard as is declining along with species extinction (Dal Cero et al., 2014). The only effort to cope with the situation is the fast documentation of and cataloguing of the ethnomedicinal knowledge (Cox, 2000; Case et al., 2005; Ramirez, 2008). Documentation not only sure the safety of the knowledge but also raise the issue among global community for taking measures to conserve the plants. Although considerable efforts have been made during the last three decades, a large proportion of the knowledge is still un-documented. Current paper is the result of a through survey for exploration of ethnomedicinal knowledge regarding the endemic flora in Hazara Division, Khyber Pakhtunkhwa, Pakistan. Hazara region was selected for the current study because of its wide geographic range, an array of altitude, climatic diversity, unique vegetation and endemic species richness. Aims of the study was to explore the ethnomedicinal importance endemic plants, the rare and endangered element of the flora along with identification of various threats in order to produce grounds for conservation of ethnomedicinal valued endemics.

Material and methods

Study area

The study area is located between 33°-44′ and 35°-35′ north latitude and between 72°-33′ and 74°-05′ east longitude (Fig. 1) (Hussain and Ilahi, 1991). Administratively it has been divided into six districts with a total area of 18,000 km^2. Population of the area according to censes 1998 is reported be 3.5 million (Book, 1995). The area is stretching 193 km from south west to north east and can be divided into three mountain ranges *i.e.* Himalayan Tanawal and Hindukush mountain ranges with rich water sources. Famous rivers like Indus, Kunhar and Siran and lakes like Saifulmaluk, Lulusar, Dudi pat sar and Supatsar are important water bodies. Numerous tributaries flow in mountains. Temperature is also another important limiting factor which generally decreases with increase in altitude (Hussain and Ilahi, 1991). About 2000 indigenous vascular plant species have been reported (Nasir et al., 1972).

Selection of plant species

All the seventy-three (73) taxa reported from the study area which were described as "Endemic to Pakistan" in Flora of Pakistan and other scientific literature were selected for current study (Nasir and Ali, 1971; Ali and Nasir, 1990; Ali and Qaiser, 1995). These include 66 wide endemics; taxa reported from the study area as well as from other areas within the country, and seven narrow endemic taxa (exclusively distributed within the study area). Out of 73 taxa, 38 were utilized by the locals for various ethnomedicinal purposes as highlighted in the current paper.

Field survey and data collection

Field surveys were arranged from 2011 to 2013; previously reported localities and other potential habitat of endemics were visited, especially in flowering and fruiting period of each taxon. In initial visits, taxonomic identification and confirmations were made. In case of ambiguities voucher specimen were compared with type specimens available at Karachi University Herbarium (KUH). For ethnomedicinal studies, locals were interviewed directly, random selection of the informants was mostly taken into the account. But for traditional healer, each (local physicians of the eastern system of medicine) found in the study area was interviewed due to their vast knowledge. Interviews were taken in field or otherwise photographs were shown for identification. Females were interviewed indirectly through male family members. The local informants were of different age groups (Table 1), most knowledgeable informants were of old age. Questions concerning the utility of different plants, their part used, route of administration were asked through questionnaire (Ijaz, 2014). Mainly local were interviewed in field, especially in case of rare and narrow endemic species. All the threats were recorded through personal observations. Voucher specimens of all the documented species were properly processed and submitted to Hazara University, Herbarium (HUP).

Table 1
Knowledge of medicinal plants remedies reported by local respondents.

Variable	Demographic categories	Number of informants	Percentages
Gender	Female	51	36
	Male	91	64
Experience	Traditional healer	17	12
	Local people	125	88
Age groups	20–40	20	14
	41–60	35	25
	Above 60	87	61
Education	Illiterate	102	72
	Primary	21	15
	Middle	3	2
	Matric and above	16	11

Statistical indices

Relative frequency of citations (RFC)

The Relative Frequency of Citations index was used to assess the traditional uses and medicinal value of each species in the area (Rahman et al., 2016b, c).

$$RFC = FC/N$$

FC = No. of local informants who use the plant species traditionally and N is the total number of informants of in the study (in this study, N = 142).

Fidelity level (FL%)

Fidelity level (FL) is the percentage of local respondents reporting the given plant species citation for the same major disease.

$$FL(\%) = Ip/Iu \times 100$$

Ip is the use of plant species suggested for a specific disease by number of informants and *Iu* is the total number of informants who addresses same plant for any disease (Rahman et al., 2016b, c).

Conservation status

For evaluation of the conservation status of the endemics, the geographic range was determined in the form of Extent of Occurrence (EOO) and Area of Occupancy (AOO).

Extent of occurrence and area of occupancy

Applying the Convex Hull joining the outermost points of the range boundary, the Extent of Occurrence was determined and the area of occupancy was determined at $p = 0.5$.

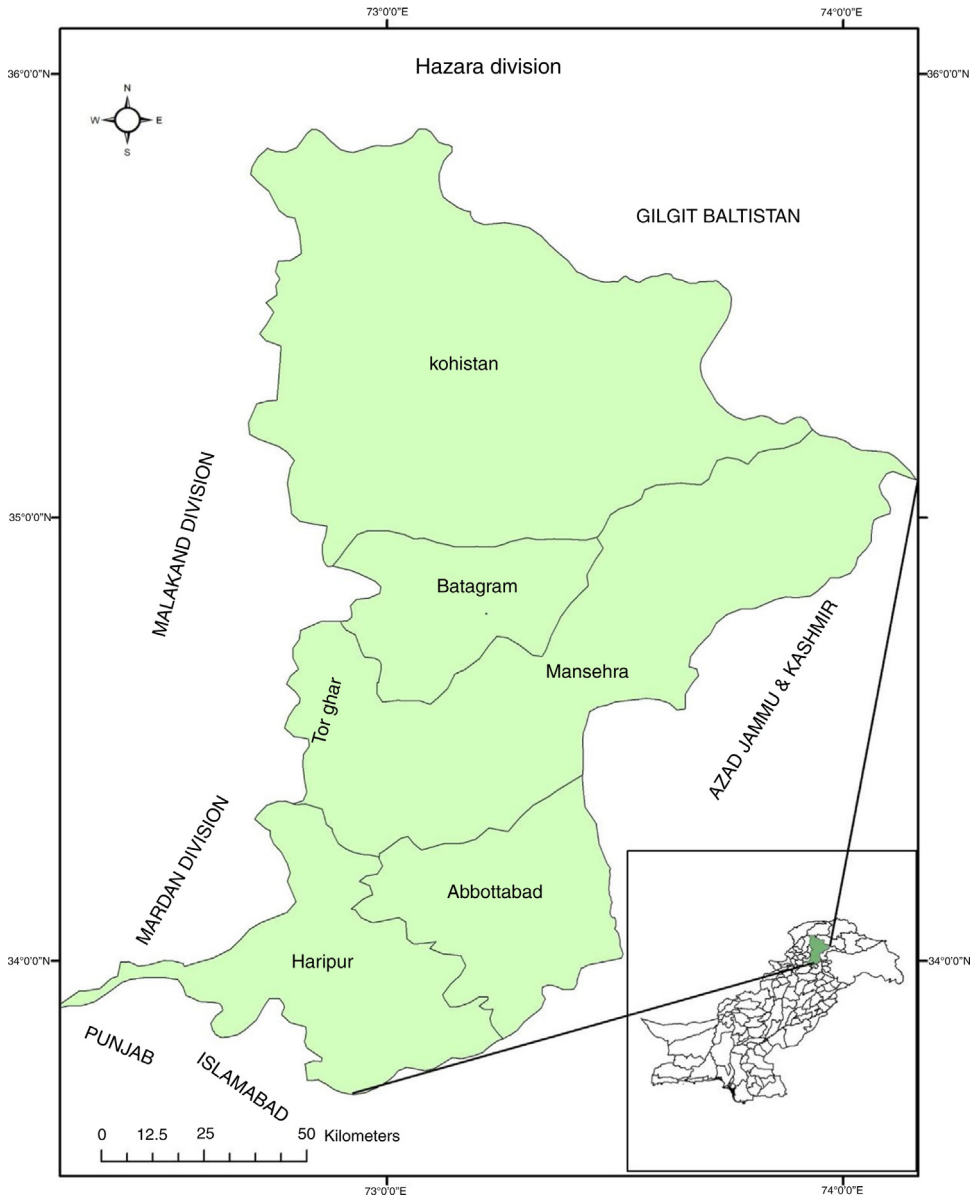

Fig. 1. Map of the study area showing district boundaries.

Result and discussion

Demography and endemics growth form diversity

The present study identified that native people of the study area depend on plant resources as the source of medicine. Interviews were conducted from different fields of life viz; farmers, local practitioners, veterinary doctors, pansaries and hakims. A total of 142 informants (91 male and 51 female) including seventeen traditional healers were interviewed. Approximately, 75–90% of the plants were known to most of the traditional healers and 0–45% to other local informants regarding their medicinal usage. Among the ethnomedicinally important endemics, herbs were dominating. This shows a general trend as herbs dominate the endemics of Pakistan (Ali and Qaiser, 1986). Among the other reports herbs contribution remain highest with respect to ethnomedicinal uses (Shinwari and Khan, 2000; Khan et al., 2011; Rahman et al., 2018b).

Species richness versus ethnomedicinal species richness

In total, 73 endemics were reported from the study area; out of which, 38 were utilized by the locals for various ethnomedicinal purposes. Although, Boraginaceae is the largest family with respect to endemism in Himalayan region, but its ethnomedicinal uses were lesser in comparison with other families, in this regard our results are in line with some recent studies (Upadhyay et al., 2011). Among nineteen families, Ranunculaceae is at the top both in species richness and ethnomedicinal species richness, followed by Rosaceae and Gentianaceae (Fig. 2). Bhattarai et al. (2010) and Kunwar et al. (2010) also reported Ranunculaceae as the rich family while working in the Himalayan region of India. The reason behind that may be the presence of medicinally important compounds often devoid in families like Boraginaceae (Waller et al., 1978). Among ethnomedicinal endemics, approximately, 45% of endemics have one traditional use. This reflects the local communities' knowledge in plant selection, where communities utilize

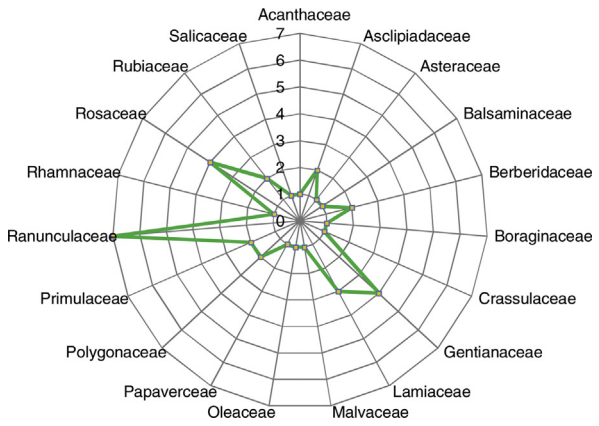

Fig. 2. Taxonomic diversity of endemic medicinal plants in the study area.

less common plants and somewhere have no use of certain species despite their abundance (Bhattarai et al., 2010).

Medicinal uses of endemics

Use of plants against diseases is from ancient times (Cotton, 1996). In mountain regions, this contributes as the basic health facility (Grabherr, 2009). In Himalayan and Hindukush ranges, several authors have reported plant use as medicine (Sheikh et al., 2002; Ghimire et al., 2004; Monteiro et al., 2006). Endemics were classified into 43 therapeutic classes based on medicinal uses (Table 2). Prominent ailments treated by four species were as fever (*Anemone falconeri, Aquilegia fragrans* var. *fragrans, Aquilegia nivalis* and *Salix denticulata* subsp. *hazarica*), wound healing (*Caltha alba* var. *alba, Cynanchum jacquemontianum, Dicliptera bupleuroides* var. *nazimii* and *Vincetoxi cumarnottianum*), throat infection (*Bistorta amplexicaulis* var. *speciosa, Gentianodes cachemirica, Gentianodes nasirii* and *Rumex crispellus*) and tonic (*Berberis parkeriana, Bistorta amplexicaulis* var. *speciosa, Meconopsis latifolia* and *Rhamnella gilgitica*), followed by the ailments treated with three species *i.e.* bronchitis (*Anemone tetrasepala, Aquilegia nivalis* and *Gentianodes eumarginata* var. *harrissii*), eye ailments (*Corydalis pakistanica, Primula hazarica* and *Thalictrum secundum* var. *hazaricum*), jaundice (*Berberis parkeriana, Otostegia limbata* and *Rumex crispellus*) and stomach ache (*Gentianodes eumarginata* var. *harrissii, Inula royaleana* and *Pimpinella stewartii*). Our findings agree with various other authors who reported plants uses for these mentioned problems (Sharma and Singh, 1989; Khanna and Kumar, 2000; Shah and Khan, 2006; Zabihullah et al., 2006; Kültür, 2007; Sreedevi et al., 2013). However, in some cases use proportion may reflect a specific use as because of the nature of environment and availability of the plant (Ugulu et al., 2009). The use may be family or genus specific as in other reports *Corydalis* and *Primula* species were often used in eye ailments, while species with poisonous latex or bark powder were utilized as anti-septic (Hamayun et al., 2007; Khan et al., 2011). Use as antiseptic and analgesics may be due to common person exposure to harsh conditions like travelling long in mountains, hard labor and physical exertion (Inngjerdingen et al., 2004; Kumar et al., 2007). Plant use in gastrointestinal problems is also (Murad et al., 2013; Adnan et al., 2014). Toothache is common problem because of unhygienic conditions and ignorance regarding oral health (Touger-Decker and Van Loveren, 2003). Uncommon use of tooth brush and excessive use of sugar may be the other reasons (Harris et al., 2004). Least common uses were plants used for abortifacient, acute dysentery, analgesic, antiseptic, appetizer, bones fracture, burns, carminative, digestive problems, diuretic, energizer, eye inflammation, flea repellent, gastro intestinal problems, high blood pressure, high uptake of salt by animals, itching, kidney stone removal, making bandages, malarial fever, skin spots, sore throat, stop bleeding, swellings, ticks in cattle, ulcer and urinary tract infections. Use of endemics in various diseases not only reflects the dependency of communities on plants for basic health care but also importance of endemics as well.

Table 2
Diseases treated by number of endemic plant species.

S. no	Diseases treated	No. of species	Percentage
1.	Bones fracture	1	1.41
2.	Jaundice	3	4.23
3.	Backache	2	2.82
4.	Diabetes	2	2.82
5.	Antiseptic	1	1.41
6.	Sore throat	1	1.41
7.	Diuretic	1	1.41
8.	Kidney stone removal	1	1.41
9.	Swellings	1	1.41
10.	Wound healing	4	5.63
11.	Eye ailments	3	4.23
12.	Throat infection	4	5.63
13.	Making bandages	1	1.41
14.	Malarial fever	1	1.41
15.	Fever	4	5.63
16.	Toothache	2	2.82
17.	Stomach ache	3	4.23
18.	Blood purification	2	2.82
19.	Ticks in cattle	1	1.41
20.	Flea repellent	1	1.41
21.	Tonic	4	5.63
22.	Diarrhea	2	2.82
23.	bronchitis	3	4.23
24.	Joints pain	2	2.82
25.	High blood pressure	1	1.41
26.	Skin spots	1	1.41
27.	Eye inflammation	1	1.41
28.	Analgesic	2	2.82
29.	Sedative	2	2.82
30.	Gastro intestinal problems	1	1.41
31.	Appetizer	1	1.41
32.	Ulcer	1	1.41
33.	Burns	1	1.41
34.	Carminative	1	1.41
35.	Stop bleeding	1	1.41
36.	Analgesic	1	1.41
37.	Itching	1	1.41
38.	Energizer	1	1.41
39.	Digestive	1	1.41
40.	Urinary tract infections	1	1.41
41.	High uptake of salt by animals	1	1.41
42.	Acute dysentery	1	1.41
43.	Abortifacient	1	1.41

Important species

Berberis parkeriana, Berberis othobotyrs ssp. *capitata* were among the highly valued species with respect to ethnobotanical uses followed by *Rhamnella gilgitica, Sophoramollis* ssp. *mollis, Spiraea hazarica, Jasminum leptophyllum* and *Otostegia limbata*. Both *Berberis* species were utilized in multiple ways *i.e.* analgesics, blood purifier, fodder and fuel wood. Genus *Berberis* is highly prized as medicinal plant in Hindukush and Himalayas (Shinwari and Khan, 2000; Uniyal et al., 2006). *Rhamnella gilgitica*; an endemic tree of the area (Hamilton and Schmitt, 2000; Dickoré and Nüsser, 2000) leaves are very nutritious. *Sophora mollis* ssp. *mollis* is mostly used as insecticidal, *Spiraea hazarica* flowers are abortifacient, while *Jasminum leptophyllum* is used as repellent against fleas. Besides their medicinal importance, being woody in nature they are highly valued in construction, fencing and as fuel wood species. Except *Jasminum leptophyllum*, all others were used as fodder as well. Where herbs can only be used for food, fodder and medicinal purposes, shrubs and trees being woody are demanded for fuel wood and

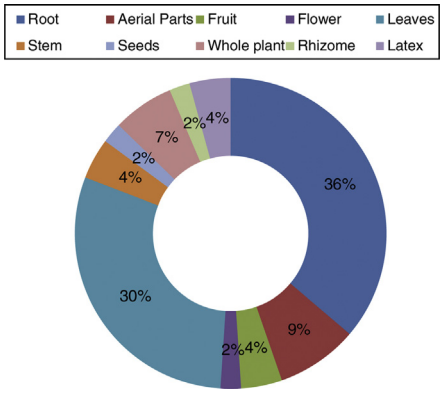

Fig. 3. Endemics parts used for the preparation of herbal medicines.

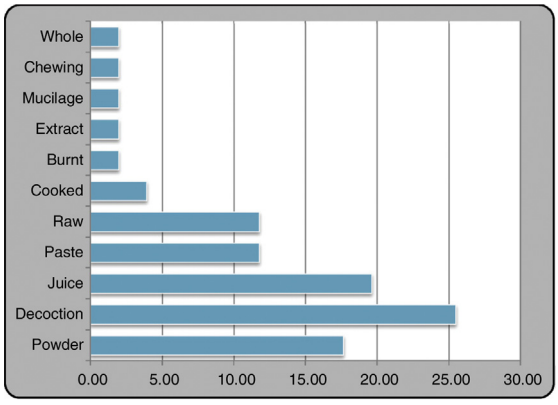

Fig. 4. Routes of administration against different diseases.

construction where overexploitation results in forest cover loss (Pimentel et al., 1986). Because of cool temperatures mountainous societies mainly depends on woody species for energy (Ali and Benjaminsen, 2004; Kumar and Sharma, 2009). *Hackelia macrophylla* was the species with least common use (swellings). *Jasminum leptophyllum* was identified as species with no alternative (replacement to cover its traditional uses). Exploration of phytochemical aspects from such species may be leads toward the discovery of new compounds.

Ethnomedicinal utilization of plant parts

Local community members use ten different parts of plants for the treatment of various diseases (Fig. 3). Out of which, root was the most widely used part (36.17%), followed by leaves (29.79%) and aerial parts (8.1%). Many researchers from regional and allied areas reported leaves as the most leading plant part utilized for various disorders (Ijaz et al., 2015; Khattak et al., 2015; Shah et al., 2015; Rahman et al., 2016a, b; Khan et al., 2018).

Mode of remedies administrated

In the present study, the endemic species were used by locals through several administrational ways out of which decoction was the most dominant and frequent way (25.49%), followed by juice (19.61%) and powder (17.65%) (Fig. 4). Bussmann (2006) reported oral and Ijaz et al. (2016) cited extraction as the most frequent mode to administrate remedies.

Citations frequency

The citations frequency of medicinal plant species was ranging from 05 to 58. Dominated medicinal plants with maximum citations were *Pimpinella stewartii* (58 citations), *Caltha alba* var. *alba* (52 citations), *Otostegia limbata* (48 citations), *Dicliptera bupleuroides* and *Salix denticulate* subsp. *hazarica* (0.46 each), *Anemone tetrasepala* (45 citations), *Anemone obtusiloba* var. *potentilloides* and *Bistorta amplexicallis* var. *speciosa* (43 citations) and *Berberis parkeriana* (41 citations). Table 3 describes all plants listed with respect to their citations to prepare the ethnomedicines.

Relative frequency citations (RFC)

In the present study, relative frequency citation ranges from 0.04 to 0.41 (Table 3). Based on the RFC values, the most valuable and cited medicinal plant species by the traditional drivers were *Pimpinella stewartii* having RFC = 0.41, *Caltha alba* (0.37), *Otostegia limbata* (0.34), *Anemone tetrasepala, Dicliptera bupleuroides* var. *nazimiia* nd *Salix denticulate* subsp. *hazarica* (0.32) each, *Anemone obtusiloba* var. *potentilloides* and *Bistorta amplexicaulis* var. *speciosa* (0.30) each. Maximum relative frequency citations clarify the facts that the cited plants species are well familiar to the number of traditional drivers (Ijaz et al., 2016). Plant species cited with lowest RFC were *Meconopsis latifolia* (0.04), *Jasminum leptophyllum* (0.05), *Cynanchum jacquemontianum* and *Thalictrum secundum* var. *hazaricum* (0.06) each. Those plant species having maximum RFC should be further evaluated pharmacognostic studies (Ahmed, 2017).

Fidelity level (FL%)

Fidelity level (FL%) is used for most preferred medicinal plant species cited by the local formants for treating particular diseases. In the present study, fidelity level ranging from 56.5% to 100%. Medicinal plants with high fidelity level and reported for various disorders were *Scutellaria chamaedrifolia* as anti-diabetic, *Dicliptera bupleuroides* var. *nazimii* for wounds healing and digestive problems, *Potentilla bannehalensis* and *P. curviseta* as anti-diarrheal agents, *P. pteropoda* for acute dysentery, *Spiraea hazarica* for abortifacient, *Cynanchum jacquemontianum* and *Caltha alba* var. *alba* for wounds healing, *Rhamnella gilgitica* as a tonic, *Salix denticulata* subsp. *hazarica* for fever, *Hackelia macrophylla* for swellings, *Thalictrum secundum* var. *hazaricum*, *Primula hazarica* and *Corydalis pakistanica* for eye ailments, *Lavatera cachemiriana* var. *haroonii* as blood purifier, *Swertia thomsonii* as malarial fever and *Galiuma sperifolium* var. *obovatum* or making bandages each species cited with FL% = 100% for its particular use respectively (Table 3). Some other medicinal plant species reported with most cited dental disorders with their fidelity values; *Anemone tetrasepala* (FL = 88.2%), *Anemone falconeri* (FL = 87.5%), *Berberi sparkeriana* (FL = 83.7%) and *Vincetoxi cumarnottianum* (FL = 83.3). Such species are important for evaluation of the phytochemical and biological experimentations.

Conservation issues

It was noted that most of the endemics have least geographic range. Only five of the endemics were found in all six districts, two in five districts, sixteen others were confined to two districts only and nine were found in one district only (Fig. 5). This shows small geographic ranges occupied by endemics. The least extent was observed in *Jasminum leptophyllum* (10 km^2) and *Thalictrum secundum* var. *hazaricum* (4 km^2). The taxa with least occupancy were *Thalictrum secundum* var. *hazaricum* (4 km^2), followed *Jasminum leptophyllum* (8 km^2). *Jasminum leptophyllum* and *Thalictrum secundum* var. *hazaricum* were very specific and restricted to sin-

Table 3
Traditional medicinal uses and quantitative analysis of the endemic flora of the study area.

Botanical name	Family	RFC	FC	FL%	Mode of use	Part used	Ethnomedicinal use
Anemone falconeri Thoms.	Ranunculaceae	0.27	35	87.5	Paste, Juice	Root	Analgesic, fever
Anemone obtusiloba D Don var. *potentilloides* (Camb. Ex Berant) Lauener	Ranunculaceae	0.37	43	78.2	Powder	Root	Analgesic, toothache, skin spots
Anemone tetrasepala Royle	Ranunculaceae	0.34	45	88.2	Juice	Root	Sedative, bronchitis
Aquilegia fragrans Benth. Varvar. *fragrans*	Ranunculaceae	0.22	24	75.0	Juice	Root	Fever, analgesic
Aquilegia nivalis Falc. ex Baker	Ranunculaceae	0.16	13	56.5	Juice, decoction	Root	Sedative, fever, bronchitis
Berberis orthobotrys Bien. ex Aitch. ssp. *capitata* Jafri	Berberidaceae	0.26	29	74.4	Juice, decoction	Root, fruits	Diabetes, blood purification, antiseptic, sore throat, backache
Berberis parkeriana Schneid.	Berberidaceae	0.33	41	83.7	Powder	Root	Bones fracture, jaundice, backache, high blood pressure, tonic
Bistorta amplexicaullis (D. Don) Green var. *speciosa* (Meisn) Muni et Jave	Polygonaceae	0.45	43	64.2	Powder, juice	Root, Leaves	Tonic, gastro intestinal problems, ulcer, throat infection
Caltha alba Camb. var *alba*	Ranunculaceae	0.35	52	100.0	Powder	Leaves	Wounds healing
Corydalis pakistanica Jafri	Primulaceae	0.13	19	100.0	Decoction, cooked	Root	Eye ailments
Cynanchum jacquemontianum Dcne	Asclepiadaceae	0.05	8	100.0	Decoction	Latex	Wounds healing
Dicliptera bupleuroides Nees var. *nazimii* Malik & a. Ghafoor	Acanthaceae	0.31	46	100.0	Decoction	Root, Leaves	Wounds healing, digestive problems
Galium asperifolium Wall. var. *obovatum* Nazim.	Rubiaceae	0.25	38	100.0	Juice, Decoction	Whole plant	Making bandages
Galium subfalcatum Nazim. & Ehrend	Rubiaceae	0.24	23	65.7	Powder	Whole plant	Urinary tract infections, blood purification
Gentianodes cachemirica (Decne.) Omer, Ali & Qaiser	Gentianaceae	0.19	17	60.7	Paste, powder	aerial parts	Appetizer, throat infection
Gentianodes eumarginata var. *harrissii* (Omer et al.) Omer	Gentianaceae	0.23	25	71.4	Paste	Root	Stomachache, bronchitis, itching
Gentianodes nasirii Omer, Ali & Qaiser	Gentianaceae	0.24	23	63.9	Paste	Whole plant	Throat infection
Hackelia macrophylla (Brand) I.M. Johnston	Boraginaceae	0.23	34	100.0	Extract	Leaves,	Swellings
Impatiens bicolor Royle subsp. *pseudobicolor* (Grey-Wilson) Y. Nasir	Balsaminaceae	0.29	35	81.4	Powder, juice, raw	Stem, seeds	Joint pains, kidney stones, diuretic
Inula royaleana DC.	Asteraceae	0.22	22	66.7	Decoction, powder	Root	Stomachache, joints pain
Jasminum leptophyllum Rubina Rafique	Oleaceae	0.07	7	63.6	Raw	Root, stem, leaves	Flea repellent, ticks in cattle,
Lavatera cachemiriana Camb var. *haroonii* S.Abedi	Malvaceae	0.26	39	100.0	Chewing	Root	Blood purification
Meconopsis latifolia (Prain) Prain	Papaverceae	0.05	5	71.4	Paste	Root	Tonic, analgesic
Otostegia limbata (Benth.) Boiss	Lamiaceae	0.43	48	75.0	Whole	Leaves,	Toothache, jaundice, eye inflammation
*Pimpinella stewartii (*Dunn) E. Nasir	Lamiaceae	0.48	58	81.7	Decoction	Leaves, fruit	Carminative, stomachache
Potentilla bennehalensis bannehalensis Cambess	Rosaceae	0.18	27	100.0	Decoction	aerial parts	Diarrhea
Potentilla curviseta Hook f.	Rosaceae	0.18	27	100.0	Decoction	aerial parts	Diarrhea
Potentilla pteropoda Royle	Rosaceae	0.15	23	100.0	Paste	aerial parts	Acute dysentery
Primula hazarica Duthie	Primulaceae	0.15	22	100.0	Mucilage	Rhizome	Eye ailments
Rhamnella gilgitica Mansf. & Melch	Rhamnaceae	0.18	26	100.0	Raw	Leaves	Tonic
Rosularia adenotricha (Wall. ex Edgew.) Jansson & Rh f *chitralica* GRS	Crassulaceae	0.28	35	85.4	Raw	Leaves,	Burns, high uptake of salt by animals, energizer
Rumex crispellus Rech.f.	Polygonaceae	0.14	15	71.4	Burnt	Leaves, root	Stop bleeding, jaundice, throat infection
Salix denticulata subsp. *hazarica* (R. Parker) Ali	Salicaceae	0.31	46	100.0	decoction	Leaves	Fever
Scutellaria chamaedrifolia Hedge & Paton	Lamiaceae	0.15	23	100.0	Juice	Leaves	Diabetes
Spiraea hazarica R. N. Parker	Rosaceae	0.13	19	100.0	Juice, Raw	Flower	Abortifacient
Swertia thomsonii Clarke	Gentianaceae	0.21	31	100.0	Decoction, powder	Root, Leaves	Malarial fever
Thalictrum secundum var. *hazaricum* H. Riedl	Ranunculaceae	0.06	9	100.0	Raw, cooked	Leaves	Eye ailments
Vincetoxicum arnottianum (Wight) Wight	Asclepiadaceae	0.12	15	83.3	Decoction	Latex	Wounds healing

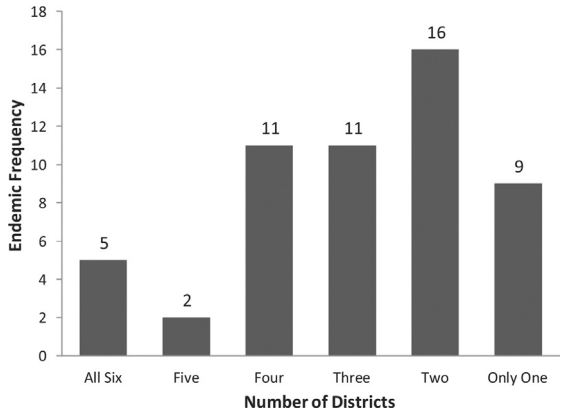

Fig. 5. Geographic range of the endemics in various districts of the study area.

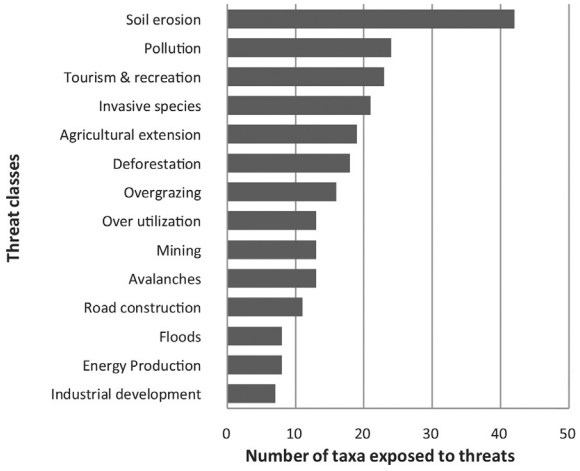

Fig. 6. Various threats targeting the ethnomedicinal endemics of the study area.

gle locality only. On the other hands endemics were facing serious threats (Fig. 6), most common being soil erosion, followed by pollution, tourism and recreational activities at endemic rich sites. Soil erosion is the result of overgrazing, deforestation and climate change where soil becomes unsuitable for plant growth. Other threats were over utilization, invasive species, agricultural extensions and overexploitation. Least common threats were industrial development, energy production, floods, avalanches and mining. As out of 73 endemics of the study area, 38 plants were being used ethnobotanically, and due to improper collection and over utilization most of them are proceeding towards narrow endemism. Keeping in view, the importance of endemics as medicinal, cultural and economic species, *in situ* and ex situ conservation programs are very necessary. Efforts towards conservation of such species are encouraging (Shinwari and Gilani, 2003), but specific focus towards endemics is uncommon (Abbas and Qaiser, 2011).

Conclusions

Study reveals that endemic plants highly contribute towards communities' services in many ways. Local knowledge is based on selection of the best species for medicinal purpose. Anthropogenic activities are responsible for the declining endemics populations. For wise use, conservation efforts are necessary. Exploration of phytochemical evaluation of these endemic species may be leads toward the discovery of new compounds.

Author's contributions

This manuscript is part of AM PhD work. AM conducted the fieldwork, collected the data and carried out interviews. AM and JA conducted the herbarium work, confirmed plants. IUR statistically analyzed the data, AM and IUR drafted this manuscript, NA helped in drafting the manuscript. HA supervised this work. ZS, AHS, UK and SAJ helped in preparing the revised manuscript. All the authors have read and approved the final manuscript.

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Ethical disclosures

The authors declare that no experiments were performed on humans or animals for this study.

Conflict of interest

The authors declare no conflicts of interest.

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