Quantitative ethnomedicinal study of indigenous knowledge on medicinal plants used by the tribal communities of Central Kurram, Khyber Pakhtunkhwa, Pakistan

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Research

Abstract

Background: The use of plants for different ethnobotanical purposes is a common practice in the remote areas of developing countries, particularly in reference to human and animal healthcare. For this aim, it is important to document ethnomedicinal use of plants for human and livestock healthcare from unexplored regions.

Objective: The current study aimed to document the use of medicinal plants and to assess their conservation status. We hypothesized that Central Kurram, due to its remoteness and maintenance of traditions would show distinct differences in medicinal plant use in comparison to other areas of Pakistan.

Method: The data was collected through semi-structured interviews and was analyzed using various quantitative indices including use value (UV), relative frequency of citation (RFC), use report (UR), fidelity level (FL), informant consensus factor (ICF) and family importance value (FIV). Plant samples were collected identified and then processed as voucher specimens following standard ethnobotanical practice.

Results: One hundred twenty participants including 80 men and 40 women were interviewed. The participants reported a total of 106 plant species, belonging to 96 genera and 50 families. There were two families of pteridophytes (2 species), 2 families of gymnosperm (4 species) and 100 species belonging to 46 families of

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angiosperms. The local population used therapeutic plants to heal 114 different diseases in 19 aliment categories in the study area.A total of 106 species belonging to 50 families were documented as used to treat different types of illness. The UV ranged from 0.01 (*Artemisia scoparia* and *Malva sylvestris*) to 0.75 (*Conyza canadensis*). The RFC varied from 0.025 (*Hyoscyamus niger* and *Senecio crysanthemoides*) to 1.992 (*Ephedra intermedia*). The species with 100% FL were *Astragalus stocksii* and *Artemisia scoparia*, while the FCI ranged from 0 to 1 for insecticides and acoustic disorders. The conservation assessment revealed that 49 plant species were vulnerable, followed by rare (34 spp.), infrequent (7 spp.), Dominant (5spp.) And 5 endangered species.

Conclusion: The current study showed that Central Kurram has a significant diversity of medicinal plant, and the use of medicinal plants and plant-based remedies is still common in the area. A total of 106 medicinal plant species, belonging to 50 families were documented for the treatment of 114 disorders. The residents used medicinal plants in treatment of important diseases such as Covid-19, cancer, dysentery, as diuretic, wound healing, and sexual diseases.

Key words: quantitative study, ethnobotanical, indigenous, conservation, Kurram, Pakistan

Background

The global community has recognized that many ethnic communities depend on natural resources, including medicinal plants. The use of plants as traditional therapeutics offers a real alternative in healthcare in emerging countries, especially for rural populations' population (Ekor 2014; Hayta *et al.* 2014; Umail *et al.* 2017; Mahmoodally *et al.* 2018). The study of therapeutic plants through qualitative research methods has become an important tool in recent decades times (Kayani *et al.* 2014; Ong & Kim 2014; Ahmad *et al.* 2017). Herbal treatments have an old practice in East Asia and are believed to have few side effects and high efficiency (Eddouks *et al.* 2014; Malik *et al.* 2019; Kang *et al.* 2020). Currently, the US, China, France, Japan, the United Kingdom, and Italy are considered the largest global markets for medicinal plants. While most countries in Asia harvest medicinal plants for their internal traditional uses, some, particularly China, India, Indonesia, Nepal, Bangladesh, Iran, and Pakistan, are able to produce them in commercial quantities. The Himalaya region, which includes parts of Pakistan Afghanistan, Bangladesh, Bhutan, China, Myanmar, Nepal, and India, is recognized as a biodiversity hotspot for medicinal plant species (Shinwar & Qaiser 2011; Hussain *et al.* 2012; Kanwal & Sherazi 2017). Pakistan is the seventh largest producer of medicinal plants in Asia. In Pakistan, about 600 species are used as traditional medicine, and more than 75% of the local populations rely on therapeutic herbs for all or most of their health care needs. The flora is widely used in the production of medicines, food, cosmetics, and nutritional supplements (Petrakoua*et al.* 2020). Most of the indigenous population in Pakistan is still dependent on herbal medicines and *Diospyros lotus* L., *Morchella esculenta* Fr., *Viola pilosa* Blume, *Trillium govanianum* Wall. ex D. Don are the main medicinal species produced in the country (Sher *et al.* 2014; Hussain *et al.* 2018a; Farooq *et al.* 2019). Knowledge of medicinal species has been transmitted largely oral from generation to generation (Fatima *et al.* 2017). Cultural practices and local biodiversity are the drivers of the use of medicinal species (Kasilo *et al.* 2010; Mwangia *et al.* 2017; Hussain *et al.* 2018b). Medicinal plants have a significant role in every culture and society. This study reports ethnomedicinal uses of plants from a remote and backward area where in several villages people are totally dependent on homemade crude drugs. The area faced worst form of militancy during last decade followed by a successful military operation, which has impacted multiple facets of sociocultural fabric. People of the area have become more dependent on indigenous medicinal plants due to lack or modern health care facilities and declining per capita income. It was need of the day to document and report such ethnobotanical practices to preserve this valuable bulk of knowledge. During the current study, participants were asked about ethnomedicinally important plants, their uses, mode of collection and recipes. The current status of medicinal plant use in the study area was also documented. It was noted that people who have access to modern health care system are becoming less and less inclined to use crude drugs and therapies. The participants mentioned several reasons for the declining folk knowledge and collection of medicinal plants including the younger generations inability to identify the plants correctly, their declining participation in collection, their reliance on cultivated crop species, and use of allopathic drugs. Destruction of native habitats due to natural disasters, repurposing of land for residential purposes due to rapid population growth in the area and climate change are other reasons for the decline in collection and use of medicinal plants by the local population. Additional reasons included: overgrazing and unwise uses. The tribal people have rich unwritten traditional medicinal knowledge. This rests mostly with elders who transfer it to younger generations orally. The traditional uses of plant resources were comparatively higher in Upper Kurram due to a lack of health facilities, agricultural land, and communal jobs. District Kurram is divided into three sub-divisions namely Upper, Lower and Central Kurram. Different researchers contributing to the Flora of Pakistan deposited specimen from Upper and Lower Kurram in KEW herbarium and Karachi university herbarium. There is however not a single

specimen reported from Central Kurram. Floristically and ethnobotanically this area has not been explored by researchers (Hussain *et al.* 2012; Hussain *et al.* 2013; Hussain *et al.* 2018a; Shah *et al.* 2020; Hussain *et al.* 2021). In the ethnobotanical literature of Pakistan, some research has been published on the Ethnomedicinal use of plants on Upper and Lower Kurram such as Ajaib *et al.* 2014, reported 45 species from Agra Valley Parachinar, Kurram. They documented that one-third species has single-usage, two and multiple usage shrubs were consumed for crafting (25%), medicinal (22.5%), culinary (11%) miscellaneous and other purposes. Hussain *et al.* 2018a, documented 92 plant species used in the treatment of 53 ailments. They reported a maximum number of species for the treatment of diabetes (16 species) followed by (16 species) carminative, laxative, antiseptic each (11 species), for cough (10 species), for the treatment of hepatitis (9 species), for curing diarrhea and ulcer each (7 species). Hussain *et al.* 2018b, reported 52 ethnobotanical important plant species from Lower Kurram for the first time. The reported plant species were used for the treatment of 50 ailments with most of these plants (35 species) for digestive problems. Muhammad *et al.* 2019, recorded 150 plant species belonging to 131 genera from 86 families. The documented plants were found to be used 64 disorders from simple to complicated health issues. Abbas *et al.* 2020, recorded 55 wild vegetables belonging from twenty-nine families, which represent the wild food in young stages of growth. However, Central Kurram is completely unexplored.

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 Central Kurram, due to its remoteness and maintenance of traditions would show distinct differences in medicinal plant use in comparison to other areas of Pakistan.

Materials and Methods

Study area and climate

Kurram is a newly formed Tribal District of Khyber Pakhtunkhwa, a beautiful green valley located in the Northwest Territory of Pakistan. The district is situated between 33° 20′ and 34° 10′ N and 69° 50′ and 70° 50′ (Fig. 1). The total length of Kurram is 115 kilometers and it covers an area of 3380 km^2 (GoP, 1998; Gilani *et al.* 2003; Hussain *et al.* 2012; Hussain *et al.* 2018a; Abbas *et al.* 2020). According to the census report of 2017, the population of the whole district is 619553, with 229356 living in Central Kurram, Bangash, Turi, Sayed, Mamozai, Mangal, Muqbal, Orakzai, Zazai, Para Chamkani, Ghilzai and Persian speaking Khoshi are the main tribes living in Kurram. "Kurram" takes its name from the River Kurram which flows through the valley. The word "Kurram" name is already mentioned in "Rag veda" and is derived from Karma. Some chronicles trace the origin of the word "Kurram" to Kirram which means silk. Legend has it that the inhabitant of this region once kept silkworm and the main source of livelihood was silk trade (Khan 2005).

The Kurram valley has originally been one of the easiest and most used routes into India, starting with the migrations which took place between 4000 and 2000 B.C. The Koh e Sufaid range which forms the boundary of present-day Kurram appears to be the same as the ancient "Svethpatha", and it is likely that the rich and healthy uplands of Kurram would always have been a place of habitation and agriculture (Kapur 1908). The climatic conditions change with altitude, ranging from extreme cold to extreme heat. Within a few hours one can start journey from a region where snow cannot fall, to glaciers where it never melts. The lowest temperature ever recorded in Kurram on 29.1.2005 was -13.4°C and the highest temperature on 27.6.2005 was 39.9°C. January is the coldest month (-1 °C to -10 °C), receiving maximum snow fall. The snow remains on the hills until mid-August. The winters are harsh and long while the summers are mild and pleasant. District Kurram is divided into three administrative subdivisions, Lower, Central and Upper Kurram (Hussain *et al.* 2018a). The area is bordered in the North by Afghanistan, in the East by Orakzai and Khyber District, in the South by Thall and Lower Kurram and to the West by Upper and Lower Kurram.

The natural vegetation of the area consists of semi evergreen forests, dry temperate coniferous forests, and alpine pastures. Dwarf palm, mulberry, poplar, willow, walnut, oak, pistachio, cedars, and pines are common (GoP 1908). According to the elders of the area, Central Kurram originally harbored rich forests dominated by conifers with a thick shrub layer. Due to the Afghan War since 1979 forest cover has declined rapidly due to bombing and refugee influx.

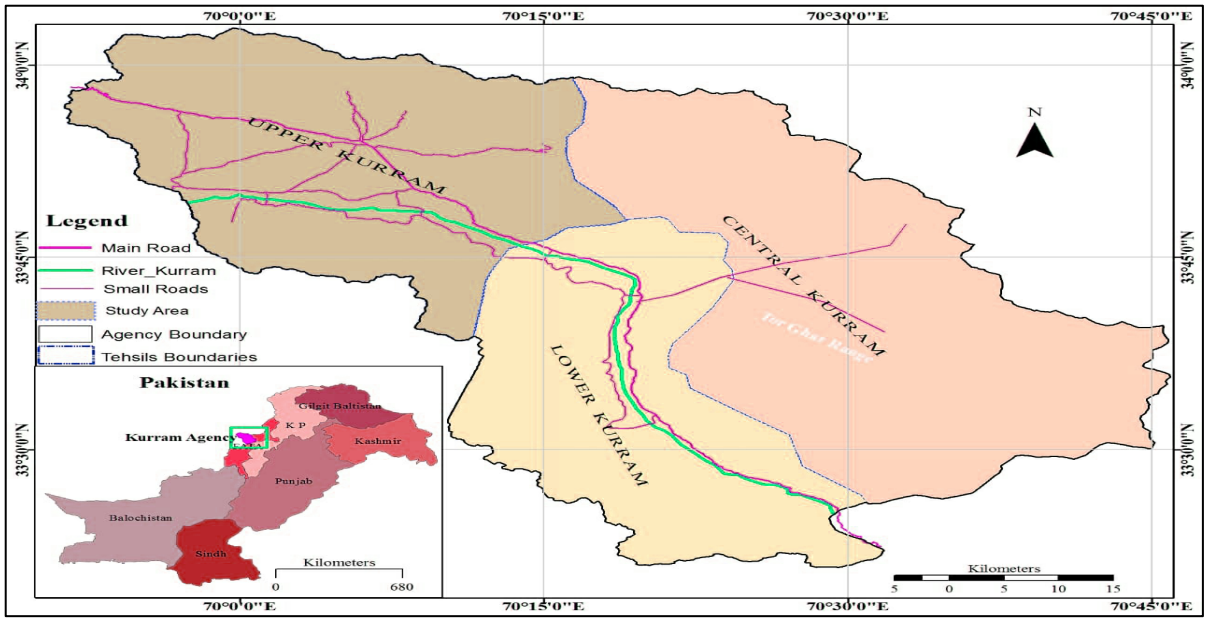

Figure 1. Map of the study area

Data collection

Ethnomedicinal information was collected from September 2019 to October 2020. A purposeful sampling method was used for the selection of informants, with local participants pointing to people they thought had specific knowledge of medicinal plants, and information on the ethnomedical uses of plants was collected through semi-structured interviews. The interviews were conducted face-to-face with individual participants, as well as in group discussions. The respondents were briefed on the objectives of the study and the prior informed consent of each participant was obtained. The work followed the Code of Ethics of the International Society of Ethnobiology (International Society of Ethnobiology. International Society of Ethnobiology Code of Ethics (with 2008 additions) 2006, http:www.ethnobiology.netwhat-we-docore-programsise-ethics-programcode-of-ethicscode-in-english). All interviews were conducted in Pashto, the local language of the communities. The questionnaire recorded data about, demographic features of the informants, local names of plants, parts used, availability, route of administration of plants and diseases treated.

Demographic data of local participants

A total of 120 respondents, including 36 housewives and non-professional elders, 16 farmers, 14 healers, 14 plant collector, 14 shepherds, 10 gardeners, 8 shopkeepers and 8 traders were interviewed in various seasons of the year. Among the male informants, 8 were less than 20, 13 aged 21-40, 35 between 41-60, and 24 aged above 60 years. Of the female respondents, four were in the age group below 20, 11 in the age group 21-40, 16 in the age group 41-60, and 9 were over 60 years. Most local people belonged to rural areas (81.66%) and mainly depended on agricultural practices and deforestation as a means of profits (Table 1).

Table 1. Demographic details

Variables	Categories	Number of Informants	Percentage	Total
Gender ratio	Female	40	33.333	1252
	Male	80	66.667	4498
	<20	12	10	346
Age	21-40	24	20	809
	41-60	51	47.5	2545
	60>	33	27.5	2050
	Illiterate	57	45	2012
Educational Background	Matric	38	31.667	1546
	Intermediate	20	16.667	963

	Graduate	5	3.333	229
	Elder (housewives and non-professional)	36	30	1990
	Farmer	16	13.333	515
	Healer	14	11.667	1090
Informant category	Plant collector	14	11.667	515
	Shepherd	14	11.667	606
	Gardener	10	8.333	475
	Shopkeeper	8	6.667	298
	Trader	8	6.667	261
Life type	Urban area	22	18.333	
	Hilly area	**98**	**81.667**	

Plant collection and identification

Plants species cited for a specific disease in the area were collected, dried, pressed and mounted on herbarium sheets for correct identification. The specimens were then identified by taxonomists at the Department of Botany Govt. Post Graduate College Parachinar with the help of Flora of Pakistan (Nasir & Ali 1970, Ali & Nasir 1989, Ali & Qaiser 1993) and deposited in the Herbarium Department of Botany, Govt. Post Graduate College Parachinar.

Statistical analysis of data

The data collected through questionnaires and personal interviews about respondents and ethnomedicinal plants were analyzed using various quantitative indices like Use Value (UV), Relative Frequency of Citation (RFC), Use Report (UR), Fidelity Level (FL), Informant Consensus Factor (ICF) and Family Importance Value (FIV). The use of a wide variety of indices is necessary to ensure a complete assessment of the data, because it has widely been shown that any one index can only give limited information, especially for conservation and management purposes (Bussmann *et al.* 2016; Paniagua *et al.* 2017).

Use Value (UV)

Use Value (UV) shows the relative importance of plant species by considering number of use reports mentioned by indigenous inhabitant of study area. It is calculated using the use-value formula:

$$UV = UVi/Ni$$

Where 'UVi' is the frequency of citations for species through all respondents and 'Ni' the number of respondents (Vitalini *et al.* 2013; Ferreira *et al.* 2009).

Relative Frequency of Citation (RFC) and Use report (UR)

Relative Frequency Citation (RFC) was used to elucidate the agreement among the local informants about therapeutic medicinal flora of the Valley which is consumed for treatment of various diseases.

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

It shows the importance of each species and is given by the frequency of citation FC, number of respondents reporting the use of species divided by the total number of respondents (N) participated in the survey as used by ((Vitalini *et al.* 2013; Yaseen *et al.* 2015).

Fidelity Level (FL)

Fidelity level is the percentage of respondents who cited the uses of specific plant species to treat a specific disease in the research area. The FL index is calculated as,

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

Where, 'Np' Number of citations of specific specie for a particular ailment and 'N' is the total number of informants mentioned the species for any disease (Idmhand *et al.* 2020).

Informant Consensus Factor (FIC)

Factor Informant Consensus (FIC) was used to evaluate the consent of respondents about the use of plant species for curing various ailments categories.

$$Fic = Nur - Nt / Nur - 1$$

Nur = number of use reports from informers for a disease category treated by a plant species, Nt = number of species or taxa used for treating that disease category.

The FIC value ranges from 0 and 1. Where 1 represents the highest value of respondent's and 0 indicates the lowest value (Heinrich *et al.* 1998).

Family Importance Value (FIV)

Family Importance Value (FIV) was used to determine the relative importance of families. It was calculated by taking the percentage of informants mentioning the family.

$$FIV = FC\ (family)/N \times 100$$

Where FC is the number of informers revealing the family, while N is the total number of informants participated in the research (Heinrich *et al.* 1998).

Conservation status

The conservation status of medicinal plant species that grew in the wild was documented. Information on different conservation aspects was collected following International Union for Conservation and Nature (Anonymous 2001). Plants were classified using International Union for Conservation of nature (IUCN) Criteria, 2001 as displayed in Table 2.

Table 2. IUCN Criteria, 2001 for conservation classes

Availability	**Collection**
0 = Uncommon or very rare	0 = More than 1000 kg/year
1 = Less common or rare	1 = Consumed from 500-1000 kg/year
2 = Occasional	2 = Consumed from 300-500 kg/year
3 = Abundant	3 = Consumed from 100-200 kg/year
Growth	**Part used**
0 = Regrowth in more 3 years	0 = Root/Whole
1 = Regrowth within 3 years	1 = Bark
2 = Regrowth within 2 years	2 = Seeds, Fruits
3 = Regrowth within 1 year	3 = Flowers
4 = Regrowth in a season	4 = Leaves/Gum/Latex
Total Score	
0-4	Endangered
5-8	Vulnerable
9-12	Rare
13-14	Infrequent
15-16	Dominant

Results

Medicinal plants diversity and growth forms

A total of 106 plant species belonging to 50 families were used for the treatment of various ailments. There were two families of pteridophytes (2 species), 2 families of gymnosperm (4 species) and 100 species belonging to 46 families of angiosperms (Table 3). The dominant families used were Lamiaceae (12 species), followed by Asteraceae (11 species), Amaranthaceae, Polygonaceae and Rosaceae, (4 species each). The most frequently cited plant species were *Ephedra intermedia*, *Papaver somniferum*, *Caralluma tuberculata*, *Punica granatum*, *Cannabis sativa, and Taraxacum officinale* likely because of their perceived efficacy and easy availability. Herbs were most used, with 77 reports (72.64%), followed by trees with 13 reports, (12.26%), and climbers, ferns, and herbaceous parasites with 1 report each (0.94%).

Table 3. Enumeration of medicinal plants species

Family Botanical name Local name Voucher number	Availability	Habit	Part(s) used	Preparation of remedies	ROA	Medicinal uses	FC	RFC	UR	UV	FL	CS
Adiantaceae												
Adiantum capillus-veneris L. Laila sonray B.S.Hus.015.GPGC.PCR	W	H	Whole plant	Juice	O, T	Diuretic, emetic, expectorant, scabies	27	0.23	4	0.14	55	R
Amaranthaceae												
Achyranthes aspera L. Buch kanda B.S.Hus.014.GPGC.PCR	W	H	Whole plant	Juice	O	Stomachache, cough, diuretic	16	0.13	3	0.18	43	V
Amaranthus spinosus L. Salaway B.S.Hus.021.GPGC.PCR	W	H	Whole plant	Vegetable	O	Anti-inflammatory, diuretic	35	0.29	2	0.05	65	V
Amaranthus viridis L. Rinzaka B.S.Hus.022.GPGC.PCR	W	H	Leaves	Vegetable	O	Emollient	23	0.19	1	0.04	100	I
Chenopodium album L. Sarmay B.S.Hus.043.GPGC.PCR	W	H	Aerial parts, Root	Vegetable	O	Anthelmintic, jaundice, laxative, urinary disorders	55	0.46	4	0.07	41	V
Dysphania botrys (L.) Mosyakin & Clemants Skha Kharawa B.S.Hus.044.GPGC.PCR	W	H	Root	Infusion	O	Wound healing	29	0.24	1	0.03	100	V
Amaryllidaceae												
Narcissus tazzeta L. Gule nargus B.S.Hus.081.GPGC.PCR	C	H	Flower	Juice	O	Emetic, purgative	11	0.09	2	0.18	63	R
Apiaceae												
Bunium persicum (Boiss.) B. Fedtsch. Toray zanrkay B.S.Hus.034.GPGC.PCR	W	H	Fruit	Paste	O	Carminative, condiment, stimulant, stomachache	56	0.47	4	0.07	41	V

Carum carvi L. Sperkai B.S.Hus.041.GPGC.PCR	W	H	Seed	Decoction	O	Carminative, flavoring agent	48	0.4	2	0.04	60	R
Foeniculum vulgare Mille Kugilani B.S.Hus.061.GPGC.PCR	W	H	Fruit, Leaves	Direct	O	Aphrodisiac, aromatic, condiment, digestive problems, diuretic, improving eyesight, laxative, stimulant	75	0.63	8	0.53	30	R
Apocynaceae												
Caralluma tuberculata N. E. Brown Pamanay B.S.Hus.040.GPGC.PCR	W	H	Aerial parts	Vegetable	O	Antidiabetic, carminative, hypertension,	169	1.41	3	0.01	60	E
Araceae												
Arisaema jacquemontii Blume. Kurkomar B.S.Hus.027.GPGC.PCR	W	H	Rhizome, Fruit	Powder	O	Snake bites	41	0.34	1	0.02	42	R
Aralicaceae												
Hedera nepalensis K. Koch. Parwatai B.S.Hus.066.GPGC.PCR	W	Climbing Liana	Whole plant	Decoction	O	Antidiabetic, antitumor, asthma	95	0.79	3	0.03	53	V
Asteraceae												
Achillea millefolium L. Binak botai B.S.Hus.013.GPGC.PCR	W	H	Whole plant	Oil	O	Astringent, diuretic, stopping perspiration	11	0.09	3	0.27	54	V
Anaphalis controta (D. Don) Hook. f. Khaar botay B.S.Hus.024.GPGC.PCR	W	H	Fresh, Leaves	Direct	T	Wound healing	21	0.18	1	0.04	100	R
Artemisia absinthium L. Mastyara B.S.Hus.028.GPGC.PCR	W	H	Whole plant	Decoction, Powder	O	Aromatic, digestive problems, jaundice, tonic, covid19	26	0.22	4	0.15	42	V

Artemisia scoparia Waldst. & Kit. JawkayKamasla tarkha B.S.Hus.029.GPGC.PCR	W	H	Flower heads	Decoction	O	Anthelmintic	69	0.58	1	0.01	100	R
Cichorium intybus L. Shin gulay B.S.Hus.045.GPGC.PCR	W	H	Whole plant	Vegetable	O	Enhances bile secretion, jaundice, promote digestion, typhoid	68	0.57	4	0.05	57	V
Conyza canadensis (L) Cronquist. Malooch B.S.Hus.049.GPGC.PCR	W	H	Aerial parts	Powder	O	Diarrhea, diuretic, dysentery	4	0.03	3	0.75	50	R
Lactuca serriola L. Soaodo Tarija B.S.Hus.71.GPGC.PCR	W	H	Whole plant	Decoction	O	Antiseptic, diaphoretic, diuretic, expectorant, sedative	16	0.13	5	0.31	31	R
Onopordum acanthium L. Ghana botay B.S.Hus.083.GPGC.PCR	W	H	Leaves, Root	Decoction	O	Antispasmodic, wound healing	12	0.1	2	0.16	58	R
Senecio crysanthemoides DC. Ghopga B.S.Hus.108.GPGC.PCR	W	H	Flowers , Leaves	Poultice	T	Emollient	3	0.03	1	0.33	100	I
Sonchus asper (L.) Hill Shawda pai B.S.Hus.111.GPGC.PCR	W	H	Young shoot, Flower	Decoction	O	Anti-constipation, diuretic, jaundice	19	0.16	3	0.15	42	I
Taraxacum officinale Weber. Ziar gulaeGunjay B.S.Hus.114.GPGC.PCR	W	H	Flower, Root, Leaves	Decoction	O	Antitumor, anti-constipation, diuretic, jaundice, kidney problems, laxative, liver diseases, purgative, tonic	158	1.32	9	0.05	42	D
Xanthium strumarium L. Zangaf botay B.S. Hus.126. GPGC.PCR	W	S	Leaves	Juice	T	Malarial fever, Skin problems, kidney problems	49	0.41	3	0.06	69	R

Berberidaceae												
Berberis lycium Royle. SarazghaiZiar largai B.S.Hus.031.GPGC.PCR	W	S	Bark, Fruit, Young shoot	Decoction	O	Colic, cooling agents, diarrhea, expectorant, jaundice, liver diseases	62	0.52	6	0.09	46	V
Podophyllum emodi Wall.ex Royle. Ghra marchak B.S.Hus.095.GPGC.PCR	W	H	Rhizome, Fruit	Decoction	O	Emetic, purgative, strengthen liver	23	0.19	3	0.13	47	E
Brassicaceae												
Capsella bursa-pastoris (L.) Medic. Bambaisa B.S.Hus.037.GPGC.PCR	W	H	Leaves, seed	Juice	O	Astringent, diuretic, stimulant,	37	0.31	3	0.08	51	D
Lepidum sativum L. Alum B.S.Hus.072.GPGC.PCR	W	H	Dried seed, Fruit	Decoction	O	Antiflatulence	9	0.08	1	0.11	100	R
Nasturtium officinale R. Br. Sharay B.S.Hus.080.GPGC.PCR	W	H	Aerial parts	Vegetable	O	Anti-scorbic, appetizer, chest problem, diuretic, stomachache	121	1.01	5	0.04	66	V
Cannabinaceae												
Cannabis sativa L. Bhang B.S.Hus.036.GPGC.PCR	W	H	Whole plant	Smoke	Inhale	Anodyne, narcotic, refrigerant, sedative, tonic	162	0.03	5	0.03	32	V
Caprifoliaceae												
Valeriana jatamansi Jone. Mukhkak B.S.Hus.120.GPGC.PCR	W	H	Rhizome, Flower	Decoction, Powder	O	Antispasmodic, carminative, cholera, dysentery	67	0.56	4	0.05	73	V
Caryophyllaceae												

Stellaria media (L.) Vill. Ululai B.S.Hus.113.GPGC.PCR	W	H	Whole plant	Vegetable	O	Increase milk in animals, purgative	22	0.18	2	0.09	59	V
Convolvulaceae												
Convolvulus arvensis L. Parwatai B.S.Hus.048.GPGC.PCR	W	H	Aerial parts	Decoction	O	Purgative, skin problems,	7	0.06	2	0.28	71	V
Cuscuta reflexa Roxb. Marazee botay B.S.Hus.052.GPGC.PCR	W	Herbaceous Parasite	Young shoot	Decoction	O	Anthelmintic, blood purifier, diuretic, purgative	13	0.11	4	0.3	53	V
Cucurbitaceae												
Citrullus colocynthis L. Pirpandan B.S.Hus.046.GPGC.PCR	W	H	Fruit	Decoction, Juice	O	Abortion, aphrodisiac, epilepsy, intestinal disorders, purgative, sciatica	53	0.44	6	0.11	41	R
Ebenaceae												
Diospyros lotus L. Toor amlook B.S.Hus.054.GPGC.PCR	W	T	Fruit	Direct	O	Antiflatulence, laxative, purgative	80	0.67	3	0.03	55	V
Ephedraceae												
Ephedra intermedia Schrenk & C.A. Mey Mava B.S.Hus.056.GPGC.PCR	W	S	Fruit, Branches	Extract	O	Asthma, bronchitis, flue influenza, rheumatism, covid19	225	1.88	4	0.01	36	V
Equisetaceae												
Equisetum arvense L. Bandukay B.S.Hus.059.GPGC.PCR	W	H	Young shoot	Decoction	O	Hair tonic	13	0.11	1	0.08	100	V
Euphorbiaceae												
Andrachne telephioides L. Krachay B.S.Hus.025.GPGC.PCR	W	H	Leaves, Fruits	Decoction	O	Purgative, vermifuge	12	0.1	2	0.16	75	I

Euphorbia prostrata Aiton Warmaga B.S.Hus.058.GPGC.PCR	W	H	Whole plant	Decoction, Paste	O	Dermatitis, dysentery, urinary disorders	129	1.08	3	0.02	55	V
Fabaceae												
Astragalus stocksii Bunge. Shasha B.S.Hus.030.GPGC.PCR	W	H	Root	Decoction	O	Sexual diseases	12	0.1	1	0.08	100	V
Fagaceae												
Quercus baloot Griff. Sayreye B.S.Hus.101.GPGC.PCR	W	T	Fruit	Decoction, Roasted	O	Diarrhea, dysentery, stop internal bleeding	26	0.22	3	0.11	46	V
Quercus semecarpifolia Sn. Ghuwaira seray B.S.Hus.102.GPGC.PCR	W	T	Nut	Decoction	O	Asthma, astringent, diarrhea, digestive problems, diuretic	27	0.23	5	0.18	33	V
Fumariaceae												
Corydalis govaniana Wall. Desi mamera B.S.Hus.050.GPGC.PCR	W	S	Flower, Young branches	Decoction	O	Eye allergies	39	0.33	1	0.02	100	R
Fumaria indica (Hausskn.) Pugsle Chawtara B.S.Hus.063.GPGC.PCR	W	H	Whole plant	Decoction	O, T	Antipyretic, antitumor, blood purifier, skin acne	102	0.85	4	0.03	49	V
Geraniaceae												
Geranium wallichianum D. Don ex Sweet Zawail B.S.Hus.065.GPGC.PCR	W	H	Whole plant	Decoction	O	Antipyretic, cold, cough	68	0.57	3	0.04	57	V
Hippocastanaceae												

Aesculus indica (Wall. ex Cambess.) Hook. Lewanay waghaz B.S.Hus.016.GPGC.PCR	C	T	Leaves, Bark	Decoction	O	Colic	7	0.06	1	0.14	100	V
Juglandaceae												
Juglans regia L. Waghaz B.S.Hus.070.GPGC.PCR	C	T	Fruit, Leaves	Decoction	O	Blood pressure, brain tonic, eczema, heart tonic, intestinal worms	66	0.55	5	0.08	67	V
Lamiaceae												
Ajuga bracteosa Wall. ex Benth. Kharbanai B.S.Hus.018.GPGC.PCR	W	H	Leaves	Paste	O	Hepatitis	62	0.52	1	0.01	100	V
Isodon rugosus (Wall. ex Benth.) Codd Sperkay B.S.Hus.094.GPGC.PCR	W	H	Branches	Decoction	O	Antiseptic	29	0.24	1	0.03	100	V
Marrubium anisodon K. Koch. Darshul B.S.Hus.075.GPGC.PCR	W	H	Whole plant	Paste	T	Wound healing	45	0.38	1	0.02	100	V
Mentha royleana Wall. ex Benth. Villanay B.S.Hus.076.GPGC.PCR	W	H	Whole plant	Direct, Powder	O	Carminative, diarrhea, dysentery, stomachache	90	0.75	4	0.04	36	V
Mentha spicata L. Podina B.S.Hus.077.GPGC.PCR	W	H	Leaves	Decoction, Direct	O	Carminative, diarrhea, dysentery, dyspepsia, mouthwash, stomachache	119	0.99	6	0.05	36	R
Otostegia limbata (Benth.) Boiss. Spinazghai B.S.Hus.084.GPGC.PCR	W	S	Leaves	Paste	T	Gum diseases, wound healing	7	0.06	2	0.28	57	V

Perovskia atriplicifolia Benth. Sansabay B.S.Hus.087.GPGC.PCR	W	S	Leaves	Direct	T	Bedbug repellent	27	0.23	1	0.03	0	R
Phlomis cashmeriana Royle ex Benth. Darshul B.S.Hus.089.GPGC.PCR	W	H	Leaves	Powder	T	Wound healing	19	0.1	1	0.05	100	R
Salvia moorcroftiana Wall. ex Benth. Prar paanri B.S.Hus.107.GPGC.PCR	W	H	Branches	Poultice	T	Wound healing	41	0.34	1	0.02	100	V
Phlomidoschem parviflorum (Benth.) Vved. Ghra darshul B.S.Hus.112.GPGC.PCR	W	H	Leaves	Decoction	O	Cough, wound healing	26	0.22	2	0.07	65	R
Teucrium stocksianum Boiss Zawail B.S.Hus.115.GPGC.PCR	W	H	Whole plant	Infusion	O	Cooling agent, hepatitis, tonic	85	0.71	3	0.03	71	V
Thymus linearis L. Sehra velany B.S.Hus.117.GPGC.PCR	W	H	Fruit, leaves	Infusion	O	Cold, cough, digestive problems	70	0.58	3	0.04	61	D
Vitex negundo L. Marvandai B.S.Hus.125.GPGC.PCR	W	S	Leaves, Root	Juice, Smoke	Inhale, O	Anthelmintic, aromatic, diuretic, headache, removing worms	13	0.11	5	0.38	38	V
Malvaceae												
Malva neglecta Wallr. Panerak B.S.Hus.073.GPGC.PCR	W	H	Leaves	Decoction	O	Anti-constipation	51	0.43	1	0.01	100	R
Malva sylvestris L. Tikkalay B.S.Hus.074.GPGC.PCR	W	H	Leaves	Decoction	O	Antispasmodic	70	0.58	1	0.01	100	R
Moraceae												

Ficus carica L. Inzar B.S.Hus.060.GPGC.PCR	W	T	Fruit	Direct	O	Anti-constipation, demulcent, laxative, piles, urinary disorders	63	0.53	5	0.07	52	V
Oleaceae												
Jasminum humile L. Yasmin B.S.Hus.068.GPGC.PCR	W	S	Whole plant	Decoction	O	Removing ring worms.	11	0.09	5	0.09	100	V
Jasminum officinale L. Yasmin B.S.Hus.069.GPGC.PCR	W	S	Whole plant	Decoction	O	Anthelmintic, diuretic, headache, mouthwash, skin problems	30	0.25	5	0.16	43	V
Olea ferruginea (Wall. ex G. Don) Cif. Khaona B.S.Hus.082.GPGC.PCR	W	T	Fruit, Leaves	Decoction	O	Antiseptic, antidiabetic, antiperiodic, astringent, diuretic, toothache	79	0.66	6	0.07	40	V
Onargaceae												
Epilobium hirsutum L. Sur velanay B.S.Hus.057.GPGC.PCR	W	H	Root	Decoction	O	Astringent, cooling agent, diarrhea	66	0.55	3	0.04	77	R
Oxalidaceae												
Oxalis corniculata L. Bibi malga B.S.Hus.085.GPGC.PCR	W	H	Leaves	Decoction	O	Dysentery, kidney problems, fever, stomachache, vermifuge	69	0.58	5	0.07	65	R
Papaveraceae												
Papaver somniferum L. Dhodda B.S.Hus.086.GPGC.PCR	C	H	Latex, Seed	Decoction, Smoke	O, Inhale	Anodyne, cough, nutritive, tea making	207	1.73	4	0.01	43	R
Partulacaceae												

Portulaca oleracea L. Warkhuray B.S.Hus.097.GPGC.PCR	W	H	Aerial parts	Vegetable	O	Kidney problems, liver diseases, lungs problems, urinary disorders, refrigerant	36	0.3	5	0.13	30	I
Pinaceae												
Abies pindrow Royle ex D Baijoor B.S.Hus.012.GPGC.PCR	W	T	Bark, Leaves	Decoction	O	Regeneration of hairs, blood purifier	16	0.13	2	0.12	62	R
Cedrus deodara (Roxb. ex Lamb.) G. Don Diyar S.Hus.042.GPGC.PCR	W	T	Bark	Oil	T	Antiflatulence	36	0.3	1	0.02	100	E
Pinus wallichiana A.B. Jacks. Nakhtar B.S.Hus.090.GPGC.PCR	W	T	Root, Resin	Decoction	O	Blood purifier, scorpion bites, ulcer	123	1.03	3	0.02	49	E
Plantaginaceae												
Plantago lanceolata L. GhazakiPalisepary B.S.Hus.091.GPGC.PCR	W	H	Leaves, Seed	Decoction, Infusion	O, T	Anti-inflammatory, dysentery, laxative, wound healing	116	0.97	4	0.03	57	I
Plantago major L. Bilamsha B.S.Hus.092.GPGC.PCR	W	H	Leaves, seed	Direct, Decoction	O, T	Dysentery, laxative, mouth diseases	58	0.48	3	0.05	77	I
Veronica anagallis-aquatica L. Waylay botay B.S.Hus.122.GPGC.PCR	W	H	Root, Leaves	Poultice	T	Expectorant, rheumatism, skin problems	36	0.3	3	0.08	52	I
Platanaceae												
Platanus orientalis L. Chinar B.S.Hus.093.GPGC.PCR	C	T	Whole plant	Decoction	O	Diarrhea, toothache	10	0.08	2	0.2	70	V
Polygonaceae												

Persicaria glabra (Wild.) M. Gómez Dherai B.S.Hus.088.GPGC.PCR	W	H	Root	Juice	O	Diarrhea, dysentery, remove worms in the ears	30	0.25	3	0.1	56	V
Polygonoum plebejum R. Br. Bandukai B.S.Hus.096.GPGC.PCR	W	H	Whole plant	Decoction, Vegetable	O	Sexual diseases, tonic, urinary disorders	76	0.63	3	0.03	47	V
Rheum australe D. Don Chotial B.S.Hus.103.GPGC.PCR	W	H	Rhizome, Leaves	Paste, Decoction	O	Anti-constipation	23	0.19	1	0.04	100	V
Rumex nepalensis Spreng. Zamda B.S.Hus.106.GPGC.PCR	W	H	Leaves, Root	Decoction, Vegetable	O	Astringent, demulcent, diuretic	19	0.16	3	0.15	36	R
Primulaceae												
Anagallis arvensis L. Bibi gul B.S.Hus.023.GPGC.PCR	W	H	Aerial parts	Direct, Decoction	O, T	Diuretic, expectorant, insect bites	27	0.23	3	0.11	48	R
Primula denticulata Sm. Asli mameera B.S.Hus.099.GPGC.PCR	W	H	Rhizome, Tender shoot	Powder	T	Antibacterial, ophthalmic, Skin problems	131	1.09	3	0.02	61	V
Punicaceae												
Punica granatum L. WangarAnar B.S.Hus.100.GPGC.PCR	C	T	Fruit, Bark, Leaves	Direct, Powder, Decoction	O	Anthelmintic, antipyretic, astringent, blood purifier, cough, dysentery, expectorant, skin problems	164	1.37	8	0.04	42	R
Ranunculaceae												
Aquilegia nivalis (Baker) Falc. ex B.D. Jacks Woudi gwalae B.S.Hus.026.GPGC.PCR	W	H	Seed, Leaves	Poultice	O	Sore mouth, sore throats	22	0.18	2	0.09	59	R

Clematis orientalis L. Ghra zealai B.S.Hus.047.GPGC.PCR	W	H	Aerial parts	Poultice	T	Skin problems	7	0.06	1	0.14	100	E
Thalictrum foliolosum DC. Mammera B.S.Hus.116.GPGC.PCR	W	H	Rhizome	Paste	T	Eye disorder	62	0.52	1	0.01	100	V
Rosaceae												
Fragaria nubicola (Hook.f.) Lindl. ex L. Ghra manzakhka B.S.Hus.062.GPGC.PCR	W	H	Fruit	Direct	O	Laxative	6	0.05	1	0.16	100	R
Potentilla anserina L. Zair gulay B.S.Hus.098.GPGC.PCR	W	H	Flower, Young shoot	Decoction	O	Astringent, dysentery	36	0.3	2	0.05	61	R
Rosa webbiana Wall ex. Royle. Sheshay B.S.Hus.104.GPGC.PCR	W	S	Flowers	Direct	O	Digestive problems, laxative	52	0.43	2	0.03	82	R
Rubus fruitcosus L. Spungair B.S.Hus.105.GPGC.PCR	W	S	Fruit, Leaves	Direct	O	Carminative, cough, diarrhea, diuretic, fever	62	0.52	5	0.08	62	R
Rubiaceae												
Galium aparine L. Zealai B.S.Hus.064.GPGC.PCR	W	H	Young shoot	Juice	O	Cough	14	0.12	1	0.07	100	V
Saxifragaceae												
Bergenia ciliata (Haw) Sternb. Qamar gul B.S.Hus.032.GPGC.PCR	W	H	Rhizome, Leaves	Decoction, Powder	O	Cure burns, diarrhea, pus discharge, relieve muscular pain, tonic, wound healing	69	0.58	6	0.08	27	R
Bergenia stracheyi (Hook. f. & Thomson) Engl. Kamar panra B.S.Hus.033.GPGC.PCR	W	H	Leaves	Decoction	O	Pus discharge, relieve muscular pain, tonic	47	0.39	3	0.06	48	R

Scrophulariaceae												
Verbascum thapsus L. Khraa ghwaig B.S.Hus.121.GPGC.PCR	W	H	Leaves, Flower, Seed	Juice	O, T	Analgesic, antiseptic, cough, diarrhea, dysentery, narcotic, pulmonary diseases, wound healing	134	1.12	8	0.05	33	I
Simaroubaceae												
Ailanthus altissima (Mill.) Swingle. Lantus B.S.Hus.017.GPGC.PCR	W	T	Leaves, Bark	Juice	O	Anthelmintic	4	0.03	1	0.25	100	R
Solanaceae												
Hyscyamus niger L. Shamla B.S.Hus.067.GPGC.PCR	W	H	Seed	Direct	T	Toothache	3	0.03	1	0.33	100	V
Solanum nigrum L. Kachmachu B.S.Hus.109.GPGC.PCR	W	H	Aerial parts	Vegetable, Poultice	O, T	Cleaning Wound, expectorant, anti-tumor, Skin problem	46	0.38	4	0.08	63	V
Solanum surratense Burm. f. Marghonay B.S.Hus.110.GPGC.PCR	W	H	Whole plant	Poultice, Decoction, Dirct	O, T	Asthma, chest problem, expectorant, fever, stomachache	37	1.14	5	0.03	30	V
Thymelaeaceae												
Daphne mucronata Royle. Laoghonay B.S.Hus.053.GPGC.PCR	W	S	Bark, Fruit	Poultice, Decoction	O, T	Rheumatism	43	0.3	1	0.02	100	V
Urticaceae												
Urtica dioica L. Sezonky B.S.Hus.119.GPGC.PCR	W	H	Leaves	Decoction	O	Astringent	21	0.18	1	0.04	100	R

Violaceae												
Viola betonicifolia Sm. Binowsha B.S.Hus.123.GPGC.PCR	W	H	Whole plant	Decoction	O	Antitumor, astringent, diaphoretic, febrifuge, purgative	71	0.59	5	0.07	40	V
Viola canescens Wall ex Roxb. Binowsha B.S.Hus.124.GPGC.PCR	W	H	Whole plant	Decoction	O	Antitumor, antipyretic, astringent, demulcent, febrifuge, purgative	119	0.99	6	0.05	54	V
Zygophyllaceae												
Tribulus terrestris L. Ziarr rinzaka B.S.Hus.118.GPGC.PCR	W	H	Fruit, Root	Decoction	O	Aphrodisiac, impotence, urinary disorders	73	0.61	3	0.09	67	R

Abbreviations:

W, Whole plant; **H**, Herb; **T**, Tree; **S**, Shrub; **O**, Orally; **T,** Topical; **RFC**, Relative Frequency of Citation; **UR**, Use Report**, FIV**, Family Importance Value; **UV**, Use Value; **UR,** Use Report; **FL**, Fidelity Level; **ICF,** Informant Consensus Factor; **FIC**, Informant Consensus Factor;

Plant parts used and preparation of remedies

Based on a total of 5750 use reports, the part of the plants most frequently used were leaves (25%), followed by whole plants (15.54%), fruits (13.51%) and roots (8.10) (Fig. 2). The least documented plant part used was latex, nuts and resin each with 1% each. The most used method of preparation was decoction (39%), followed by vegetable (10%), juice (9%) and direct (8%) (Fig. 3). The most frequent route of administration of remedies were oral (76%), topical (12%), both oral and topical (8%), inhaled and oral (2%) and only inhaled (1%).

Most participants indicated that plants were usually collected from a variety of different wild habitats i.e., forest, hilly and deserts areas.

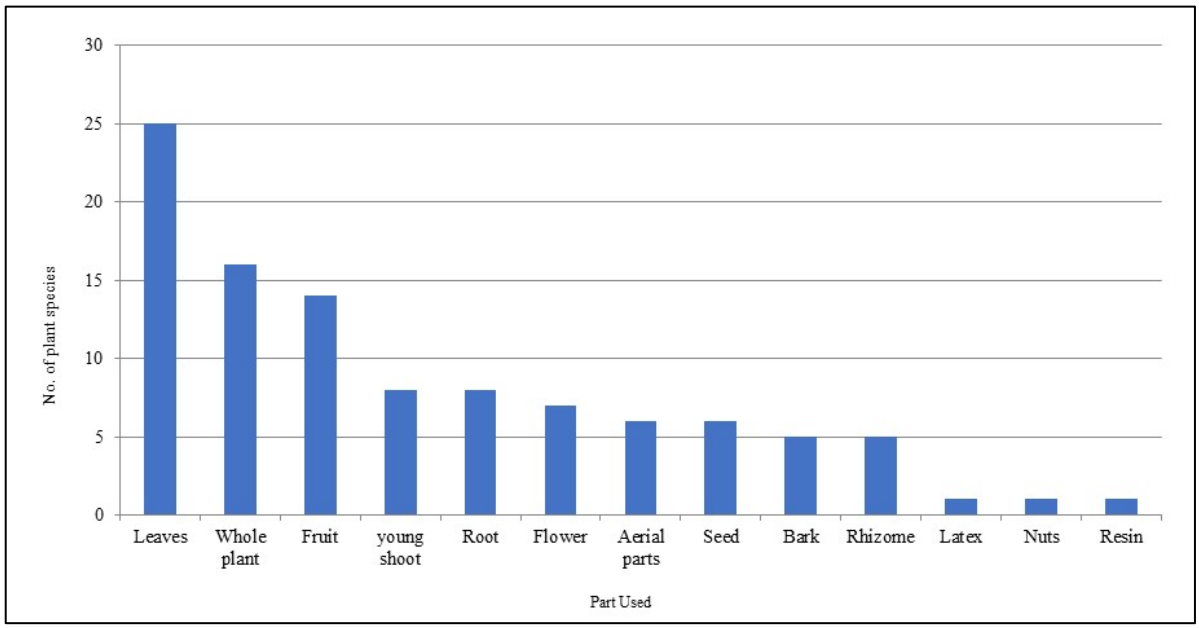

Figure 2. Plant parts used in the preparation of remedies

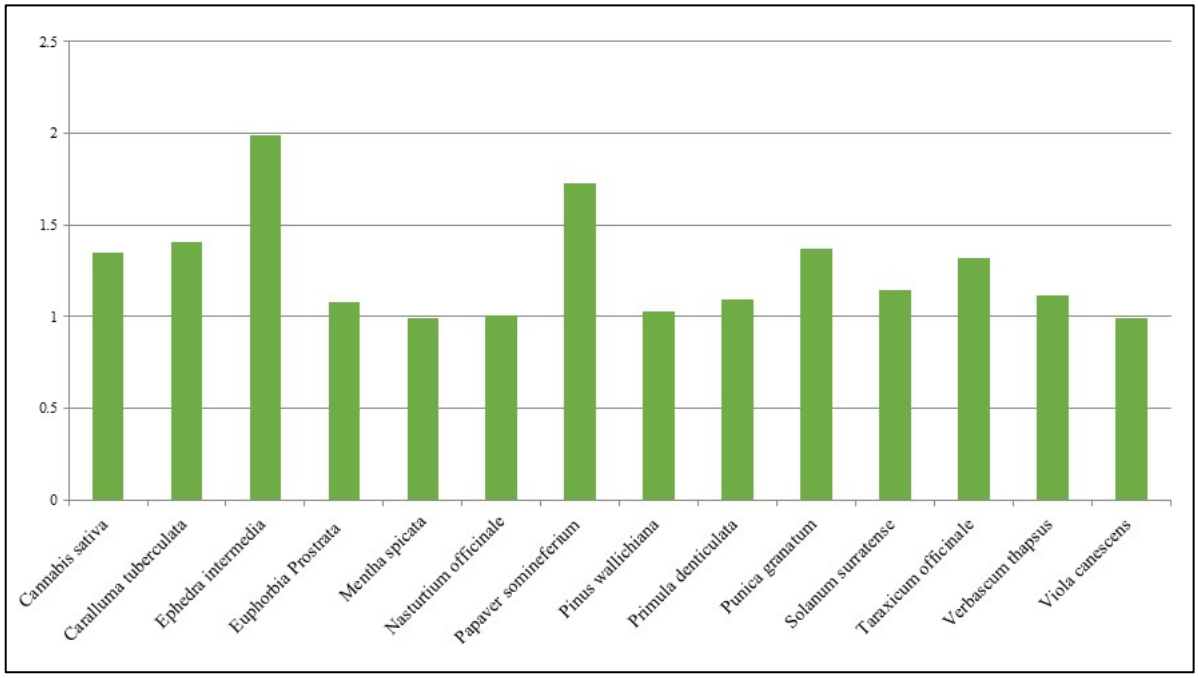

Figure 3. Medicinal plants with Highest Relative Frequency Citation

Quantitative ethno-medicinal data analysis

Use value (UV)

In our study, UV varied from 0.01 to 0.75. Maximum UV was calculated for *Conyza canadensis*, and lowest for *Ephedra intermedia, Papaver somniferum, Caralluma tuberculata, Ajuga bracteosa, Malva neglecta, Thalictrum foliolosum, Malva sylvestris and Artemisia scoparia*. Other significant plant taxa with high use value, *Vitex negundo* (0.38), *Senecio crysanthemoides* (0.33), *Hyoscyamus niger* (0.33), *Lactuca serriola* (0.31), *Cuscuta reflexa* (0.31), *Convolvulus arvensis* (0.29), *Otostegia limbata* (0.29) and *Achillea millefolium* (0.27).

Relative Frequency of Citation (RFC) and Use Report (UR)

The RFC ranged from 0.025% to 1.992%. Most of the respondents reported an average of 16 plant species. Species with high RGC were *Ephedra intermedia* (1.992%), *Papaver somniferum* (1.725%), *Caralluma tuberculata* (1.408%), *Punica granatum* (1.367%) and *Cannabis sativa* (1.35%) and *Taraxacum officinale* (1.317%). Extracts of *Ephedra intermedia* were used to treat Covid-19, bronchitis, asthma, and rheumatism. The latex of *Papaver somniferum*, obtained from its unripe fruits, was used as narcotic and anodyne. The highly nutritive seeds were used for making tea. *Caralluma tuberculata* was used as anti-diabetic, carminative, and for hypertension, *Punica granatum* was used as anthelmintic, antipyretic, expectorant, astringent and for blood purifier, cough, dysentery, skin problems, *Cannabis sativa* was used as anodyne, narcotic, sedative and refrigerant, and *Taraxacum officinale* was used as tonic, diuretic and treatment for jaundice and constipation, as well as remedy for liver and kidney diseases. The lowest RFC value (0.025%) was documented for *Hyoscyamus niger* and *Senecio crysanthemoides*.

In the current study, Use Report values varied from 3 to 239. *Ephedra intermedia*, *Papaver somniferum*, *Caralluma tuberculata*, *Punica granatum*, *Cannabis sativa*, *Taraxacum officinale*, *Solanum surratens*, *Verbascum thapsus*, *Primula denticulata* and *Euphorbia prostrata* were the most therapeutic used plant.

Fidelity Level (FL)

In the current research FL ranged from 28 to 100%. The plant species mostly used in the study area with 100% fidelity level were *Aesculus indica*, *Ailanthus altissima*, *Ajuga bracteosa*, *Amaranthus viridis*, *Anaphalis controta*, *Arisaema jacquemontii*, *Artemsia scoparia*, *Cedrus deodara*, *Chenopodium botrys*, *Clematis orientalis*, *Corydalis govaniana*, *Daphne mucronata*, *Fragaria nubicola*, *Galium aparine*, *Hyoscyamus niger*, *Jasminum humile*, *Lepidum sativum*, *Malva neglecta*, *Malva sylvestris*, *Marrubium anisodon*, *Perovskia atriplicifolia*, *Phlomis cashmeriana*, *Plectranthus rugosus*, *Rheum australe*, *Senecio crysanthemoides*, *Thalictrum foliolosum*, and *Urtica dioica*.

Informant consensus factor (FIC)

The local population used therapeutic plants to heal 114 different diseases. The most important diseases treated were Covid-19, diuretic, dysentery, diarrhea, astringent, purgative, wound healing, laxative, and cough. To determine the informant consensus factor (FIC), all the plant species used for the cure of different disorders are first grouped into 19 categories based on disease treated (Table 4). Highest ICF value was recorded for acoustic disorders, insecticides (1), followed by ophthalmic disorders (0.98), muscles disorders, antidepressant, body energizers, hepatic disorders (0.97) and respiratory disorders, cancer (0.96). Among the four major ailments categories, gastrointestinal disorders were most common with 1449 use-reports, followed by, (AAA) antiseptic, (AAR) analgesic, antipyretic, refrigerant (666, 603 and 489 use reports respectively Table 4). Around antiviral, antiallergic, respiratory disorders and 91.51% plant taxa were used to cure gastrointestinal disorders followed by (AAA) antiseptic, antiviral, antiallergic (34.91%), urological disorders (26.42%), respiratory disorders (23.58%) and (AAR) analgesic, antipyretic, refrigerant (21.7%), dermatological disorders and cardiovascular disorders (18.87%). These results indicate that gastrointestinal disorder and antiseptic, antiviral and anti-allergic disorders are common in the study area.

Table 4. Informant consensus factor (FCI) by categories of ailments in the study area**.**

Disease category	Nur	% of use reports	Nt	% of species	Nur/Nt	Nur1	FCI
Gastrointestinal disorders	1450	25.32	97	91.51	1353	1449	0.93
Antiseptic, Antiviral and Anti-allergic	667	11.65	37	34.91	630	666	0.95
Urological disorders	373	6.514	28	26.42	345	372	0.93
Respiratory disorders	604	10.55	27	25.47	577	603	0.96

Analgesic, Antipyretic, and Refrigerant	490	8.557	23	21.7	467	489	0.96
Dermatological disorders	335	5.851	20	18.87	315	334	0.94
Cardiovascular disorders	283	4.942	20	18.87	263	282	0.93
Nervous disorders	185	3.231	10	9.43	175	184	0.95
Body energizers	258	4.506	9	8.49	249	257	0.97
Hair tonic, Tonic	146	2.55	9	8.49	137	145	0.94
Muscles disorders	227	3.964	8	7.55	219	226	0.97
Cancer	141	2.462	7	6.6	134	140	0.96
Sexual diseases	128	2.235	7	6.6	121	127	0.95
Hepatic disorders	149	2.602	6	5.67	143	148	0.97
Glandular disorders	67	1.17	5	4.72	62	66	0.94
Ophthalmic disorders	185	3.231	4	3.77	181	184	0.98
Antidepressant	33	0.576	2	1.89	31	32	0.97
Insecticides	27	0.472	1	0.94	26	26	1
Acoustic disorders	2	0.035	1	0.94	1	1	1
Mean FCI							**0.958**

Nur, Total use report; **Nt**, Total number of species used in a disease category; **FCI**, Informant consensus factor.

Family Importance Value (FIV)

Seven 7 plant families had maximum FIV, with Lamiaceae as the leading family with (96.67%) followed by Asteraceae (92.5%), Amaranthaceae (87.5%), Polygonaceae (85.83%) and Rosaceae (79.17%). Zygophyllaceae had the lowest family importance value with (6.67%) (Fig. 4)

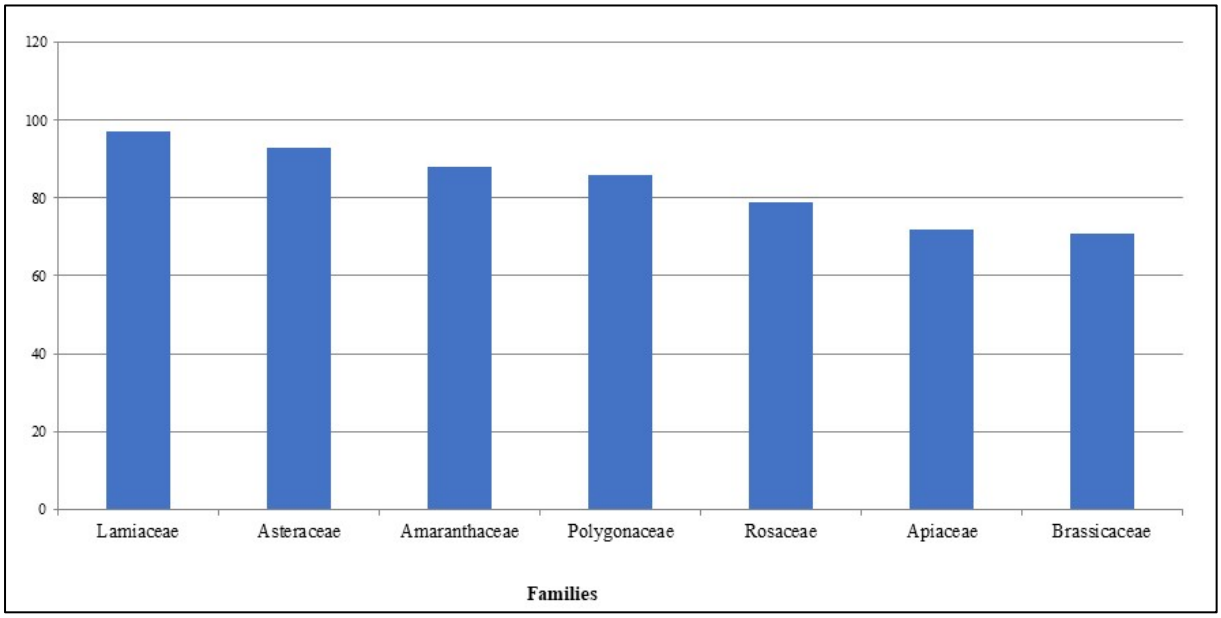

Figure 4. Family Importance Values.

Conservation status of the medicinal flora

Based on IUCN Red List criteria (2001), the conservation status of the 100 wild medicinal species was assessed, and 49 were found to be vulnerable, followed by 34 species that were rare, 9 infrequent, and 3 dominant (Fig. 5). We found that 5 species in the study area were in danger of extinction due to anthropogenic activities, high collection, small population, urbanization, marble quarrying and adverse climatic conditions. The remaining 6 plants were cultivated. The unsustainable uses and lack of suitable habitats have already affected their regeneration and placed them in the extinct category. Indigenous knowledge can also contribute to the sustainable use and conservation of important medicinal plant species.

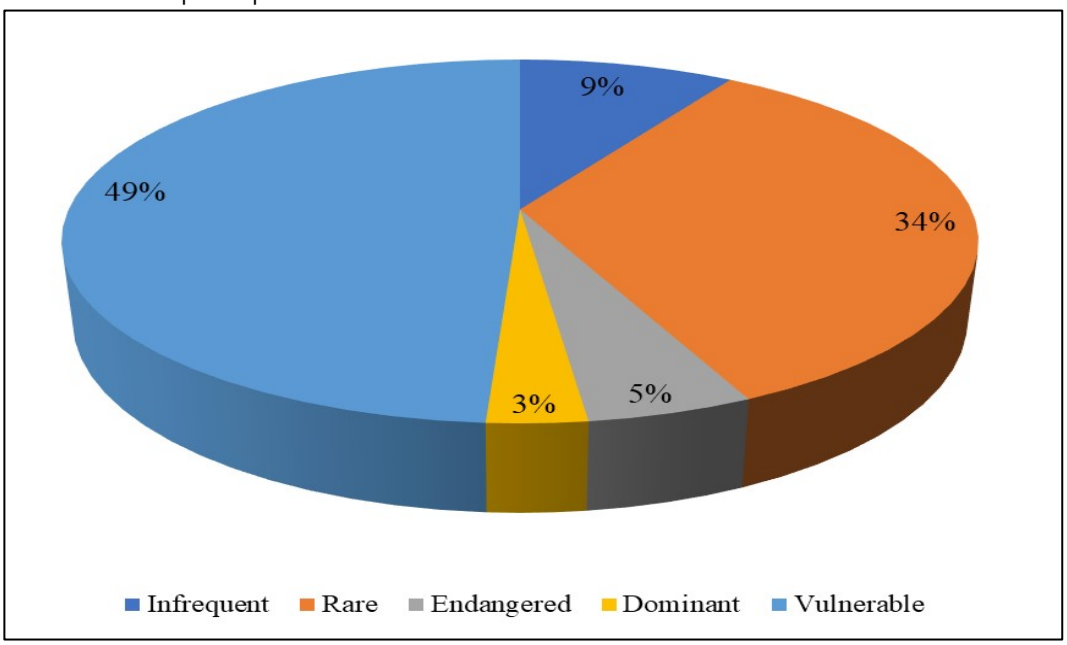

Figure 5. Conservation status of medicinal plants

Discussion

The Kurram flora is considered one of the most diverse, rich, and unique in the Himalayas. The high number of medicinal plants highlights the diversity as well as their traditional uses. A large number of medicinal plants have been earlier documented from neighboring areas (Abbasi *et al.* 2010; Abbassi *et al.* 2015; Abbas et al. 2016; Ahmad *et al.* 2017). In most cases herbal medicines were prepared from a single plant species (Ahmad *et al.* 2017; Umair e *et al.* 2017). However, in some cases, more than one plant species was used in traditional recipes similar to our study (Malik *et al.* 2011; Tausha *et al.* 2018). Medicinal plants with maximum UV might require protection to sustain biodiversity in the investigation region. However, so far, no program or project for the maintenance and conservation of flora and vegetation is functioning in the study area. The critically endangered flora of Central Kurram consists of 5 plant species. The conservation status was determined through direct field observation and by the information given by local people and applied IUCN, 2001. 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 use of therapeutic plant species is increasing day by day also increase the demand of their harvesting. Due to small population, over harvesting and adverse climatic conditions some of the medicinal plants including *Caralluma tuberculata*, *Podophyllum emodi* and *Clematis orientalis* are the most endangered medicinal plant due to improper picking from wild population. *Cedrus deodara* and *Pinus wallichiana* are endangered due to over harvesting, urbanization, and marble mining (Ali *et al.* 2022). During the current study we applied different statistical tools to elucidate the relative importance of ethnobotanical important plants such as 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. It is considered to be effective at determining which plants are considered most useful to a particular group of people, evaluating potential uses of a plant, and determining the extent of knowledge about it within the group. In current study, UV varied from 0.01 to 0.75. Maximum UV (0.75) was calculated for *Conyza canadensis* and lowest (0.1) for *Malva sylvestris.* The relative frequency of citation is used to record the highest therapeutic medicinal plants which are consumed for the treatment of numerous ailments. The RFC ranged from 0.025% to 1.992%. Most of the respondents reported an average of 16 plant species. Species with high RGC were *Ephedra intermedia* (1.992%), and lowest value (0.025%) was documented for *Hyoscyamus niger* and *Senecio*

crysanthemoides. Fidelity level is an important induces which highlights the medicinal plants with maximum curative properties have the highest fidelity level, i.e., 100%. 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. High Fidelity level value indicates high frequency of use of the plant species for treating a particular ailment category by the informants. Current findings showed that Fidelity level ranged from 28 to 100%. The plant species mostly used in the study area with 100% fidelity level were *Aesculus indica*, *Ailanthus altissima*, *Ajuga bracteosa*, *Amaranthus viridis*, *Anaphalis contorta*, *Arisaema jacquemontii*, *Artemsia scoparia*, *Cedrus deodara*, *Chenopodium botrys*, *Clematis orientalis*, *Corydalis govaniana*, *Daphne mucronata*, *Fragaria nubicola*, *Galium aparine*, *Hyoscyamus niger*, *Jasminum humile*, *Lepidum sativum*, *Malva neglecta*, *Malva sylvestris*, *Marrubium anisodon*, *Perovskia atriplicifolia*, *Phlomis cashmeriana*, *Plectranthus rugosus*, *Rheum australe*, *Senecio crysanthemoides*, *Thalictrum foliolosum*, and *Urtica dioica*.

The use report is the most basic ethnobotany calculation. It is a single record for use of a plant mentioned by an individual. It is the use recorded for every species. If a plant secures a high UV score that indicates there are many use reports for that plant, while a low score indicates fewer use reports cited by the informants. In the current study, Use Report values varied from 3 to 239. *Ephedra intermedia*, *Papaver somniferum*, *Caralluma tuberculata*, *Punica granatum*, *Cannabis sativa*, *Taraxacum officinale*, *Solanum surratens*, *Verbascum thapsus*, *Primula denticulata* and *Euphorbia prostrata* were the most therapeutic used plant. Informant Consensus Factor is used to test the homogeneity of knowledge on the use of species in the illness categories between the populations. The ICF provides a range of (0-1). High ICF shows that there is a narrow well-defined group of species used to cure a particular ailment category andor that information is exchanged between informants and low ICF values (close to zero) indicate that informants disagree over which plant to use due to random choosing or lack of exchange of information about the use among informants. The local population used therapeutic plants to heal 114 different diseases. The most important diseases treated were Covid-19, diuretic, dysentery, diarrhea, astringent, purgative, wound healing, laxative, and cough. To determine the informant consensus factor (FIC), all the plant species used for the cure of different disorders are first grouped into 19 categories based on disease treated (Table 4). Family Importance Value (FIV) was used to determine the relative importance of family. The importance of a plant family increases with the increase in the frequency of citations of all species. FIV is an index to compare the importance value of not just individual species, but also of plant families. This shows the relative importance of family in a particular of a specific area. Sevenplant families had maximum FIV such as Lamiaceae as the leading family with (96.67%) followed by Asteraceae (92.5%), Amaranthaceae (87.5%), Polygonaceae (85.83%) and Rosaceae (79.17%). Zygophyllaceae had the lowest family importance value with (6.67%).

Relevance of the study

Medicinal plants are used as therapeutic agents in tribal and rural areas for maintaining better health. Such practices have been described in the ethnobotanical studies conducted across Pakistan. A wide range studies have confirmed the use of medicinal species and the medicinal significance of plants also found in our research area. Inflorescence paste and dried leaves of *Artemisia absinthium* were used as anthelminthic and for stomach pain (Tausha *et al.* 2018*)*. Bark leaves and roots of *Berberis lycium* were used for broken bones, muscle growth, diabetes, and diarrhea (Ahmad *et al.* 2017). *Lepidium sativum* and *Foeniculum vulgare* are used to cure renal diseases and diabetes. The flower of *Viola canescens* was used as a purgative (Shinwari & Khan 2000). Bark and fruit bark of *Punica granatum* were used to cure intestinal problems (Tumpa *et al.* 2014). Flower and leaves of *Verbascum thapsus* were used to stimulate the coughing up of phlegm and reduce mucous formation. Externally *Verbascum thapsus* were used as a good wound healer. *Thymus linearis* leaves were effectively used against cough, roundworms, and asthma (Ullah *et al.* 2013). *Chenopodium album* was used as diuretic, anthelmintic, and laxative and decoction its roots are effective against jaundice. The whole plant decoction of *Fumaria indica* was used for blood purification. The roots of *Oxalis corniculata* are anthelmintic and *Chenopodium album* powder was used effective against seminal weakness and headache (Devi *et al.* 2013). *Plantago major* boiled leaves were effective against gastralgia while boiled leaves of *Cichorium intybus* were used as laxative and stomachic (Dogan & Ugula 2013). The recent study found several plant species with more than one medical use, including *Artemisia absinthium, Berberis lyceum*, *Lepidium sativum*, *Foeniculum vulgare, Punica granatum*, and *Cichorium intybus*. Their medicinal is validated by a number of studies conducted across the country. *Artemisia absinthium* is used against malaria, diabetes, as tonic, for blood pressure. It is also known as blood purifier (Khan & Khatoon 2008; Ashrif *et al.* 2010; Murad *et al.* 2012; Abbas *et al.* 2018; Hussain *et al.* 2018a; Muhammad *et al.* 2019; Abbas *et al.* 2020; Shah *et al.* 2020). In our study it was used for the treatment of digestive problem, jaundice as well as Covid-19. *Berberis lycium* is widely used to cure cough, skin, and liver problems (Amjad *et al.* 2020). This study reports its effectiveness against colic and jaundice. It is also used as cooling agent. *Cichorium intybus* is used in diabetes, typhoid, gastric ulcer, malaria,

hepatitis, and it is also used as digestive, laxative, and antipyretic agent (Ahmad *et al.* 2009; Jan *et al.* 2009; Ali *et al.* 2011; Jan *et al.* 2011; Muhammad *et al.* 2013; Jabeen *et al.* 2015; Hussain *et al.* 2018a; Muhammad *et al.* 2019) While in current study it is used to enhance bile secretion and curing jaundice as well. The whole plant of *Fumaria indica* is used against constipation. It is used as antipyretic, anthelmintic and blood purifier; and also used against itching (Khan & Khatoon 2008, Mura *et al.* 2013; Hussain *et al.* 2018b). In present study it is used as anti-tumor and skin achene. Fruit of *Foeniculum vulgare* is used to cure vomiting, as carminative and flavoring agent (Ahmad *et al.* 2011*)* while in current study it is used as aphrodisiac, diuretic and for improving eyesight. *Lepidium sativum* seeds are used against internal parasites and general body weakness (Goraya 2013). In current study it is used as ant-flatulence. Fruit extract and dried rind powder of *Punica granatum* are taken orally for curing anemia, diabetes, diarrhea, and dysentery. It is also used for the treatment of cough and eye disorder (Haq *et al.* 2011; Abbassi *et al.* 2013; Ijaz *et al.* 2015; Devi *et al.* 2013; Ijaz *et al.* 2015; Hussain *et al.* 2018a). In current study it is used as anthelmintic, astringent and expectorant as well as for curing skin problem. *Teucrium stocksianum* is used for treating diabetes as anthelmintic and antipyretic agent (Alamgeer *et al.* 2013; Hussain *et al.* 2018; Ullah *et al.* 2016). In this study it is used as cooling agent and treating hepatitis. *Thymus linearis* is used against stomachache, liver complaints and cough (Amjad *et al.* 2020), whereas in current study it is used against cold. Decoction of seeds of *Verbascum thapsus* is used for the treatment of diarrhea, dysentery, as analgesic and for skin infections (Ahmad *et al.* 2014) but in this study it is used to cure cough, pulmonary diseases and used as narcotic.

Novelty and future impacts

The comparison of our study with the ethnomedicinal literature indicated adjacent areas (Hussain *et al.* 2013; Hussain *et al.* 2018) indicated that the more far-flung areas had relatively less similarities because of cultural and traditional differences - thus confirming our hypothesis that Central Kurram would harbor different plant use practices. The comparative study between previously reported medicinal plants showed that 59 plant species, (e.g., *Achillea millefolium*, *Aesculus indica*, *Andrachne telephioides*, *Arisaema jacquemontii*, *Artemisia absinthium*, *Astagalus stocksii*, *Clematis orientalis*, *Cuscuta reflexa*, *Ephedra intermedia*, *Euphorbia prostrata*, *Galium aparine*, *Hedera nepalensis*, *Podophyllum emodi*, *Quercus semecarpifolia* and *Vitex negundo*), were not previously reported in the study area for their medicinal values. The newly documented plants (and their uses) were *Achillea millefolium* (stopping perspiration), *Aesculus indica* (colic), *Andrachne telephioides* (anthelminthic), *Arisaema jacquemontii* (snakebites), *Artemisia absinthium* (Covid-19), *Astagalus stocksii* (sexual diseases), *Clematis orientalis* (skin problems), *Cuscuta reflexa* (blood purifier), *Ephedra intermedia* (Covid-19), *Euphorbia prostrata* (urinary disorders), *Galium aparine* (cough), *Hedera nepalensis* (anti-tumor), *Podophyllum emodi* (to strengthen liver), *Quercus semecarpifolia* (digestive problems) and *Vitex negundo* (headache). These plant species can provide leads for future pharmaceutical research. The study also revealed that the ethnomedicinal use of 15 species as diuretics and two species to treat Covid-19, such as *Artemisia absinthium* and *Ephedra intermedia*, were not previously reported from any parts of Pakistan.

Conclusions

The current study showed that Central Kurram has a significant diversity of medicinal plant, and the use of medicinal plants and plant-based remedies is still common in the area. A total of 106 medicinal plant species, belonging to 50 families were documented for the treatment of 114 disorders. *Dysphania botrys*, *Corydalis govaniana*, *Isodon rugosus*, *Bunium persicum*, and *Perovskia atriplicifolia* were documented for the first time in the study area for the treatment of wounds, eye allergies, antiseptic, stomachache, and bedbug repellent. The residents used medicinal plants in treatment of important diseases such as Covid-19, cancer, dysentery, as diuretic, wound healing, and sexual diseases. The data analyzed may provide opportunities for extraction of new bioactive compounds and for the development of herbal medicines. The study also confirmed that the communities living in the area are still achieving the preservation of this traditional wealth of indigenous knowledge and medicinal plants. Conservation strategies must be adopted for the protection of medicinal plants and traditional knowledge in the study area to preserve them in the future.

Declarations

List of abbreviations: W, Whole plant; H, Herb; T, Tree; S, Shrub; O, Orally; T, Topical; RFC, Relative Frequency of Citation; UR, Use Report, FIV, Family Importance Value; UV, Use Value; UR, Use Report; FL, Fidelity Level; ICF, Informant Consensus Factor; FIC, Informant Consensus Factor

Ethics approval and consent to participate: This study was authorized by the Department of Botany, GPGC Parachinar affiliated with Kohat University of Science and Technology Kohat KP, Pakistan. All participants provided oral prior informed consent.

Consent for publication: All authors read and approved the final manuscript for publication.

Availability of data and materials: All the data are in manuscript and supporting documents.
Author's contributions: Sayed Hussain collect the field data, Wahid Hussain supervised the project, Ashiq Nawaz, design the project, Lal Badshah, Asghar Ali, Shariat Ullah and Maroof Ali reviewed the manuscript, Rainer W. Bussmann and Hidayat Hussain participated in in data analysis and the final revision of the manuscript.
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Literature Cited

Abbas G, Abbas Q, Khan SW, Hussain I, Najumal-ul-Hassan S. 2018. Medicinal plants diversity and their utilization in Gilgit region. Norhern Pakistan. Journal of Plant and Soil Science 5(4):234-48.

Abbas W, Hussain W, Hussain W, Badshah L, Hussain K, Pieroni A. 2020. Traditional wild vegetables gathered by four religious groups in Kurram District, Khyber Pakhtunkhwa, North-West Pakistan. Genetic Resources and Crop Evolution 67:1521-36.

Abbas Z, Khan SM, Abbasi AM, Pieroni A, Ullah Z, Iqbal M, Ahmad Z. 2016. Ethnobotany of the Balti community, Tormik valley, Karakorum range, Baltistan, Pakistan. Journal of Ethnobiology and Ethnomedicine 12:38.

Abbasi AM, Khan MA, Ahmad M Zafar, M, Jahan S, Sultana S. 2010. Ethnopharmacological application of medicinal plants to cure skin diseases and in folk cosmetics among the tribal communities of North-West Frontier Province, Pakistan. Journal of Ethnopharmacology 128:322-335.

Abbasi AM, Khan MA, Khan N, Shah MH. 2013.Ethnobotanical survey of medicinally important wild edible fruits species used by tribal communities of lesser Himalayas-Pakistan. Journal of Ethnopharmacology 148(2):528-36.

Abbasi AM, Shah MH, Khan MA. 2015. Wild Edible Vegetables of Lesser Himalayas: Ethnobotanical and Nutraceutical Aspects, Springer: Cham, Switzerland.

Ahmad I, Ibrar M, Ali N. 2011. Ethnobotanical study of tehsil Kabal, Swat District, KPK. Pakistan Journal of Botany doi: 10.1155/2011/368572

Ahmad KS, Hamid A, Nawaz F, Hameed M, Ahmad F, Deng J, Akhtar N, Wazarat A. Mahroof S. 2017. Ethnopharmacological studies of indigenous plants in Kel village, Neelum Valley, Azad Kashmir, Pakistan. Journal of Ethnobiology and Ethnomedicine 13:68.

Ahmad M, Qureshi R, Arshad M, Khan MA, Zafar M. 2009.Traditional herbal remedies used for the treatment of diabetes from district Attock (Pakistan). Pakistan Journal of Botany 41(6):2777-82.

Ahmad M, Sultana S, Fazl-i-Hadi S, Ben Hadda T, Rashid S, Zafar M, Khan MA, Khan MP, Yaseen G. 2014.An Ethnobotanical Study of Medicinal Plants in High Mountainous Region of Chail Valley (District Swat-Pakistan). Journal of Ethnobiology and Ethnomedicine 10(1):1-8.

Ahmad M, Zafar M, Shahzadi N, Yaseen G, Murphey TM, Sultana S. 2017. Ethnobotanical importance of medicinal plants traded in Herbal markets of Rawalpindi-Pakistan. Journal of Herbal Medicine 11:78-89.

Ajaib M, Haider SK, Zikrea A. 2014. Ethnobotanical studies of shrubs and trees of Agra valley Parachinar, upper Kurram agency, Pakistan. FUUAST Journal of Biology 4(1):73-81.

Alamgeer TA, Rashid M, Malik MNH, Mushtaq MN.2013. Ethnomedicinal survey of plants of Valley Alladand Dehri, Tehsil Batkhela, District Malakand, Pakistan. International Journal of Basic Medicinal Science and Pharmacology 3(1):23-32.

Ali H, Sannai J, Sher H, Rashid A. 2011.Ethnobotanical profile of some plant resources in Malam Jabba valley of Swat. Pakistan. Journal of Medicinal Plants Research 5(18):4676-4687.

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. doi: 10.37360blacpma.22.21.3.22

Ali SI, Nasir YJ, (Eds.). 1989-1992. Flora of Pakistan. Islamabad, Karachi.

Ali SI, Qaiser M, (Eds.). 1993-2015. Flora of Pakistan. Islamabad, Karachi.

Amjad MS, Zahoor U, Bussmann RW, Altaf M, Gardazi SM, Abbasi AM. 2020. Ethnobotanical survey of the medicinal flora of Harighal, Azad Jammu & Kashmir, Pakistan. Journal of Ethnobiology and Ethnomedicine 16(1):1-28.

Anonymous. 2001.IUCN Red List Categories and Criteria, IUCN Species Survival Commission IUCN: Gland, Switzerland, Cambridge, UK.

Ashraf M, Hayat MQ, Jabeen S, Shaheen N, Khan MA, Yasmin G. 2010. Artemisia L, Species recognized by the local community of the northern areas of Pakistan as folk therapeutic plants. Journal of Medicinal Plants Research4(2):112-9.

Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze, D, Khutsishvili M, Batsatsashvili K, Hart RE.2016. A comparative ethnobotany of Khevsureti, Samtskhe-Javakheti, Tusheti, Svaneti, and Racha-Lechkhumi, Republic of Georgia (Sakartvelo), Caucasus. Journal of Ethnobiology and Ethnomedicine 12:43, doi: 10.1186s13002-016-0110-2.

Devi U, Seth M, Sharma P, Rana J. 2013. Study on ethnomedicinal plants of Kibber Wildlife Sanctuary: A cold desert in Trans Himalaya, India. Journal of Medicinal Plants Research. 7: 3400-3419.

Dogan Y, Ugulu I. 2013. Medicinal plants used for gastrointestinal disorders in some districts of Izmir province, Turkey. Studies in Ethno-Medicine 7:149-161.

Eddouks M, Bidi A, El Bouhali B, Hajji L, Zeggwagh NA. 2014. Anti-diabetic plants improving insulin sensitivity. Journal of Pharmacy and Pharmacology 66:1197-1214.

Ekor M. 2014. The growing use of herbal medicines: Issues relating to adverse reactions and challenges in monitoring safety. Frontiers in Pharmacology 7:1-10.

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 09.004.

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.

Gilani SS, Abbas SQ, Shinwari ZK, Hussain F, Nargis K. 2003. Ethnobotanical studies of Kurram Agency Pakistan through rural community participation. Pakistan Journal of Biological Science 6:1368-1375. doi: 10.3923pjbs.2003.

GoP. 1998. Census Report of Kurram Agency, Government of Pakistan, Islamabad. 2000.

Goraya K, Iqbal Z, Sajid MS, Muhammad G, ul Ain Q, Saleem M.2013. Diversity of flora used for the cure of equine diseases in selected peri-urban areas of Punjab, Pakistan. Journal of Ethnobiology and Ethnomedicine 9(1):1-9.

Haq F, Ahmad H, Alam M. 2011. Traditional uses of medicinal plants of Nandiar Khuwarr catchment (district Battagram). Pakistan. Journal of Medicinal Plants Research 5(1):39-48.

Hayta S, Polat R, Selvi S. 2014.Traditional uses of medicinal plants in Elazıg (Turkey). Journal of Ethnopharmacology 154:613-623.

Heinrich M, Ankli A, Frei B, Weimann C, Sticher O.1998. Medicinal plants in Mexico: Healers' consensus and cultural importance. Social Science and Medicine 47:1859-1871.

Hussain S, Malik F, Khalid N, Qayyum MA, Riaz H. 2012. Alternative and traditional medicines systems in Pakistan: History, Regulation, Trends, Usefulness, Challenges, Prospects and Limitations. In A Compendium of Essays on Alternative Therapy; InTech: London UK .67.

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 14:30.

Hussain W, Hussain H, Ali A. 2021. Herbal Medicine Used in Corona Treatment: An Ethnopharmacological Survey. Bioscience Research 1284-1293.

Hussain W, Hussain J, Ali R, Khan I, Shinwari ZK, Nascimento I A. 2012. Tradable and conservation status of medicinal plants of Kurram Valley. Parachinar, Pakistan. Journal of Applied Pharmacological Science 2:66-70.

Hussain W, Hussain J, Hussain S, Shinwari Z K, Ali R & Basir A. 2013. Ethono medicinal study of Parachinar, Kurram Valley (FATA) KPK, Pakistan. Journal of Applied Pharmacological Science 3(11):85.

Hussain W, Ullah M, Dastagir G, Badshah L. 2018.Quantitative ethnobotanical appraisal of medicinal plants used by inhabitants of lower Kurram, Kurram agency, Pakistan. Avicenna Journal of Phytomedicine 8:313.

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

Ijaz F, Iqbal Z, Alam J, Khan SM, Afzal A, Rahman IU. 2015. Ethnomedicinal study upon folk recipes against various human diseases in Sarban Hills, Abbottabad. Pakistan World Journal of Zoology 10(1):41-46.

Jabeen N, Ajaib M, Siddiqui MF, Ulfat M, Khan B. 2015. A survey of ethnobotanically important plants of District Ghizer. Gilgit-Baltistan FUUAST Journal of Biology 5(1):153-160.

Jan G, Khan MA, Farhatullah JFG, Ahmad M, Jan M, Zafar M. 2011. Ethnobotanical studies on some useful plants of Dir Kohistan valleys, KPK. Pakistan. Pakistan Journal of Botany 43(4):1849-1852.

Jan G, Khan MA, Jan F. 2009. Medicinal value of the Asteraceae of Dir Kohistan Valley, NWFP, Pakistan. Ethnobotanical Leaflets 13:1205-1215.

Kangl A, Moon SK, Cho SY, Park SU, Jung WS, Park JM, Ko CN, Cho KH, Kwon S. 2020. Herbal medicine treatments for essential tremor: A retrospective chart review study. Journal of Herbal Medicine 19:100295.

Kanwal H, Sherazi BA. 2017. Herbal medicine: Trend of practice, perspective, and limitations in Pakistan. Asian Pacific Journal of Health Science 24: 6-8.

Kapur BK. 1908. Settlement report of Captain B.K. Kapur, N. W F. Province Gazetteer Kurram Agency. 1-64.

Kasilo OM, Trapsida JM, Ngenda MC, LusambaDikassa PS. 2010. World Health Organization. An overview of the traditional medicine situation in the African region. African Health Monitor 4: 7-15.

Kayani S, Ahmad M, Zafar M, Sultana S, Khan MPZ, Ashraf MA, Hussain J, Yaseen G. 2014. Ethnobotanical uses of medicinal plants for respiratory disorders among the inhabitants of Gallies-Abbottabad, Northern Pakistan. Journal of Ethnopharmacology 156:47-60.

Khan SW, Khatoon S. 2008.Ethnobotanical studies on some useful herbs of Haramosh and Bugrote valleys in Gilgit, northern areas of Pakistan. Pakistan Journal of Botany 40(1):43.

Khan T 2005.Gazetteer of Kurram agency Parachinar. 43-47.

Mahomoodally F, Suroowan S, Sreekeessoon U. 2018. Adverse reactions of herbal medicine a quantitative assessment of severity in Mauritius. Journal of Herbal Medicine 2018. doi: 10.1016j.hermed.01.006.

Malik AH, Khuroo AA, Dar G, Khan Z. 2011. Ethnomedicinal uses of some plants in the Kashmir Himalaya. Indian Journal of Traditional Knowledge 10:362-366.

Malik K, Ahmad M, Zafar M, Ullah R, Mahmood HM, Parveen B, Rashid N, Sultana S, Shah SN. 2019. An ethnobotanical study of medicinal plants used to treat skin diseases in northern Pakistan. BMC Complementary and Alternative Medicine 19:210.

Mohammad I, Rahmatullah Q, Shinwari ZK, Muhammad A, Mirza SN. 2013. Some ethnoecological aspects of the plants of Qalagai hills, Kabal valley, swat. Pakistan International Journal of Agricultural Biology 15(5):801-10.

Muhammad S, Hussain M, Abbas Z, Saqib Z, Bussmann RW Shah GM. 2019. An ethnomedicinal appraisal of the Kurram Agency, tribal area, Pakistan. Indian Journal of Traditional Knowledge 18(4):631-647.

Murad W, Ahmad A, Ishaq G, Saleem KM, Muhammad KA, Ullah I. 2012.Ethnobotanical studies on plant resources of Hazar Nao forest, district Malakand, Pakistan. Pakistan. Journal of Weed Science Research 18(4):509-527.

Murad W, Azizullah A, Adnan M, Tariq A, Khan KU, Waheed S, Ahmad A. 2013. Ethnobotanical assessment of plant resources of Banda Daud Shah, district Karak, Pakistan. Journal of Ethnobiology and Ethnomedicine 9(1).

Mwangia VI, Mumob RM, Nyachieoa A, Onkoba N.2017. Herbal medicine in the treatment of poverty associated parasitic diseases: A case of sub-Saharan Africa. Journal of Herbal Medicine 10:1-7.

Nasir E, Ali SI, (Eds.). 1970-1989. Flora of West Pakistan. Islamabad, Karachi. 1-131.

Ong HG, Kim YD. 2014.Quantitative ethnobotanical study of the medicinal plants used by the Ati Negrito indigenous group in Guimaras Island, Philippines. Journal of Ethnopharmacology 157: 228-242.

Paniagua Zambrana NY, Bussmann RW, Hart RE, Moya Huanca AL, Ortiz Soria G, Ortiz Vaca M, Ortiz Álvarez D, Soria Morán J, Soria Morán, M, Chávez S, Chávez Moreno B, Chávez Moreno G, Roca O, Siripi E. 2017. Traditional knowledge hiding in plain sight - 21st century ethnobotany of the Chácobo in Beni, Bolivia. Journal of Ethnobiology and Ethnomedicine 13:57. doi: 10.1186s13002-017-0179-2.

Petrakoua K, Iatroub G, Lamari FN.2020. Ethnopharmacological survey of medicinal plants traded in herbal markets in the Peloponnisos, Greece. Journal of Herbal Medicine 19:100305.

Rashid N, Gbedomon RC, Ahmad M, Salako VK, Zafar M, Malik K. 2018.Traditional knowledge on herbal drinks among indigenous communities in Azad Jammu and Kashmir, Pakistan. Journal of Ethnobiology and Ethnomedicine 14:16.

Shah S, Khan S, Sulaiman S, Muhammad M, Badshah L, Bussmann RW, Hussain W. 2020. Quantitative study on medicinal plants traded in selected herbal markets of Khyber Pakhtunkhwa, Pakistan. Ethnobotany Research and Application 20: 1-36.

Sher H, Aldosari A, Ali A, De Boer HJ. 2014. Economic benefits of high value medicinal plants to Pakistani communities: An analysis of current practice and potential. Journal of Ethnobiology and Ethnomedicine 10:71.

Shinwari MI, Khan MA. 2000.Folk use of medicinal herbs of Margalla hills national park, Islamabad. Journal of Ethnopharmacology 69:45-56.

Shinwari ZK, Qaisar M. 2011. Efforts on conservation and sustainable use of medicinal plants of Pakistan. Pakistan Journal of Botany 43:5-10.

Tuasha N, Petros B, Asfaw Z. 2018. Medicinal plants used by traditional healers to treat malignancies and other human ailments in Dalle District, Sidama Zone, Ethiopia. Journal of Ethnobiology and Ethnomedicine 14:15.

Tumpa SI, Hossain MI, Ishika T. 2014. Ethnomedicinal uses of herbs by indigenous medicine practitioners of Jhenaidah district, Bangladesh. Journal of Pharmacognosy and Phytochemistry 3:23-33.

Ullah M, Khan MU, Mahmood A.Malik RN, Hussain M, Wazir SM, Shinwari Z. 2013.An ethnobotanical survey of indigenous medicinal plants in Wana district south Waziristan agency, Pakistan. Journal of Ethnopharmacology 150:918-924.

Ullah R, Iqbal ZHZ, Hussain J, Khan FU, Khan N, Muhammad Z. 2010. Traditional uses of medicinal plants in Darra Adam Khel NWFP Pakistan. Journal of Medicinal Plants Research 4(17):1815-1821.

Umair M, Altaf M, Abbasi AM. 2017. An ethnobotanical survey of indigenous medicinal plants in Hafizabad district, Punjab-Pakistan. PLoS ONE. 12:0177912.

Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico G. 2013.Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)—An alpine ethnobotanical study. Journal of Ethnopharmacology 145:517-529.

Yaseen G, Ahmad M, Sultana S, Alharrasi AS, Hussain J, Zafar M. 2015. Ethnobotany of medicinal plants in the Thar Desert (Sindh) of Pakistan. Journal of Ethnopharmacology 163:43-59.