Ethnobotanical documentation of medicinal flora traditionally used for pediatric diseases in Khar, district Bajaur, Khyber Pakhtunkhwa, Pakistan

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Research

Abstract

Background: The use of plants for primary healthcare continues in both developed and developing countries. In rural areas, where healthcare facilities are limited, conventional medicine is expensive, and resources are often mismanaged, parents turn to herbal remedies instead of modern medicine to treat children's illnesses. Therefore, it is crucial to document the ethnomedicinal use of plants for children's healthcare in the studied regions.

Objectives: The aim of this study was to document ethnomedicinal plants used for treating children's disorders and assess their conservation status.

Methods: The data was collected using a semi-structured questionnaire, incorporating various quantitative indices such as Relative Frequency of Citation (RFC) and Family Importance Value (FIV). Plant specimens identified by local informants were collected and verified with the aid of existing literature. The accuracy of scientific names was confirmed through the International Plant Names Index (IPNI) database. (IPNI) https://www.inpni.org.

Results: A total of forty-six different medicinally important plants belonging to twenty eight families were recorded utilizing for the curing of children disorders during March to December 2023. The Lamiaceae family, with six species, was reported to have the highest number of plants used for treating children's illnesses, followed by five species from other families. Seeds (30%) and leaves (28%) were the most commonly used plant parts by the local inhabitants. According to the family importance value, Apiaceae ranked highest (82.92%), followed by Lamiaceae (80.48%), while the species *Ammi visnaga* had the highest relative frequency of citation (0.48). The conservation status indicated that 47.82% of the plants were considered rare, while 41.3% were classified as vulnerable. The highest informant consensus was observed for abdominal pain (15 species), followed by diarrhea (6 species), and constipation, wounds, and chest infections (5 species each).

C*onclusion***:** This study documents ethnomedicinal plants from various areas of Khar, District Bajaur, focusing on those used for paediatric diseases. It does not target a specific disease or involve quantitative analysis. There are significant gaps in

ethnobotanical knowledge in this region of Khyber Pakhtunkhwa, Pakistan, with much of the knowledge held by traditional societies at risk due to lack of documentation. Many medicinal plants are also facing extinction, threatening genetic diversity. The study aims to preserve this knowledge to support the development of affordable, low-cost therapies for the poor.

Keywords: Quantitative, Ethnobotany, Conservation, diseases, Bajaur, Pakistan.

Background

Plants are a primary source of supplements, phytonutrients, and secondary metabolites (Zevollas, 2021). Traditional medicine encompasses all knowledge and practices, whether explainable or not, used in diagnosing, preventing, and treating physical, mental, or social imbalances. It relies solely on practical experience and observations passed down through generations, either verbally or in writing. Herbal medicine, in particular, seems to emphasize promoting health and preventing illness, rather than just focusing on curing diseases (Karakaya *et al.* 2019). The World Health Organization (WHO) reports that approximately 80% of the populations in developing countries rely on herbal medicine to fulfil their primary healthcare needs (WHO, 2019). Herbal medicine continues to be used in primary healthcare in both developed and developing countries (Sahoon *et al.* 2010). It is recognized globally as a vital part of the cultural heritage of various groups or societies. In rural areas of developing countries, where medicinal plants are often the only accessible and affordable treatment option, herbal medicine plays a crucial role (WHO, 2002). In developing countries, traditional medicines offer an affordable and alternative source of primary healthcare, driven by the lack of modern health facilities, their effectiveness, and cultural preferences and choices (Aziz *et al.* 2018). In China, traditional herbal preparations account for 30-50% of total drug consumption. Similarly, in countries like Nigeria, Ghana, Zambia, and Mali, herbal medicines are the first choice for 60% of children suffering from high malarial fever. In Ethiopia, approximately 80% of the population relies on traditional medicines, driven by the cultural acceptance of healers, local pharmacopeias, the relatively low cost of traditional remedies, and limited access to modern drugs (Kebede *et al.* 2006). Documenting ancestral knowledge through ethnobotanical surveys can help bridge existing gaps and lead to the discovery of effective new drugs (Heinrich *et al.* 2009).

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). It is therefore, imperative to increase ethnomedicinal studies in order to preserve this precious knowledge before its extinction (Khan *et al.* 2011). In Pakistan several studies have reported the medicinal uses of plant resources (Aziz *et al.* 2017; Hussain *et al.* 2022; Ullah *et al.* 2023). Folk knowledge, passed down through generations, faces the dual threat of gradual loss and extinction, highlighting the urgent need for preservation efforts. In recent decades, there has been a growing scientific and commercial interest in plant-based herbal products due to their cultural acceptability and economic potential (Sher *et al.* 2015). The country is home to diverse cultures and numerous languages, particularly in rural and remote areas. Limited access to healthcare services in these regions is a key factor contributing to the continued use of traditional herbal medicines (Chaudhry *et al.* 2006).

There is now a considerable amount of information regarding the knowledge and use of medicinal plants by adults, thanks to the large number of published studies on this subject, including research on complementary and alternative medicine and studies focusing on ethnomedicinal knowledge (Wegener, 2017). Nonetheless, little is still known about herbs' knowledge by younger generation, with particular references to the field of the ethnobiological research (Gallois and Garcia, 2018). Children are particularly vulnerable to various viral diseases and infections due to their underdeveloped immune systems. Common childhood illnesses worldwide include gastrointestinal, respiratory, urinary, kidney, liver disorders, ear, nose, and throat (ENT) diseases, eye infections, and dental issues. The onset of these diseases in children is a significant concern, as their health can be severely impacted (Ahmadipour *et al.* 2015). In rural areas, owing to inadequate health facilities, high cost of conventional medicine, underfunding and mismanagement of the available health facilities, parents resort to the use of herbal medicine rather than modern medicine for treatment of children ailments (Kajungu *et al.* 2015). The literature indicates that limited scientific research has been done on ethnobotany and the conservation of medicinal plants in Khar, District Bajaur. The objectives of this study were to gain a thorough understanding of the ethnomedicinal uses of local plants for treating children's disorders, raise awareness among locals about the diminishing availability of traditional and medicinal plants in the area, and assess the conservation status of these plant resources to provide policy recommendations for decision-makers.

Materials and Methods

Research area

Khar Bajaur is located near the border with Afghanistan, stretching along both sides of Munda Khar Road, and is relatively narrow in the north-south direction. It is bordered by tributaries of the Panjkora River to the north and south. The district is home to several springs and streams that provide fresh water for drinking and irrigation. Most households have a herd of domestic animals, which contribute to their socioeconomic well-being. The area has only three degree-level colleges and five higher secondary schools. Additionally, there are just two government hospitals, leaving many people without access to modern healthcare, making them reliant on local herbalists (Hakims). Due to the distance from health centers, the local population continues to use traditional remedies. The climate in Khar Bajaur is extreme, with winter lasting from November to March. During this period, the temperatures can drop below freezing (as low as 0.3°C). The summer season lasts from May to October, with June, July, and August being the hottest months, reaching temperatures as high as 39°C.

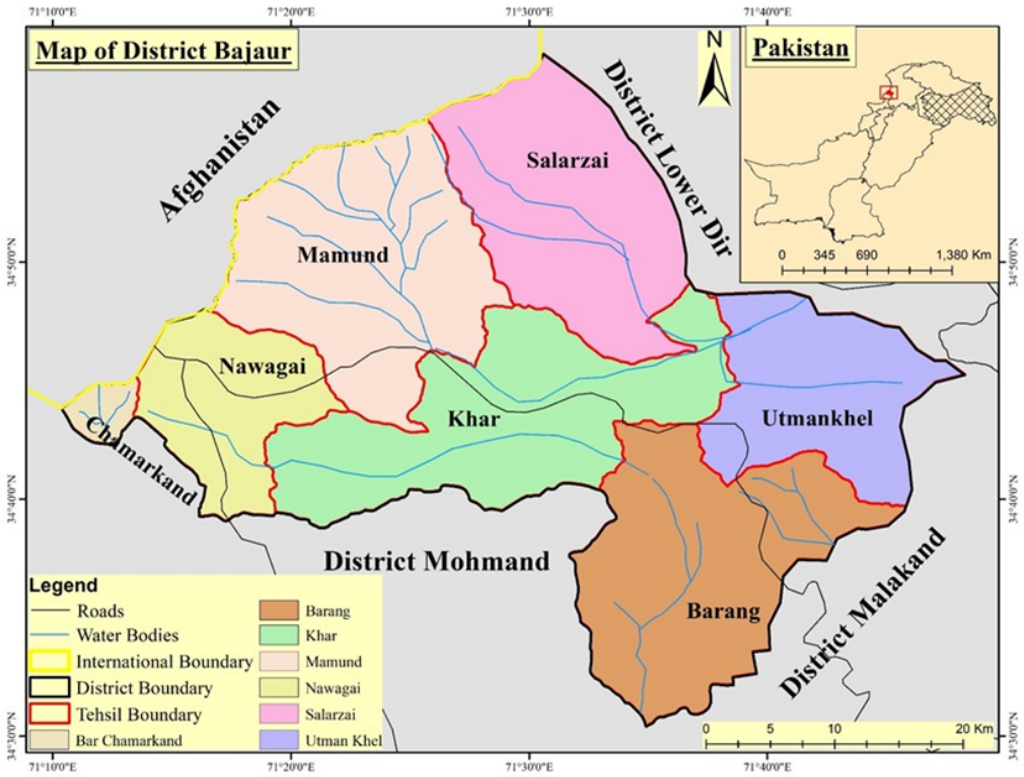

Figure 1. Map of the research area

Data collection method and field interviews

The present ethnobotanical study was carried out from March to December 2023 in Khar, Bajaur District, Pakistan, to document the medicinal properties of plant species used to treat childhood diseases, the plant parts utilized, and the methods of preparation and administration. Data collection was based on structured interviews (Heinrich *et al.* 2009). A total of 40 informants, all women over the age of 30, were interviewed using a questionnaire, as they are typically responsible for child care. The interviews were conducted in the local language, Pashto, since most informants were uneducated. Prior verbal informed consent was obtained from all participants before conducting the interviews. The first section of the questionnaire gathered demographic information, while the second section focused on local herbal remedies, including the plant parts most commonly used, as well as the growth habits and habitats of the plant species.

Collection and identification

In this study, household heads, specifically older women, were purposefully selected for interviews as they are primarily responsible for the health care of children. The medicinal plants mentioned by local informants were collected and identified with the assistance of available literature (Ali and Qaisar, 1995-2010). The accuracy of the scientific names was verified using the International Plant Names Index (IPNI) database at https://www.ipni.org.

Phenological observations

The phenological behavior of the plant species was observed by visiting the study area at regular intervals (monthly) from March to December 2023. The phenological stages, such as the flowering stage, of each plant species were documented (Zeb *et al.* 2020).

Data analysis

The ethnobotanical data was analysed and using different quantitative indices like Relative frequency of citation (RFC) and Family important value (FIV) (Hussain *et al.* 2018; Hussain *et al.* 2022; Ullah *et al.* 2023).

Relative Frequency Citation (RFC)

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

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

RFC shows the importance of each species and is given by the frequency of citation FC, the number of respondents (N) in the survey as used by (Batool *et al.* 2025).

Family Importance value (FIV)

It is used to describe the relative importance of families and was calculated on basis of the percentage of informants who mentioned the family. The FIV was assessed according to the standard protocol described by Fazal *et al.* 2024.

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

where FC represents the informants who mention the family and while N for the total informants involved in the study.

Conservation status

The conservation status of the plant species was calculated by using (IUCN, 2001) criteria (Hussain *et al.* 2018; Hussain *et al.* 2019) as below:

Key for conservation status

1. Availability class

0 = Uncommon or very rare
1 = Less common or rare
2 = Occasional
3 = Abundant

2. Growth behavior

0 = Regrowth in more 3 years
1 = Regrowth within 3 years
2 = Regrowth within 2 years
3 = Regrowth within 1 year
4 = Regrowth in a season

3. Collection status

0 = More than 1000 kg/yr
1 = Consumed from 500-1000 kg/yr
2 = Consumed from 300-500 kg/yr
3 = Consumed from 100-200 kg/yr

4. Part used

0 = Root/whole plant
1 = Bark
2 = Seeds, fruits
3 = Flower
4= Leaves/gum/latex

5. Total score:

1= 0 - 4 Endangered
2= 5 - 8 Vulnerable
3= 9 - 12 Rare:
4= 13 - 14 Infrequent
5= 15 - 16 Dominant

Results and Discussion

Demographic information of the informants

In the study area, all the informants were females, as information regarding childhood disorders is primarily shared among women over the age of 30. Since all the informants were illiterate. A total of 40 interviews were conducted in this study, focusing on childhood diseases.

Source of Income of locals

Majority of the population is directly related to farming. The main crops grown in the area are wheat and maize. The irrigation system is also not favorable mostly agriculture depends upon rainfall. In winter the young people migrates to big cities of the province or country in search of earning in different sectors. Other sources of income are fuel wood trade, daily wage labor and livestock production.

Population and health facilities of the study area

The total population of the area is 301,778 according to the 2023 Pakistani national census. Overpopulated area not only economically poor but also physically not healthy. There is single hospital for primary healthcare are not enough to fulfil the growing need of the locals. Due to the lack modern medical facilities the locals had no choice but to rely on herbal medicine for healthcare.

Diversity of plant species used for children diseases

In the current study a total of 46 medicinal plants from 28 families were used to treat paediatric diseases.

Habit of plant used in children's diseases

In the current study, a total of 46 ethnomedicinally important plant species were documented, belonging to 28 different families. Of these, 28 species (61%) were herbs, which served as the primary source of endemic medicine, followed by shrubs (9 species, 20%), trees (8 species, 17%), and climbers (1 species, 2%). Herbs constituted the largest proportion of medicinal plants due to their greater availability and accessibility in the study area (Table 1, Fig. 2). Shah *et al.* (2024) reported the same growth form while, conducting a research on ethnomedicinal survey of medicinal plants traditionally used in Sakhra valley district Swat. The families with the highest species richness were Lamiaceae (6 species, 13.4%) and Apiaceae (5 species, 10.9%). Hussain *et al.* (2022) reported 50 families and 106 species from Central Kurram, Khyber Pakhtunkhwa, Pakistan, while Ullah *et al.* (2023) documented 83 medicinal species from 49 families in Jelar Valley, Dir Upper, Northern Pakistan. Ali *et al.* (2024) reported 110 plant species from 60 families in Torwali community of Hinduraj areas of Northern Pakistan, with Rosaceae, Lamiaceae being the leading families. The same families were also noted as dominant by Irfan *et al.* (2023) from district Lower Dir Khyber Pakhtunkhwa, Pakistan, and Ali *et al.* (2016) from Chail Valley, Swat (Fig. 2)

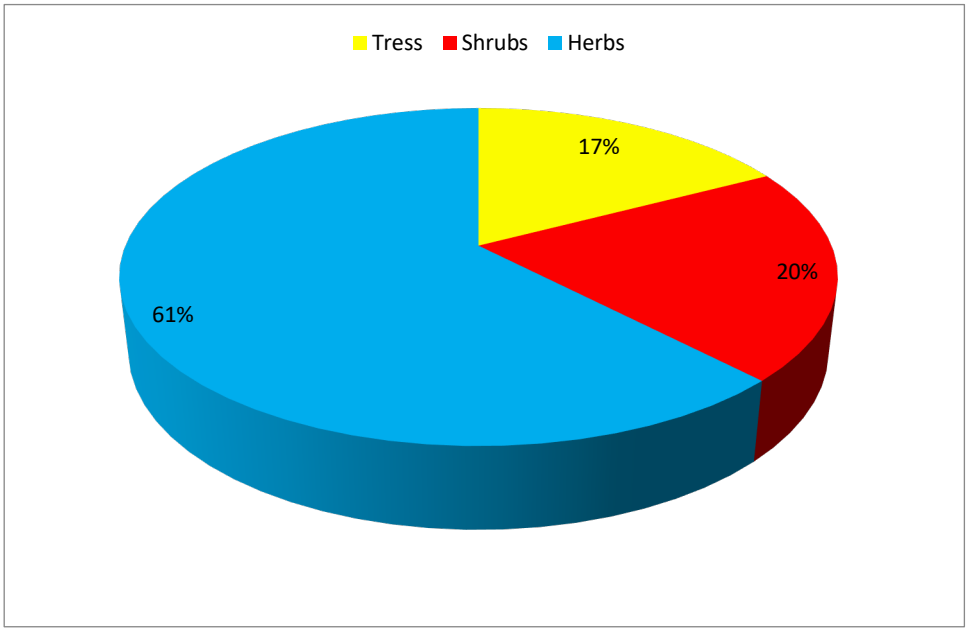

Figure 2. Classification of flora based on habit

Table 1. Medicinal Plants, Part used, RFC, FIV, Ethnomedicinal uses and Conservation Status

Botanical name	Family	Vernacular name	Habit	Part used	Phenology	Mode of utilization	Remedies	Disease treated	RFC	FIV	Conservation status					
											1	2	3	4	5	
Acorus calamus L. **Ullah Bot. 1 (UOM)**	Acoraceae	**Skha waja**	Herb	Roots	Autumn	Raw form	Grind it and then use with water or milk twice a day.	Abdominal pain	0.02	2.43	2	2	4	0	8	V
Allium sativum L. **Ullah Bot. 2 (UOM)**	Alliaceae	**Oga**	Herb	Bulb	Autumn	Raw form	Fry in mustard oil and used 2 or 3 drops daily.	Ear pain	0.02	2.43	3	2	1	0	6	V
Aerva javanica var. *bovei* Webb. **Ullah Bot. 3 (UOM**)	Amaranthaceae	**Kharr boty**	Herb	Leaves	Spring	Extract	Boil in green tea with cardamom then sieve it with porous clothes and give it to the baby thrice a day.	Abdominal pain & Diarrhoea	0.02	2.43	1	3	4	4	12	R
Allium cepa L. **Ullah Bot. 4 (UOM)**	Alliaceae	**Pyaz**	Herb	Bulb	Spring	Extract	Take 5 cups of water; boil it until one cup of water remains then 2 spoons give to the child before meal.	Vomiting	0.07	7.3	3	0	4	0	7	V
Calotropis procera W.T. Aiton. **Ullah Bot. 5 (UOM**)	Asclepiadaceae	**Spalmay**	Shrub	Leaves	Winter	Extract	Boil in water with *Ajuga parviflora* and then that water is used.	Diarrhoea & Cough	0.02	4.87	3	2	3	4	12	R
Caralluma faucicola Bruyns. **Ullah Bot. 6 (UOM)**		**Pamanky**	Herb	Leaves	Summer	Raw form	Boil in water and then trickled its water through porous cloth and then the water is put in the ear.	Ear pain	0.02		1	3	4	4	12	R
Ammi visnaga (L.) Lam. **Ullah Bot. 7 (UOM**)	Apiaceae	**Sperkai**	Herb	Seeds	Summer	Decoction, raw form & powder	Boil it in water and then use or seeds are half fried and half taken as without frying then blend and mix it in mother milk and use twice a day.	Abdominal pain , Soft spot, Navel cut & Wounds	0.48	82.92	3	1	4	2	10	R

Foeniculum vulgare Mill. **Ullah Bot. 8 (UOM)**		**Kagelany**	Herb	Fruits	Summer	Decoction	Boil in water and then that water is used.	Chest infection, Vomiting & Hepatitis	0.19		1	2	4	2	9	R
Ferula asa-foetida Spreng. **Ullah Bot. 9 (UOM)**		**Anja**	Herb	Seeds	Spring	Decoction	Boiled in mother milk and then give it to child.	Cold & flu	0.02		1	3	4	2	10	R
Coriandrum sativum L. **Ullah Bot. 10 (UOM)**		**Wacha danya**	Herb	Seeds	Spring	Powder	It is sprinkled with *Ammi visnaga* on cinder and then cotton balls are put upon their smoke and then kept upon on both sides of the lungs and chest.	Lungs & Chest infection	0.09		3	0	4	2	9	R
Cuminum cyminum Wall. **Ullah Bot. 11 (UOM)**		**Kali zere**	Herb	Seeds	Summer	Raw form	Boil in mustard oil and sieve it and apply it on baby's whole body and massage it.	Baby rashes, Abdominal pain & diarrhoea	0.02		2	3	4	2	11	R
Berberis lycium Royle. **Ullah Bot. 12 (UOM)**	Berberidaceae	**Kwary**	Shrub	Roots	Spring	Raw form	Grind the roots and then this powder is used with water or milk.	Throat, & mouth infection	0.02	2.4	2	2	3	0	7	V
Lepidium sativum L. **Ullah Bot. 13 (UOM)**	Brassicaceae	**alam**	Herb	Seeds	Summer	Decoction	Take 2 cups of water, put sugar and boil then use once a day.	Abdominal pain & constipation	0.12	36.58	2	2	4	2	10	R
Lepidium didymum L. **Ullah Bot. 14 (UOM)**		**Skha boty**	Herb	Whole plant	Summer	Decoction	Boil in water with lemon leaves, green tea, cardamom and ajwain then used thrice a day.	Vomiting	0.24		3	2	4	0	9	R

Cassia abbreviata oliv. **Ullah Bot. 15 (UOM)**	Leguminosae	**Laspaly**	Herb	Fruits	Summer	Decoction	Fruits are boil in water or black tea and then sieve and used 2 time a day.	Abdominal pain	0.26	58.53	2	3	1	2	8	V
Cassia senna L. **Ullah Bot. 16 (UOM**)		**Sana parrny**	Shrub	Leaves	Summer	Extract	Boil in water with the addition of 1 spoon sugar in one cup used 2 time a day.	Constipation	0.02		1	1	3	4	9	R
Glycyrrhiza echinata L. **Ullah Bot. 17 (UOM)**		**Khwaga zeal**	Shrub	Roots	Autumn	Decoction	Boil the roots in water and then use.	Abdominal pain	0.09		1	3	4	0	8	V
Cassia absus L. **Ullah Bot. 18 (UOM)**		**Sakhku**	Shrub	Seeds	Summer	Raw form	Open by needle and inside there is gel like part which is then applied by a small stick of eyes.	Eye disease	0.19		1	3	3	2	9	R
Juglans nigra L **Ullah Bot. 19 (UOM**)	Juglandaceae	**Ghuz, dandasa**	Tree	Bark & leaves	Spring	Decoction	(1). Its bark is boiled in oil with basil and then poured in the ear, (2). Its leaves are boiled in water and then used.	Ear pain & throat infection	0.12	12.19	3	1	1	2	7	V
Sideritis scardica Griseb. **Ullah Bot. 20 (UOM)**	Lamiaceae	**Bartang**	Herb	Seeds	Summer	Extract	Boil in milk or water and when it condensed then give to the baby.	Hunger & chest infection	0.34	80.48	3	1	4	2	10	R
Mentha piperita L. **Ullah Bot. 21 (UOM)**		**Podina**	Herb	Leaves	Summer	Raw form Decoction	(1). First grind it and then mixed with yogurt and give to the child, (2). Boil in water with the addition of sugar and then used.	Vomiting	0.24		3	1	4	4	12	R

Ajuga parviflora Benth. **Ullah Bot. 22 (UOM)**		**Boti**	Herb	Leaves	Winter	Extract	Boiled in water and then used twice a day	Abdominal pain	0.02		3	3	4	4	14	I
Vitex negundo L. **Ullah Bot. 23 (UOM)**		**Marwandai**	Tree	Seeds	Summer	Decoction	Dry it then boiled and used.	Diarrhoea	0.02		1	3	3	2	9	R
Ocimum basilicum L. **Ullah Bot. 24 (UOM)**		**Kashmali**	Herb	Leaves	Spring	Extract	Boil in water and when small amount of water remains in condensed form then give 3 times a day.	Abdominal pain	0.09		3	2	4	4	13	I
Ajuga integrifolia Buch.-Ham. **Ullah Bot. 25 (UOM)**		**Goti**	Herb	Leaves	Summer	Extract	Boiled in water with green tea then used thrice a day.	Abdominal pain	0.07		3	2	4	4	13	I
Malva pusilla Sm. **Ullah Bot. 26 (UOM)**	Malvaceae	**Pandery**	Herb	Roots	Summer	Decoction	Fresh roots are first washed then boil in one cup of water until when 2 spoons of water remains then used.	Constipation & abdominal pain	0.02	2.4	3	0	4	0	7	V
Azadirachta indica A. Juss. **Ullah Bot. 27 (UOM)**	Meliaceae	**Neem**	Tree	Leaves	Summer	Decoction	1-2 drops of bark decoction dropped in ear and nose then olive oil is mixed with bark and massage on the affected area.	Ear ache & scabies	0.02	2.4	2	1	1	1	5	V
Peganum harmala L. **Ullah Bot. 28 (UOM)**	Zygophyllaceae	**Spelani**	Herb	Seeds	Summer	Raw form	It is sprinkled on cinder then cotton balls are put upon its smoke and that cotton ball is kept on chest.	Chest infection	0.14	14.63	2	1	4	2	9	R
Olea europaea L. **Ullah Bot. 29 (UOM)**	Oleaceae	**Khuna**	Tree	Leaves	Summer	Extract	Boil in water then used.	Throat infection	0.07	2.43	2	3	2	4	11	R

Papaver somniferum L. **Ullah Bot. 30 (UOM)**	Papaveraceae	**Apem , koknar**	Herb	Capsule/ Latex	Autumn	Raw form Decoction	Boil in mother's milk and then with the help of a cotton bud put on the soft spot of head.	Cold, Sleeping & Soft spot	0.36	2.43	2	2	2	4	10	R
Pinus roxburghii Sarg. **Ullah Bot. 31 (UOM)**	Pinaceae	**Nakhtar**	Tree	Bark	Spring	Raw form	Grind it and then sprinkle on the affected area	Wounds	0.04	4.8	3	0	2	2	7	V
Piper longum L. **Ullah Bot. 32 (UOM)**	Piperaceae	**Peply**	Climbing shrub	Dried fruits	Summer	Raw form	Narrow stick like fruit of this plant is used.	Eyelid infection	0.04	4.87	2	2	2	0	6	V
*Sorghum bicolor (*L.) Moench. **Ullah Bot. 33 (UOM**)	Poaceae	**Ginger**	Herb	Seeds	Summer	Decoction	Boil it and that boiled water is used.	Chest diseases	0.12	14.63	1	3	4	2	10	R
Triticum aestivum L. **Ullah Bot. 34 (UOM)**		**Ghanam**	Herb	Seeds	Summer	Raw form	A heated sickle is kept on wheat then from the wheat a small amount of water oozes out and that water should be applied to that affected area.	Eyelid infection	0.02		3	0	4	2	9	R
Plantago ovata Forssk. **Ullah Bot. 35 (UOM)**	Plantaginaceae	**Sat**	Herb	Seeds	Spring	Infusion	Soak in water and then used.	Constipation	0.09	9.7	1	0	4	3	8	V
Punica granatum L. **Ullah Bot. 36 (UOM)**	Punicaceae	**Anar**	Shrub	Fruit peel	Summer	Raw form Powder	Pomegranate peel is covered with flour and then add mother milk let the flour heated then this milk is used.	Abdominal pain & wound	0.17	17.07	3	0	2	2	7	V

Aconitum abbreviatum Langsd. ex DC. **Ullah Bot. 37 (UOM)**	Ranunculaceae	**Sarbawaly**	Herb	Seeds	Summer	Raw form	Seeds are crushed then mixed with mother milk and then give to the baby.	Extremely weakness,	0.09	9.7	2	3	4	2	11	R
Rosa indica L. **Ullah Bot. 38 (UOM)**	Rosaceae	**Gull quanj**	Shrub	Flowers	Spring	Infusion	Boil water with *ammi visnaga* add sugar then give it to baby.	Abdominal pain & constipation	0.14	17.07	3	3	4	5	13	I
Rosa bifera Poir. **Ullah Bot. 39 (UOM)**		**Gulaby gull**	Shrub	Flowers	Spring	Extract	Boil the flower petals in water and then give it to baby.	Flue	0.02		3	2	3	3	11	R
Citrus medica L. **Ullah Bot. 40 (UOM)**	Rutaceae	**Nembo**	Tree	Leaves Fruits	Summer	Extract	Lemon leaves and lemon peel is boiled along with green tea and onion then give it to the child.	Diarrhoea	0.14	14.63	1	0	3	4	8	V
Sapindus mukorossi Gaertn. **Ullah Bot. 41 (UOM)**	Sapindaceae	**Rerrha**	Tree	Fruits	Summer	Raw form	First, remove the peel of the fruit and then grinded and then mixed in milk or milk and used twice a day.	Abdominal pain & diarrhoea	0.09	9.75	1	2	2	2	6	V
Tamarix dioica Roxb. ex Roth. **Ullah Bot. 42 (UOM)**	Tamaricaceae	**Ghaz**	Tree	Bark	Summer	Powder	Grind it and sprinkle on the affected area.	Wounds & groin region infection	0.12	12.19	3	3	0	1	7	V
Camellia sinensis (L.) Kuntze. **Ullah Bot. 43 (UOM)**	Theaceae	**Sheen chy**	Shrub	Leaves	Summer	Extract	Boil in water and add sugar and then use.	Hunger	0.19	19.51	0	0	4	4	8	V
Viola canescens Wall. **Ullah Bot. 44 (UOM)**	Violaceae	**Benawsha**	Herb	Flowers	Winter	Extract	Boil in water and then give it to the baby twice a day	Abdominal pain	0.02	2.4	2	3	4	3	12	R

*Elettaria cardamomum (*L.) Maton. **Ullah Bot. 45 (UOM)**	Zingiberaceae	**Elaichi**	Herb	Seed	Summer	Decoction	Boil in water with onion, mint, and green tea and then give to the child.	Cough & urinary problems	0.09	41	1	0	4	2	7	V
Curcuma longa L. **Ullah Bot. 46 (UOM)**		**Kurkaman**	Herb	Rhizome	Summer	Raw form	Heat the turmeric in oil and then keep it on cut part of navel.	Navel cut	0.03		1	1	4	0	6	V

Part used

Various plant parts were used in the preparation of herbal remedies, including leaves, seeds, roots, fruits, flowers, bark, bulbs, and latex. In some cases, whole plants were utilized. Among the plant parts, seeds were the most frequently used (30%), followed by leaves (28%), fruits (15%), roots (8%), bark and flowers (7% each), bulbs (4%), and latex and whole plants (2% each). Seeds and leaves were the most commonly used, while latex, flowers, bulbs, and whole plants were less frequently used (Table 1, Fig. 3). A similar study conducted by Shaheen *et al.* (2017) reported 55 medicinally important plants from Bannu. As there were no specific documented studies on childhood diseases, general ethnobotanical literature was referenced for comparison. These plants contain various secondary metabolites that help combat plant pathological stress and can be used by local people to treat a variety of diseases (Shah *et al.* 2013). However, this finding contrasts with other studies where leaves were primarily used to treat digestive issues (Ullah *et al.* 2019) (Fig. 3)

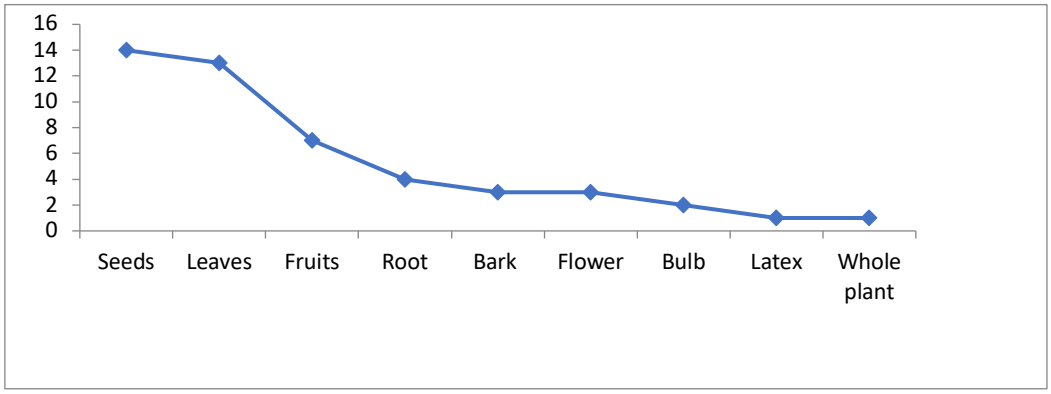

Figure 3. Classification of plants based on parts used

Phenology

Phenology is an integrative field that studies regular biological events or phenomena (Elmendorf *et al.* 2016). The ethnomedicinal flora of the monitored site showed distinct cyclical phenological variations due to climatic variability. The study found that the flowering season for most plants began in March and lasted until August. Summer-growing plants made up the largest proportion of medicinal plants (28 species, 61%), followed by spring (11 species, 24%), autumn (4 species, 9%), and winter (3 species, 6%) (Table 1, Fig. 4). Our findings closely align with those of Ullah *et al.* (2020), who, in their study of the floristic structure and ecological characteristics of Dardyal Valley in District Swat, Hindu-Kush Range, Pakistan, reported that the highest number of species were found in summer, while the lowest number were in winter due to harsh climatic conditions (Fig. 4)

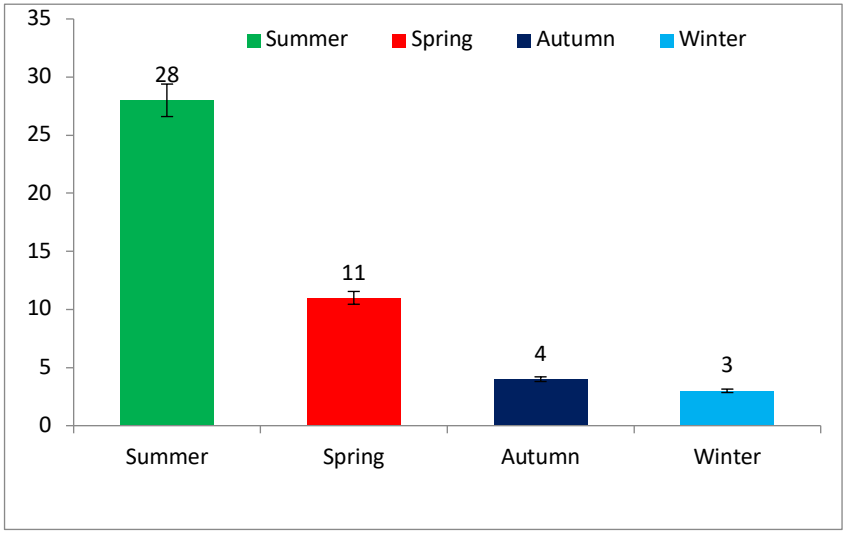

Figure 4. Classification of plants based on phenology

Mode of utilization

Herbal medicine preparations were utilized in various forms, including raw, decoction, extract, powder, and infusion. Water was the primary solvent used for preparing these herbal concoctions, with different plant parts mixed with water. The raw form was the most common preparation method (16 species), followed by decoctions (15 species), which were made by boiling plant materials in a specific amount of water for 15-20 minutes and allowing the mixture to cool before use. Extracts (13 species) involved crushing plant materials, either from a single species or a combination of parts from different plants, to extract a liquid, which was applied either topically or orally. Powdered forms (3 species) were made by drying and grinding the plant materials. Infusions (2 species) were prepared by pouring hot or warm water over plant material and letting the mixture cool before use. Some plant materials were roasted before being applied topically to the affected body parts. The methods of administration included applying dry powdered plant materials, drinking decoctions, infusions, and extracts, applying crushed plant materials to the affected areas, rubbing extracts on the affected parts, and mixing herbal preparations with food. Most respondents agreed that oral administration of herbal remedies was the most convenient method for children. There were similarities and differences in the use of plant species across various villages in the study area. Some plant species were used in all villages to treat the same ailments (Table 1, Fig. 5). A similar study by Aziz *et al.* (2016) in Ladha subdivision, South Waziristan Agency, Pakistan, recorded the medicinal uses of 82 plants for various diseases. Ethnomedicinal uses of these plant species have also been reported by other researchers in different regions of the country (Haq *et al.* 2023; Hameed *et al.* 2023; Hussain *et al.* 2018; Shaheen *et al.* 2017) and internationally (Bussmann and Sharon, 2006; Jeruto *et al.* 2008), which aligns with our findings (Fig. 5).

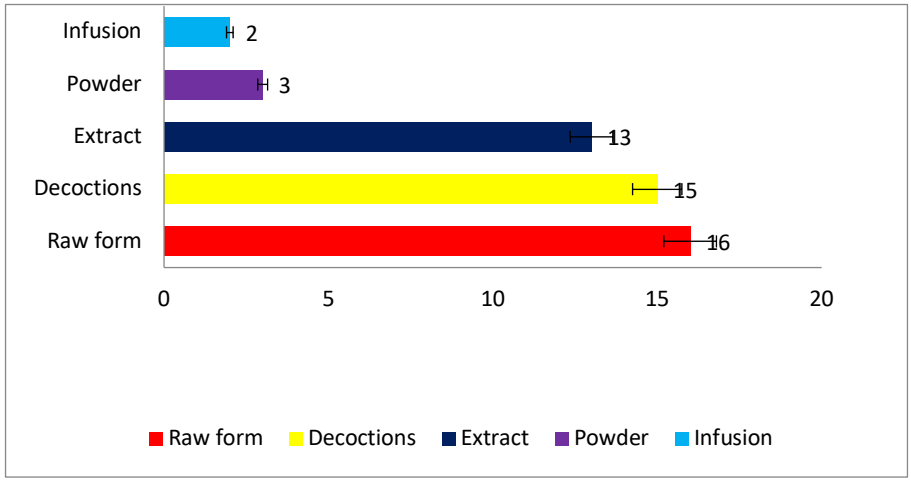

Figure 5. Classification of plants based on mode of utilization

Relative frequency of citation

The Relative Frequency of Citation (RFC) reflects the local use of a plant species for treating various ailments, and it also highlights the strong and long-term relationship between the residents and the local flora (Ahmad *et al.* 2014). The results indicated that the highest RFC value was recorded for *Ammi visnaga* (0.48), followed by *Sideritis scardica* (0.36), *Cassia abbreviata* (0.26), *Lepidium didymum* and *Mentha piperita* (0.24 each), *Foeniculum vulgare*, *Camellia sinensis*, and *Cassia absus* (0.19 each), *Punica granatum* and *Papaver somniferum* (0.17 each), *Rosa bifera*, *Citrus medica*, and *Pegnum harmala* (0.14 each), *Juglans nigra*, *Lepidium sativum*, *Sorghum bicolor*, and *Tamarix dioica* (0.12 each), and *Ocimum basilicum*, *Aconitum abbreviatum*, *Plantago ovata*, *Elettaria cardamomum*, *Glycyrrhiza echinata*, and *Coriandrum sativum* (0.09 each), while *Olea europaea* and *Allium cepa* had an RFC of 0.07 each (Table 1, Fig. 6). Ahmad *et al.* (2014), in their study on ethnobotanical knowledge in Chail Valley, reported the highest RFC values for *Origanum vulgare*, *Geranium wallichianum*, and *Skimmia laureola*. Similarly, Ali *et al.* (2016) recorded the highest RFC for *Skimmia laureola* (0.321), *Juglans regia*, *Olea ferruginea*, and *Papaver somniferum* in Chail Valley Swat (Fig. 6).

Family importance values

The Family Importance Value (FIV) reflects the number of locally significant species within a particular family. The results revealed that the most represented family in terms of species was Apiaceae (82.92%), followed closely by Lamiaceae (80.48%), Fabaceae (58.53%), Zingiberaceae (41%), Brassicaceae (36.58%), Theaceae (19.51%), Punicaceae and Rosaceae (17.07% each), Nitrariaceae, Poaceae, and Rutaceae (14.63% each), and Juglandaceae and Tamaricaceae (12.19% each), with Sapindaceae at 9.75% (Table 1, Fig. 7). Apiaceae and Lamiaceae were the dominant families in the study area, being the most frequently cited for use in herbal remedy preparations for childhood diseases. The prevalence of herbs could indicate their

abundance in the study area. The large number of medicinal plant species from these families may be attributed to their wide distribution and richness in the region. Our findings closely related with those of Ahmad *et al.* (2014), who identified Lamiaceae, Polygonaceae, Apiaceae, and Ranunculaceae as the most represented families in terms of FIV in Chail Valley Swat. Additionally, our results are consistent with previous studies on medicinal plants by Ullah *et al.* (2023) and Hong *et al.* (2015) conducted in various parts of the world (Fig. 7).

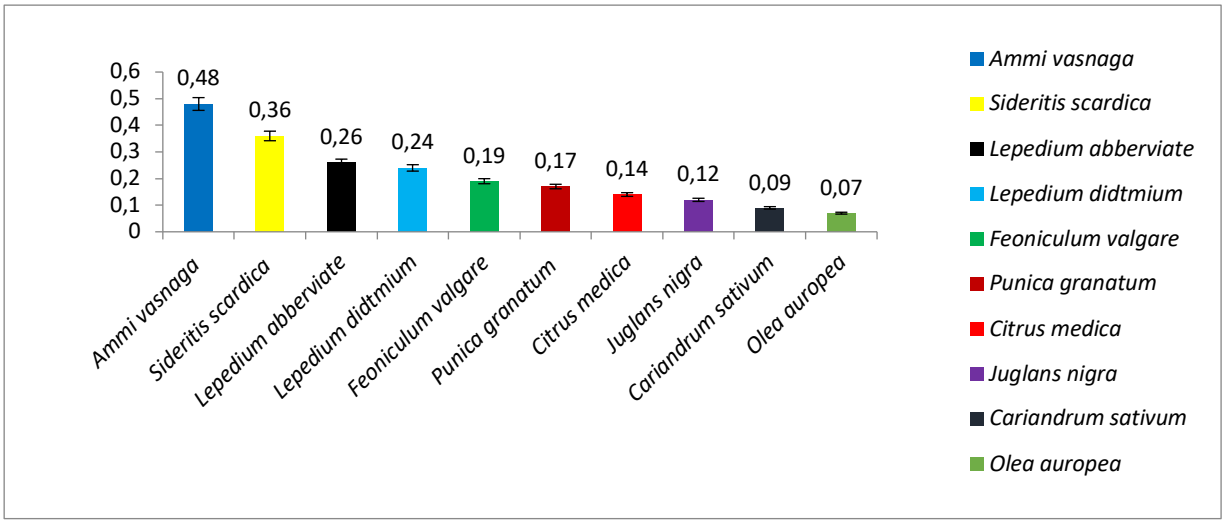

Figure 6. Species with highest RFC value

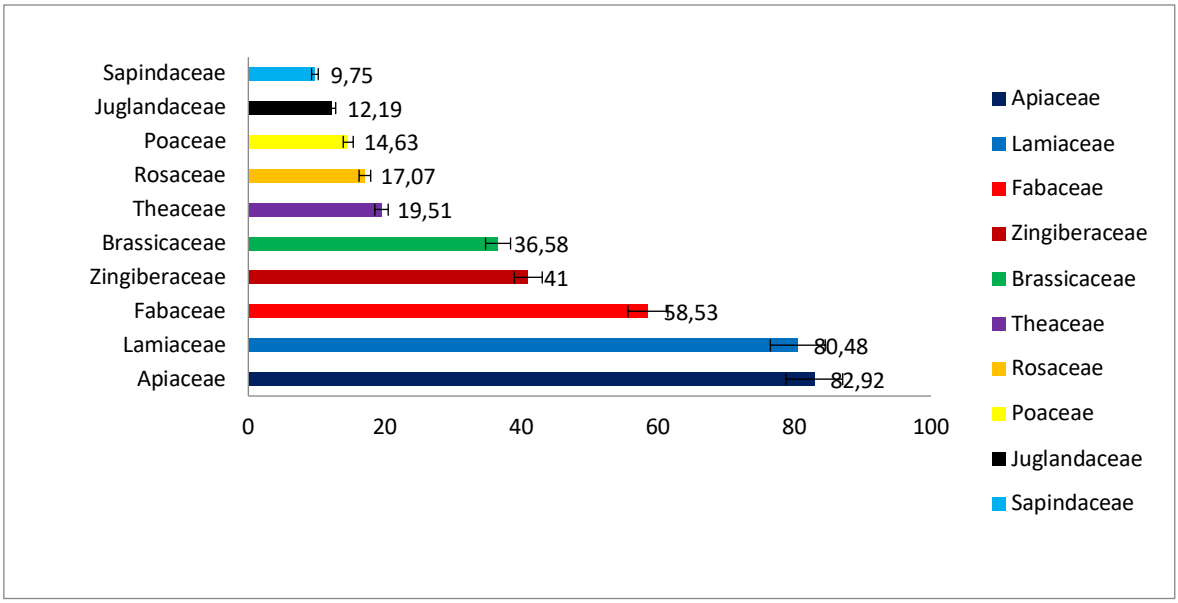

Figure 7. Families with highest (FIV) values

Conservation status

Conservation biology focuses on the protection and preservation of biodiversity and ecosystems (Soule, 1985). In this survey, the conservation status of 46 medicinal plant species was assessed using the IUCN criteria (IUCN, 2001). The results indicated that 47.82% of the species were classified as rare, 41.3% as vulnerable, and 8.69% as infrequent. No species were categorized as dominant in this study. Some of the rare species identified included *Sideritis scardica*, *Mentha piperita*, *Vitex negundo*, *Peganum harmala*, *Olea europaea*, *Papaver somniferum*, *Sorghum bicolor*, *Rosa bifera*, and *Viola incisa* (Table 1, Fig. 8). Many of these rare species were frequently collected for medicinal purposes, while tree species like *Olea europaea* were also used for construction. The rare species require conservation attention to prevent them from becoming endangered in the near future. Vulnerable species identified in the area included *Malva pusilla*, *Azadirachta indica*, *Pinus roxburghii*, *Plantago ovata*, *Punica granatum*, *Citrus medica*, and *Curcuma longa*. Locals primarily depend on these species for timber and fuelwood (Ullah *et al.* 2023). In the present study, the major threats to the local flora were the commercial value of medicinal plants

and the conversion of land for farming and agriculture (Corlett, 2016). Therefore, both ex-situ and in-situ conservation of the flora in the study area are crucial for future generations. My findings align with those of Hussain *et al.* (2023), who explored the conservation status of medicinal orchids in the western Himalayas of Azad Jammu & Kashmir, Pakistan, and found that 61% of the species were vulnerable. Additionally, my results are consistent with those of Hussain *et al.* (2022), who conducted research on medicinal plants used by tribal communities in Central Kurram, Khyber Pakhtunkhwa, Pakistan, reporting 49 species as vulnerable, 34 species as rare, and 7 species as infrequent (Fig. 8, 9).

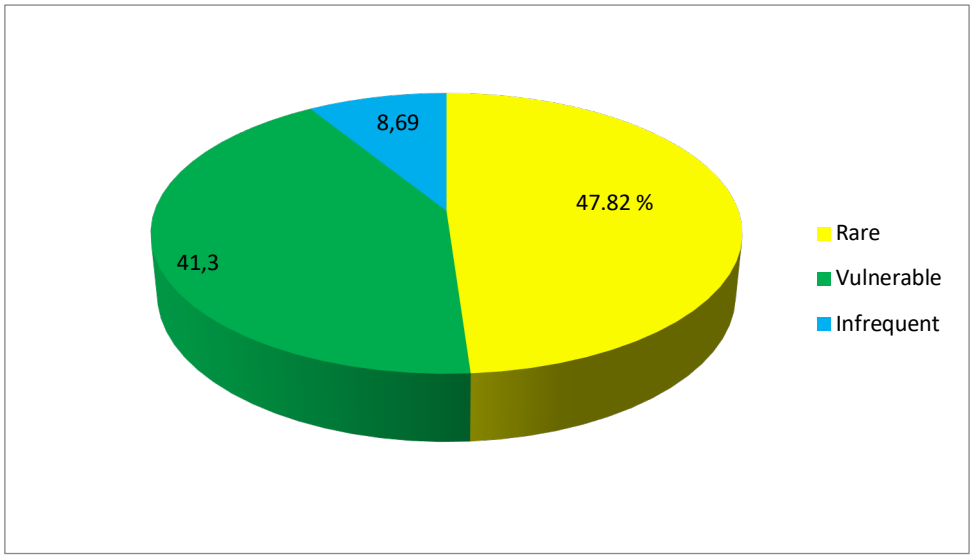

Figure 8. Conservation status of the Plants

Figure 9. *Papaver somniferum* L.

Figure 10. *Pinus roxburghii* Sarg.

Figure 11. *Olea ferruginea* Royle

Specific Conservation polies for sustainable use of plants in the area

1. Government and non-governmental organizations should establish large-scale nurseries in the area to promote the propagation of high-value species such as *Olea europaea* and *Pinus roxburghii*.
2. Reforestation initiatives should be launched in the area to protect and conserve the indigenous flora identified in the study.
3. Alternative energy sources should be introduced to reduce the pressure on local flora due to fuel demands.
4. In-situ conservation efforts should be prioritized and implemented urgently.
5. Ecotourism should be developed as an additional economic resource to improve the socioeconomic conditions of the area.
6. The forestry and horticulture departments should organize timely programs to educate and train local individuals; as such activities were not observed during the study.

Conclusion

This study successfully documented the ethnomedicinally important plants used for treating children's disorders in Khar District, Bajour, Khyber Pakhtunkhwa, Pakistan. The findings reveal a diverse range of plant species, with a focus on commonly used plant parts such as seeds and leaves, and the importance of the Apiaceae and Lamiaceae families in treating common children's health issues. However, the research also highlights significant gaps in the systematic documentation of this indigenous knowledge, which is at risk due to the declining practice of traditional medicine and the extinction of key

medicinal plant species. The conservation status of the identified plants is concerning, with nearly half of them classified as rare and a large proportion as vulnerable. This underscores the urgent need for conservation efforts to preserve these plants before they are lost, potentially leading to the extinction of valuable genetic resources that could offer future solutions for healthcare in rural areas. While ,the study provides a general overview of plant species used for children's ailments, it lacks detailed, disease-specific data. Further research is needed to quantify and categorize the plants used for individual conditions to strengthen our understanding of their medicinal potential. Additionally, efforts to preserve the traditional knowledge surrounding these plants are critical, as they offer a sustainable, low-cost healthcare option for communities that struggle with access to conventional medicine.

By documenting these medicinal plants and the associated indigenous knowledge, this study contributes to the creation of a foundation for the development of new, affordable treatments for pediatric diseases, which could help alleviate the burden on rural healthcare systems and provide accessible alternatives to expensive conventional treatments. It is vital that further research and conservation initiatives are undertaken to protect both the plants and the cultural heritage tied to their use.

Suggested ways to bridge the traditional knowledge gap among the younger generations

1. One key way to conserve and pass on traditional knowledge is by encouraging conversations between older and younger generations. Timely "Herbal Days" seminars should be arranged where the elderly can teach young people about the uses and preparation of local plant species, which can create a connection while keeping the knowledge alive.
2. To confirm that knowledge is not lost, it should be recorded in written or soft forms. Local elders should collaborate with younger ones to document traditional methods and the benefits of different plant species. Generating online resources, and books could make this information available for coming generations.
3. Teach younger generations about the importance of maintaining biodiversity and sustainably harvesting plants. Educating the youth about the environmental impact of overharvesting will ensure that medicinal plants are available for future use.

Declarations

Ethics approval and consent to participate: The consent of all contributors of study was taken before any kind of questioning. The respondents were thoroughly guided on the importance of data and its contribution towards research and improvement of society.

Availability of data and materials: Data is available from the first author.

Competing interests: The authors declare that they have no competing interests.

Funding: The research did not receive any specific grant from funding agencies in the public, commercial, or not -for-profit sectors.

Author contributions: All authors contributed to the study. The research was design and supervised by SU and WH the field data was collected by AA, SK and SF, SU wrote the first draft of article while, SN, GR and SA reviewed and edited draft. All the authors read and approved the final manuscript.

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