



Ethnomedicinal plants used by indigenous communities in Malakand District, Northern Pakistan

Hazrat Ali, Zahir Muhammad, Tahseen Ullah, Naila Inayat, Mujeeb Ur Rahman, Rahman Ullah, Ishaq Ali Shah, Shujaul Mulk Khan

Correspondence

Hazrat Ali^{1,2*}, Zahir Muhammad¹, Tahseen Ullah¹, Naila Inayat³, Mujeeb Ur Rahman¹, Rahman Ullah¹, Ishaq Ali Shah^{1,4}, Shujaul Mulk Khan⁵

¹Department of Botany, University of Peshawar, Peshawar, Pakistan.

²Elementary & Secondary Education Department, Khyber Pakhtunkhwa, Pakistan.

³Department of Botany, Shaheed Benazir Bhutto Women University, Peshawar, Pakistan.

⁴Governament HAJN Degree College Gulbahar, Peshawar, HED KP.

⁵Department of Plant Sciences, Quaid-i-Azam University, Islamabad, Pakistan.

*Corresponding Author: hazratlibotanist@gmail.com

Ethnobotany Research and Applications 34:5 (2026) - <http://dx.doi.org/10.32859/era.34.5.1-27>

Manuscript received: 18/08/2025 - Revised manuscript received: 02/04/2026 - Published: 03/04/2026

Research

Abstract

Background: Plants have been an integral part of human history as a source of traditional medicines. In spite of their extensive usage, ethnomedicinal plants (EMPs) of Malakand District, which is well-known for its floristic diversity, has yet to be explored. This research documented the EMPs employed by local communities to conserve indigenous knowledge and recognize plant species having therapeutic values.

Methods: Field surveys were carried out at different locations of District Malakand during the summer and spring seasons of 2018-2019. Data on the EMPs were collected through interviews with 220 local informants using semi-structured questionnaires and open group discussion. Different ethnobotanical indices like informant consensus factor (ICF), fidelity level (FL), relative frequency of citation (RFC), consensus index (CI) and use values (UVs) were used for quantitative analysis of ethnomedicinal data.

Results: In this study, 74 ethnomedicinal plant species, representing 65 genera and 42 families were reported. The predominant plant families included Fabaceae, Lamiaceae, Asteraceae, Berberidaceae, Apocynaceae, and Solanaceae. Based on the growth habits, herbs were the frequently used life form representing 38 species. Most of the EMPs were employed in the treatment of gastrointestinal disorders (38 species), skin disorders (23 species), and as analgesics (22 species). Leaves were the frequently used part, with pastes being the usual preparation method and oral route being the principal method of administration. The highest ICF values were found for wounds/cuts (0.65) and diabetes (0.63). *Mentha longifolia* and *Justicia adhatoda* had the highest FL values, while *Dodonaea viscosa*, *Berberis lycium*, and *Calotropis procera* exhibited the highest values for RFC, CI, and UV.

Conclusions: The findings highlight a diverse ethnomedicinal heritage of Malakand and offers significant pharmacological potential of EMPs for future studies.

Keywords: Medicinal flora; indigenous uses; quantitative indices; Malakand; Pakistan

Background

Plants have played a critical role throughout the history of humankind, as they have been the basic sources of medicine, especially in remote regions where modern health is unavailable or is limited. In most societies, herbal medicine is still the dominant source of healthcare because it is affordable and is culturally meaningful (Niazi and Monib 2024). Traditional healers and family-based health systems are still delivering primary healthcare services throughout the globe. This dependence is influenced not just by availability but also by the efficacy and cultural importance of plant treatments. Traditional medicines involve knowledge, skills and practices to prevent and treat diseases and promote healthcare practices (Che *et al.* 2024). There are about 35,000 to 70,000 plant species, recognized to have medicinal properties worldwide (Azmi 2017), testifying to their enormous pharmacological potential.

Ethnomedicinal knowledge constitutes an essential component of traditional healthcare systems worldwide, particularly in rural regions where access to modern medical facilities remains limited. Medicinal plants (MPs) served as primary therapeutic resources for a substantial proportion of the global population and contributed significantly to drug discovery and pharmacological development (Qureshi *et al.* 2016; Mercy and David 2018). Indigenous knowledge allows the effective and safe application of medicinal plant as traditional practitioners are familiar with the preparation, dosage, and therapeutic use of herbal medicine (Marcus 2010; Benarba 2016). Several ethnomedicinal studies have been carried out worldwide (Dube *et al.* 2025; Sylver-Francis and Pelkonen 2025; Ulhaq *et al.* 2025; Rajoo *et al.* 2025) reflect the universal applicability of traditional medicines.

Pakistan harbors a rich diversity of medicinal plants species and long standing ethnomedicinal traditions. Several studies have been carried out in different parts of Pakistan (Shinwari 2010; Wali and Akhtar 2017; Amjad *et al.* 2017; Jan *et al.* 2017; Zaman and Badshah 2019; Umair *et al.* 2019; Majid *et al.* 2019; Bahadur *et al.* 2020). The local communities of the adjacent districts such as Swat (Ahmad *et al.* 2014; Ali *et al.* 2023; Shah *et al.* 2024), Dir (Ullah *et al.* 2020; Irfan *et al.* 2023), Bajaur (Haq *et al.* 2023; Ali *et al.* 2025), and Buner (Jan *et al.* 2022; Sulaiman *et al.* 2020), highlighting the importance of indigenous knowledge in supporting healthcare practices of the local communities.

As indigenous ethnomedicinal knowledge is highly localized and shaped by distinct cultural traditions and plants availability. Therefore findings from the adjacent districts can't be generalized across regions without localized investigations. Consequently systematic documentation and quantitative evaluation of plants have become increasingly important for safeguarding biocultural heritage and supporting evidence based research. Therefore, the present study aimed to comprehensively document the EMPs used by indigenous communities of Malakand district and to quantitatively evaluate their cultural importance using standard ethnobotanical indices. By integrating qualitative documentation with quantitative analysis and regional comparison, this study provides novel baseline data to contribute in biocultural conservation, sustainable resource management and future pharmacological investigation for drug discoveries.

Materials and Methods

Study area

This study was carried out in District Malakand. It is situated in the northern part of Pakistan and is a region of geographical and cultural importance. Malakand lies at an average elevation of 824 m a.s.l., between 34°22' -34°41' N latitude and 71°37' -72°14' E longitude. It has an approximate area of 952 square kilometers. The population density of the area is 596 individuals per square kilometer. Malakand is bordered by District Dir (Lower) to the north side, District Swat to the northeast side, District Buner to the east side, and Districts Mardan and Charsadda to the south side. It shares its western boundaries with Mohmand and Bajaur districts (Fig. 1). The valley includes both plain and hilly land, rich in biodiversity (Iqbal *et al.* 2015; Ali *et al.* 2022; Ali *et al.* 2023). This region has a dry climate with not enough rainfall, characterizing a subtropical zone. The winters are cold, and summers, particularly June to August, are hot. This climate fluctuation sustains a variety of ethnomedicinal plant species that have now become an essential part of the traditions and health practices of the local inhabitants of Malakand.

Ethnomedicinal information

Field explorations were carried out in the mentioned places of district Malakand (Table 1, Fig. 1). Data were collected during the spring and summer seasons of 2018-2019, when most medicinal plants are actively growing and easily identifiable. Information regarding ethnomedicinal profile of the valley was obtained through semi-structured interviews and open group discussion with the local people after their prior informed consent. All interactions were conducted in Pashto, the native language of the informants, to ensure clear communication and accurate documentation of traditional knowledge. During

fieldwork, information on plant local names, parts used, preparation methods, administration, and indigenous uses was systematically documented. When contradictory information arose regarding ethnomedicinal plant species, their availability, or preparation methods, it was carefully documented. Follow-up probing questions were used to clarify these differences and ensure consistency and accuracy.

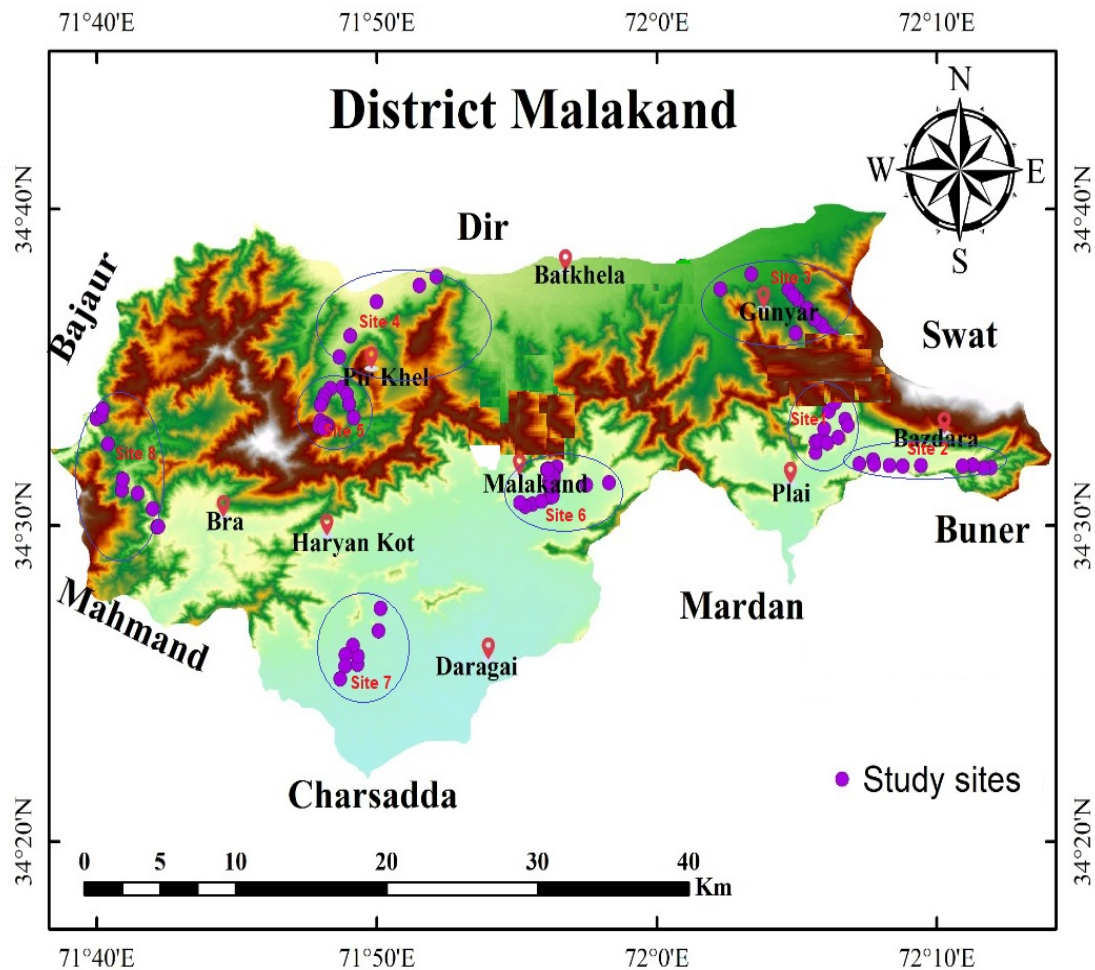


Figure 1. Locational map of District Malakand with study sites (Sites names are given in Table 1).

Plant collection and identification

Plants specimens were collected from different localities, dried and preserved properly. Plant specimens were identified using the taxonomic references from the Flora of Pakistan (Nasir & Ali, 1971-1989; Ali and Nasir, 1989-1991; Ali & Qaiser, 1991-2019). The naming of plants was confirmed following the International Plant Name Index (<https://www.ipni.org>).

Table1. Elevation and geographical coordinates data of the study sites, District Malakand.

Sites	*Elevation (m a.s.l)	*Geographic coordinates	
		North latitude	East longitude
1. Palai	494-531	34.538486-34.566793	72.094491-72.113713
2. Bazdara	496-660	34.530209-34.534506	72.120600-72.198706
3. Thana	670-800	34.601248-34.636570	72.003585-72.093846
4. Totakan	612-675	34.556878-34.631025	71.805873-71.868756
5. Baika-Chapal	690-1110	34.551081-34.568990	71.798991-71.804385
6. Wartair	468-517	34.510071-34.530854	71.918738-71.971611
7. Palonao	430-454	34.419211-34.482823	71.811648-71.867221
8. Dheri-Kandao	501-688	34.49932-34.561230	71.666670-71.703456

Data Analysis

The traditional knowledge of ethnomedicinal plants were analyzed quantitatively through different ethnobotanical indices as follows:

Family Importance Value (FIV)

This is a quantitative index measuring the relative culture importance of plant families based on their reported ethnomedicinal plant species. The FIVs were determined according to the formula below as applied by Ali *et al.* 2018.

$$FIV = \frac{FC \text{ (Family)}}{N} \times 100$$

Here, FC represents frequency of citation of the plant family, and N denotes the total number of informants in the study.

Relative Frequency of Citation (RFC)

This is the quantitative value that indicates the local importance of a species. RFC was determined using the method employed by Vitalini *et al.* 2013.

$$RFC = \frac{FC}{N} \quad RFC = (0 < RFC < 1)$$

FC refers to the informants who reported traditional use of the plant species, while N indicates the total informants involved in the study.

Informant Consensus Factor (ICF)

This factor examines the local people's consensus and utilization of plants for different categories of ailments. It was determined using the following formula (Bhat *et al.* 2014) as

$$ICF = \frac{Nur - Nt}{Nur - 1}$$

Here, Nur is the overall count of use reports for a given disease category and Nt is the count of plant species reported for that category by all informants.

Fidelity Level (FL)

This index measures the degree of specificity of plant species for a particular ailment. The value of fidelity was calculated using the following formula (Alexiades & Sheldon 1996).

$$FL = \frac{Ip}{Iu} \times 100$$

Here, Ip indicates the informants who cited the use of a plant species for a specific disease, while Iu refers to the total informants who mentioned the same plant for any ailment.

Consensus Index (CI)

This measure assesses the extent of informant agreement concerning the use of plants for a given ailment. CI was computed according to the following formula (Khan and Ahmad 2015).

$$CI = \frac{n}{N} \times 100$$

Where n is total informants referred medicinal plant species and N stands for total respondents of the study.

Use Value (UV)

This index determines the relative value of every medicinally used species depending on the relative use by the respondents. It was computed following the standard method (Phillips *et al.* 1994) as,

$$UV = \frac{\sum U_i}{N}$$

Here, U_i represents the number of use-reports given by a single informant, whereas, N is the number of informants interviewed about a particular plant species.

Results and Discussion

Demographic distribution of local respondents

In the current study a total of 220 randomly selected native people were interviewed to collect information about the indigenous utilizations of EMPs by local communities. Among the participants, them, 204 (93%) were male, whereas 16 (7%) were female. The marked predominance of male respondents reflects prevailing sociocultural norms and gender-related constraints within the study area. In particular, cultural practices restrict direct communication between women and unrelated male individuals, thereby limiting female participation in formal data collection for ethnomedicinal purposes. Based on the age, the highest proportion of respondents (30%) were in the age of 51-60 years followed by 25% in the age of 41-50 years and 20% in the age of 61-70 years. The respondents in the age of 31-40 years were 21%, while a small proportion (4%) of respondents was observed among younger participants (aged up to 30 years). This age distribution reflects generational differences in healthcare preferences. Younger individuals are more inclined toward allopathic medical treatments, potentially due to modernity of lifestyle and contemporary healthcare systems. Regarding the educational background, 95 respondents (43%) were illiterate. All participants were Muslims of Pashtun ethnicity, and Pashto was their native language (Table 2). These demographic patterns suggest that ethnomedicinal knowledge is largely maintained and transmitted by elderly members of the community, many of whom have limited formal education.

Table 2. Demographic profile of respondents (N=220) in District Malakand, Pakistan.

Parameter	Demographic category	Respondents number	% age
a. Gender	(i) Female	16	7
	(ii) Male	204	93
b. Religion (Muslims)		220	100
c. Language (Pashto)		220	100
d. Age groups	(i) Up to 30 years	9	4
	(ii) 31 to 40 years	46	21
	(iii) 41 to 50 years	54	25
	(iv) 51 to 60 years	65	30
	(v) 61 to 70 years	43	20
	(vi) 71 to 80 years	3	1
e. Education	(i) Illiterate	95	43
	(ii) Primary level	28	13
	(iii) Middle level	34	15
	(iv) Metric level	32	15
	(v) Above	31	14

Diversity of Ethnomedicinal Plants (EMPs)

In the present study, a total of 74 ethnomedicinal plants (EMPs) belonging to 65 genera of 42 different families were documented. Substantial ethnobotanical variation has been documented across Pakistan, reflecting their central role in maintaining traditional knowledge. Haq *et al.* (2023) recorded 77 plant species from 46 families in Arang Valley, Bajaur. Shah *et al.* (2024) documented 153 plant species belonging to 63 in Sakhra Valley, Swat. Shariat *et al.* (2025) recorded 46 medicinally important plants belonging to 28 families in Khar, Bajaur. Similarly, Wang *et al.* (2025) documented 39 medicinal plant species from 19 families in Tehsil Hasilpur, Punjab. All these studies underscore the dynamic interrelationship of traditional healthcare practices in local communities and ethnobotanical flora, emphasizing their mutual dependence and cultural significance.

Depending upon the plant habit, local people used herbs (38 species) in ethnomedicines (Table 4). The people also used shrubs and trees as ethnomedicines to treat many diseases. Both of these utilized 24% each. Previous studies from Malakand (Ullah *et al.* 2018; Zeb *et al.* 2022; Ibrahim *et al.* 2023) consistently reported herbs as the dominant growth forms followed by trees and shrubs, indicating the predominance of herbaceous species utilized as ethnomedicines in the region. The ethnomedicine uses of herbs, shrubs and trees had also been documented by various workers in other parts of Pakistan (Umair *et al.* 2019; Bahadur *et al.* 2020; Zaman and Badshah 2019), reflecting their integral role in indigenous healthcare system. As herbs hold great diversity, thus it is presumed that the more widespread the plant is, the greater the therapeutic

significance it could have (Shrestha and Dhillion 2003). Herbs are more effective and efficient for drug utilization and are widely utilized by traditional healers (Uniyal *et al.* 2006). This makes herbs not only a vital component of ethnomedicine but also a promising resource for future pharmacological exploration. Herbs, due to its considerable diversity possess greater therapeutic significance (Shrestha and Dhillion 2023). Owing to their effectiveness and accessibility, herbs are extensively utilized by traditional healers for medicinal purposes (Uniyal *et al.* 2006). Consequently, herbs represent a fundamental component of ethnomedicine and a valuable resource for future pharmacological research.

Dominant Families

Based on family importance values (FIVs), Fabaceae was the dominant family (FIV, 18.57) followed by Lamiaceae (15.57), Asteraceae (9.58), Berberidaceae (9.58) and Solanaceae (7.19) among total of 42 families (Table 4, Fig. 2). Previous studies in Malakand have reported varying dominant families. Nazli *et al.* (2022) identified Asteraceae, Solanaceae and Fabaceae as the most prevalent, while Zeb *et al.* (2022) recorded Lamiaceae, Poaceae, Euphorbiaceae, Moraceae and Polygonaceae as dominant. The reported dominant families are widely distributed in nature (Chittibabu and Parthasarathy 2000; Wali and Akhtar 2017; Dorni *et al.* 2017; Zaman and Badshah 2019) and are important in traditional medicine due to their rich phytochemical composition. Asteraceae species contain flavonoids and phenolic acids, exhibiting anti-inflammatory, analgesic, and antioxidant activities (Sharma *et al.* 2022). Apocynaceae species are alkaloid-rich and possess cardiotoxic and anticancer properties, while Solanaceae species possess alkaloids with potent anticholinergic effects (Ghuge *et al.* 2023).

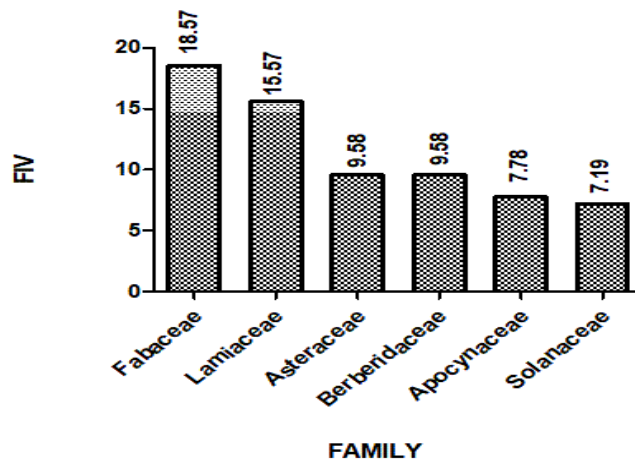


Figure 2. Dominant plant families based on family importance values (FIV) in District Malakand, Pakistan.

Plant parts used

The present study documented various plant parts that are being used by folklores for preparation of traditional remedies (Table 4). The findings revealed that leaves (28%) were the frequently utilized plant part, followed by fruits (25%), seeds (12%) and whole plant (11%) respectively. The other notable plant parts were shoots (8%), twigs (5%), and gum/latex/resin (4%), while pods (3%), flowers (2%), roots (1%) and barks (1%) were also used (Fig. 3). Compared with previous ethnobotanical investigations conducted at the same site, notable differences with minor similarities can be observed. Ibrahim *et al.* (2023), reported whole plant, followed by leaves and fruits as the most commonly used component in crude drug preparation. Similarly, Zeb *et al.* (2022) documented leaves followed by roots and fruits, while Ullah *et al.* (2018) documented leaves followed by whole plant and fruits as the dominant plant parts. The findings from the current study indicate a clear predominance of leaf-based preparation of traditional remedies as recorded by several researchers in their studies (Ijaz *et al.* 2015; Rahman *et al.* 2016; Khan *et al.* 2018; Zaman and Badshah 2019; Bahadur *et al.* 2020). This consistency may reflect factors such as availability, ease of harvest, and high concentration of bioactive compounds typically present in leaves.

Methods of preparation of herbal remedies

In traditional medicines, the particular method of preparation and administration of the remedies is very vital. The present study identified paste as the predominant method of herbal preparation (22 species), followed by raw use (18 species), decoction (16 species), juice and powder (10 species each) and roasted forms (7 species) (Fig. 4). The preference for paste and raw preparations as documented in several studies (Kichu *et al.* 2015; Amjad *et al.* 2017) suggests reliance on simple minimally processed remedies that preserve fresh plant constituents and allow rapid application. In contrast to the present

study, Ibrahim *et al.* (2023), reported decoction followed by infusion as the principal preparation methods. Similarly, Zeb *et al.* (2022) documented concoction, infusion and decoction, while Ullah *et al.* (2018) documented decoction, powder and infusion as the dominant methods. Compared to these findings, the present study indicates a relative shift from heat-based extraction towards more direct preparation methods.

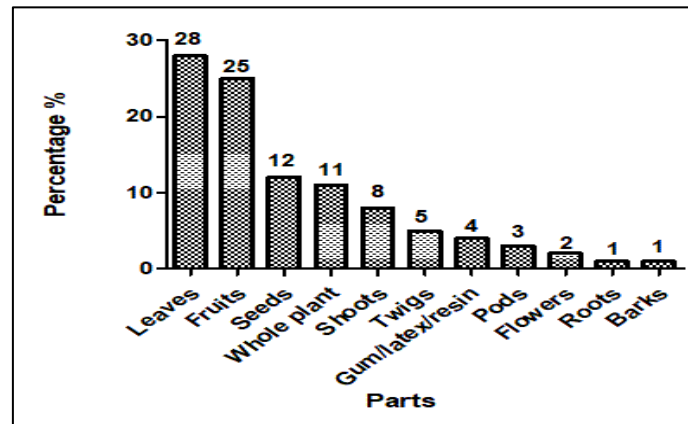


Figure 3. Percentage of plant part used as herbal remedies in District Malakand, Pakistan.

Methods of administration of herbal remedies

Among the various modes of remedy administration documented in this study, oral intake emerged as the most prevalent route, involving 46 species. This was followed combined oral and topical use (16 species), and exclusively topical application (12 species) (Fig. 5). These findings are consistent with previous studies from the same region (Ibrahim *et al.* 2023; Ullah *et al.* 2018), reinforcing the central role of oral delivery in regional traditional healthcare practice. Several species-based examples illustrate the dual pattern of administration. The leaf paste of *Eremostachys superba* the leaves paste is applied topically to treat burns, reduce swelling, and promote wound healing. A decoction prepared from the leaves of *Justicia adhatoda* is consumed orally to aid digestion. Likewise, for wound care and inflammatory conditions, topical paste of *Verbascum thapsus* and *Datura innoxia* are applied directly to the affected areas of the body. The oral as well as topical application reflects therapeutic strategy targeting both systemic and localized ailments consistent with established ethnomedicinal practices (Ijaz *et al.* (2015; Ali *et al.* 2018).

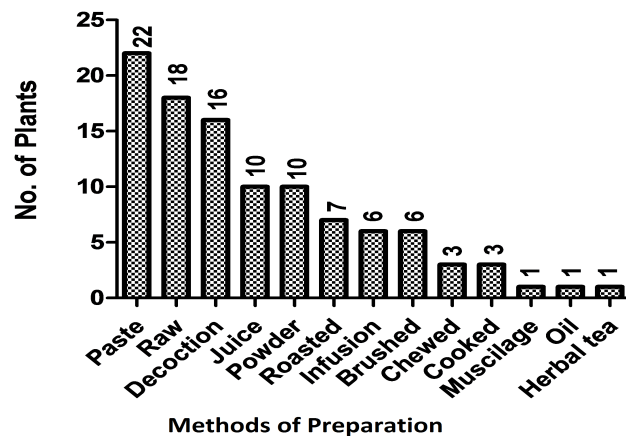


Figure 4. Methods of preparation of herbal remedies of EMPs in District Malakand, Pakistan.

Informant Consensus Factor (ICF)

In the current study, overall sicknesses which were treated by locals using EMPs were grouped under 17 categories. For these sicknesses, ICF values varied from 0.02 to 0.65 (Table 3). The maximum ICF value (0.65) was calculated for wounds and cuts. Diabetes, cough and asthma and rheumatism also scored high values of 0.63, 0.60 and 0.53 respectively. Similarly, high ICF values were described in other studies (Ahmad *et al.* 2017; Khan *et al.* 2020; Muhammad *et al.* 2020). The previous study in Malakand (Ibrahim *et al.* 2023) recorded the highest ICF values for cardiovascular and hypertensive diseases (1.0) followed by sore throat and narcotic diseases (0.80). Another study from Wartair, Malakand (Ullah *et al.* 2018), revealed that the maximum Informant Consensus Factor (ICF) values were for cardiovascular diseases (0.82), sore throat disease (0.81), and

skin disease (0.70). Muhammad *et al.* 2016 recorded high ICF values (0.99) for skeletomuscular and respiratory systems disorders. Ayub *et al.* (2023) recorded high ICF values for diabetes (0.91) followed by anticancer (0.89) and muscular diseases (0.88). The results on ethnomedicines related to ICF reflected the heavy reliance on traditional knowledge for the handling of diverse ailments. The ICF values in the current research showed clear consensus among informants for the effectiveness of certain ethnomedicinal plants.

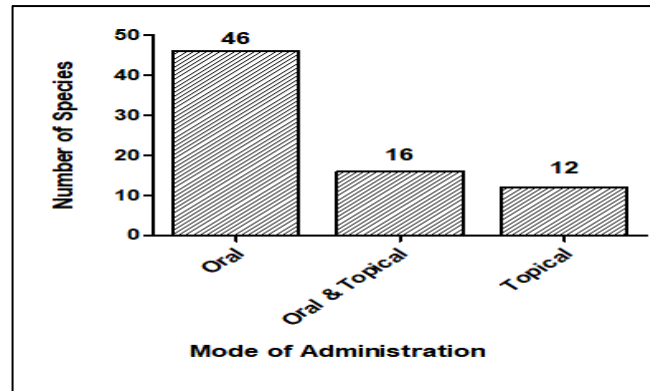


Figure 5. Methods of administration of remedies of EMPs in District Malakand, Pakistan.

Table 3. Informant consensus factor (ICF) values recorded for various ailments.

Ailments	Nur	Nt	IFC
Anthelmintic	12	8	0.36
Anti-diabetic	20	8	0.63
Anti-poisons	4	3	0.33
Brain disorders	4	3	0.33
Cough and asthma	21	9	0.60
Flu and fever	10	6	0.44
Gastrointestinal problem	121	81	0.33
Gynecological problems	3	2	0.50
Heart problems	18	12	0.35
Jaundice	11	9	0.20
Kidney disorders	17	13	0.25
Mouth problems	23	14	0.41
Painkillers	53	26	0.52
Potent, aphrodisiac and tonic	32	22	0.32
Rheumatism	16	8	0.53
Skin problems	48	34	0.30
Wounds and cuts	56	20	0.65

Fidelity Level (FL)

In the present study, the highest FL values were recorded for *Mentha longifolia* (gastrointestinal disorders) and *Justicia adhatoda* (anthelmintic use), achieving complete consensus (100%). Other species with high FL values included *Phoenix sylvestris* (80%) as potent, aphrodisiac and tonic, *Dodonaea viscosa* (68%) for wounds and cuts, *Opuntia dillenii* (60%) as anti-rheumatic, *Mirabilis jalapa* (57%), *Caralluma tuberculata* and *Dochesnea indica* (50%) each (Fig. 6). The high FL values of the mentioned species sustain cultural and therapeutic prominence (Umair *et al.* 2017; Majid *et al.* 2019; Bahadur *et al.* 2020; Ralte *et al.* 2024). Previous studies from the same study site reported high FL values for different species. Muhammad *et al.* (2016) recorded high FL values for *Dodonaea viscosa* and *Vitex negundo*, while Ibrahim *et al.* (2023) documented high values for *Allium sativum*, *Caralluma tuberculata* and *Mentha spicata*. Similarly, Ayub *et al.* (2023) identified *Amaranthus viridis*, *Rumex hastatus* and *Eucalyptus camaldulensis*, and Ullah *et al.* (2018) reported *Acacia modesta*, *Cannabis sativa*, and *Ricinus communis* as significant species. The FL pattern of the present study in comparison with previous studies suggests that the use of plants is dynamic and shaped by local knowledge, cultural practices and plants availability.

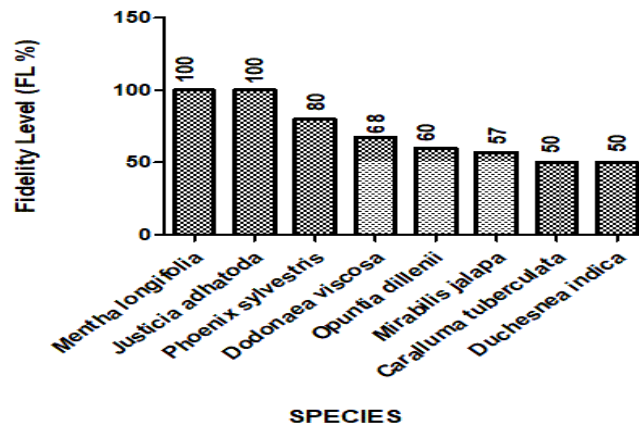


Figure 6. Highest fidelity level values of ethnomedicinal plants in District Malakand, Pakistan.

Relative Frequency of Citation (RFC)

Relative Frequency of Citation (RFC) serve as indicator of the cultural and medicinal prominence of specific plant species within a community (Upadhyay 2014; Umair *et al.* 2017; Ahmad *et al.* 2017; Malik *et al.* 2018; Sharma *et al.* 2024). In the present study, *Dodonaea viscosa*, *Berberis lyceum* and *Calotropis procera* exhibited the highest RFC values of 0.09, 0.07, and 0.05 respectively (Fig. 7), reflecting their widespread recognition and utilization by traditional healers. Previous studies in Malakand region have reported varying pattern of ethnomedicinal plant citation. Barkatullah *et al.* (2015) identified *Berberis lyceum*, *Plantago major*, and *Mirabilis jalapa* as the frequently cited species by local informants. Similarly, Nazli *et al.* (2022) documented *Caralluma tuberculata*, *Cestrum nocturnum*, and *Jasminum officinale* species with high RFC values, while Ayub *et al.* (2023) reported the highest RFC values for *Morus alba*, *Verbesina encelioides*, and *Quercus baloot*. The variation in RFC values across studies highlights the dynamic and context-dependent nature of ethnomedicinal practices.

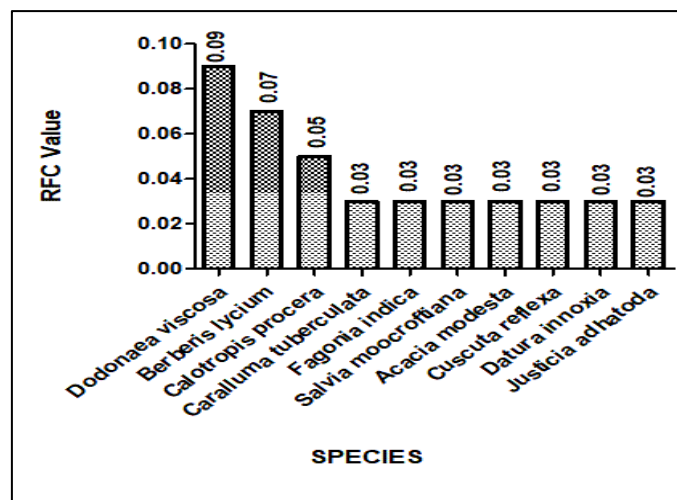


Figure 7. Highest relative frequency of citation (RFC) values of ethnomedicinal plants in District Malakand, Pakistan.

Consensus Index (CI)

The consensus index (CI) reflects the agreement among informants regarding the medicinal use of specific plants. In the present study, the CI values ranged from 14% to 91% (Table 4), with *Dodonaea viscosa* (91%), *Berberis lyceum* (73%) and *Calotropis procera* (46%) exhibiting the highest consensus (Fig. 8). The other important species included *Caralluma tuberculata*, *Fagonia indica*, *Salvia mocroftiana* each with CI value of 32%. Similarly, *Acacia modesta*, *Cuscuta reflexa*, and *Justicia adhatoda* (27%, each) were the next important species. These results indicate strong agreement on their therapeutic efficacy. Previous studies from various regions of Pakistan have highlighted the ethnomedicinal significance of different plant species based on Consensus Index. In Kaghan Valley, Akhtar *et al.* (2021) reported highest CI values for *Bergenia ciliata*, *Silybum marianum* and *Valeriana jatamansi*. Similarly, in Shishi Koh valley, Chitral, Wali *et al.* (2021) observed the highest CI values for *Prunus armenica* and *Rumex hastatus*, while in Kuz Abakhel Valley, Swat, Muhammad *et al.* (2021) recorded maximum CI values for *Aesculus indica* and *Ajuga bracteosa*. The documented plants with high CI values suggest that these

plants are integral to local healthcare practices, reflecting deep-rooted cultural beliefs and practices (Bhat *et al.* 2013; Rahman *et al.* 2016; Jan *et al.* 2017; Muhammad *et al.* 2020; Sharma *et al.* 2024). Such species play prime role in pharmacological investigation, with potential implication for novel drug development.

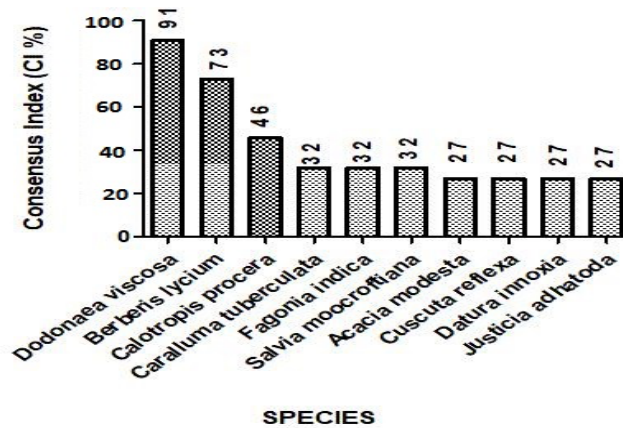


Figure 8. Highest consensus index (CI) values of ethnomedicinal plants in District Malakand, Pakistan.

Use Values (UVs)

The Use Values (UVs) of ethnomedicinal plants provide valuable insights into their significance in traditional healthcare practices. In the present study, the UVs varied considerably (Table 4), with *Dodonaea viscosa* exhibiting the highest value (0.17). The other species with high UVs included *Berberis lycium* (0.12), *Cuscuta reflexa* (0.07), *Mentha longifolia* (0.07), *Calotropis procera* (0.06), *Mentha arvensis* (0.06), *Salvia moolcroftiana* (0.06), *Caralluma tuberculata* (0.05), *Fagonia indica* (0.05) and *Punica granatum* (0.05) respectively (Fig. 9). These findings highlighting the species frequently utilized and valued by local communities. In contrast, previous studies in Malakand reported variable UVs for different plant species. Barkatullah *et al.* (2015) identified *Plantago major*, *Ajuga bracteosa* and *Mirabilis jalapa* as the species with highest use values. Similarly, Nazli *et al.* (2022) reported the highest use values for *Cucuta reflexa*, *Acacia modesta* and *Acacia nilotica* while, Ayub *et al.* (2023) documented maximum use values for *Cyperus esculentus*, *Caralluma adscendens* var. *fimbriata*, and *Justicia adhatoda*. The high values reported for the plants species might be due to their wide range of distribution and awareness of the indigenous people who prescribed these plants as first choice for the treatment of ailments.

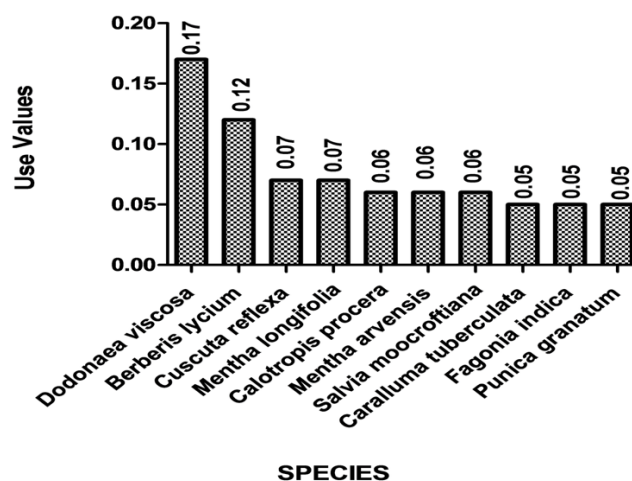


Figure 9. Highest use values (UVs) of ethnomedicinal plants in District Malakand, Pakistan.

Ailments treated with ethnomedicinal plants

In this study, the documented ethnomedicinal plants (EMPs) were used to manage 17 categories of ailments (Fig. 10). Gastrointestinal disorders represented the most treated category (38 species), followed by skin diseases (23 species) and pain killer (22 species). Other therapeutic categories included wounds and cuts (18 species), mouth problems (18 species), potent, aphrodisiac and tonic (17 species), kidney disorders (15 species), heart problems (11 species), cough and asthma (9

species), jaundice (9 species), antidiabetic (8 species), rheumatism (8 species), anthelmintic applications (8 species), flu and fever (5 species), brain problems (2 species), anti-poisons (2 species), and gynecological problems (2 species). Further details regarding the uses of ethnomedicinal plants are presented in table 4. Comparatively, the pattern of EMPs utilization in the present study differs from the previous studies. Alamgeer *et al.* (2013) reported diuretic, diarrhea and diabetes as the most treated ailment categories. Similarly, Zeb *et al.* (2022) recorded dysentery, diarrhea and stomachache as the primary ailments treated by local inhabitants, while Barkatullah *et al.* (2015) revealed wound healing as the prominent applications.

In the present study, several plant species with ethnomedicinal significance were documented for the first time from the study site. Species reported for gastrointestinal disorders included *Argyrobolium roseum*, *Asphodelus tenuifolius*, *Cordia myxa*, *Coronopus didymus*, *Duchesnea indica* and *Pyrus pashia*. Plants with analgesic potential included *Ailanthus altissima*, *Debregeasia salicifolia*, and *Tribulus terrestris*. For wounds and cuts, *Rhynchosia minima*, and *Eremostachys superba* were reported. Species used for mouth disorders were *Acacia modesta*, *Adiantum capillus-veneris*, *Allium griffithianum*, *Tribulus terrestris* and *Ziziphus mauritiana*. Plants recognized for their tonic and aphrodisiac properties included *Argyrobolium roseum*, *Asparagus gracilis*, *Cordia myxa*, *Duchesnea indica*, *Myrsine africana*, *Phoenix sylvestris* and *Pyrus pashia*. Species useful for kidney and urinary disorders included *Asparagus gracilis*, *Citrullus lanatus*, *Cucumis melo var. agrestis*, *Lespedeza juncea*, *Micromeria biflora* and *Tribulus terrestris*. *Cucumis melo var. agrestis*, *Citrullus lanatus*, and *Coronopus didymus* were documented for skin complications. Plants used for respiratory disorders included *Lathyrus aphaca*, *Phyllanthus emblica*, *Vicia monantha* and *Vicia sativa*. The other important plants species documented were *Citrullus lanatus*, *Cucumis melo var. agrestis*, *Fagonia indica* for antidiabetic potential, *Duchesnea indica* and *Myrsine africana* for cardiac applications, *Tagetes minuta*, *Artemisia vulgaris* and *Rhynchosia minima* for anthelmintic properties.

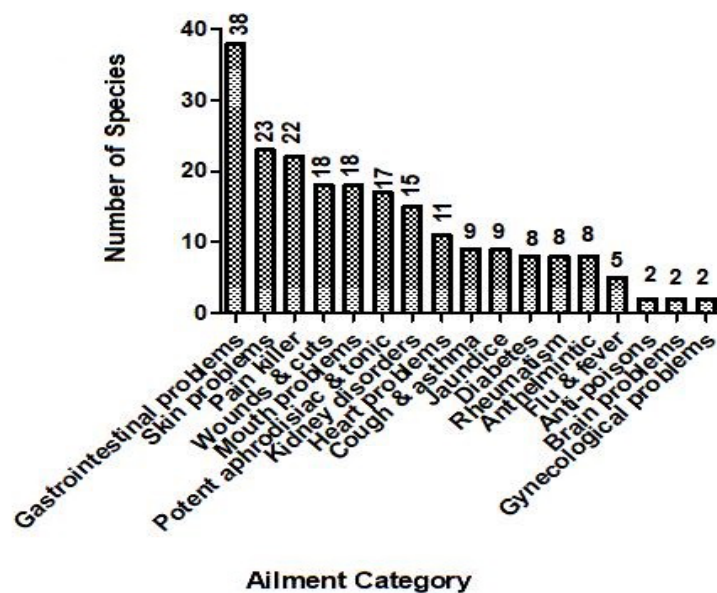


Figure 10. Disease classes treated with ethnomedicinal plants in District Malakand, Pakistan.

In the present study, several plant species were documented with distinct therapeutic applications within the study area. Latex of *Calotropis procera* was used topically for spine removal, complementing its known roles in wound healing and pain relief. *Carthamus lanatus* showed anthelmintic use, while *Carthamus oxyacantha* was applied for cardiac disorders beyond its previously reported gastrointestinal uses (Barkatullah *et al.* 2009; Alamgeer *et al.* 2013). *Berberis lycium* acted as a blood purifier, *Opuntia dillenii* was used for bruises and scars, and *Cannabis sativa* for cooling and insect-repellent effects, expanding on prior pharmacological uses as antispasmodic effects, managing anxiety and depression (Barkatullah and Ibrar 2011; Barkatullah *et al.* 2015; Gulzar *et al.* 2019; Ayub *et al.* 2023). *Equisetum arvense* demonstrated antidiabetic relevance, *Justicia adhatoda* served as a natural insect repellent. Gum of *Acacia modesta* was used for flu, *Olea ferruginea* as an aphrodisiac, *Sageretia thea* as a diuretic, *Rubus fruticosus* for sore throat, *Monotheca buxifolia* as a blood purifier and aphrodisiac, and *Bergenia ciliata* for bruises, boils, and wound healing apart of its previously reported use as diuretic and kidney stone removal (Ayub *et al.* 2023). These findings reveal novel and expand therapeutic applications, reinforcing the pharmacological potential of these species and emphasizing the importance of preserving indigenous medicinal knowledge.

Table 4. Indigenous uses and quantitative indices of ethnomedicinal plants (EMPs) in District Malakand.

Family/Species/ Voucher number	Vernacular name	Habit	Indigenous Uses	Available Literature	Part Used	Remedy Administration	Remedy Preparation	FIV	CI%	RFC	UV
Acanthaceae								3.59			
<i>Justicia adhatoda</i> L. /H.Ali Bot. (610) PUP	Biakar	Shrub	The leaf extract has been used to ease stomach pain. The paste is known for pain relieving properties. The smoke produced by burning the leaves acts as natural insect repellent	Murad <i>et al.</i> 2011-2012; Alamgeer <i>et al.</i> 2013; Muhammad <i>et al.</i> 2016; Ibrahim <i>et al.</i> 2023	Leaves	Oral, topical, volatile eminent	Decoction, paste, burn	27	0.03	0.03	
Adiantaceae								1.80			
* <i>Adiantum capillus-veneris</i> L. /H.Ali Bot. (342) PUP	Bandokay	Herb	Fronds act as natural remedy for dental plaque. Infusion from fresh fronds provides anti-diabetic and anti-asthmatic benefits	-----	Fronds	Brush, oral	Raw, infusion	14	0.01	0.02	
Alliaceae								1.80			
* <i>Allium griffithianum</i> Boiss. /H.Ali Bot. (101) PUP	Piazakay	Herb	Powder of the whole plant is used as anticold, antipyretic, anthelmintic, in mouth sores, in jaundice, and also controls blood pressure	-----	Whole plant	Oral	Powder	14	0.01	0.03	
Apocynaceae								7.78			
<i>Caralluma tuberculata</i> N. E. Brown /H.Ali Bot. (80) PUP	Pamankay	Herb	Infusion of the fresh plant is effective in diabetes	Alamgeer <i>et al.</i> 2013; Nazli <i>et al.</i> 2022; Ibrahim <i>et al.</i> 2023	Whole plant	Oral	Infusion	32	0.03	0.05	
<i>Nerium oleander</i> L. /H.Ali Bot. (84) PUP	Gandecher	Shrub	Topical application of fresh leaf paste is helpful for reducing swelling and pain. Decoctions made from leaves relieve toothaches and help with gingivitis	Murad <i>et al.</i> 2011-2012; Ullah <i>et al.</i> 2018; Ibrahim <i>et al.</i> 2023	Leaves	Topical, oral	Paste, decoction	14	0.01	0.02	
<i>Rhazya stricta</i> Decne. /H.Ali Bot. (74) PUP	Ganderay	Shrub	Leaf paste is antirheumatic and analgesic	Sher, 2011; Murad <i>et al.</i> 2012; Ullah <i>et al.</i> 2018; Ibrahim <i>et al.</i> 2023	Leaves	Topical	Paste	14	0.01	0.01	
Arecaceae								1.80			
* <i>Phoenix sylvestris</i> (L.) Roxb. /H.Ali Bot. (02) PUP	Kajoora	Tree	Fruits in raw form are quite effective and known for their potency, aphrodisiac and anti-pyretic properties	-----	Fruits	Oral	Raw	14	0.01	0.02	

Asclepiadaceae										5.99
<i>Calotropis procera</i> (Willd) R. Br. /H.Ali Bot. (192) PUP	Spalmai	Shrub	Warm leaf paste is used to treat abscesses, promote wound healing, and relieve pain. Crushed leaf poultices are applied to relieve rheumatic pain. Topical use of latex assists to facilitate the removal of spines from the skin	Barkatullah <i>et al.</i> 2009; Murad <i>et al.</i> 2011-2012; Barkatullah <i>et al.</i> 2015; Nazli <i>et al.</i> 2022; Ayub <i>et al.</i> 2023	Latex, Leaves	Topical	Paste, juice	46	0.05	0.06
Asparagaceae										1.80
* <i>Asparagus gracilis</i> Royle /H.Ali Bot. (179) PUP	Teendona y	Herb	Young sprouted fresh shoots when cooked in milk, act as body tonic, demulcent, aphrodisiac and is an effective remedy for urinary problems	-----	Shoots	Oral	Cooked	14	0.01	0.02
Asphodelaceae										2.40
* <i>Asphodelous tenuifolius</i> Cav. /H.Ali Bot. (201) PUP	Piazay	Herb	Seed paste is believed to have diuretic properties and is also used to treat wounds, swelling, and piles. The decoction made from the roots and leaves can be beneficial for jaundice	-----	Whole plant	Oral, topical	Paste, decoction	18	0.02	0.03
Asteraceae										9.58
<i>Carthamus lanatus</i> L. /H.Ali Bot. (102) PUP	Kareza	Herb	Roasted seed are employed for their anti-diuretic and anthelmintic properties as well as for relieving stomach pain	Barkatullah and Ibrar 2011; Barkatullah <i>et al.</i> 2015	Seeds	Oral	Roast	14	0.01	0.02
<i>Carthamus oxycantha</i> M. Bieb. /H.Ali Bot. (96) PUP	Kareza	Herb	Roasting seeds in oil and mixing them with sugar work as a natural laxative, relieve stomach discomfort and ulcers and are considered beneficial for heart disorders	Barkatullah <i>et al.</i> 2009; Alamgeer <i>et al.</i> 2013	Seeds	Oral	Roast	14	0.01	0.02
* <i>Tagetes minuta</i> L. /H.Ali Bot. (62) PUP	Dambergul ay	Herb	Shoots infusion is anthelmintic	-----	Shoots	Oral	Infusion	14	0.01	0.01
* <i>Artemisia persica</i> Boiss /H.Ali Bot. (85) PUP	Tarkha	Herb	Decoction prepared from the shoots is taken on empty stomach to combat malaria, relieve jaundice and induce body cooling	-----	Shoots	Oral	Decoction	18	0.02	0.02
* <i>Artemisia vulgaris</i> L. /H.Ali Bot. (87) PUP	Tarkha	Herb	Shoot extract removes intestinal worms	-----	Shoots	Oral	Decoction	14	0.01	0.01

Berberidaceae										9.58
<i>Berberis lycium</i> Royle /H.Ali Bot. (77) PUP	Ziarlargay	Shrub	Root decoctions are used for their cooling properties and help manage jaundice and diabetes. They also act as a laxative, promote wound healing, and provide relief from pain in the mouth, throat, and other areas of the body The extracted juice from the fruits is valued as a natural blood purifier	Barkatullah <i>et al.</i> 2009; ; Sher 2011; Murat <i>et al.</i> 2011-2012; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015;Ullah <i>et al.</i> 2018; Zeb <i>et al.</i> 2020; Ayub <i>et al.</i> 2023; Ibrahim <i>et al.</i> 2023	Roots, Fruits	Oral	Decoction, juice	73	0.07	0.12
Boraginaceae										1.80
* <i>Cordia myxa</i> L. /H.Ali Bot. (154) PUP	Nashona	Tree	Fruit juice mixed with curd acts as a laxative and helps alleviate pediatric diarrhea. Raw fruits have aphrodisiac property	-----	Fruits	Oral	Juice, raw	14	0.01	0.02
Brassicaceae										2.40
* <i>Coronopus didymus</i> (L.) Smith. /H.Ali Bot. (183) PUP	Skhabootay	Herb	Aqueous decoction act as purgative relieves constipation and also provide a cooling effect on the body. Fresh plant juice cures ringworm	-----	Whole plant	Oral, topical	Decoction, juice	18	0.02	0.02
Cactaceae										1.80
<i>Opuntia dillenii</i> Haw. /H.Ali Bot. (177) PUP	Zoqam	Shrub	Mucilage applied externally is effective for rheumatoid inflammation, hemorrhoids, bruises and scars on the skin	Barkatullah <i>et al.</i> 2015	Cladodes	Topical	Mucilage	14	0.01	0.02
Cannabaceae										1.80
<i>Cannabis sativa</i> L. /H.Ali Bot. (200) PUP	Bhang	Herb	Leaf juice demonstrated cooling and antispasmodic properties, as well as its ability to help with anxiety and depression. Combusted leaves emit smoke that serves as an insect repellent	Barkatullah and Ibrar 2011; Barkatullah <i>et al.</i> 2015; Gulzar <i>et al.</i> 2019; Ayub <i>et al.</i> 2023	Leaf	Oral, volatile emanant	Juice, burn	14	0.01	0.01
Cucurbitaceae										3.59
<i>Cucumis melo</i> var. <i>agrestis</i> Naudin. /H.Ali Bot. (249) PUP	Kakora	Herbs	Fruit pericarp in dried powdered form is administered for flatulence, jaundice, diabetes, obesity, removal of kidney stones, and as a topical skin moisturizer	-----	Fruit	Oral, topical	Powder	14	0.01	0.01

* <i>Citrullus lanatus</i> (Thunb.) Mats. /H.Ali Bot. (244) PUP	Hindwana	Herb	Dried powdered pericarp is administered as a diuretic, antidiabetic agent, and for the removal of kidney stones. The fruit pulp is used for skin softening and spot removal	-----	Fruits	Oral, topical	Powder	14	0.01	0.03
Cuscutaceae								3.59		
* <i>Cuscuta reflexa</i> Roxb. /H.Ali Bot. (239) PUP	Ziaraperwt ai	Herb	Decoction of the whole plant cures jaundice and hepatitis	-----	Whole Plant	Oral	Decoction	27	0.03	0.07
Equisetaceae								1.80		
<i>Equisetum arvense</i> L. /H.Ali Bot. (581) PUP	Bandakay	Herb	The decoction prepared from the whole plant exhibits antidiabetic effects and facilitates kidney stones expulsion. The plant is also utilized as a natural disinfectant for cleansing utensils	Barkatullah <i>et al.</i> 2009; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015	Whole plant	Oral	Decoction, wash	18	0.02	0.02
Euphorbiaceae								4.19		
* <i>Phyllanthus emblica</i> L. /H.Ali Bot. (265) PUP	Kela	Tree	Roasted fruits are employed for treating coughs, flu, and sores in the mouth. The intake of raw fruits promotes digestion and is valued for its aphrodisiac activity	-----	Fruits	Oral	Roast, raw	18	0.02	0.04
<i>Ricinus communis</i> L. /H.Ali Bot. (277) PUP	Arhanda	Shrub	Raw seeds act as a laxative and are employed to induce vomiting to ease gastric burden. A poultice from fresh leaves is placed on boils and pustules expel pus, aid healing, and relieve pain	Barkatullah <i>et al.</i> 2009, Murad <i>et al.</i> 2011-2012; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015, Gulzar <i>et al.</i> 2019, Ibrahim <i>et al.</i> 2023	Seeds, leaves	Oral, topical	Raw, paste	18	0.02	0.04
Fabaceae								18.5 7		
<i>Acacia modesta</i> Wall. /H.Ali Bot. (01) PUP	Palosa	Tree	Gum combined with coconut, almonds, and peanuts and cooked in milk is orally given to restore strength, support uterine recovery after childbirth, relieve backache, and control bleeding The gum is mixed into tea and act as a remedy for flu relief . Young twigs are employed for their antiplaque properties	Barkatullah <i>et al.</i> 2009, Barkatullah and Ibrar 2011; Sher, 2011; Murad <i>et al.</i> 2012; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015; Ullah <i>et al.</i> 2018, Gulzar <i>et al.</i> 2019; Nazli <i>et al.</i> 2022; Ayub <i>et al.</i> 2023	Gum, twigs	Oral, brush	Cooked, brush	27	0.03	0.04

<i>Acacia nilotica</i> (L.) Delile /H.Ali Bot. (343) PUP	Keekar	Tree	A paste of warmed leaf is applied for wounds and cuts to promote healing and reduce pain. Chewing the flowers cleanse the mouth and remove bad smell from the teeth	Barkatullah <i>et al.</i> 2009; Murad <i>et al.</i> 2012; Ullah <i>et al.</i> 2018; Zeb <i>et al.</i> 2020; Ibrahim <i>et al.</i> 2023	Leaves, flowers	Oral	Paste, chewed	23	0.02	0.02
* <i>Lathyrus aphaca</i> L. /H.Ali Bot. (350) PUP	Kurkaman ay	Herb	Oil-roasted pods and seeds are employed to relieve cough	-----	Pods/seeds	Oral	Roast	14	0.01	0.01
* <i>Lespedeza juncea</i> (L. f.) Pers. /H.Ali Bot. (395) PUP	Oormaray	Herb	Shoot decoctions are effective in eliminating kidney stones	-----	Shoots	Oral	Decoction	14	0.01	0.01
* <i>Argyrolobium roseum</i> (Camb.) Jaub. /H.Ali Bot. (397) PUP	Dana Booti	Herb	Fruit powder is administered for the treatment of ulcers, stomach ailments, and as a general tonic	-----	Fruits	Oral	Powder	14	0.01	0.02
* <i>Rhynchosia minima</i> (L.) DC. /H.Ali Bot. (423) PUP		Herb	Seed powder is employed as an anthelmintic, for wound healing, and for the treatment of piles	-----	Seeds	Oral	Powder	14	0.01	0.02
* <i>Vicia monantha</i> Retz. /H.Ali Bot. (437) PUP	Marghaikha pa	Herb	Roasted pods/seeds act as anti-cough	-----	Pods/seeds	Oral	Roasted	18	0.02	0.02
* <i>Vicia sativa</i> L. /H.Ali Bot. (435) PUP	Chelo	Herb	Roasted pods/seeds act as anti-cough	-----	Pods/seeds	Oral	Roasted	18	0.02	0.02
Juglandaceae								2.40		
<i>Juglans regia</i> L. /H.Ali Bot. (296) PUP	Ghwaz	Tree	Raw fruits are used as a cardiogenic, enhance memory and act as a brain stimulant. The prepared fruit dish is consumed for its tonic properties and its effectiveness in reducing back pain during pregnancy. Brushing teeth with leaf/stem/root bark serves a natural antiplaque measure	Barkatullah <i>et al.</i> 2009; Murad <i>et al.</i> 2011; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015; Adnan <i>et al.</i> 2015; Ullah <i>et al.</i> 2018; Ibrahim <i>et al.</i> 2023	Leaves, fruits, stem and root, bark	Oral, brush	Raw, cooked, brush	18	0.02	0.03
Lamiaceae								15.5		
								7		
<i>Ajuga bracteosa</i> Wall. /H.Ali Bot. (289) PUP	Booti	Herb	Aqueous decoctions are used for body cooling, purification of blood, and as an antipyretic remedy. Fresh leaf is chewed to relieve sores of the mouth as well as tongue	Barkatullah <i>et al.</i> 2009, Murad <i>et al.</i> 2011, Barkatullah and Ibrar, 2011; Sher, 2011; Murad <i>et al.</i> 2012; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015; Zeb <i>et al.</i> 2020; Ibrahim <i>et al.</i> 2023	Whole plant	Oral	Decoction, chewed	18	0.02	0.01

<i>*Eremostachys superba</i> Royle ex Benth. /H.Ali Bot. (295) PUP	Tamakobotay	Herb	Leaf paste is applied externally for burns, swelling reduction, and for promoting wound healing	-----	Leaves	Topical	Paste	14	0.01	0.02
<i>Mentha arvensis</i> L. /H.Ali Bot. (365) PUP	Podina	Herb	Powder obtained from dried plant shoots is employed as a refrigerant and is also used to treat stomach disorders, act as an antiemetic, carminative, relieve flatulence, and stimulate appetite	Gulzar <i>et al.</i> 2019; Zeb <i>et al.</i> 2020; Nazli <i>et al.</i> 2022; Ayub <i>et al.</i> 2023	Shoots	Oral	Powder	23	0.02	0.06
<i>Mentha longifolia</i> (L.) L. /H.Ali Bot. (304) PUP	Enalay	Herb	The powdered form of dried shoots is administered as a remedy for to controlling vomiting, diarrhea, and dysentery, while also serving as a carminative, anti-flatulent, digestive aid, and appetite stimulant	Barkatullah <i>et al.</i> 2009; Sher, 2011, Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015; Ullah <i>et al.</i> 2018, Gulzar <i>et al.</i> 2019; Zeb <i>et al.</i> 2022; Nazli <i>et al.</i> 2022; Ayub <i>et al.</i> 2023; Ibrahim <i>et al.</i> 2023	Shoots	Oral	Powder	23	0.02	0.07
<i>*Micromeria biflora</i> (Buch. -Ham. ex D.Don) Benth. /H.Ali Bot. (197) PUP	Narary Shamkay	Herb	The whole plant decoction is taken to expel kidney stones	-----	Whole plant	Oral	Decoction	14	0.01	0.01
<i>Salvia mocroftiana</i> Wall. ex Benth. /H.Ali Bot. (325) PUP	Karghwag	Herb	Leaf paste is traditionally used for managing muscle aches, inflammatory skin conditions, rheumatic disorders, and wound bleeding	Ibrahim <i>et al.</i> 2023	Leaf	Topical	Paste	32	0.03	0.06
Meliaceae								2.99		
<i>Melia azedarach</i> L. /H.Ali Bot. (337) PUP	Tora shandai	Tree	Infusion of leaves is administered as an analgesic, for treating skin disorders, counteracting scorpion and snake envenomation, and for expelling intestinal worms. Fumigation with leaf smoke acts as a natural insect repellent	Alamgeer <i>et al.</i> 2013; Ullah <i>et al.</i> 2018	Leaf	Oral, volatile emanant	Infusion, burn	23	0.02	0.03
Moraceae								6.59		
<i>Morus alba</i> L. /H.Ali Bot. (330) PUP	Spin toot	Tree	Raw fruits function as a laxative and purgative. Leaves paste are applied on the skin to treat injuries, bruises, and itching swellings	Alamgeer <i>et al.</i> 2013; Amin 2018	Leaves, fruits	Oral, topical	Raw, Paste	14	0.01	0.04
<i>Morus nigra</i> L. /H.Ali Bot. (319) PUP	Tor toot	Tree	Raw fruits are administered for their purgative and cooling effects, purify the blood while also alleviating sore throat, jaundice, flu, cold, and cough	Amin 2018	Fruits	Oral	Raw	14	0.01	0.04

<i>Ficus carica</i> Hausskn. ex. Boiss. /H.Ali Bot. (412) PUP	Baghiinzar	Tree	Intake of raw fruits is aphrodisiacs, regulate the digestive system and stomach functions. The latex can remove the deep spine from fingers and feet	Barkatullah <i>et al.</i> 2009, Murad <i>et al.</i> 2011-2012; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015; Ibraheem <i>et al.</i> 2023	Fruit, latex	Oral, topical	Raw, juice	18	0.02	0.03
Myrsinaceae								1.80		
* <i>Myrsine africana</i> L. /H.Ali Bot. (376) PUP	Marowran g	Shrub	Raw fruits are regarded as an aphrodisiac, blood-cleansing agent, and general body tonic	-----	Fruit	Oral	Raw	14	0.01	0.02
Myrtaceae								4.79		
<i>Eucalyptus camaldulensis</i> Schlecht /H.Ali Bot. (383) PUP	Lachi	Tree	Leaves paste is topically applied to treat cuts, scratches , and skin bruises . Leaves are applied as a natural cleansing agent for utensils. Leaves are burned to produce insect-repellent smoke. Miswak is employed as a natural toothbrush with antiplaque property	Nazli <i>et al.</i> 2022	Leaf, twig	Topical, brush, volatile emanant	Paste, wash, burn, brush	23	0.02	0.02
<i>Myrtus communis</i> L. /H.Ali Bot. (364) PUP	Manroo	Shrub	Fresh fruit infusion exhibits carminative and anti-flatulent properties, while also helping to control diarrhea and vomiting	Murad <i>et al.</i> 2011-2012	Fruits	Oral	Infusion	14	0.01	0.02
Nyctaginaceae								1.80		
<i>Mirabilis jalapa</i> L. /H.Ali Bot. (408) PUP	Gulabbasi	Herb	A paste of leaves is applied externally to treat boils, abscesses, and painful muscles, serving as a natural analgesic. Seed powder is valued in folk medicine for its emetic and purgative actions	Barkatullah <i>et al.</i> 2009, Barkatullah <i>et al.</i> 2015; Gulzar <i>et al.</i> 2019; Ibraheem <i>et al.</i> 2023	Leaf, seed	Topical, oral	Paste, powder	14	0.01	0.03
Oleaceae								2.40		
<i>Olea ferruginea</i> Royle /H.Ali Bot. (352) PUP	Khona	Tree	Chewing fresh leaves alleviate toothache, sore throat, oral ulcers, and cracked tongue. Oil extracted from seeds is applied externally to reduce bone and muscle pain. Seeds are regarded as having aphrodisiac properties. Miswak is valued in preventing plaque	Barkatullah <i>et al.</i> 2009, Murad <i>et al.</i> 2011-2012; Zeb <i>et al.</i> 2020; Ayub <i>et al.</i> 2023; Ibrahim <i>et al.</i> 2023	Leaf, seed, twig	Oral, topical, brush	Chewed, oil, brush	14	0.01	0.04

Pinaceae										2.40
* <i>Pinus roxburghii</i> Sargent /H.Ali Bot. (57) PUP	Nakhtar	Tree	Adding gum to tea cleanses blood and reduces internal tumors. Eating raw seeds have aphrodisiac qualities	-----	Resin, seed	Oral	Tea, raw	18	0.02	0.02
Plantaginaceae										4.19
* <i>Plantago amplexicaulis</i> Cav. /H.Ali Bot. (563) PUP	Ispaghool	Herb	The juice extracted from the seeds acts as a laxative, a purgative, and has anti-inflammatory properties. It also used to help treat ulcers and piles	-----	Seed	Oral	Juice	14	0.01	0.04
<i>Plantago lanceolata</i> L. /H.Ali Bot. (431) PUP	GhwayeJa bai	Herb	Seed juice acts as laxative, helping to relieve constipation, beneficial for treating dysentery and easing abdominal pains	Sher 2011, Barkatullah <i>et al.</i> 2015; Zeb <i>et al.</i> 2020; Ibrahim <i>et al.</i> 2023	Seed	Oral	Juice	18	0.02	0.03
Punicaceae										2.99
<i>Punica granatum</i> L. /H.Ali Bot. (474) PUP	Ananguna y	Shrub	The juice from the seeds acts as a refrigerant, help ease heart and stomach issues, serving as a tonic for the body. The dried and powdered pericarp used to treat whooping cough. A paste made from it is applied for skin whitening	Sher 2011; Murad <i>et al.</i> 2011-2012; Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015; Ullah <i>et al.</i> 2018; Nazli <i>et al.</i> 2022, Ayub <i>et al.</i> 2023; Ibrahim <i>et al.</i> 2023	Seeds, Fruits	Oral	Juice, powder	23	0.02	0.05
Ranunculaceae										2.40
* <i>Clematis grata</i> Wall. /H.Ali Bot. (461) PUP	Zelaiboota y	Shrub	A poultice of crushed shoots paste relieves rheumatic pain and joints inflammation	-----	Shoots	Topical	Paste	18	0.02	0.02
Rhamnaceae										5.99
<i>Sageretia thea</i> (Osbeck) Johnst. /H.Ali Bot. (470) PUP	Momana	Shrub	Eating raw fruits provides a cooling effect, manage diabetes and jaundice and act as a natural diuretic	Murad <i>et al.</i> 2012; Ibrahim <i>et al.</i> 2023	Fruits	Oral	Raw	18	0.02	0.04
* <i>Ziziphus mauritiana</i> Lam. /H.Ali Bot. (472) PUP	Bera	Tree	Fruits are consumed to boost muscles strength and purifying blood. Miswaks are used for its antiplaque properties	-----	Fruits, twigs	Oral, brush	Raw, brush	14	0.01	0.02
<i>Ziziphus nummularia</i> (Burm. f.) Wight and Arn. /H.Ali Bot. (480) PUP	Karkanda	Shrub	Fruits in raw form are refrigerant, stomachache. The leaves poultices are applied topical and acting as pain killer	Murad <i>et al.</i> 2012; Ayub <i>et al.</i> 2023; Ibrahim <i>et al.</i> 2023	Leaves, fruits	Oral, topical	Raw, paste	14	0.01	0.01

Rosaceae											7.19
<i>Pyrus pashia</i> Buch. - Ham. exD Don. /H.Ali Bot. (481) PUP	Tanga	Tree	Fruits in raw form are astringent, laxative, and tonic	Murad <i>et al.</i> 2011-2012	Fruits	Oral	Raw	14	0.01	0.04	
* <i>Pyrus pseudopashia</i> T. T. Yu /H.Ali Bot. (486) PUP	Gidarhtan ga	Tree	Eating raw fruits are tonic, laxative, and astringent	-----	Fruits	Oral	Raw	14	0.01	0.01	
* <i>Duchesnea indica</i> (Andrews) Focke /H.Ali Bot. (478) PUP	Da Zmakey Toot.	Herb	Fruit juice is beneficial for stomach issues, jaundice, heart problems and act as blood purifier	-----	Fruits	Oral	Juice	14	0.01	0.03	
<i>Rubus fruticosus</i> Wallich /H.Ali Bot. (476) PUP	Karwara	Shrub	Fruits have a cooling effect, serve as general body tonic and are effective in relieving sore throat	Barkatullah and Ibrar 2011; Murad <i>et al.</i> 2011-2012; Gulzar <i>et al.</i> 2019	Fruits	Oral	Raw	14	0.01	0.01	
Sapindaceae											11.38
<i>Dodonaea viscosa</i> (L.) Jacq. /H.Ali Bot. (436) PUP	Ghwarhas kay	Shrub	Paste made from the leaves soothes wounds, cuts, swellings, burns, and pain	Barkatullah <i>et al.</i> 2009, Murad <i>et al.</i> 2011-2012; Barkatullah <i>et al.</i> 2015, Nazli <i>et al.</i> 2022; Ayub <i>et al.</i> 2023, Ibrahim <i>et al.</i> 2023	Leaves	Topical	Paste	91	0.09	0.17	
Sapotaceae											1.80
<i>Monothea buxifolia</i> (Falc.) A. DC. /H.Ali Bot. (531) PUP	Gurgura	Tree	Fruits act as a blood purifier, refrigerant, improving digestion, aphrodisiac and potent	Ibrahim <i>et al.</i> 2023	Fruits	Oral	Raw	14	0.01	0.03	
Saxifragaceae											1.80
<i>Bergenia ciliata</i> (Haw.) Sternb. /H.Ali Bot. (504) PUP	Ghatpanrha	Herb	Leaves paste is effective in bruises and boils , helps heal wounds , and reduce inflammation . An infusion of fresh leaves acts as a diuretic and helps dissolve kidney stones	Ayub <i>et al.</i> 2023	Leaf	Oral, topical	Infusion, paste	14	0.01	0.03	
Scrophulariaceae											2.99
<i>Verbascum thapsus</i> L. /H.Ali Bot. (517) PUP	Khardag	Herb	Paste of fresh leaves is effective in wounds healing	Murad <i>et al.</i> 2011; Alamgeer <i>et al.</i> 2013; Gulzar <i>et al.</i> 2019	Leaf	Topical	Paste	23	0.02	0.03	
Simaroubaceae											2.40
* <i>Ailanthus altissima</i> (Mill.) Swingle /H.Ali Bot. (496) PUP	Speena Shandai/Lantus	Tree	Leaves are used to neutralize snake and scorpion venoms. Warmed leaves are applied to wounds to promote healing and relieve pain. The smoke from fresh leaves acts as a natural insect repellent	-----	Leaf	Topical, volatile emanant	Paste, burn	18	0.02	0.02	

Solanaceae										7.19
<i>Datura innoxia</i> Miller /H.Ali Bot. (338) PUP	Datura	Herb	Fresh leaves paste is effective in treating boils. Warmed leaves help reduce swellings, relieve rheumatic pain, and treat infected wounds	Barkatullah <i>et al.</i> 2015, Zeb <i>et al.</i> 2020; Ayub <i>et al.</i> 2023	Leaves	Topical	Paste	27	0.03	0.04
* <i>Withania somnifera</i> (L.) Dunal /H.Ali Bot.(536) PUP	Kutelal	Shrub	Powder seeds are used to relieve constipation. Leaves oil-roasted are effective in treating boils, pimples and rheumatism	-----	Leaf, seed	Oral	Powder, roasted	14	0.01	0.02
<i>Solanum surattense</i> Burm. f. /H.Ali Bot. (535) PUP	Marhagon ay	Herb	A decoction made from the fruits acts as an anti-asthmatic and anti-diuretic agent	Murad <i>et al.</i> 2011-2012; Alamgeer <i>et al.</i> 2013; Ayub <i>et al.</i> 2023, Ibrahim <i>et al.</i> 2023	Fruits	Oral	Decoction	14	0.01	0.01
Urticaceae										1.80
* <i>Debregeasia salicifolia</i> (D.Don) Rendle /H.Ali Bot. (551) PUP	Ajlai	Shrub	Leaves paste relieves swellings and pain	-----	Leaf	Topical	Paste	14	0.01	0.02
Verbenaceae										2.40
<i>Vitex negundo</i> L. /H.Ali Bot. (502) PUP	Marwanda i	Shrub	Leaf paste has analgesic property, while a decoction of the leaves acts as a vermifuge. Miswak is used for its antiplaque effects	Alamgeer <i>et al.</i> 2013; Barkatullah <i>et al.</i> 2015, Ibrahim <i>et al.</i> 2023	Leaves, twigs	Topical, decoction, brush	Paste, brush	18	0.02	0.01
Zygophyllaceae										5.39
* <i>Fagonia indica</i> Burm. f. /H.Ali Bot. (571) PUP	Azghakay	Herb	The aqueous decoction has a cooling effect and is beneficial in managing diabetes	-----	Whole plant	Oral	Decoction	32	0.03	0.05
* <i>Tribulus terrestris</i> L. /H.Ali Bot. (321) PUP	Markundai	Herb	Aqueous decoction is used to treat urinary disorders and helps relieve toothache	-----	Fruit	Oral	Decoction	14	0.01	0.01

Key: Species marked with (*) represents taxa newly documented for traditional uses. Indigenous uses shown in bold indicate newly recorded applications of previously reported plant species within the study area.

Conclusion

The present investigation provides a comprehensive account of the ethnomedicinal flora of the study area. The findings demonstrate that traditional plant-based remedies play a central role in the local healthcare system and underscore the community's continued reliance on natural resources for the management of diverse ailments. The study further identified several species with high FL, CI, and UV indices, reflecting substantial therapeutic significance. These species represent promising candidates for detailed pharmacological investigation and may contribute to novel drug discovery, thereby reinforcing the scientific value of traditional healthcare systems. Despite the ethnobotanical richness, field observations revealed that the native flora of the area is undergoing a marked decline. In particular, the harvesting of whole plants, roots, shoots, seeds, and flowers emerged as a major driver of biodiversity loss. In light of these findings, the conservation of medicinal flora must be carried on priority basis. The implementation of sustainable harvesting protocols, scientifically guided collection practices, habitat protection measures, community-based conservation initiatives, and systematic documentation of indigenous knowledge is essential to ensure ecological and cultural sustainability. Overall, this study contributes substantially to the existing ethnobotanical literature and highlights the urgent need to conserve valuable plant resources for their sustainable utilization.

Declarations

List of abbreviations: EMPs - Ethnomedicinal plants; FIVs - Family importance values; ICF - Informant consensus factor; FL- Fidelity level; RFC - Relative frequency of citation; CI- Consensus index; TK - Traditional knowledge; UV - Use values

Ethical approval and consent for participation: The current ethnomedicinal study was duly approved by the Graduate Studies Committee (GSC), Department of Botany and Advanced Studies Research Board (ASRB) University of Peshawar, Pakistan. All participants gave informed consent prior to engaging in the study.

Availability of Data: Data can be accessed by consulting the first author.

Funding sources: This research was not supported by any particular grant from public, private, or non-profit sources.

Conflict of interest: The authors state that they have no competing interests.

Consent for publication: Not applicable

Author contributions: HA: Methodology, Investigation, Conceptualization, original draft writing. ZM: Supervision, Conceptualization, review and editing. TU, NI, MUR, RU, IAS and SMK: Writing, review and editing.

Acknowledgements

The authors are sincerely grateful to the local inhabitants of Malakand Valley for generously sharing their invaluable indigenous knowledge about the ethnomedicinal plants.

Literature cited

Adnan M, Tariq A, Mussarat S, Begum S, AbdElsalam NM, Ullah R. 2015. Ethnogynaecological assessment of medicinal plants in Pashtun's tribal society. *BioMed Research International* 196475. <http://dx.doi.org/10.1155/2015/196475>.

Ahmad KS, Hamid A, Nawaz F, Hameed M, Ahmad F, Deng J, Mahroof S. 2017. Ethnopharmacological studies of indigenous plants in Kel Village, Neelum Valley, Azad Kashmir, Pakistan. *Journal of Ethnobiology and Ethnomedicine* 13:68. doi: 10.1186/s13002-017-0201-8.

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* 10:36. <http://www.ethnobiomed.com/content/10/1/36>.

Ahmed N, Mahmood AM, Bano T, Malik A, Hassan R, Ashraf S, Aisha. 2014. Ethnomedicinal knowledge and relative importance of indigenous medicinal plants of the Cholistan desert, Punjab Province, Pakistan. *Journal of Ethnopharmacology* 155:doi: 10.1016/j.jep.2014.07.007.

Akhtar A, Shah AH, Jabeen T, Khan KR, Farooq M. 2021. Qualitative and quantitative ethnobotanical evaluation of plant resources of Kiwai, Kaghan valley, district Mansehra, Pakistan. *Indian Journal of Traditional Knowledge* 20(1):141-153.

Alamgeer TA, Rashid M, Malik MNH, Mushtaq MN, Khan J, Qayyum R, Khan AQ, Muhammad N. 2013. Ethnomedicinal survey of plants of valley Alladand Dehri, Tehsil Batkhela, District Malakand, Pakistan. *International Journal of Basic Medical Sciences and Pharmacy* 3(1):23-32.

- Alexiades NM, Sheldon JW. 1996. Selected guidelines for ethnobotanical research: A field manual. New York Botanical Garden, New York, USA.
- Ali A, Badshah L, Hussain F. 2018. Ethnobotanical appraisal and conservation status of medicinal plants in Hindu Kush range, District Swat, Pakistan. *Journal of Herbs, Spices and Medicinal Plants* 24(4):332-355.
- Ali A, Zeb BS, Khan A, Haq A, Haq MA, Ullah I, Badshah L, Zeb S. 2025. Quantitative ethnobotanical study of wild plant resources of tehsil Utman Khel, District Bajaur, Pakistan. *Ethnobotany Research and Applications* 31:1-15.
- Ali H, Muhammad Z, Ahmad Z, Khan SM. 2022. Environmental determinants of vegetation in district Malakand, a sub tropical zone of the outer Hindu Kush Mountain range. *Applied Ecology and Environmental Research* 20(1):339-361. http://dx.doi.org/10.15666/aeer/2001_339361.
- Ali H, Muhammad Z, Majeed M, Aziz R, Khan A, Mangrio WM, Abdo HG, Almohamad H, Al Dughairi AA. 2023. Vegetation diversity pattern during spring season in relation to topographic and edaphic variables in sub tropical zone. *Botanical Studies* 64:25. <https://doi.org/10.1186/s40529-023-00398-5>.
- Ali S, Sayed AS, Saeed RF, Iqbal J, Ijaz S, Munazir M. 2023. Ethnomedicinal plant use value in Lower Swat, Pakistan. *Ethnobotany Research and Applications* 25:1-22.
- Ali SI, Nasir YJ. 1989-1991. Flora of Pakistan. Nos. 191-193. Department of Botany, University of Karachi and National Herbarium, PARC, Islamabad, Pakistan.
- Ali SI, Qaiser M. 1991-2019. Flora of Pakistan. Department of Botany, University of Karachi, Pakistan.
- Ali SR, Kumari S, Prasad SK, Prasad RS, Sinha SK, Shakya A. 2023. Drug development projects guided by ethnobotany and ethnopharmacology studies. In: *Drug Discovery and Design Using Natural Products*. Pp. 3-21.
- Amin R, Ullah A, Ahmad I, Fu Y. 2018. Ethnobotanical survey of medicinal plants used as a remedy in District Malakand, KP, Pakistan. *Journal of Biodiversity and Environmental Sciences* 13(1):52-59.
- Amjad MS, Arshad M, Saboor A, Page S, Chaudhari SK. 2017. Ethnobotanical profiling of the medicinal flora of Kotli, Azad Jammu and Kashmir, Pakistan: empirical reflections on multinomial logit specifications. *Asian Pacific Journal of Tropical Medicine* 10(5):503-514.
- Ayub M, Shah GM, Irfan M, Ullah F, Ullah A. 2023. Ethnomedicinal study of the flora of Sella Pattay valley, district Malakand, Khyber Pakhtunkhwa, Pakistan. *Ethnobotany Research and Applications* 26:1-17.
- Azmi L, Shukla I, Kant P, Rao VC. 2017. Traditional medicine: blessing of nature for human being. *Bioequivalence and Bioavailability International Journal* 1(2):1-5.
- Bahadur S, Khan MS, Shah M, Shuaib M, Ahmad M, Zafar M, Begum N, Gul S, Ashfaq S, Mujahid I, Hussain F. 2020. Traditional usage of medicinal plants among the local communities of Peshawar Valley, Pakistan. *Acta Ecologica Sinica* 40(1):1-29.
- Barkatullah, Ibrar M, Abdur Rauf TB, Hadda BS, Mubarak MS, Seema P. 2015. Quantitative ethnobotanical survey of medicinal flora thriving in Malakand Pass hills, Khyber Pakhtunkhwa, Pakistan. *Journal of Ethnopharmacology* 169:335-346.
- Barkatullah, Ibrar M, Hussain F. 2009. Ethnobotanical studies of plants of Charkotli hills, Batkhela district, Malakand, Pakistan. *Frontiers of Biology in China* 4(4):539-548.
- Barkatullah, Ibrar M. 2011. Plants profile of Malakand Pass hills, District Malakand, Pakistan. *African Journal of Biotechnology* 10(73):16521-16535.
- Benarba B, Belabid L, Righi K, Bekkar AA, Elouissi M, Khaldi A, Hamimed A. 2015. Ethnobotanical study of medicinal plants used by traditional healers in Mascara (North West of Algeria). *Journal of Ethnopharmacology* 175:626-637.
- Bhat JA, Kumar M, Negi AK, Todaria NP. 2013. Informants' consensus on ethnomedicinal plants in Kedarnath Wildlife Sanctuary of Indian Himalayas. *Journal of Medicinal Plant Research* 7(4):148-154.
- Bhat P, Hedge GR, Hedge G, Mulgund GS. 2014. Ethnomedicinal plants to cure skin diseases: an account of the traditional knowledge in the coastal parts of central Ghats, Karnataka, India. *Journal of Ethnopharmacology* 151:493-502.

- Boutlelis DA, Mounia B, Hadjer C, Bahia H, Salah B, Chaima B, Ibtissam L. 2025. An ethnopharmacological study of medicinal plants used for the treatment of urinary illness in the El-Oued region (Algerian Sahara). *Journal of Herbal Medicine* 101026. <https://doi.org/10.1016/j.hermed.2025.101026>.
- Calixto JB. 2005. Twenty five years of research on medicinal plants in Latin America: a personal review. *Journal of Ethnopharmacology* 100:131-134.
- Che C, George V, Ijini TP, Pushpangadan P, Andrae Marobela K. 2024. Traditional medicine. In: *Traditional Medicine*. Elsevier BV, Pp. 11-28.
- Chittibabu CV, Parthasarathy N. 2000. Understorey plant diversity in a tropical evergreen forest in the Kolli hills, Eastern Ghats, India. *Ecotropica* 6:129-140.
- Dorni AC, Amalraj A, Gopi S, Varma K, Anjana SN. 2017. Novel cosmeceuticals from plants: an industry-guided review. *Journal of Applied Research on Medicinal and Aromatic Plants* 7:1-26.
- Dube M, Nyoni S, Konono KCC, Chikwambi Z. 2025. An ethnobotanical survey of medicinal plants used to manage diabetes in Bulawayo, Zimbabwe. *Journal of Herbal Medicine* 51:101018.
- Ghuge AD, Timewar RR, Kohale NB, Rathod SB. 2023. Medicinal plants of the family Solanaceae: A review of ethno medicinal uses and pharmacological properties. *International Journal of Advanced Research in Science, Communication and Technology*:432-438. doi: 10.48175/ijarsct-8853.
- Gulzar H, Hazrat A, Gulzar K, Ali F, Khan N, Nisar M, Khan I, Ullah A. 2019. Medicinal plants and their traditional uses in Thana village, district Malakand, Khyber Pakhtunkhwa, Pakistan. *International Journal of Endorsing Health Science Research* 7(1):11-21.
- Haq A, Badshah L, Hussain W, Ullah I. 2023. 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.
- Ibrahim M, Akhtar N, Khan S, Bahadar H. 2023. Ethno-pharmacological evaluation of plants resources of District Malakand, Pakistan. *Ethnobotany Research and Applications* 25:1-15.
- Ijaz F, Iqbal Z, Alam J, Khan SM, Afzal A, Rahman IU, Afzal M, Islam M, Sohail. 2015. Ethnomedicinal study upon folk recipes against various human diseases in Sarban Hills, Abbottabad, Pakistan. *World Journal of Zoology* 10:41-46.
- IPNI. 2022. International Plant Names Index. The Royal Botanic Gardens, Kew; Harvard University Herbaria and Libraries; Australian National Botanic Gardens. <https://www.ipni.org> (Accessed 27/08/2022).
- Iqbal M, Khan S, Khan MA, Rahman IU, Abbas Z, Zahidullah. 2015. Exploration and inventorying of weeds in wheat crop of District Malakand, Pakistan. *Pakistan Journal of Weed Science Research* 21(3):435-452.
- Irfan M, Ullah F, Haq IU. 2023. Ethnomedicinal and traditional uses of the flora of District Lower Dir, Khyber Pakhtunkhwa, Pakistan. *Ethnobotany Research and Applications* 26:1-22.
- Jan HA, Jan S, Ahmad N, Aysha M. 2017. Ethnomedicinal survey of indigenous medicinal plants used by the local population of Goleen Valley, Chitral, Pakistan. *SMJ Medical Plant Studies* 1(1):1-8.
- Kala CP, Farooquee NA, Dhar U. 2004. Prioritization of medicinal plants on the basis of available knowledge, existing practices and use-value status in Uttaranchal, India. *Biodiversity and Conservation* 13(2):453-469.
- Khan KU, Shah M, Ahmad H, Khan SM, Rahman IU, Iqbal Z, Khan R, Abd Allah EF, Alqarawi AA, Hashem A, Aldubise A. 2018. Exploration and local utilization of medicinal vegetation naturally grown in the Deosai of Gilgit, Pakistan. *Saudi Journal of Biological Sciences* 25:326-331.
- Khan M. 2014. Ethnobotanical studies on plant resources of Sheikh Maltoon, District Mardan, Pakistan. *Journal of Medicinal Plant Research* 4(5):35-45.
- Khan MPZ, Ahmad M. 2015. Traditional preference of wild edible fruits (WEFs) for digestive disorders (DDs) among the indigenous communities of Swat Valley, Pakistan. *Journal of Ethnopharmacology* 174:339-354.

- Khan MZ, Saeed S, Ahmed A, Kakar S, Leghari SK, Gul J. 2020. Ethnobotanical appraisal and medicinal use of plants of District Nushki Balochistan, Pakistan. *International Journal of Biosciences* 17(4):60-72.
- Kichu M, Malewska T, Akter K, Imchen I, Harrington D, Kohen J, Jamie JF. 2015. An ethnobotanical study of medicinal plants of Chungtia Village, Nagaland, India. *Journal of Ethnopharmacology* 166:5-17.
- Majid A, Ahmad H, Saqib Z, Rahman IU, Khan U, Alam J, Shah AH, Jan SA, Ali N. 2019. Exploring threatened traditional knowledge: ethnomedicinal studies of rare endemic flora from lesser Himalayan region of Pakistan. *Revista Brasileira de Farmacognosia* 29(6):785-792.
- Marcus DM. 2010. Traditional medicine: a global perspective. *Bulletin of the World Health Organization* 88:953.
- Maroyi A. 2013. Traditional use of medicinal plants in south central Zimbabwe: review and perspectives. *Journal of Ethnobiology and Ethnomedicine* 9:31.
- Mercy R, David UE. 2018. Natural products as lead bases for drug discovery and development. *Research Reports in Medical Sciences* 2(1):1-2.
- Muhammad N, Uddin N, Khan MKU, Mengjun L, Xuang Z, Ali N, Liu Z. 2020. Ethnomedicinal and cultural uses of Ziziphus species in Malakand Division, K.P., Pakistan. *Singapore Journal of Scientific Researchs* 10:1-7.
- Muhammad N, Uddin N, Khan MKU, Umer M, Ali N, Ullah S. 2021. Traditional and cultural uses of medicinal plant species in the flora of Kuz Abakhel, for the treatment of various ailments. *Advances in Traditional Medicine* 21(3):591-607.
- Muhammad Z, Khan N, Ullah A. 2016. Quantitative ethnobotanical profile of understory vegetation in *Acacia modesta* (Wall) forests of Malakand Division, Pakistan. *Science, Technology and Development* 35(2):88-93.
- Murad W, Ahmad A, Gilani SA, Khan MA. 2011. Indigenous knowledge and folk use of medicinal plants by the tribal communities of Hazar Nao Forest, Malakand District, North Pakistan. *Journal of Medicinal Plant Research* 5(7):1072-1086.
- Murad W, Ahmad A, Ishaq G, Khan MS, Khan AM, Ullah I, Khan I. 2012. Ethnobotanical studies on plant resources of Hazar Nao forest, district Malakand, Pakistan. *Pakistan Journal of Weed Science Research* 18(4):509-527.
- Nasir E, Ali SI. 1970-1989. *Flora of Pakistan*. Nos. 1-190. Department of Botany, University of Karachi, Pakistan and Pakistan Agricultural Research Council, Islamabad, Pakistan.
- Nazli BHA, Hamayun M, Khan A, Yaseem T, Bussmann RW, Murad W. 2022. Quantitative ethnobotanical appraisal of medicinal plants used by indigenous communities of District Malakand, Pakistan. *Ethnobotany Research and Applications* 24:1-14.
- Niazi P, Monib AW. 2024. The role of plants in traditional and modern medicine. *Journal of Pharmacognosy and Phytochemistry* 13(2):643-647.
- Phillips OL, Hall P, Gentry AH, Sawyer SA, Vasquez R. 1994. Dynamics and species richness of tropical rain forest. *Proceedings of the National Academy of Sciences USA* 91:2805-2809.
- Qureshi R, Ghazanfar SA, Obied H, Vasileva V, Tariq MA. 2016. Ethnobotany: a living science for alleviating human suffering. *Evidence-Based Complementary and Alternative Medicine* 2016:9641692.
- Rahman IU, Ijaz F, Afzal A, Iqbal Z, Ali N, Khan SM. 2016. Contributions to the phytotherapies of digestive disorders; traditional knowledge and cultural drivers of Manoor Valley, Northern Pakistan. *Journal of Ethnopharmacology* 192:30-52.
- Rajoo KS, Lepun P, Kayok BL, Umayrah NA, Abdullah N. 2025. Ethnomedicinal survey of antidiabetic plants used by six indigenous communities in Sarawak, Borneo. *Journal of Herbal Medicine* 51:101011.
- Ralte L, Sailo H, Singh YT. 2024. Ethnobotanical study of medicinal plants used by the indigenous community of the western region of Mizoram, India. *Journal of Ethnobiology and Ethnomedicine* 20(1):2.
- Shah SHA, Shah GM, Ali N, Alam J, Rehman S, Alia A, Nasar N, Rahman KU, Basit A. 2024. Ethnomedicinal survey of medicinal plants traditionally used in Sakhra Valley district Swat, Pakistan. *Ethnobotany Research and Applications* 29:1-28.

- Shariat, U., 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.
- Sharma A, Adhikari D, Wagh VV. 2024. An ethnobotanical investigation of medicinal plants used among rural communities in Northeastern Madhya Pradesh, India: a quantitative study. *Plant Biosystems* 158(5):1160-1181.
- Sharma M, Sharma M, Bithel N, Sharma M. 2022. Ethnobotany, phytochemistry, pharmacology and nutritional potential of medicinal plants from Asteraceae family. *Journal of Mountain Research* 17(2):67-83.
- Sher H. 2011. Ethnoecological evaluation of some medicinal and aromatic plants of Kot Malakand Agency, Pakistan. *Scientific Research and Essays* 6(10):2164-2173.
- Shinwari KZ. 2010. Medicinal plants research in Pakistan. *Journal of Medicinal Plant Research* 4(3):161-176.
- Shrestha PM, Dhillon SS. 2003. Medicinal plant diversity and use in the highlands of Dolakha district, Nepal. *Journal of Ethnopharmacology* 86(1):81-96.
- Sulaiman SS, Khan S, Bussmann RW, Ali M, Hussain D, Hussain W. 2020. Quantitative ethnobotanical study of indigenous knowledge on medicinal plants used by the tribal communities of Gokand Valley, District Buner, Khyber Pakhtunkhwa, Pakistan. *Plants* 9(8):1001.
- Sylver Francis RA, Pelkonen O. 2025. Medicinal plants as alternatives for the management of hypertension and diabetes in Nigeria: analysis of the structured interview of Nigerian patients. *Phytomedicine Plus* 5(1):100708.
- Ulhaq ZS, Widowati L, Andarwati P, Renjana E, Firdiana E, Istifiani LA, Pamungkas SA. 2025. The use of herbal medicine for cancer therapy in Indonesia: a prospective cohort study. *Journal of Herbal Medicine* 100991.
- Ullah S, Badshah L, Ali A, Muhammad N. 2020. Quantitative assessment and status of ethnomedicinal plants of Sheen Ghar Valley, Dir Lower, Khyber Pakhtunkhwa, Pakistan. *Plant Science Today* 7(1):17-22.
- Ullah Z, Rashid A, Uddin B. 2018. Ethnobotanical studies of medicinal plants of Malakand district. *FUJAST Journal of Biology* 8(1):161-167.
- Umair M, Altaf M, Abbasi AM. 2017. An ethnobotanical survey of indigenous medicinal plants in Hafizabad District, Punjab, Pakistan. *PLoS One* 12(6):e0177912. doi: 10.1371/journal.pone.0177912.
- 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):7.
- Uniyal SK, Singh K, Jamwal P, Lal B. 2006. Traditional use of medicinal plants among the tribal communities of Chhota Bhangal, Western Himalaya. *Journal of Ethnobiology and Ethnomedicine* 2:14. doi: 10.1186/1746-4269-2-14.
- Upadhyay RK. 2014. Ethnomedicinal, pharmaceutical and pesticidal uses of *Calotropis procera* (Aiton) (Family: Asclepiadaceae). *International Journal of Green Pharmacy* 8(3):135-146. <https://doi.org/10.22377/ijgp.v8i3.375>.
- Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, IFCo 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.
- Wali S, Akhtar N. 2017. Taxonomic and palynological diversity of the family Papilionaceae in the flora of Shishi Koh Valley, Chitral, Pakistan. *Pakistan Journal of Science* 69(1):44.
- Wali S, Jan HA, Haq SM, Yaqoob U, Bussmann RW, Rahim F. 2021. The traditional phyto-recipes used to cure various ailments by the local people of Shishi Koh valley, Chitral, Pakistan. *Ethnobotany Research and Applications* 22:1-32.
- Wang, X., Anwar, T., Qureshi, H., El-Beltagi, H.S., Sehar, Z., Solieva, D., Azizov, B., Rebouh, N.Y., Abbasov, M.A., Yakubov, F. & Alomran, M.M. (2025). Plant-based traditional remedies and their role in public health: Ethnomedicinal perspectives for a growing population. *Journal of Health, Population and Nutrition* 44:300.
- Zaman A, Badshah L. 2019. Ethnomedicinal exploration of plant resources of Terich Valley, Hindu Kush range, Chitral, Pakistan. *International Journal of Biosciences* 14(5):413-424.

Zeb A, Khan Y, Yaseen T, Shah S. 2020. Ethno botanical study of wild medicinal plants of Peerano Valley, District Malakand, Khyber Pakhtunkhwa, Pakistan. *Asian Plant Research Journal* 6(1):34-44.

Zeb U, Batool A, Khan H, Ullah H, Gul B. 2022. Ethnobotanical assessment of Hazar Nao Hills, District Malakand, Khyber Pakhtunkhwa, Pakistan. *International Journal of Applied and Experimental Biology* 1(2):59-66.