Quantitative ethnobotanical study of wild plant resources of tehsil Utman Khel, District Bajaur, Pakistan

Adnan Ali, Bakhat Shah Zeb, Amjad Khan, Aminul Haq, Muhammad Abdul Haq, Irshad Ullah, Lal Badshah, Shaista Zeb

Correspondence

Adnan Ali[1], Bakht Shah Zeb [1], Amjid Khan[1], Aminul Haq[1*], Muhammad Abdul Haq[1], Irshad Ullah [2], Lal Badshah[3] and Shaista Zeb[4]

[1]Department of Botany, Govt. Post Graduate College Khar, District Bajaur, Pakistan.
[2]Department of Botany, Islamia College University, Peshawar, Pakistan.
[3]Department of Botany, University of Peshawar, Peshawar, Pakistan.
[4]Department of Botany, University of Karachi, Karachi, Pakistan.

*Corresponding Author: aminulhaq.bot@gmail.com

Ethnobotany Research and Applications 31:21 (2025) - http://dx.doi.org/10.32859/era.31.21.1-15
Manuscript received: 13/01/2025 - Revised manuscript received: 12/06/2025 - Published: 12/06/2025

Research

Abstract

Background: Plants have historically played a vital role in traditional medicine worldwide. This study investigates the quantitative ethnobotanical knowledge of tehsil Utman Khel, District Bajaur, Pakistan. For the first time, it systematically documents the therapeutic and cultural uses of local flora, aiming to preserve this traditional knowledge and explore its potential for modern medicinal applications.

Methods: The area's unique flora supports diverse traditional knowledge, particularly in healthcare. Data were collected from 82 local informants through semi-structured questionnaires, field observations, and group discussions. Quantitative analysis was complicated for the Relative Frequency of Citation (RFC), Use Value (UV), and Family Importance Value (FIV) to assess the significance of plant species and families.

Results: A total of 88 ethnobotanical species from 48 families were recorded. Leaves and fruits were the most commonly used plant parts due to their availability and ease of use. Herbal remedies were predominantly administered orally (73.86%), with fewer used topically (12.5%) or both ways (13.63%). These remedies treated ailments such as pulmonary infections, gastrointestinal and urogenital disorders, kidney stones, nerve issues, and diabetes. *Ajuga integrifolia* and *Allium cepa* were the most significant species based on UV (0.027), while *Juglans regia* and *Mentha arvensis* had the highest RFC values (0.28 and 0.19). Among plant families, Lamiaceae had the highest FIV (79.48), followed by Fabaceae (47.62), Apiaceae (46.22) and Asteraceae (43.5).

Conclusions: Tehsil Utman Khel possesses rich ethnomedicinal and cultural diversity due to its unique geography and climate. However, this traditional knowledge is at risk of being lost, making its documentation essential for preservation and potential use in modern drug development.

Keywords: Wild plants, Relative Frequency Citation, Use Value, Family importance value

Background

Ethnobotany is the study of how people interact with plants to meet their essential needs for daily life (Turner *et al.* 2022). Plants serve a variety of vital functions, providing food, fuel, fodder, timber, fruits, and medicines (Ishtiaq *et al*. 2024). The exploration of plants to fulfill basic human needs dates back to prehistoric times, with ethnobotanical knowledge playing a key role in the survival and development of early societies (Kumar *et al*. 2021). In recent years, ethnobotany has gained significant global attention as researchers aim to ensure the effective use of plants in treating various diseases. New medications and natural remedies are continually being discovered, enhancing the therapeutic potential of plants (Mbaveng *et al.* 2014; Abdullah *et al*. 2021a). Ethnobotanical studies have become increasingly important worldwide, particularly in improving healthcare systems, especially in regions where access to modern medicine may be limited (Amjad *et al.* 2020).

The World Health Organization estimates that over 21,000 plant species have the potential to be used therapeutically. Furthermore, it is noted that more than 80% of the global population relies on herbal medicines for their primary healthcare needs (Tugume and Nyakoojo, 2019; Ghosh *et al.* 2023). In many developing countries, medicinal herbs are widely used due to their accessibility, affordability, and the perception of fewer side effects compared to synthetic pharmaceuticals (Khan *et al.* 2023). Pakistan, with its diverse geography and climatic conditions, holds a unique position among developing nations, supporting a remarkable variety of medicinal plants (Shuaib *et al.* 2019; Haq *et al.* 2024). The flora of Pakistan includes over 6,000 species, a significant portion of which are known for their medicinal uses (Aziz *et al.* 2018; Hazrat *et al.* 2020; Haq and Badshah, 2021; Haq *et al.* 2022). This rich botanical diversity presents valuable opportunities for further exploration and use in healthcare.

In herbal medicine, various plant parts—including stems, leaves, roots, flowers, fruits, and seeds—are utilized to treat a wide range of illnesses (Abdullah *et al*. 2021b; Chaachouay *et al.* 2022; Haq *et al.* 2023a). Across the globe, these plant parts have been identified and used for their medicinal properties, forming the foundation of many herbal remedies (Courric *et al.* 2023). Every component of a plant, from the sturdy roots that anchor it to the soil to the delicate petals that embellish its stems, contains a complex array of bioactive compounds with distinct therapeutic effects (Chaachouay *et al.* 2024; Haq and Badshah, 2024). Plants as natural and traditional therapeutics offer a viable option in developing countries' healthcare systems, especially in rural areas (Umair *et al.* 2017). Today, the use of traditional medicinal plants has become increasingly common for treating various health conditions (Chaughule and Brave, 2024). Natural remedies have proven to be remarkably effective in managing a broad spectrum of ailments (Sharma *et al.* 2021). In many impoverished regions, medicinal plants serve as a crucial alternative to the formal healthcare system, offering accessible and affordable treatment options (Mussarat *et al.* 2021; Haq *et al.* 2022). The purpose of such ethnobotanical studies is to figure out the importance of plants in terms of medicine to people. This study also aims to explore the indigenous knowledge of local communities regarding medicinal plants used for therapeutic purposes and to ensure to conservation of the cultural heritage in the region.

Materials and Methods

Study area

Bajaur, a merged tribal district in Khyber Pakhtunkhwa, is located in the northwestern region of Pakistan. The landmass of District Bajaur lies between 34°30′ and 34°58′ north latitudes and between 71°11′ and 71°48′ east longitudes. The total area of Bajaur is 1,290 km², and it has a population of 1,093,684 according to the 2017 census. The district stretches approximately 45 miles (72 km) in length and 20 miles (32 km) in width. Geographically, about 23.6% of the area is flat, while the remaining 76.4% is mountainous. Bajaur shares a 52 km border with the Kunar province of Afghanistan to the northwest. The district of Bajaur is bordered by District Mohmand to the southwest, the Kunar province of Afghanistan to the northwest, District Dir to the northeast, and District Malakand to the southeast. Bajaur is divided into eight tehsils: Bar Chamer Kand, Barang, Khar, Loe Mamund, Wara Mamund, Nawagai, Salarzai, and Utman Khel. Tehsil Mamund is the largest in terms of area, while the tehsil Chamar Kand is the smallest. Tehsil Utman Khel is located in the southeastern part of Bajaur and is surrounded by the villages of Mattako, Jar, Pandoki, Shamozo, and Arang. The district's administrative center, tehsil Khar, has the highest population in the region.

Ethnobotanical survey and collection of information

An ethnobotanical survey was conducted in various regions of tehsil Utman Khel, Bajaur, to document traditional knowledge of medicinal plants by following Haq *et al.* (2022) and Haq *et al.* (2023a). Prior informed oral consent was obtained from all 82 informants, who were selected based on their expertise in traditional plant use. Data were collected through multiple field visits using semi-structured questionnaires. Interviews, each lasting 10 to 20 minutes, focused on plant local names, used parts, traditional applications, and economic value (Haq *et al.* 2022; Wubu *et al*. 2023). The Code of Ethics provided by

the International Society of Ethnobiology (www.ethnobiology.net/whatwe-do/coreprograms/ise-ethics-program/code-of-ethics) was strictly followed during the field survey.

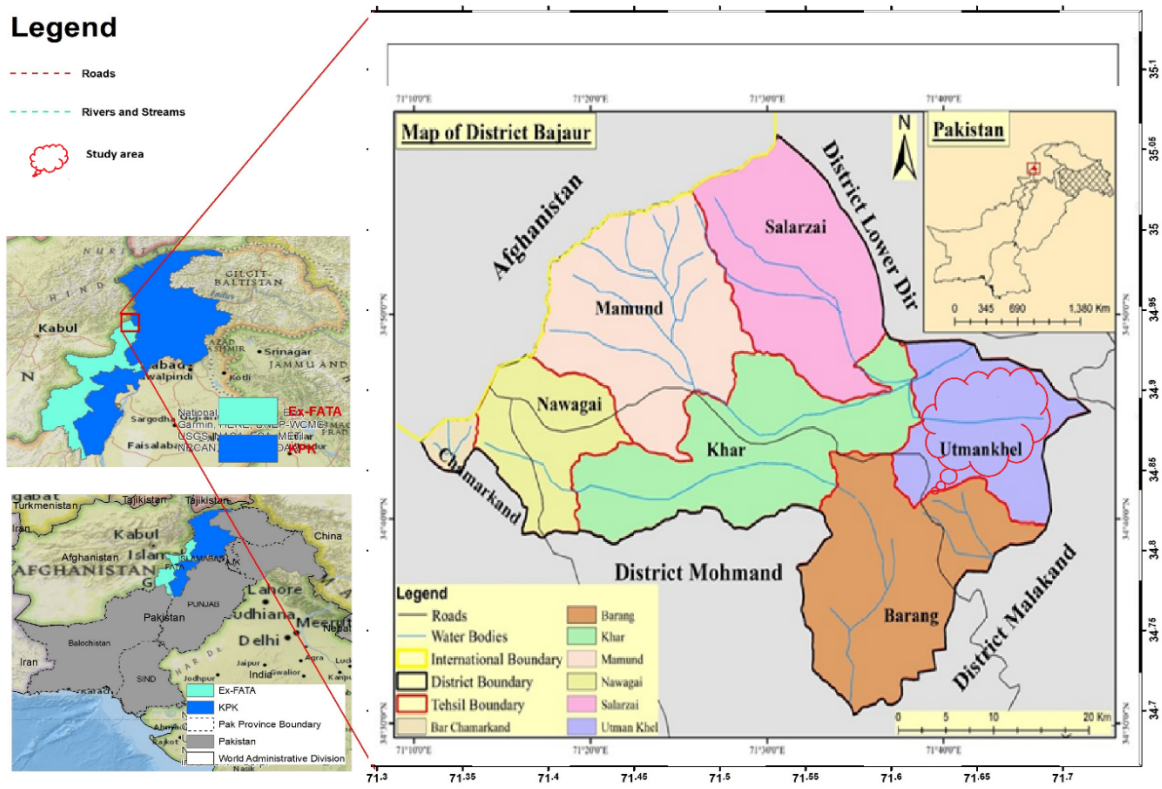

Figure 1. Map of the area

Collection, preservation and identification of medicinal plants

Plants from the study area were collected, pressed until drying, sprayed with 1% $HgCl_2$ for preservation and mounted on standard herbarium sheets to ensure their longevity and proper cataloging. Species identification was carried out using the *Flora of Pakistan* (Ali & Qaiser, 1993-2023) as the primary reference. To ensure taxonomic accuracy, species names were further verified through the '*World Flora Online*' database (https://www.worldfloraonline.org/), a globally recognized resource for plant identification. The authenticated and preserved specimens were then submitted to the Department of Botany, Government. Post Graduate College Khar, for archival and future research purposes.

Quantitative analysis

Use value (UV)

The use-value evaluates each ethno-medicinal plant species and its relative importance based on its relative use among responders (Tardio *et al.* 2008; Haq *et al.* 2022). The use-value (UV) was calculated through the following formula:

$$UV = (\sum Ui) / N$$

Where Ui is the number of used reports mentioned by each participant and N is the total number of respondents interviewed for a given plant species

Relative frequency citation (RFC)

Values of Relative Frequency Citation (RFC) were determined by the available standard formula (Vitalini *et al*. 2013; Haq *et al.* 2022).

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

Where FC is the number of informants who reported the use of plant species and N is the number of informants who contributed to the study.

Family importance value (FIV)

FIV is determined by calculating the percentage of informants who mention plants from a given family during ethnobotanical surveys. The methodology for FIV calculation is based on established approaches outlined by Vitalini *et al.* (2013) and further refined by Haq *et al*. (2022). This metric provides valuable insights into the cultural and practical relevance of plant families in traditional knowledge systems.

$$FIV=FC\ (family)/\ N\times100$$

Where FC is the number of informants mentioning the family and N is the total number of informants who contributed to the study.

Results and Discussion

Medicinal plant diversity in the area

A significant diversity in medicinal plants was recorded in the study area, with a total of 88 plant species from 48 families (Table 1). The most dominant families were Asteraceae and Lamiaceae, each represented by seven species, followed by Fabaceae with six species and Rosaceae with five. Apiaceae included four species, while Poaceae and Solanaceae were each represented by three species. The dominance of Asteraceae, Lamiaceae, Fabaceae and Rosaceae may be attributed to favorable environmental conditions, the strong interaction between local communities and these plants, and the suitability of the habitat for their growth (Haq *et al*. 2023b). Their dominance is attributed to a combination of ecological versatility, reproductive efficiency, and adaptive traits such as effective seed dispersal mechanisms, high phenotypic plasticity, and allelopathic potential. These characteristics enable them to rapidly colonize new areas and outcompete other species. Additionally, many of their species act as pioneer plants, capable of thriving in nutrient-poor or degraded soils, further enhancing their ecological success. These findings are consistent with earlier research, which has repeatedly highlighted Lamiaceae as one of the most prominent and widely utilized families of medicinal plants on a global scale. Studies conducted by Hussain *et al*. (2018a), Mir *et al*. (2021), Haq *et al*. (2022) and Haq *et al*. (2023a) have all emphasized the significant role of Lamiaceae in traditional medicine systems due to its diverse range of species, bioactive compounds, and therapeutic applications. Also, these families are cosmopolitan in distribution and known worldwide for their medicinal uses.

Plant parts used, remedy preparation and route of administration

Medicinal plant parts are a valuable and versatile resource that has long been utilized in both traditional and modern medicine due to the wide array of bioactive compounds they contain, each with potential therapeutic benefits. Various plant parts, such as leaves, stems, roots, flowers, and seeds, have unique phytochemical profiles that contribute to their specific medicinal properties. The therapeutic qualities of these plant parts are the focus of the present study. Among the various plant parts, leaves were the most commonly used in the preparation of herbal remedies, accounting for 39.44% of the total usage, which is due to their easy availability (Hussain *et al*. 2018b) and cause less damage to the plant (Rehman *et al*. 2023). Apart from this, fresh leaves are often preferred for their ability to provide immediate relief and maintain their natural aroma and flavor. However, dry leaves are more convenient for long-term storage and are often used in the preparation of decoctions and powdered formulations. The use of dry leaves becomes particularly useful when fresh leaves are not available or are out of season. This was followed by fruits (26.13%) due to their diverse color and sweet taste, roots (13.63%), whole plants (12.5%), seeds (11.36%), stems (6.81%), and aerial parts (7.95%), as illustrated in Figure 2.

Among the ethnomedicinal plants listed, *Foeniculum vulgare,* locally known as 'Kagi Lani', stands out for its effectiveness in treating digestive disorders and vomiting, making it a cornerstone in gastrointestinal therapy. *Calotropis procera,* a wild poisonous plant, is widely used for dog bites and sugar regulation, showing both topical and systemic medicinal properties. *Berberis lycium* is traditionally used for treating mouth and stomach ulcers. *Allium sativum* (garlic), known for its broad-spectrum medicinal properties, is used to manage hypertension and infectious diseases. *Cannabis sativa*, despite legal constraints, is highly effective as a painkiller and antipyretic. *Ajuga integrifolia* is a significant plant used in the treatment of diabetes and respiratory ailments. *Juglans regia* (walnut) bark and leaves are traditionally used for oral hygiene due to their antibacterial activity. *Rydingia limbata* has wound-healing properties, making it valuable in traditional therapies. *Withania somnifera,* locally known as 'Koti Lal', is a key adaptogen used for arthritis and abdominal disorders. Lastly, *Curcuma longa* (turmeric) is renowned for its anti-inflammatory and healing properties, especially in treating internal injuries and reproductive issues. These plants hold immense pharmacological potential and are integral to traditional healthcare systems.

Table 1. Medicinal Flora of tehsil Utman Khel, Bajaur

Species name/ Voucher number	Family	Local name	Part used	Disease treated	Route of Administration	UV	RFC	FIV
Dicliptera bupleuroides Nees. A. BOT. GPGC KH. 01	Acanthaceae	Tura Panra	Whole plant	For stomach and abdominal pain	Oral	0.007	0.04	4.08
Achyranthes aspera L. A. BOT. GPGC KH. 02	Amaranthaceae	Spay Botay	Roots	Used for stomach pain and cough	Oral	0.014	0.03	21.12
Amaranthus viridis L. A. BOT. GPGC KH. 03	Amaranthaceae	Chalwai	Stem and leaves	Jaundice, tonic and snake bite	Dermal	0.014	0.06	
Chenopodium album L. A. BOT. GPGC KH. 04	Amaranthaceae	Sarmay	Leaves	For piles and antihelminthic	Oral	0.014	0.12	
Coriandrum sativum L. A. BOT. GPGC KH. 05	Apiaceae	Dhanya	Fruit	Foot and mouth disease	Dermal	0.014	0.03	46.22
Ferula jaeschkeana Vatke. A. BOT. GPGC KH. 06	Apiaceae	Skherwa	Leaves and rhizomes	Aphrodisiac and menstrual cycle regulation	Oral	0.014	0.2	
Foeniculum vulgare Mill. A. BOT. GPGC KH. 07	Apiaceae	Kagi Lani	Leaves and seeds	Digestive disorders and preventing vomiting	Oral	0.014	0.2	
Visnaga daucoides Gaertn. A. BOT. GPGC KH. 08	Apiaceae	Sperkai	Fruit	Pulmonary infections	Oral	0.007	0.03	
Calotropis procera (Aiton) W.T.Aiton A. BOT. GPGC KH. 09	Asclepiadaceae	Splamai	Leaves	For dog bites and sugar control	Dermal	0.007	0.05	8.84
Periploca aphylla Decne. A. BOT. GPGC KH. 10	Asclepiadaceae	Barara	Bark and latex	Purgative and criminative	Oral	0.007	0.03	
Artemisia vulgaris L. A. BOT. GPGC KH. 11	Asteraceae	Tarkha	Aerial part	Antihelmentic and abdominal pain	Oral	0.007	0.04	43.5
Cichorium intybus L. A. BOT. GPGC KH. 12	Asteraceae	Kashni	Whole plant	Fever, respiratory diseases and tonic	Oral	0.02	0.07	
Helianthus annuus L. A. BOT. GPGC KH. 13	Asteraceae	Nawarparast	Seeds	Anti-diuretic and laxative	Oral	0.014	0.16	
Sonchus asper (L.) Hill A. BOT. GPGC KH. 14	Asteraceae	Shodafai	Leaves and roots	Laxative and criminative	Oral	0.007	0.04	
Sonchus oleraceus L. A. BOT. GPGC KH. 15	Asteraceae	Zaerguly	Leaves and roots	Diarrhea and abdominal pain	Oral	0.014	0.06	

Xanthium strumarium L. A. BOT. GPGC KH. 16	Asteraceae	Jeshkai	Leaves and roots	Fever and kidney stone removal	Oral	0.014	0.06	
Berberis lycium Royle. A. BOT. GPGC KH. 17	Berberidaceae	Kowarai	Root, fruit and leaves	Mouth and stomach ulcer	Oral	0.007	0.26	25.9
Brassica campestris L. A. BOT. GPGC KH. 18	Brassicaceae	Sharsham	Leaves and seeds	Stomach disorder and abdominal pain	Oral	0.007	0.14	23.12
Eruca sativa Mill. A. BOT. GPGC KH. 19	Brassicaceae	Toorpak	Leaves and stems	For skin disease	Dermal	0.007	0.1	
Cannabis sativa L. A. BOT. GPGC KH. 20	Cannabaceae	Bhang	Leaves	Fever and painkiller	Both	0.007	0.1	10.2
Viburnum cotinifolium D. Don. A. BOT. GPGC KH. 21	Caprifoliaceae	Tora	Leaves	Antidiuretic and purgative	Oral	0.014	0.06	6.12
Silene conoidea L. A. BOT. GPGC KH. 22	Caryophyllaceae	Mangottay	Stem	As fodder for cattle and abdominal disorders	Oral	0.007	0.03	8.16
Stellaria media (L.) Vill. A. BOT. GPGC KH. 23	Caryophyllaceae	Khwrenakai	Aerial part	For constipation and abdominal pain	Oral	0.007	0.05	
Cuscuta reflexa Roxb. A. BOT. GPGC KH. 24	Cuscutaceae	Zelai	Shoot	Anti-helminthic, skin disease and purgative	Both	0.02	0.07	6.8
Equisetum arvense L. A. BOT. GPGC KH. 25	Equisetaceae	Bandakai	Aerial part	Gastric acidity, hair tonic	Oral	0.014	0.07	7.48
Euphorbia helioscopia L. A. BOT. GPGC KH. 26	Euphorbiaceae	Arbay	Whole plant	Laxative and antihelmintic	Oral	0.014	0.06	18.32
Ricinus communis L. A. BOT. GPGC KH. 27	Euphorbiaceae	Aranda	Seeds	Laxative, spasmodic and arthritis	Both	0.02	0.12	
Astragalus grahamianus Benth. A. BOT. GPGC KH. 28	Fabaceae	Ghwarrakai	Fruits	Respiratory infection and antidiabetic	Oral	0.014	0.03	47.62
Indigofera heterantha Wall. ex Brandis A. BOT. GPGC KH. 29	Fabaceae	Ghwareja	Root	Headache and chest pain	Oral	0.014	0.07	
Medicago minima (L.) Bartal. A. BOT. GPGC KH. 30	Fabaceae	Shapeshtari	Aerial parts	For dysentery, the healing of a wound	Both	0.014	0.05	
Medicago sativa L. A. BOT. GPGC KH. 31	Fabaceae	Marghy Khpa	Aerial parts	Kidney problems, fever and arthritis.	Oral	0.02	0.05	

Senegalia modesta (Wall.) P.J.H. Hurter A. BOT. GPGC KH. 32	Fabaceae	Palosa	Bark, seed, leaves and gum	Bandages, headache and cough	Both	0.027	0.13	
Vachellia nilitica subsp. *tomentosa* (Benth.) Kyal. & Boatwr. A. BOT. GPGC KH. 33	Fabaceae	Kikar	Bark, leaves and fruit	Diabetic, cough and cold	Oral	0.02	0.15	
Quercus incana W. Bartram A. BOT. GPGC KH. 34	Fagaceae	Serrai	Nuts and seeds	For gastrointestinal disorders	Oral	0.007	0.18	18.4
Fumaria parviflora Lam. A. BOT. GPGC KH. 35	Fumariaceae	Shahtara	Whole plant	Anti-helminthic and skin disease	Both	0.014	0.04	4.08
Juglans regia L. A. BOT. GPGC KH. 36	Juglandaceae	Ghoz	Bark, leaves and fruit	For cleaning teeth and gum bleeding.	Both	0.014	0.28	27.9
Ajuga integrifolia Buch.-Ham. Ex D.Don A. BOT. GPGC KH. 37	Lamiaceae	Gotte	Stem and leaves	Diabetes, chest and throat pain, blood purifier	Oral	0.027	0.15	79.48
Isodon rugosus (Wall. Ex Benth.) Codd A. BOT. GPGC KH. 38	Lamiaceae	Khrachy	Leaves	Antiseptic and spasmotic	Dermal	0.007	0.09	
Mentha arvensis L. A. BOT. GPGC KH. 39	Lamiaceae	Podina	Whole plant	Stimulant and carminative	Oral	0.014	0.19	
Mentha longifolia L. A. BOT. GPGC KH. 40	Lamiaceae	Enalay	Leaves and stems	Diarrhea and constipation	Oral	0.014	0.16	
Ocimum basilicum L. A. BOT. GPGC KH. 41	Lamiaceae	Kashmalai	Leaves and seeds	Cough, cold and an emetic agent	Oral	0.02	0.12	
Origanum vulgare L. A. BOT. GPGC KH. 42	Lamiaceae	Shamakay	Leaves	Fever and abdominal pain	Oral	0.014	0.03	
Rydingia limbata (Benth.) Scheen & V.A.Albert A. BOT. GPGC KH. 43	Lamiaceae	Azghakai	Leaves	Healing of a wound	Dermal	0.007	0.05	
Punica granatum L. A. BOT. GPGC KH. 44	Lythraceae	Anaar	Fruit and leaves	Respiratory disorders, heart disease and antipyretic	Oral	0.02	0.15	15
Allium cepa L. A. BOT. GPGC KH. 45	Liliaceae	Piaz	Bulb	Diarrhea, Mastitis, fever and vaginal prolapse	Oral	0.027	0.11	19.06
Allium sativum L. A. BOT. GPGC KH. 46	Liliaceae	Ooga	Bulb	Hypertension, off-feeding, foot and mouth disease	Oral	0.02	0.08	

Malva neglecta Wallr. A. BOT. GPGC KH. 47	Malvaceae	Panderack	Leaves	For digestive disorders	Oral	0.007	0.07	7.48
Melia azedarach L. A. BOT. GPGC KH. 48	Meliaceae	Tora Bakanra	Leaves and fruit	Emetic, diarrhea and diabetes	Oral	0.02	0.12	11.6
Ficus carica L. A. BOT. GPGC KH. 49	Moraceae	Inzar	Latex and fruit	Expectorant, constipation and laxative	Dermal	0.007	0.16	31.3
Morus alba L. A. BOT. GPGC KH. 50	Moraceae	Spen Toot	Fruit and leaves	Emollient, laxative and astringent	Oral	0.02	0.15	
Myrtus communis L. A. BOT. GPGC KH. 51	Myrtaceae	Manrro	Fruit and leaves	Carminative and abdominal pain	Oral	0.014	0.22	22.4
Olea europaea subsp. *caspidata* (Wall. Ex G.Don) Cif. A. BOT. GPGC KH. 52	Oleaceae	Khona	Seeds and leaves	Anti-diabetic and cures body pain	Both	0.014	0.2	19.7
Cephalanthera longifolia (L.) Fritsch. A. BOT. GPGC KH. 53	Orchidaceae		Rhizome	Milk production in lactation women	Oral	0.007	0.02	2.04
Oxalis corniculata L. A. BOT. GPGC KH. 54	Oxalidaceae	Trewakay	Whole plant	For diarrhea and stomach problems	Oral	0.014	0.07	6.8
Papaver rhoeas L. A. BOT. GPGC KH. 55	Papaveraceae	Redai	Flowers	Cough and chest pain	Oral	0.014	0.02	2.04
Pinus gerardiana Wall. ex D.Don A. BOT. GPGC KH. 56	Pinaceae	Chalghoza	Seeds	Antiseptic, diuretic and tonic	Oral	0.014	0.1	4.08
Pinus roxburghii Sarg. A. BOT. GPGC KH. 57	Pinaceae	Nakhtar	Whole plant	Healing of wounds	Dermal	0.007	0.13	
Plantago lanceolata L. A. BOT. GPGC KH. 58	Plantaginaceae	Ghwa Jabai	Whole plant	Reduce obesity, skin disease and laxative use	Oral	0.02	0.04	
Aristida cyanantha Steud. A. BOT. GPGC KH. 59	Poaceae	Wakha	Aerial part	For the healing of wounds	Dermal	0.007	0.05	10.88
Avena sativa L. A. BOT. GPGC KH. 60	Poaceae	Jawder	Seeds and stems	For gastro problems	Oral	0.007	0.03	
Cynodon dactylon (L.) Pers. A. BOT. GPGC KH. 61	Poaceae	Kabal	Aerial part	Anti-constipation and antidiuretic	Oral	0.014	0.03	
Rumex dentatus L. A. BOT. GPGC KH. 62	Polygonaceae	Shalkhai	Leaves	Anit diuretic and astringent	Oral	0.014	0.07	19.08

Rumex hastatus D.Don. A. BOT. GPGC KH. 63	Polygonaceae	Tarokai	Leaves	Stomach disorders, diuretic and carminative	Oral	0.02	0.12	
Portulaca oleracea L. A. BOT. GPGC KH. 64	Portulacaceae	Warkharry	Leaves	Kidney disorders	Oral	0.007	0.1	10.2
Adiantum capillus-veneris L. A. BOT. GPGC KH. 65	Pteridaceae	Batosana	Whole plant	Toothache, hepatitis, scorpion bites, cough and eye disease	Both	0.034	0.06	6.12
Sageretia thea (Osbeck) M.C. Johnst. A. BOT. GPGC KH. 66	Rhamnaceae	Mamanarra	Leaves and roots	Blood purifier, tonic and for hepatitis	Oral	0.014	0.2	36.7
Ziziphus jujuba Mill. A. BOT. GPGC KH. 67	Rhamnaceae	Markhanay	Leaves, fruit	Astringent and tonic	Oral	0.007	0.16	
Cotoneaster nummularius Fisch. & C.A.Mey. A. BOT. GPGC KH. 68	Rosaceae	Khurach	Fruits	Stomachache and coughing	Oral	0.014	0.1	42.2
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita. A. BOT. GPGC KH. 69	Rosaceae	Balmangai	Fruit	Laxative and criminative	Oral	0.014	0.18	
Rosa indica L. A. BOT. GPGC KH. 70	Rosaceae	Gulab	Flowers, fruits and leaves	Treatment of asthma	Oral	0.007	0.05	
Rosa webbiana Wall. ex Royl. A. BOT. GPGC KH. 71	Rosaceae	Zangli Gulab	Flower and fruit	Asthma and coughing	Oral	0.007	0.07	
Rubus ulmifolius Schott. A. BOT. GPGC KH. 72	Rosaceae	Karwarra	Leaves and fruit	Cough and diarrhea	Oral	0.014	0.02	
Citrus medica L. A. BOT. GPGC KH. 73	Rutaceae	Limbo	Leaves and fruit	Dry cough and indigestion	Oral	0.014	0.14	37.4
Zanthoxylum armatum DC. A. BOT. GPGC KH. 74	Rutaceae	Dambara	Fruit	Bronchitis, asthma and indigestion	Oral	0.02	0.24	
Salix babylonica L. A. BOT. GPGC KH. 75	Salicaceae	Wala	Leaves and fruit	Internal and external body pain	Both	0.007	0.03	3.4
Dodonaea viscosa Jacq. A. BOT. GPGC KH. 76	Sapindaceae	Ghwarraskay	Leaves and stems	For extremely burnt wounds and dermatitis	Dermal	0.014	0.15	15
Sideroxylon mascatense (A.DC.) T.D.Penn.	Sapotaceae	Gurgura	Fruits	As a body tonic	Oral	0.007	0.23	23.1

A. BOT. GPGC KH. 77								
Verbascum thapsus L. A. BOT. GPGC KH. 78	Scrophulariaceae	Kharghwag	Whole plant	Antiseptic and sposmotic	Both	0.014	0.07	6.8
Datura innoxia Mill. A. BOT. GPGC KH. 79	Solanaceae	Bathura	Leaves and seeds	Antipyretic, toothache and spasmodic	Both	0.02	0.09	40.74
Solanum nigrum L. A. BOT. GPGC KH. 80	Solanaceae	Kachmacho	Whole plant	Painkiller and body coolant	Oral	0.007	0.12	
Withania somnifera (L.) Dunal A. BOT. GPGC KH. 81	Solanaceae	Koti Lal	Leaves and roots	For arthritis and abdominal pain	Dermal	0.014	0.2	
Daphne mucronata Royle. A. BOT. GPGC KH. 82	Thymelaeaceae	Laghonay	Fruit and roots	For gastrointestinal infections	Oral	0.007	0.05	4.76
Celtis eriocarpa Decne. A. BOT. GPGC KH. 83	Ulmaceae	Tagha	Leaves and fruit	Blood purifier and as a colic	Oral	0.014	0.08	8.16
Vitex negundo L. A. BOT. GPGC KH. 84	Verbenaceae	Marwandai	Leaves and roots	Anthelmintic and diuretic	Oral	0.014	0.18	17.7
Vitis jacquemontii R.Parker. A. BOT. GPGC KH. 85	Vitaceae	Zangli Kower	Fruit and leaves	Laxative and criminative	Oral	0.007	0.09	23.64
Vitis vinifera L. A. BOT. GPGC KH. 86	Vitaceae	Kower	Leaves and fruit	Laxative and tonic	Oral	0.014	0.24	
Curcuma longa L. A. BOT. GPGC KH. 87	Zingiberaceae	Korkaman	Rhizomes	Extremely injury and vaginal prolapsed	Dermal	0.014	0.12	12.2
Tribulus terrestris L. A. BOT. GPGC KH. 88	Zygophyllaceae	Malkonday	Roots, fruits and leaves	Kidney stone removal and aphrodisiac	Oral	0.014	0.1	9.52

Key: UV- Use Value, RFC- Relative Frequency of Citation, FIV- Family Importance Value

In herbal medicine, different preparation methods are employed to extract the therapeutic properties of plant materials. The decoction method emerged as the most commonly employed technique for preparing herbal remedies in the study area. This traditional method involves simmering tougher plant parts—such as roots, bark, or woody stems—in water over an extended period to extract their bioactive compounds. The resulting preparation is typically a strong and concentrated liquid believed to possess potent medicinal properties. In the current study, decoctions were used in the preparation of remedies from 27 plant species, accounting for 30.68% of the total recorded. These findings are consistent with previous ethnobotanical research conducted in other regions of Northern Pakistan, including Ullah *et al.* (2025) in Khar, District Bajaur; Kayani *et al.* (2024) in the Palas Valley of Kohistan; and Ahmad *et al.* (2014) in the Chail Valley of Swat. The widespread use of decoction across these geographically diverse areas highlights its significance and enduring role in traditional healthcare practices. Following decoction, powder form was used for 26 species (29.54%), extracts for 18 species (20.45%), and cooked preparations for 8 species (Table 1). Infusions, another common method, are prepared by steeping plant parts like leaves, flowers, or seeds in hot water, allowing the water-soluble compounds to dissolve and form a therapeutic tea (Shiak *et al.* 2023). Extracts are made using solvents such as ethanol or water to isolate specific compounds from the plant material, yielding concentrated forms of herbal medicine (Bitwell *et al*. 2023).

The method of remedy preparation and route of administration are critical factors in determining the efficacy and suitability of herbal treatments. Each preparation technique offers distinct benefits and is selected based on the nature of the plant material, the targeted therapeutic effect, and local traditions or individual preferences. Our data also supported these traditional practices through observed administration patterns. Among the documented remedies, 73.86% were administered orally, 12.5% topically, and 13.63% both orally and topically (Fig. 3). This distribution aligns with the broader therapeutic intentions of the remedies. Oral methods, such as decoctions or powders taken with water or milk, were predominant for treating systemic or internal ailments, including gastrointestinal disorders, fever, and respiratory issues. In contrast, topical applications—such as ointments and poultices—were more common for dermatological conditions, joint pain, and injuries. A smaller proportion of remedies were utilized both orally and topically, reflecting the flexibility of certain plants in treating both internal and external symptoms. Inhalation methods, although less frequently reported, were also noted for respiratory conditions and psychological relief. These findings are consistent with previous ethnobotanical studies (Bibi *et al.* 2014; Umair *et al.* 2014; Zahoor *et al.* 2017; Khan *et al.* 2018; Wali *et al.* 2019; Akram *et al*. 2020), further validating the versatility and effectiveness of traditional herbal practices in the study region.

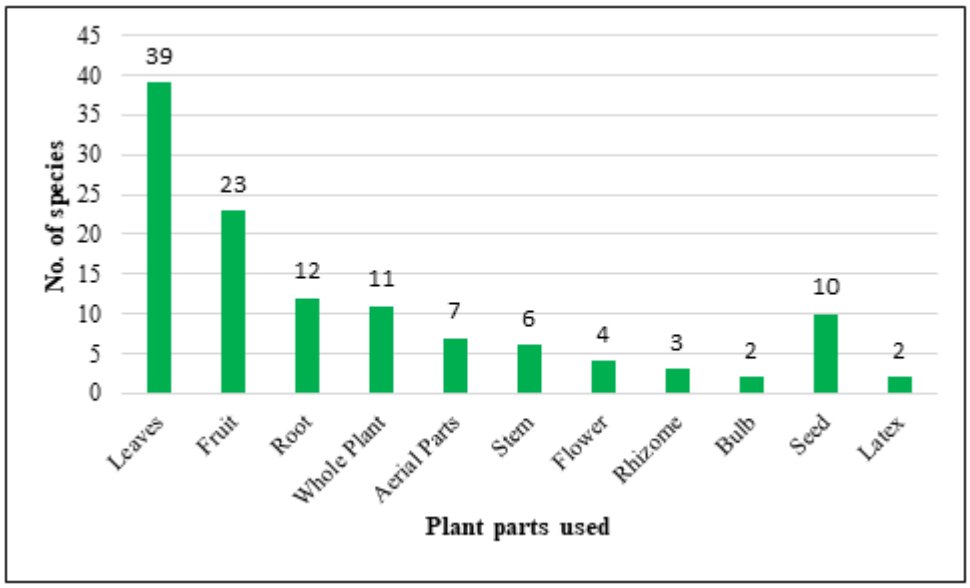

Figure 2. Plant parts used in herbal recipes

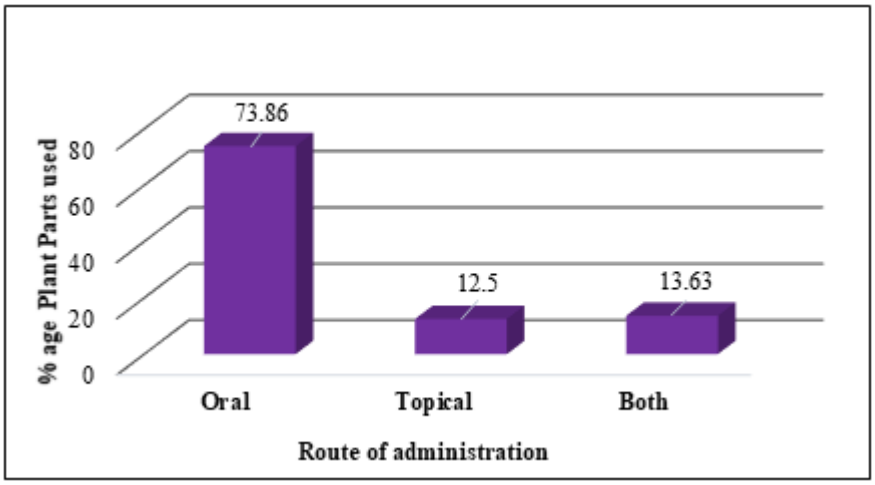

Figure 3. Route of administration of remedies

Use value

In ethnobotany, the use value (UV) is used to help and estimate a better understanding of the indigenous knowledge of plants that the local people use (Nasab and Khosravi, 2014). The use value (UV) index was employed to quantify the ethnomedicinal significance of the documented plant species in the study, with values ranging from 0.007 to 0.027 (Table 1). The species with the highest UV was *Ajuga integrifolia*, followed by *Allium cepa*, *Berberis lycium, Coriandrum sativum*, *Achyranthes aspera, Foeniculum vulgare* and *Cannabis sativa.* The elevated UV for these species indicates that they are frequently utilized by local communities, highlighting their strong dependence on local plant life for medicinal purposes, food, and livelihood. A higher UV reflects the greater importance of a species within the community, though it does not specify whether a plant is used for a single purpose or a wide array of uses (Zenderand *et al*. 2019). It is important to note that while many plants are beneficial, some can be highly toxic. For example, plants like *Calotropis procera*, *Euphorbia helioscopia,* and *Ricinus communis* can be dangerous if consumed in large quantities, potentially leading to severe poisoning or even death (Haq *et al.* 2023a). Thus, while the use of medicinal plants is widespread and valued, caution must be exercised, particularly with species that have toxic properties.

Relative frequency citation

The Relative Frequency of Citation (RFC) value is used to know the popularity level of a specific plant species in the community. Plants with high RFC value are well-known and the indigenous people use them widely (Kayani *et al*. 2024). The RFC values for the reported plant species ranged from 0.02 to 0.28 (Table 1). The RFC value reflects the relative importance of each plant species based on the frequency with which informants reported its use. The plant species with the highest RFC was *Juglans regia* (0.28), followed by *Berberis lycium* (0.26), *Zanthoxylum armatum* (0.24), *Mentha arvensis* (0.19), and *Malva neglecta* (0.17). A higher RFC indicates that a particular species is more frequently cited by local informants, signifying its widespread use and importance in the community. Ullah *et al*. (2025) reported the highest RFC for *Ammi vasnaga* from Bajaur, Shah *et al*. (2016) for *Brassica juncea* and *Lipidium sativum* from Swat, while Haq *et al*. (2023a) reported the highest RFC for *Berberis lycium* from Bajaur. This high RFC value could be because of their easy availability, cultural practices and broad distribution. High RFC indicates the retention of traditional knowledge and its smooth transmission among the community (Tounekti *et al*. 2019). Chemical studies on species with high RFC values may provide valuable insights for the development of new medicinal compounds (Molares and Ladio, 2009). Therefore, investigating these plants with prominent RFC scores could potentially lead to the discovery of novel medications.

Family importance value

The Family Importance Value (FIV) is a quantitative metric used to evaluate the local significance of plant families, especially those consisting of wild species. This value reflects the extent to which a specific plant family is recognized and utilized within a community. The FIV for the plant species documented in this study varied significantly, ranging from 2.04 to 79.48 (Table 1). The family Lamiaceae recorded the highest FIV of 79.48, followed by Fabaceae (47.62), Apiaceae (46.22), Asteraceae (43.5), Rosaceae (42.2), Solanaceae (40.74), Rutaceae (37.4) and Rhamnaceae (36.7). These high FIV values indicate that certain plant families are particularly favored for medicinal use within the local community. In contrast, families with the lowest FIV included Orchidaceae and Papaveraceae (2.04), followed by Acanthaceae and Fumariaceae (4.08). The significant FIV values observed for certain families reflect the strong preference and reliance of local communities on specific plant

species for the treatment of a wide array of ailments. This high FIV emphasizes the substantial role these plant families play in local herbal medicine systems, underlining their importance in addressing a diverse range of health conditions (Bibi *et al*. 2014; Islam *et al*. 2014; Haq *et al*. 2023a).

Conclusion

The ethnobotanical study of tehsil Utman Khel and its surrounding areas highlights the region's rich diversity of medicinal plants, comprising 88 plant species from 48 families and the community's deep reliance on traditional remedies. Asteraceae and Lamiaceae were the leading families. Leaves and fruits were the most utilized part of the plant and decoction was the most common method of herbal remedy preparation, which is administered orally. Quantitative analyses further reveal the widespread use of plants for various ailments. *Ajuga integrifolia* and *Allium cepa* were the widely used plants for disease treatment in the studied area with a UV of 0.027. The highest RFC was recorded for *Juglans regia* and *Berberis lycium,* which were the most common among the inhabitants of the area due to their wide commercial uses. Family Lamiaceae was the most significant family based on FIV value. These quantitative indices were helpful in figuring out the most common and important medicinal plants in the area. This study will preserve the traditional ethnobotanical knowledge, which is increasingly at risk as it remains confined to local healers (Hakims) and elders and the young generation is unaware. Documenting this knowledge not only helps to protect cultural heritage but also offers significant potential for pharmaceutical research and the development of new treatments. Integrating traditional wisdom with modern scientific methods is crucial for ensuring sustainable conservation and fostering medical innovation**.**

Declarations

Ethics Approval and Consent to Participate: All participants gave prior informed oral consent.
Consent for Publication: Individuals featured in images provided oral informed consent for publication.
Availability of Data and Materials: Data can be accessed by consulting the first author.
Funding: This research received no external funding; all expenses were covered by the authors.
Conflict of Interest: The authors declare no conflicts of interest.
Author contributions: AA, BSZ, and AK collected the data, conducted the experimental work, and wrote the manuscript. AQ and MAQ supervised the research, identified the plant specimens, and reviewed and edited the manuscript. IU, LB, and SZ analyzed and tabulated the data and revised the list of cited literature.

Acknowledgments

This paper is a part of the BS research group thesis of the authors Adnan Ali, Bakht Shah Zeb and Amjad Khan. The authors would like to thank all the informants in the area for sharing useful information regarding the medicinal plants.

Literature cited

Abdullah A, Khan SM, Pieroni A, Haq A, Haq ZU, Ahmad Z, Sakhi S, Hashem A, Al-Arjani ABF, Alqarawi AA, Abd_Allah EF. 2021b. A Comprehensive appraisal of the wild food plants and food system of tribal cultures in the Hindu Kush Mountain Range; A way forward for balancing human nutrition and food security. Sustainability 13(9):5258.

Abdullah, Khan SM, Kashif R A, Haq Z U, Ahmad Z, Haq A, Haq MA 2021a. Ethnobotanical appraisal of medicinal plants from Bajaur; A remote area of the Khyber Pakhtunkhwa province of Pakistan. In Abbasi AM, Bussmann RW (eds) Ethnobiology of Mountain Communities in Asia. Springer, Cham. pp. 277-293.

Ahmad M, Sultana S, Fazl-i-Hadi S, Ben Hadda T, Rashid S, Zafar M, Khan MA, Khan MPZ, 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): 1-18.

Akram MA, Iqbal N, Aqeel M, Khalid N, Alamri S, Hashem M, Abrar M, Manan A, Islam W, Noman A. 2020. Exploration of medicinal phyto-diversity of the semi-arid area in Punjab Province, Pakistan. Journal of Animal and Plant Sciences 30(6): 1442-1464.

Ali SI, Qaiser M. (Eds.). 1993-2023. Flora of Pakistan. Islamabad, Karachi.

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

Aziz MA, Khan AH, Adnan M, Ullah H. 2018. Traditional uses of medicinal plants by Indigenous communities for veterinary practices at Bajaur Agency, Pakistan. Journal of Ethnobiology and Ethnomedicine 14(1): 1-18.

Bibi T, Ahmad M, Tareen RB, Tareen NM, Jabeen R, Rehman SU, Sultana S, Zafar M. 2014. Ethnobotany of medicinal plants in district Mastung of Balochistan Province, Pakistan. Journal of Ethnopharmacology 147: 79-80.

Bitwell C, Indra SS, Luke C, Kakoma MK. 2023. A review of modern and conventional extraction techniques and their applications for extracting phytochemicals from plants. Scientific African 19: e01585.

Chaachouay N, Douira A, Zidane L. 2022. Herbal medicine used in the treatment of human diseases in the Rif, Northern Morocco. Arabian Journal for Science and Engineering 47(1): 131-153.

Chaachouay N, Zidane L. 2024. Plant-derived natural products: A source for drug discovery and development. Drugs and Drug Candidates 3(1): 184-207.

Chaughule, R.S. and Barve, R.S., 2024. Role of herbal medicines in the treatment of infectious diseases. In *Infectious Diseases* (pp. 74-91). Bentham Science Publishers.

Courric E, Brinvilier D, Couderc P, Ponce-Mora A, Méril-Mamert V, Sylvestre M, Pelage JH, Vaillant J, Rousteau A, Bejarano E, Cebrian-Torrejon G. 2023. Medicinal plants and plant-based remedies in Grande-Terre: An ethnopharmacological approach. Plants 12(3): 1-19.

Ghosh S, Sarkar T, Chakraborty R. 2023. Ankol plant (*Alangium salvifolium*)—The treasure trove of bioactives and medicinal potential. Food Bioscience 51: 102230.

Haq A, Badshah L. 2021. Floristic description and ecological characteristics of the plants of Pashat Valley, Pak-Afghan border, district Bajaur, Pakistan. Acta Ecologica Sinica 41(6): 524-536.

Haq A, Badshah L. 2024. Proximate and elemental assessment of six selected plant species at various phenological stages from district Bajaur, Pakistan. Pakistan Journal of Botany 56(3): 1-8.

Haq A, Badshah L, Ali A, Ullah A, Khan SM, Ullah I. 2022. Ethnobotanical study of medicinal plants of Pashat Valley, Bajaur, along Pakistan-Afghanistan border: a mountainous region of the Hindu Kush Range. Nordic Journal of Botany 10: e03580.

Haq A, Badshah L, Hussain W, Ullah I. 2023a. Quantitative ethnobotanical exploration of wild medicinal plants of Arang Valley, District Bajaur, Khyber Pakhtunkhwa, Pakistan: a mountainous region of the Hindu Kush Range. Ethnobotany Research and Applications 25: 1-29.

Haq A, Badshah L, Ullah S, Hussain W, Ullah I, Ullah H, Ahmad S. 2023b. Phytodiversity, ecological attributes and phytogeographical distribution of plants in Arang Valley, district Bajaur, a remote area in the northwest of Pakistan. Phytotaxa, 625(1):28-50.

Haq A, Ullah H, Ullah I, Badshah L, Ahmad S. 2024. Vegetation Dynamics along the Altitudinal Gradient. Intechopen 1-1

Hazrat A. 2020. Floral diversity of Rosaceae family in Dir Kohistan Forest, Khyber Pakhtunkhwa Province, Pakistan. Pakistan Journal of Weed Science Research 26(2): 157-165.

Hussain W, Badshah L, Ullah M, Ali M, Ali A, Hussain F. 2018a. Quantitative study of medicinal plants used by the communities residing in Koh-e-Safaid Range, northern Pakistani-Afghan borders. Journal of Ethnobiology and Ethnomedicine 14: 1-18.

Hussain W, Ullah M, Dastagir G, Badshah L. 2018b. Quantitative ethnobotanical appraisal of medicinal plants used by inhabitants of lower Kurram, Kurram agency, Pakistan. Avicenna Journal Phytomedicine. 8(4):313-329.

Ishtiaq, M., Sardar, T., Hussain, I., Maqbool, M., Mazhar, M.W., Parveen, A., Ajaib, M., Bhatti, K.H., Hussain, T., Gul, A. and Azeem, M., 2024. Traditional ethnobotanical knowledge of important local plants in Sudhnoti, Azad Kashmir, Pakistan. Scientific Reports 14(1):22165.

Islam MK, Saha S, Mahmud I, Mohamad K, Awang K, Uddin SJ, Rahman MM, Shilpi JA. 2014. An ethnobotanical study of medicinal plants used by tribal and native people of Madhupur forest area, Bangladesh. Journal of Ethnopharmacology 151: 921-930.

Kayani S, Ahmad M, Gillani SW, Manzoor M, Rehman FU, Jabeen S, Butt MA, Babar CM, Shah SAH. 2024. Ethnomedicinal appraisal of the medicinal flora among the sub-alpine and alpine Iindigenous communities of Palas Valley Kohistan, Northern Pakistan. Ethnobotany Research and Applications 28: 1-29.

Khan, S., Khan, R., Osama, M., Muhammad, I.N. and Iqbal, S., 2023. Exploring the Acceptance and Perceptions of Herbal Medicine among the General Public in Pakistan: A Societal Perspective.

Kumar, A., Kumar, S., Komal, Ramchiary, N. and Singh, P., 2021. Role of traditional ethnobotanical knowledge and indigenous communities in achieving sustainable development goals. Sustainability 13(6):062.

Mir TA, Jan M, Khare RK. 2021. Ethnomedicinal application of plants in Doodhganga forest range of district Budgam, Jammu and Kashmir, India. European Journal of Integrative Medicine 46: 101366.

Molares S, Ladio A. 2009. Ethnobotanical review of the Mapuche medicinal flora: use patterns on a regional scale. Journal of Ethnopharmacology 122: 251-260.

Mussarat S, Ali R, Ali S, Mothana RA, Ullah R, Adnan M. 2021. Medicinal animals and plants as alternative and complementary medicine in southern regions of Khyber Pakhtunkhwa, Pakistan. Frontiers in Pharmacology 12: 649046.

Nasab FK, Khosravi AR. 2014. Ethnobotanical study of medicinal plants of Sirjan in Kerman Province, Iran. Journal of ethnopharmacology 154(1): 190-197.

Rehman S, Iqbal Z, Qureshi R, Shah GM, Irfan M. 2023. Ethnomedicinal plant uses for the treatment of respiratory disorders in tribal District North Waziristan, Khyber Pakhtunkhwa, Pakistan. Ethnobotany research and Applications 25: 1-16

Sharma A, Khanna S, Kaur G, Singh I. 2021. Medicinal plants and their components for wound healing applications. Future Journal of Pharmaceutical Sciences 7(1): 1-13.

Shuaib M, Ahmed S, Ali K, Ilyas M, Hussain F, Urooj Z, Shah SS, Kumar T, Shah M, Khan I, Hussain F. 2019. Ethnobotanical and ecological assessment of plant resources at district Dir, Tehsil Timergara, Khyber Pakhtunkhwa, Pakistan. Acta Ecologica Sinica 39(1): 109-115.

Tardio J, Pardo-de Santayana M. 2008. Cultural importance index: A comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain). Economic Botany 62: 24-39.

Tounekti T, Mahdhi M, Khemira H. 2019. Ethnobotanical study of indigenous medicinal plants of Jazan region, Saudi Arabia. Evidence-Based Complementary and Alternative Medicine (1): 3190670.

Tugume P, Nyakoojo C. 2019. Ethnopharmacological survey of herbal remedies used in the treatment of paediatric diseases in Buhunga Parish, Rukungiri District, Uganda. BMC Complementary and Alternative Medicine 19: 1-10.

Turner NJ, Cuerrier A, Joseph L. 2022. Well grounded: Indigenous Peoples' knowledge, ethnobiology, and sustainability. People and Nature 4(3): 627-651.

Ullah S, Hussain W, Nasim S, Ahmad S, Khan S, Faisal S, Ali A. 2025. Ethnobotanical documentation of medicinal flora traditionally used for pediatric diseases in Khar, district Bajaur, Khyber Pakhtunkhwa, Pakistan. Ethnobotany Research and Applications 30: 1-19.

Umair M, Altaf M, Abbasi AM. 2017. An ethnobotanical survey of indigenous medicinal plants in Hafizabad district, Punjab-Pakistan. PlosOne 12(6):e0177912.

Umair M, Altaf M, Bussmann RW, Abbasi AM. 2019. Ethnomedicinal uses of the local flora in Chenab riverine area, Punjab province Pakistan. Journal of Ethnobiology and Ethnomedicine 15(1): 1-31.

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(2): 517-529.

Wali RK, Raja NI, Qureshi R. 2019. A quantitative medico-botanical expedition of Fairy Meadows National Park, Diamir, Gilgit Baltistan, Pakistan. BioRxiv 2019: 507848.

Wubu, K.A., Ngatie, A.H., Haylie, T.A. and Osman, A.D., 2023. Ethnobotanical study of traditional medicinal plants in Kebridehar and Shekosh districts, Korahi zone, Somali Region, Ethiopia. Heliyon 9(12).

Zahoor M, Yousaf Z, Aqsa T, Haroon M, Saleh N, Aftab A, Javed S, Qadeer M, Ramazan H. 2017. An ethnopharmacological evaluation of Navapind and Shahpur Virkan in District Sheikhupura, Pakistan for their herbal medicines. Journal of Ethnobiology and Ethnomedicine 13(1): 1-26.

Zenderland J, Hart R, Bussmann RW, Paniagua Zambrana NY, Sikharulidze S, Kikvidze Z, Kikodze D, Tchelidze D, Khutsishvili M, Batsatsashvili K. 2019. The use of “Use Value”: Quantifying importance in ethnobotany. Economic Botany 73: 293-303.