Understanding people-nature relationships through ethnobotanical knowledge and plant resource utilization in peri-urban Punjab, Pakistan

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Research

Abstract

Background: Traditional ethnobotanical knowledge (TEK) is an important source of ecological information and cultural history gathered over many generations of human interactions with the environment.

Methods: To understand this knowledge, data was obtained from six different local villages in peri-urban areas of the Lahore, Pakistan, using a snowball sampling methods that included semi-structured interviews with informants.

Results: This study documented the TEK of 27 plants from 23 genera and 18 families, and the plant applications were divided into several categories. Leaves, fruits, and seeds were the most used plant parts in traditional medicine. Most remedies recorded in the survey were prepared as cooked dishes (19%), followed by boiled infusions, herbal tea (15%), and pastes (12%). Most medicinal plant species treated digestive disorders (Number = 9, 23.1%), followed by musculoskeletal conditions (N = 7, 17.9%), skin ailments (N = 6, 15.4%), respiratory problems (N = 5, 12.8%), fever and headaches (N = 4, 10.3%), liver and reproductive disorders (N = 3, 7.7%), and psychological disorders (N = 2, 5.1%). Most of the recorded plant resources in the study area served as fodder (23%) and food (22%), with cultural uses (11%), ornamental purposes (10%), and fuelwood (8%). Two-way cluster analysis identified clear patterns of resource use by grouping species and use categories based on similarity.

Conclusions: These findings indicate that local communities depend on a wide variety of plant species to fulfill diverse socioeconomic and cultural needs, and the strong overlap between food and fodder categories underscores their central role in sustaining local livelihoods. Considering their multiple uses, especially in food, fodder, and medicine, multipurpose species including *Morus alba* L.*, Morus nigra* L.*,* and *Broussonetia papyrifera* L. formed a cluster. *Morus serrata* had the highest UV levels (0.95), followed by Morus nigra (0.89*)*, indicating that these species are highly valued and widely used in the community. This study illustrates the peri-urban community ethnobotanical knowledge, illustrating the critical importance of plant resources in healthcare, livelihoods, and cultural traditions, with a strong emphasis on multipurpose species.

Keywords: Ethnobotanical practices, multipurpose species, urban communities, sustainable development, sociocultural influences

Background

Human cultures have relied on plants for food, medicine, cultural traditions, and support, resulting in deep bonds between people and their natural environment (Turner *et al*. 2022). Traditional ethnobotanical knowledge, accumulated through generations of interactions with nature, serves as an important cultural and conservation legacy (Ianni *et al.* 2015). Local communities have long relied on integrating fine-grained plant knowledge of species identity, seasonal cycles, harvesting methods, and conservation measures into daily life (Cotton, 1996; Albuquerque *et al.* 2011; Berkes, 2018). This collected knowledge promotes household well-being, livelihood stability, and strong local resource management, and it remains an important source of information for biodiversity conservation and sustainable development (Martin 2014; Andriamparany *et al.* 2014).

However, rapid urbanization, socioeconomic growth, and the breakdown of traditional knowledge systems have undermined these ties between people and nature, resulting in biocultural erosion and the loss of important ethnobotanical knowledge (Ali and Qaiser 2009; Haq *et al.* 2023). The loss of traditional ecological knowledge (TEK) has a wide-ranging impact on communities. It undermines cultural traditions and identity, diminishes local approaches to health care and food production, and eliminates essential information for plant protection and sustainable resource use (Pieroni *et al*. 2020). As a result, fewer elders pass these practices on, and the knowledge is fading (Ullah *et al.* 2024; Manzoor *et al.* 2023). Environmental problems, including habitat loss, overharvesting, deforestation, invasive species, and climate change, are making useful plants rarer (Mir *et al.* 2021; Asif *et al.* 2021). This reduces people's chances to use and learn about these plants, so traditional knowledge is being lost (IPBES 2019; Aslam *et al.* 2017; Karaköse 2022; Karaköse 2026). To conserve cultural history and promote sustainable interactions with natural resources, it is critical to document and understand local plant use traditions.

Documenting ethnobotanical knowledge meets both current community needs and long-term conservation objectives (Haq & Kyarong, 2026). First, it helps to verify plant utilization inventories for *in situ* and *ex situ* conservation. Second, it establishes sustainable harvesting methods. Finally, it promotes community-based management and livelihood diversification (Haq *et al.* 2024). Despite growing recognition of the relevance of TEK, there has been few research recording local traditional knowledge on plant resources in the Punjab Province capital (Lahore), Pakistan. In this context, the present study aims to document the ethnobotanical profile of plant species used by local communities and to evaluate their significance for healthcare, food security, livestock management, cultural traditions, and household livelihoods. Specifically, we (1) document traditional knowledge related to plant-resource utilization, (2) identify species according to ethnobotanical applications (medicinal, food, fodder, fuelwood, ornamental, cosmetic, timber, cultural, and veterinary), and (3) assess the importance of these plant resources for sustaining local livelihoods and preserving traditional ecological knowledge. The findings are expected to inform biodiversity conservation planning, promote sustainable use of plant resources, and contribute to protecting indigenous knowledge for future generations by highlighting species and practices of high cultural and utilitarian value.

Materials and Methods

Study area

This study was conducted in Lahore, the capital of Punjab Province, Pakistan (approximately 31.5497° N, 74.3436° E), at about 217 m above sea level. Located on the upper Indus Plain near the Ravi River, the region has fertile alluvial soils that support agriculture in peri-urban and adjoining rural areas. Lahore has a semi-arid to humid subtropical climate with hot summers and mild winters. Average annual rainfall is about 630 mm, delivered during the monsoon. May and June are the hottest months, often exceeding forty, while winter temperatures can drop to around 3°C. The area follows the Kharif and Rabi cropping seasons, which sustain a variety of agricultural crops.

The ethnobotanical data was collected from six villages in the study area to document and verify local traditional knowledge regarding plant resources. The surveyed areas included (Kahna Nau, Narang Mandi, Lidher, Hadyara cantt. Lill Pind, Lalyani Kasur) (Fig. 1). Lahore District has a population of over thirteen million people, making it one of the most populous districts in Pakistan. Although Lahore is a major urban centre, the surrounding rural communities continue to rely on agriculture, livestock rearing, and related activities for their livelihoods. Punjabi is the predominant language spoken in the study area. The local population comprises various castes and ethnic groups, including Arain, Jutt, Rajput, Gujjar, and Bhatti, who possess rich traditional knowledge regarding the use and management of plant resources.

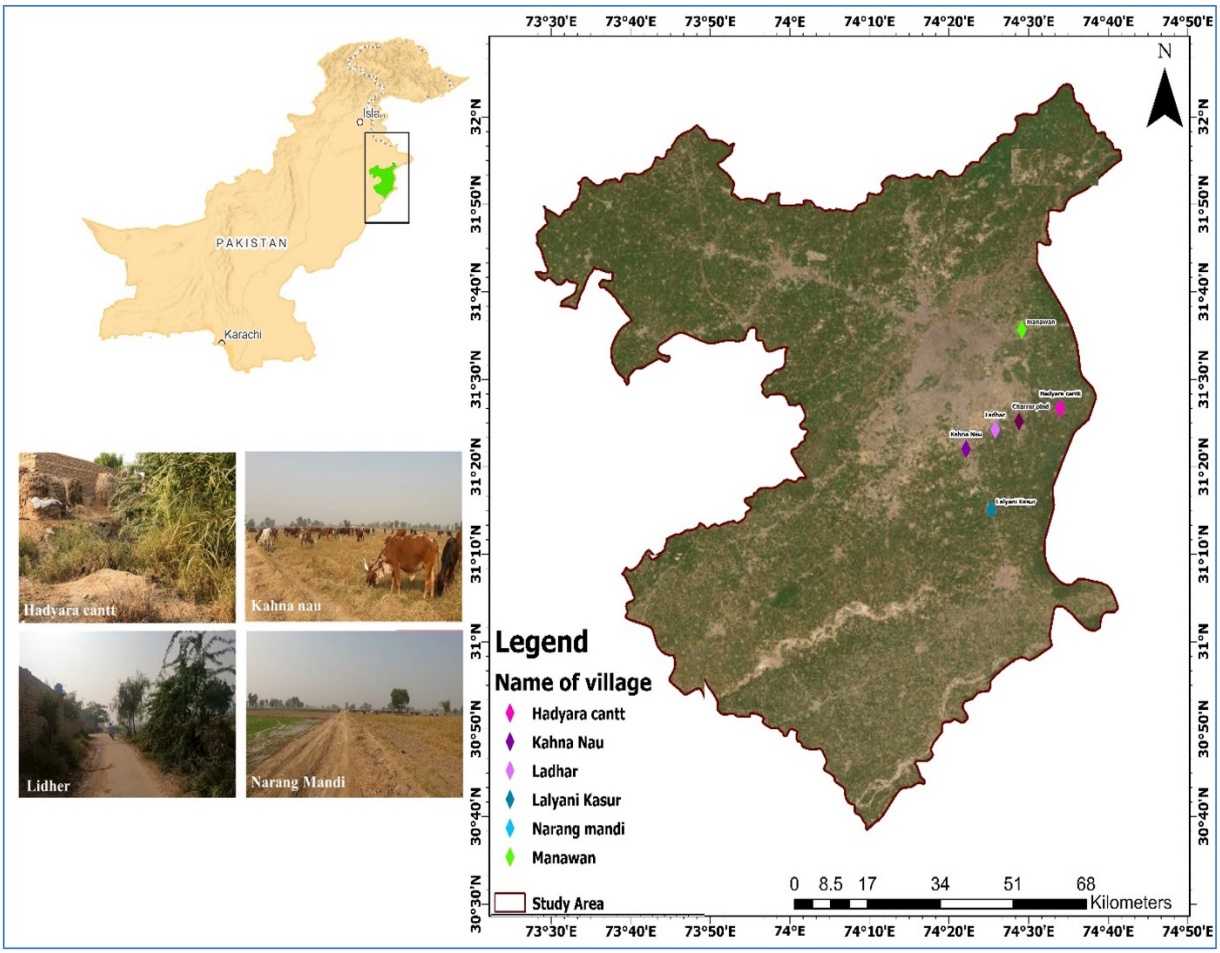


Figure 1. Map of the study area showing the six sampling villages in the study area

Data collection

The current investigation was conducted between 2025 and 2026. Data was gathered and analyzed using the snowball sampling approach (Niaz *et al.* 2026), which included semi-structured interviews with informants and the classification of plant uses into separate use categories. Farmers, pastoralists, government workers, and housewives were among the various occupations and age groups interviewed from six villages (Fig. 2). We are aware that snowball sampling may reduce the sample's representativeness by adding bias by preferring those with stronger social ties. As a result, the perspectives collected could not fairly represent the variety of opinions that are common in the greater community. This constraint was offset by using focus groups and open-ended, semi-structured interviews, which were conducted in compliance with the guidelines provided by Haq *et al.* 2024. This strategy was regarded appropriate since information-rich respondents were difficult to identify using traditional sampling methods and were frequently linked through local social networks. Initial participants were chosen based on their community involvement and understanding of local practices, and they then referred to more suitable people. Data collection proceeded until thematic saturation was reached, at which point no significant new material or perspectives emerged from subsequent interviews. The sample size was thus chosen by the amount and diversity of the material gathered rather than a requirement for statistical representativeness.

A total of thirty-five semi-structured interviews were performed in the original languages of each ethnic group, with one of the writers fluent in the languages (see Table 1). Interviews were conducted in the local languages (Punjabi and Urdu) to

facilitate effective communication and ensure accurate documentation of indigenous knowledge related to plant use. The interviews were then translated into English. To identify the plants and learn their native names, the informants were shown photos (Fig. 3). The survey aimed to record how local communities use plant parts for medicine, veterinary care, cultural and religious practices, ornamentals, cosmetics, fuelwood, timber, and herbal teas. The data were gathered from peri-urban areas at the urban-rural border, which are distinguished by a combination of urban development and agricultural land usage. For the purposes of this study, urban communities are defined as densely populated areas with established municipal infrastructure and predominantly non-agricultural livelihoods, peri-urban communities as transitional zones with both urban and agricultural characteristics, and rural communities as settlements with lower population densities that rely primarily on agriculture. The findings are thus evaluated within the context of the studied communities and are not meant to be extrapolated to Punjab as a whole.

Field surveys and semi-structured interviews were undertaken during June and July, allowing documentation of plant knowledge during the active growing season when many useful plant species were readily available and recognizable. The geographical distribution of the study sites provides a representative overview of traditional plant knowledge across peri-urban communities surrounding Lahore and adjacent Sheikhupura District are provided in table 1.



Figure 2. Photographic representation of the study area and field activities in Kahna Nau and Lidher Village, Lahore: (A) natural vegetation site Hadyara Cantt., (B) agricultural land and irrigation infrastructure, Kahna Nau (C) livestock grazing area, Lidher (D) village access road with roadside vegetation, Narang Mandi (E) interview with local informants, and (F) cultivated agricultural fields.

Table1. Geographic locations of the study sites and distribution of interviewed participants.

Village name	Administrative unit	Latitude	Longitude	Participants interviewed	Date of data collection	Language
Kahna Nau	Lahore District	31.36709	74.36899	5	June 2025, 2026	Punjabi/Urdu
Narang Mandi	Sheikhupura District	31.90376	74.51587	6	June 2025, 2026	Punjabi/Urdu
Lidher	Lahore District	31.45940	74.44127	5	June 2025, 2026	Punjabi/Urdu
Hadyara cantt	Lahore District	31.44399°	74.56747°	5	July 2025, 2026	Punjabi/Urdu

Leel Pind	Lahore District	31.43132°	74.35124°	5	July 2025, 2026	Punjabi/Urdu
Lalyani Kasu	Lahore District	31.25176°	74.42211°	5	July 2025, 2026	Punjabi/Urdu

After data collection, the survey results were re-presented to informants to fix any errors or omissions. We cross-checked the data with relevant literature sources to validate it (Stevens 2017; Hussain *et al.* 2021). Before conducting the interviews, all informants gave their verbal informed consent. Additionally, we chose an individual who was well-respected and knowledgeable about the customs and traditions of each indigenous tribe to go with us on the field research. To maintain confidentiality, no personally identifying information was included in the study database or mentioned in the publication. Interview responses were anonymized, securely stored, and used only for research purposes. We followed the International Society of Ethnobiology's Code of Ethics during the research, which can be found at https://www.ethnobiology.net (accessed May 28, 2022). We gathered comprehensive data, including pertinent taxonomic information, on every plant specimen during our field investigations. We used the taxonomic literature (https://eforaindia.bsi.gov.in/eFlora/eFloraHomePage.action) to identify the plants. The obtained plant specimens were thoroughly dried, stored, labeled, and mounted on herbarium sheets using normal herbarium procedures. The specimens were then identified, authenticated, and placed in the M.S. Zahoor Herbarium, Institute of Botany, University of the Punjab, Lahore, Pakistan, where voucher specimens were allocated and stored for future reference. The taxonomy database Plants of the World Online (POWO) (https://powo.science.kew.org) was used to update the nomenclature.

The ethnobotanical significance of each documented plant taxon was assessed based on the variety of its reported applications. Ten usage categories were investigated, including medical, food, fodder, cultural, decorative, fuelwood, cosmetic, timber, herbal tea, and veterinary. For each species, a binary scoring approach was used, with 1 representing the presence of a use category and 0 representing its absence. The scores from all usage categories were added together to provide a plant usage score (PUS) for each species. As a result, species could receive values ranging from 0 to 10, with higher scores suggesting a wider range of use and, therefore, greater ethnobotanical importance. To facilitate interpretation, species were classified into three categories based on their total PUS: Low use (scores 1-2), representing species used for a limited number of purposes; Moderate use (scores 3-4), representing species used for multiple purposes; and High use (scores ≥5), representing multipurpose species with a wide range of reported uses. The classification is based on quantitative ethnobotanical approaches that assess plant importance through use diversity, frequency of citation, and cultural importance indices (Haq *et al.* 2023).

Data analysis

The data were summarized in MS Excel and analyzed using PAST and OriginPro (version 9.95). To show how preparation methods, plant parts, and traditional use categories relate, we made a chord diagram in OriginPro; the diagram shows weighted links between plant species and their uses. A species-by-use-category matrix was constructed to examine the relationships between documented plant species and their reported utilization patterns. Plant species were arranged in rows, while the documented use categories were represented in columns. The matrix was based on presence/absence data with each cell representing the occurrence of a particular use category. Similarity among plant species was assessed using the Sørensen similarity coefficient. The resulting similarity values were used to examine the degree of overlap in reported plant-use patterns. For hierarchical clustering, distance measure was used, and clustering was performed using the clustering algorithm with the linkage method approach. The heat map was used to visualize the distribution of plant-use associations across species and utilization categories, whereas the dendrograms illustrated the hierarchical relationships derived from the similarity matrix using PAST software. Sørensen's similarity coefficient was interpreted as a measure of similarity rather than a statistical test of significance. Diseases were grouped using the International Classification of Primary Care (ICPC) and the International Classification of Diseases (ICD), which are standard systems for classifying symptoms and health conditions.

Use value (UV)

The UV index was used to measure the significance of species (Phillips et al., 1994). The UV shows the relative importance of medicinal plants known locally. To compute UV, the formula below was used (Haq et al., 2023).

$$\mathrm{UV} = \sum \frac{\mathrm{Ui}}{\mathrm{N}}$$

Where Ui is the total number of uses for a specific species that were mentioned by all the informants, and N is the total number of informants. UV index is based on the frequency of species citations by informants, and the plant use score assesses the diversity of use categories associated with each species.



Figure 3. Photographic representation of different plants collected from the study area: (A) *Amaranthus viridis*, (B) *Ficus religiosa*, (C) *Helianthus annuus*, (D) *Morus nigra*, € *Bauhinia variegata*, and (F) *Azadirachta indica*.

Results and Discussion

Respondents' demography

Current research highlights the close relationship between the local community and the supply of ecosystem services through forest resources, indicating that the local people in the study region still possess vital traditional knowledge. Our study comprised 35 respondents, including (N=20, 57 %) men and (N=15, 43%) women (see Table 2). The observed difference in male and female involvement reflects the composition of the recruited sample collected using the study's snowball sampling method. Although factors impacting participation, such as gender-specific mobility, accessibility, and social norms, were not particularly explored, no inferences can be reached about the underlying causes for the gender distribution found in the sample (Khoja et al. 2024; Adeel et al. 2014). The respondents represented a wide range of occupational groups, including farmers (N=10, 29%), shopkeepers (N=7, 20%), housewives (N=6, 17%), daily wage laborers (N=4, 11%), government employees (N=5, 14%), and pastoralists (N=3, 9%). Educated people are more exposed to modern ideas and usually depend on current medical treatments, so it is reasonable that less educated people have greater knowledge of traditional medicine (Haq et al. 2024). The greatest percentage of the informants (N=16, 46%) was between the ages of 27 and 55 years, followed by those over the age of 56 years (N=13, 37%) and those between the ages of 18 and 26 years (N=6, 17%). Many older people in rural areas simply know more about traditional remedies than the young. Younger generations often turn to modern, generic medicine and are less curious about these older practices, so their knowledge is lower. These interpretations are based on qualitative observations rather than statistically demonstrated age-related differences. The possible impact of urbanization and shifting livelihood patterns on the preservation and transfer of traditional plant knowledge. Increasing reliance on modern healthcare, changing occupational activities, diminished engagement with natural surroundings, and changes in intergenerational knowledge transmission may affect younger generations' familiarity with traditional plant usage.

In our study, the elder consistently showed deeper traditional knowledge than younger participants, which is in line with what other studies have also observed (Abbas *et al.* 2021). There was a clear gap in plant knowledge between generations: younger people knew far less about traditional uses of plants than their elders. This suggests that the flow of ethnobotanical knowledge within families is weakening, as formal education, new types of work, and less dependence on local natural resources give younger generations fewer chances to learn from older family members. In turn, much of the cultural knowledge that was once passed down through stories and daily practice is slowly being lost.

Table 2. Demographic Characteristics of Respondents (n=35)

Variable	Categories	Number of people (n=35)	Percentage (%)
Gender	Male	20	57
	Female	15	43
Age group	Young (18-26 years)	6	17
	Middle (27-55 years)	16	46
	Old (>56 years)	13	37
Profession	Farmers	10	29
	Housewives	6	17
	Shopkeepers	7	20
	Daily wage laborers	4	11
	Pastoralists	3	9
	Government employees	5	14
Religion	Islam	35	100
Ethnic Groups	Arain	14	40
	Bhatti	4	11
	Rajput	10	29
	Jutt	7	20

Ethnobotany resources

In this study, 27 plant taxa belonging to 23 genera and 18 families were documented (see Table 3). In areas where plant diversity is higher, people usually have access to a larger number of useful plant resources. It is therefore reasonable to assume that when more species are available, more of them will be brought into use (Emmanuel & Didier 2011; Karaköse 2022). The ways species are used depend strongly on the local socio-economic conditions, and their patterns of use and distribution can vary markedly from one area to another (Rana *et al.* 2019).

The contributions of families to the different utilization categories vary greatly. People living in different communities use plants, which shows that these species are particularly important for people's daily life. Women and men do not know the same things about plants, but their knowledge often fits together. Because of their daily work and responsibilities, women usually know more about plants used at home, in cooking, and for medicine, while men know more about plants used in farming, grazing animals, and trading. These differences between men's and women's roles shape what kind of plant knowledge each group keeps and how deep that knowledge is. As work patterns, education, and ways of earning a living change, these traditional patterns of knowledge may also change or slowly become weaker over time.

Plant distribution across families

Across the 18 plant families recorded in the study, species were not evenly distributed. Moraceae was the most species-rich family with 7 species (N=7), followed by Fabaceae (N=2), Lamiaceae (N=2), and Malvaceae (N=2), each represented by 2 species. Other 14 families (Amaranthaceae, Anacardiaceae, Apiaceae, Apocynaceae, Arecaceae, Asteraceae, Brassicaceae, Lythraceae, Meliaceae, Myrtaceae, Polygonaceae, Rhamnaceae, Salvadoraceae, and Solanaceae) were each represented by only a single species, reflecting a minor share in the floristic composition of the area (Fig. 4).

Areas with higher floristic diversity provide a greater variety of useful plant resources for local communities. The utilization of plant resources often varies across regions due to differences in species composition, ecological conditions, and the socioeconomic characteristics of local populations, which influence the selection and application of plant species for various purposes (Umair *et al.* 2019). Similarly, an ethnobotanical survey in Hafizabad District reported Moraceae as one of the most represented families, recording six species and underscoring the family's ecological abundance and cultural significance in Punjab (Rashid *et al.* 2017). These observations showed that Moraceae commonly dominates the flora across much of Punjab, reflecting the widespread availability and high usefulness of its species to local communities.

The family Moraceae's relatively high representation among known plant species may reflect its ecological presence and the diversity of useful plants in the surrounding environment. Members of this family relate to a variety of traditional applications, which may help them gain recognition and inclusion in local ethnobotanical knowledge. Their representation may also be influenced by the abundance of these species and their accessibility to community members. The many applications of several Moraceae plants may help to explain their importance in local subsistence strategies. However, family-level representation should be evaluated considering reported species composition and sampling coverage rather than as direct proof of greater ethnobotanical significance.

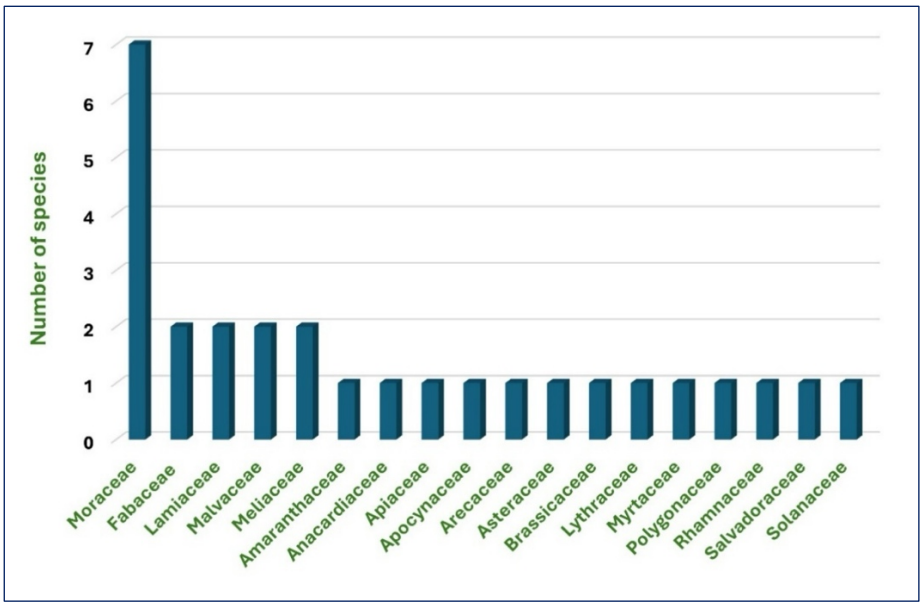


Figure 4. Number of Species Reported in Different Families.

Plant usage patterns

According to the plant usage analysis, the majority of the recorded plant species showed moderate use intensity, with fourteen species (51.9%) falling into this group and 11 species (40.7%) having low use intensity (Fig. 5). Only two species, *Azadirachta indica* A. Juss. And *Ocimum tenuiflorum* L., had high use, demonstrating their greater cultural and practical value among reported plants. Species with intermediate use included *Bauhinia variegata* L.*, Brassica juncea* (L.) Czern.*, Mangifera indica* L.*,* and *Phoenix dactylifera* L., showing a comparably widespread but less intensive use. Overall, the findings indicate that, while local groups employ a wide range of plant species, just a few are highly desired and extensively used, indicating differences in perceived utility, availability, and cultural significance.

Plant part used

The preference analysis showed that leaves were the most frequently utilized plant part (n = 11; 30.6%), followed by fruits (n = 8; 22.2%), seeds (n = 5; 13.9%), stems (n = 4; 11.1%), roots (n = 2; 5.6%), bark (n = 2; 5.6%), buds (n = 2; 5.6%), latex (n = 1; 2.8%), and flowers (n = 1; 2.8%) (Fig. 6). The percentages were calculated based on the total number of recorded plant-part use reports (n = 36) rather than the total number of species, as several species were reported to provide more than one useful plant part. Most plant materials were crushed into dry powders after thorough drying and stored in glass containers for later use. Local communities used leaves and whole herbaceous plants. Leaves were the most used part because they are abundant, easy to collect, and easy to process. This pattern matches previous ethnobotanical studies, where leaves and roots were widely used for medicine due to their accessibility and prominent levels of bioactive compounds (Haq *et al.* 2024).

Leaves accumulate many medicinal phytochemicals and harvesting them is less destructive than collecting roots or bark, making it more sustainable. Similar findings have been reported in ethnobotanical studies from Punjab and other regions of Pakistan (Umair *et al.* 2019). There are multiple active secondary constituents in leaves for the preparation of herbal medicines. Compared to previously published reports, these results show a similar pattern in that leaves were the most used (Akbulut *et al.* 2019; Waheed *et al.* 2023; Alrhmoun *et al.* 2024). Leaves are thought to contain more easily extractable phytochemicals, crude drugs, and many other mixtures that could prove valuable in phytotherapies (Ahmad *et al.* 2014; Savikin *et al.* 2013). This could be the reason why several studies, including the present one, cite leaves as the most utilized plant part for medicinal purposes (Khan *et al.* 2015; Haq & Singh 2020; Zaman *et al.* 2024).

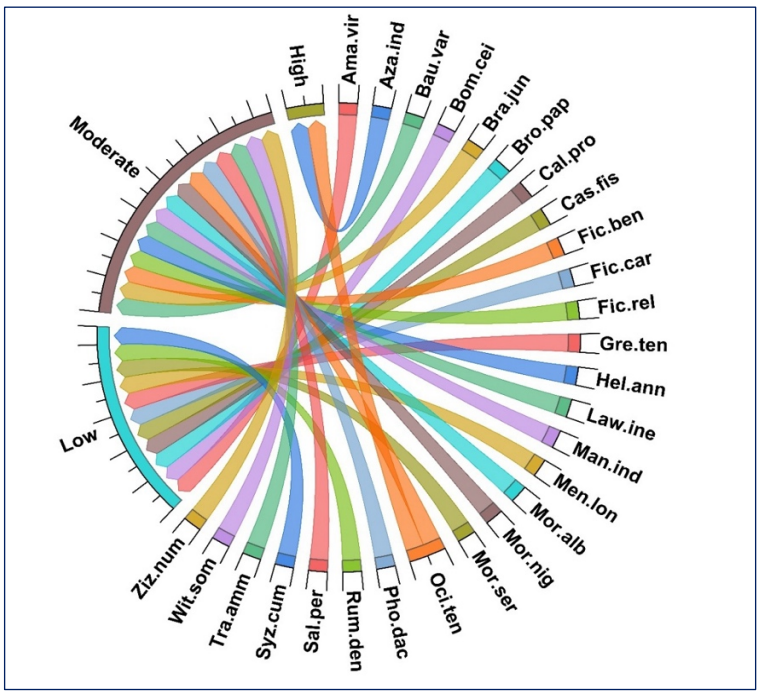


Figure 5. Plant usage pattern of the documented species in the study area.

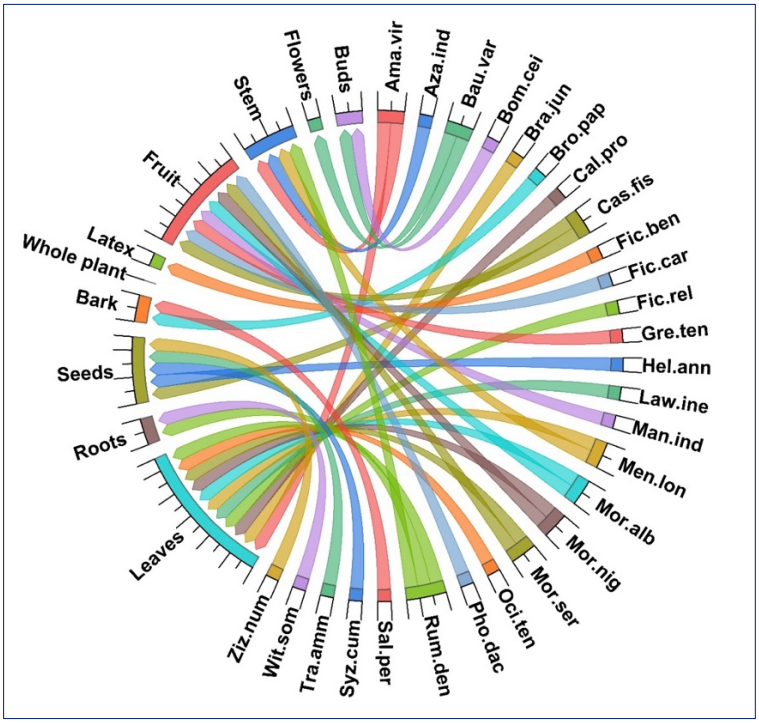


Figure 6. Plant resources and plant parts used for the different ethnobotanical uses.

Preparation

The most frequently reported preparation method was cooked preparations (n = 6; 19.4%), followed by boiled (n = 5; 16.1%), herbal tea (n = 4; 12.9%), powder (n = 3; 9.7%), raw consumption (n = 3; 9.7%), paste (n = 3; 9.7%), and juice (n = 3; 9.7%). Less frequently reported methods included oil (n = 1; 3.2%), infusion (n = 1; 3.2%), marinated (n = 1; 3.2%), and preservative preparations (n = 1; 3.2%) (Fig. 7). The percentages were calculated based on the total number of recorded preparation-method use reports (n = 31) rather than the total number of plant species, because several species were associated with more than one preparation method. The photographic representation of the different preparations reported in the study area is shown in Figure 8. The overall findings showed that the cooked preparation of food is preferable compared to other methods. Cooked food is preferred because it improves nutrient bioavailability, reduces antinutritional factors, enhances

digestibility, and maintains lower caloric content compared to other cooking methods. While it may reduce some water-soluble vitamins (like vitamin C), the overall benefits for antioxidant availability and protein digestibility make it the most used preparation method (Vissamsetti *et al.* 2024). Other studies have found comparable results. In the Madhupur forest area of Bangladesh, people used certain preparation methods (Islam *et al.* 2014).

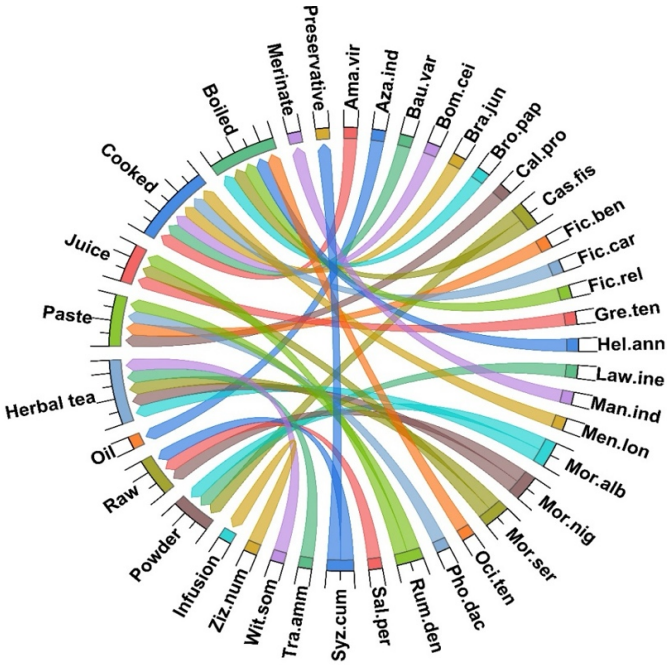


Figure 7. Plant resources and different preparations used reported in the study area.

Research suggests that cooked or home-prepared food may be a better choice because it is linked to healthier eating patterns, better diet quality, and a higher intake of fruits and vegetables than pre-prepared meals (Mills *et al.* 2017). Compared with pre-prepared meals, fully home-cooked meals prepared in families with young children were more likely to include nutritious ingredients, suggesting that home cooking may support healthier food choices and improve overall meal quality (Fertig *et al.* 2019).



Figure 8. Photographic representation of the different preparations reported in the project area: (A) Fruit of *Ficus carica* L. boiling in sugar syrup. (B) Flower buds of *Bombax ceiba* L. in mustard oil. (C) Leaves of *Amaranthus viridis* L. (D) Saag from leaves of Brassica *juncea* (L.) Czern. (E) Staining of oil from leaves of *Azadirachta indica* A.Juss. (F) Roasted seeds of *Helianthus annuus L.*

Table 3. Checklist of plants with scientific name, family, common name, part used, preparation, disease treated, and ethnoecological usage reported in the study area.

Scientific Name/ Collection Voucher	English Name	Code	Family name	Common name	Part(s) used	Name of traditional dish/ medicine	Preparation	Disease treated	Other Ethno uses	Use value
Amaranthus viridis L. (HAS-1341)	Slender Amaranth	Ama.vir	Amaranthaceae	Chulai	Leaves and young shoots	Chulai ki Sabzi	Chop leaves finely; sauté garlic and onions till golden; cook on heat until soft.	Digestive, Dermatological Joint and Muscles	Food Fodder	0.33
Azadirachta indica A. Juss. (HAS-1318)	Neem	Aza.ind	Meliaceae	Naim/ Neem	Seed	Oil for skin diseases	Oil Application: Dilute neem seed oil with coconut oil (1:1) and massage on affected areas for skin diseases.	Respiratory, Digestive, Dermatologica	Medicinal Cultural Fuelwood Cosmetics Timber	0.74
Bauhinia variegata L. (HAS-1315)	Orchid Tree	Bau.var	Fabaceae (Leguminosae)	Kachnar	Flower buds	Kachnar ki sabzi	Flower buds cooked with spices as a vegetable dish.	Digestive	Food Fodder Ornamental	0.54
Bombax ceiba L. (HAS-1356)	Red Silk Cotton Tree	Bom.cei	Malvaceae	Simbal	Flower buds	Flower bud sabzi	Wash flower buds, remove petals, sepals, stamens. Boil buds in. Add boiled buds in oil and stir-fry.	Digestive, Dermatological, Joint and Muscle Reproductive	Food Ornamental	0.56
Brassica juncea (L.) Czern. (HAS-1317)	Indian Mustard	Bra.jun	Brassicaceae	Sarson	Leaves	Sarson da saag	Cook leaves, green chilies, salt, and water to a pot. Cook until leaves become soft. Add maize flour with water. Add it to the saag.	Joint and Muscle	Food Fodder Cultural	0.74
Broussonetia papyrifera (L.) L'Hér. Ex Vent. (HAS-1361)	Paper Mulberry	Bro.pap	Moraceae	Jangli toot	Bark	Bark tonic	Dried bark boiled in water; the resulting liquid is used to help reduce inflammation.	Dermatological	Fodder Fuelwood	0.66
Calotropis procera (Aiton) Dryand. (HAS-1358)	Apple of Sodom	Cal.pro	Apocynaceae	Akk	Leaves	Haldi leaf for joints	Warm leaves coated with mustard oil and haldi. Then applied poultice over joints to help relieve pain.	Dermatological, Joint and Muscle	Medicinal	0.79
Cassia fistula L. (HAS-1301)	Golden Shower Tree	Cas.fis	Fabaceae (Leguminosae)	Amaltas, Ambartash	Fruit pulp, seeds	Medicine for stomach	Boil dried fruit pulp to prepare a laxative drink. Seed powder mixed with honey for parasitic infections.	Digestive Hepatic	Medicinal	0.72
Ficus benghalensis L. (HAS-1305)	Banyan Tree	Fic.ben	Moraceae	Bohr	Latex	Medicine for skin	Collect fresh milky latex and apply cuts or bruises to reduce inflammation and promote healing.	Joint and Muscle	Fodder Cultural Ornamental	0.73
Ficus carica L. (HAS-1309)	Common Fig	Fic.car	Moraceae	Anjeer	Fruit	Murabba-e-Anjeer	Fresh figs soaked, then boiled in concentrated sugar syrup with cardamom.	Digestive	Food Fodder	0.82

Ficus religiosa L. (HAS-1359)	Sacred Fig	Fic.rel	Moraceae	Peepal	Leaves	Cough medicine	Leaf Decoction: Boil leaves, strain and consume to cure cough.	Respiratory	Fodder Cultural	0.85
Grewia tenax (Forssk.) Fiori (HAS-1322)	White Crossberry	Gre.ten	Malvaceae	Phalsa, Ganger, Gangu, Raisin bush	Fruit	Falsa Sharbat	Boil fruit then mash, strain pulp, discard seeds. Make sugar syrup, add pulp, lemon juice, black salt. Serve with ice	Digestive Hepatic	Food Fodder	0.50
Helianthus annuus L. (HAS-1320)	Sunflower	Hel.ann	Asteraceae	*Suraj Mukhi*	Seeds	Bhunnay huye beej	Boil water with salt. Add sunflower seeds and simmer. Drain and dry the seeds. Roast them in pan.	Headache and fever	Food Fodder	0.52
Lawsonia inermis L. (HAS-1302)	Henna	Law.ine	Lythraceae	Mehndi	Leaves	No dish (natural dye)	Dried leaves are powdered and mixed with water/lemon juice to prepare a natural dye (Mehndi).	Dermatological	Fodder Cultural Ornamental Cosmetics	0.66
Mangifera indica L. (HAS-1307)	Mango	Man.ind	Anacardiaceae	Aam	Fruit	Achar	Raw mangoes are cut into pieces, mixed with salt, red chili powder, turmeric, and mustard oil. Then stored in a clean glass jar and kept in sunlight.	Dermatological	Food, cultural Ornamental, Timber	0.84
Mentha longifolia (L.) L. (HAS-1328)	Wild Mint	Men.lon	Lamiaceae	Podina	Leaves and stems	Mint pulao	Mint Pulao- Cook rice with mint leaves and stems spices, and vegetables for a fragrant and appetizing dish.	Respiratory	Food	0.78
Morus alba L. (HAS-1391)	White Mulberry	Mor.alb	Moraceae	Toot	Leaves, fruits	Herbal tea of mulberry	Boil leaves in water. Fresh fruits are eaten to improve digestion.	Digestive	Food Fodder Fuelwood Timber	0.71
Morus nigra L. (HAS-1390)	Black Mulberry	Mor.nig	Moraceae	Toot (Black mulberry)	Fruits, leaves	Natural medicine for diabetes	Fruit eaten fresh or dried for nourishment. Leaf Tea: Boil dried leaves in hot water.	Respiratory	Food Fodder Fuelwood	0.89
Morus serrata Roxb. (HAS-1389)	Himalayan Mulberry	Mor.ser	Moraceae	Shahtoot	Leaves, fruits	Fruit juice of mulberry	Extract juice from fruit. Leaves are boiled in water for herbal tea.	Digestive	Medicinal Fodder	0.95
Ocimum tenuiflorum L. (HAS-1379)	Holy Basil	Oci.ten	Lamiaceae	Niazbo	Leaves	Qahwa	Leaves are boiled in water. Add sugar, then strain. It is traditionally consumed to sore throat.	Respiratory	Medicinal Fodder Cosmetics	0.45
Phoenix dactylifera L. (HAS-1350)	Date Palm	Pho.dac	Arecaceae	Khajoor	Fruit	Khajoor ki chutney	Remove seeds and cook fruit pulp with water, cumin powder, red chili powder, and salt are added.	Digestive	Food Fodder Cultural	0.88

Rumex dentatus L. (HAS-1323)	Toothed Dock	Rum.den	Polygonaceae	Jangli Palak	Leaves	Natural medicine for skin	Extract fresh leaf juice or crush leaves to paste and apply on affected skin areas.	Hepatic	Medicinal Fodder	0.78
Salvadora persica L. (HAS-1337)	Toothbrush Tree	Sal.per	Salvadoraceae	Peelu, Miswak Tree	Bark	Bark for teeth/fruit can be eaten	Wash twigs properly with tap water then use them as a teeth brush.	Reproductive	Medicinal Cultural Fuelwood, cosmetics	0.65
Syzygium cumini (L.) Skeels (HAS-1321)	Java Plum	Syz.cum	Myrtaceae	Jaman, jamu	Fruit	Powder for diabetes	Fruit Consumption: Fresh or dried fruits eaten raw or made into sweet preserves.	Digestive	Medicinal Food	0.87
Trachyspermum ammi (L.) Sprague (HAS-1345)	Ajwain	Tra.amm	Apiaceae	Ajwain	Seeds	Qahwa	Add the seeds to the water and boil. The mixture is strained.	Respiratory, Digestive Reproductive Joint and Muscle	Medicinal	0.64
Withania somnifera L. Dunal. (HAS-1352)	Ashwagandha	Wit.som	Solanaceae	Ashwagandha, Asgandh	Roots	Ashwagandha dodh	Root powder added to warm milk Add sugar and the preparation is consumed as a tonic to improve strength.	Psycological Reproductive	Medicinal Food	0.80
Ziziphus nummularia (Burm.f.) Wight & Arn. (HAS-1319)	Wild Jujube	Ziz.num	Rhamnaceae	Saho Berri Jangli Bairi Kathy Beer Karkanr	Seeds	Beri ka tel	Cold-pressed seed oil applied on wounds to reduce inflammation.	Digestive	Food Fodder Fuelwood	0.36

Disease treated

Digestive disorders were the most frequently cited medicinal use category (n = 8; 23.5%), followed by joint and muscle ailments (n = 6; 17.6%), dermatological conditions (n = 5; 14.7%), respiratory disorders (n = 4; 11.8%), hepatic disorders (n = 3; 8.8%), fever and headache (n = 3; 8.8%), reproductive disorders (n = 3; 8.8%), and psychological conditions (n = 2; 5.9%) (Fig. 9). The percentages were calculated based on the total number of ailment-use reports (n = 34) recorded across all documented medicinal plant species. In peri-urban populations, digestive problems remain common and are often linked to insufficient access to irregular eating habits, and consumption of contaminated or street foods. The next most frequently reported by informant conditions are respiratory disorders, driven by air pollution, exposure to indoor smoke from solid fuels in poorly ventilated homes, and seasonal viral outbreaks.

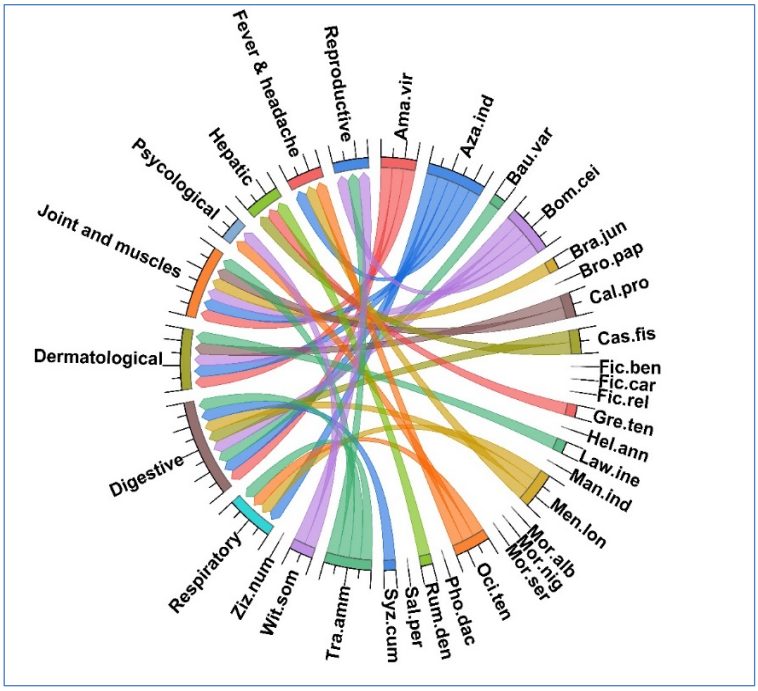


Figure 9. Distribution of plant resources used for the treatment of different diseases in the study area.

These environmental and lifestyle factors match our findings: people rely heavily on medicinal plants to treat digestive and respiratory problems. Gastrointestinal problems, such as stomachache, diarrhea, constipation, and indigestion, are among the most common reasons people in Pakistan and nearby regions use medicinal plants. Previous studies have also shown a strong use of local plant remedies for these ailments: Traditional herbs are widely used for stomach-related illnesses in Pakistan (Tariq *et al.* 2015); gastrointestinal diseases are an important category treated with indigenous remedies in North Waziristan (Rehman *et al.* 2023); 73 plant species are used for digestive problems in Sahiwal District, especially for indigestion and stomachache Harun *et al.* (2025); and Rokaya *et al.* (2014) observed similar patterns in Nepal. Overall, these studies suggest that digestive disorders remain a major health issue in South Asia and that people often depend on medicinal plants because of eating highly spicy food, and limited access to modern healthcare. Treating digestive disorders is one of the most common uses of medicinal plants (Khoja *et al.* 2022). The study documents traditional knowledge and reported uses of plant species and does not evaluate their pharmacological efficacy, therapeutic effectiveness, or safety. The reported medicinal applications are based solely on informant knowledge and experiences, and no experimental, toxicological, or clinical assessments were conducted as part of this research.

Other ethnobotanical uses

Fodder use was the most frequently reported category (n = 17; 22.4%), followed by food (n = 16; 21.1%), medicinal (n = 7; 9.2%), cultural (n = 8; 10.5%), ornamental (n = 7; 9.2%), fuelwood (n = 7; 9.2%), cosmetic (n = 4; 5.3%), herbal tea (n = 4; 5.3%), timber (n = 3; 3.9%), and veterinary uses (n = 3; 3.9%) (Fig. 10). The percentages were calculated based on the total number of recorded use reports across all categories (n = 76). The complete species-by-use matrix, including all recorded species and their corresponding use categories, has been provided as supplementary table S1. The two-way cluster analysis (heatmap with dendrogram) showed clear patterns in how people use plant species and the various kinds of uses in the study area. Plants were grouped by similarity in how they are used, and use categories were grouped by which plants they share. The clusters showed that plant uses are spread out in diverse ways, meaning local people use different species for many

social, economic, and cultural reasons (Fig. 11). Food and fodder were closely related, showing plants are important as food for people and livestock. Medicinal use, cosmetic use, herbal tea, and veterinary use were grouped together, suggesting overlapping traditional knowledge about health. Cultural and ornamental uses were also linked, showing some plants are valued for beauty and ceremonies. Fuelwood and timber were separate but related, pointing to the role of trees and woody plants for energy and building.

The species tree (dendrogram) showed groups of plants with similar use patterns. For example, *Morus alba* L., *Morus nigra* L., and *Broussonetia papyrifera* (L.) L'Hér. Ex Vent.grouped together because they have many uses, especially food, fodder, and medicine. *Ficus religiosa* L.and *Ficus benghalensis* L., formed a group, reflecting their shared cultural, medicinal, and ecological importance. *Syzygium cumini* (L.) Skeels, *Withania somnifera* L. Dunal., *Mentha longifolia* (L.) L., and *Trachyspermum ammi* (L.) Sprague, were grouped for their strong medicinal and health uses. Other plants formed their own small groups, showing unique or specialized uses.

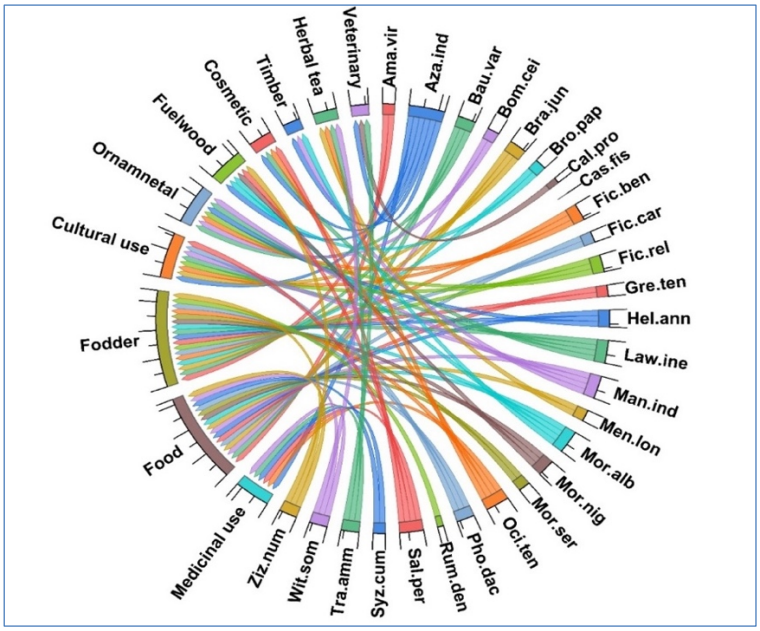


Figure 10. Distribution of plant resources used for the ethnobiological use of plant resources in the study area.

The heatmap makes it clear that some species are used in many ways, while others are used for only one or two purposes. Food, fodder, and medicine were the most common uses, suggesting these are the top priorities for the local community. Clustering supports the idea that people choose plants based on their needs for living, traditional health care, and cultural tastes. These results match earlier ethnobotanical studies from Pakistan and nearby Himalayan areas, which also found food, fodder, medicine, and cultural uses to be the main reasons people use plants (Bano *et al.* 2014; Sher *et al.* 2020). The distinct grouping of use categories also shows that local people have strong traditional ecological knowledge, helping them use plant resources well for many needs.

Overall, the two-way cluster analysis shows the wide range and complexity of plant use in the study area and underlines the need to conserve both plant diversity and indigenous knowledge. Unlike rural communities, urban households have better access to markets, healthcare facilities, and commercial products. Nevertheless, plant resources continue to play a significant role in supporting food security, health care, cultural traditions, and household well-being. Urban residents frequently use edible plants, fruits, vegetables, herbs, and medicinal species from home gardens, urban green spaces, local markets, and herbal shops (Perveen *et al.* 2024). The reported range of plant applications emphasizes the practical use of local plant resources in traditional community activities. The recorded applications, which include food, fodder, medicine, cultural, and other purposes, indicate the various ways in which plant resources are integrated into daily life. These uses may help to promote household subsistence and increase the availability of locally available resources. However, the current study did not directly analyze household income, economic returns, market value, or the role of plant resources in household food security.

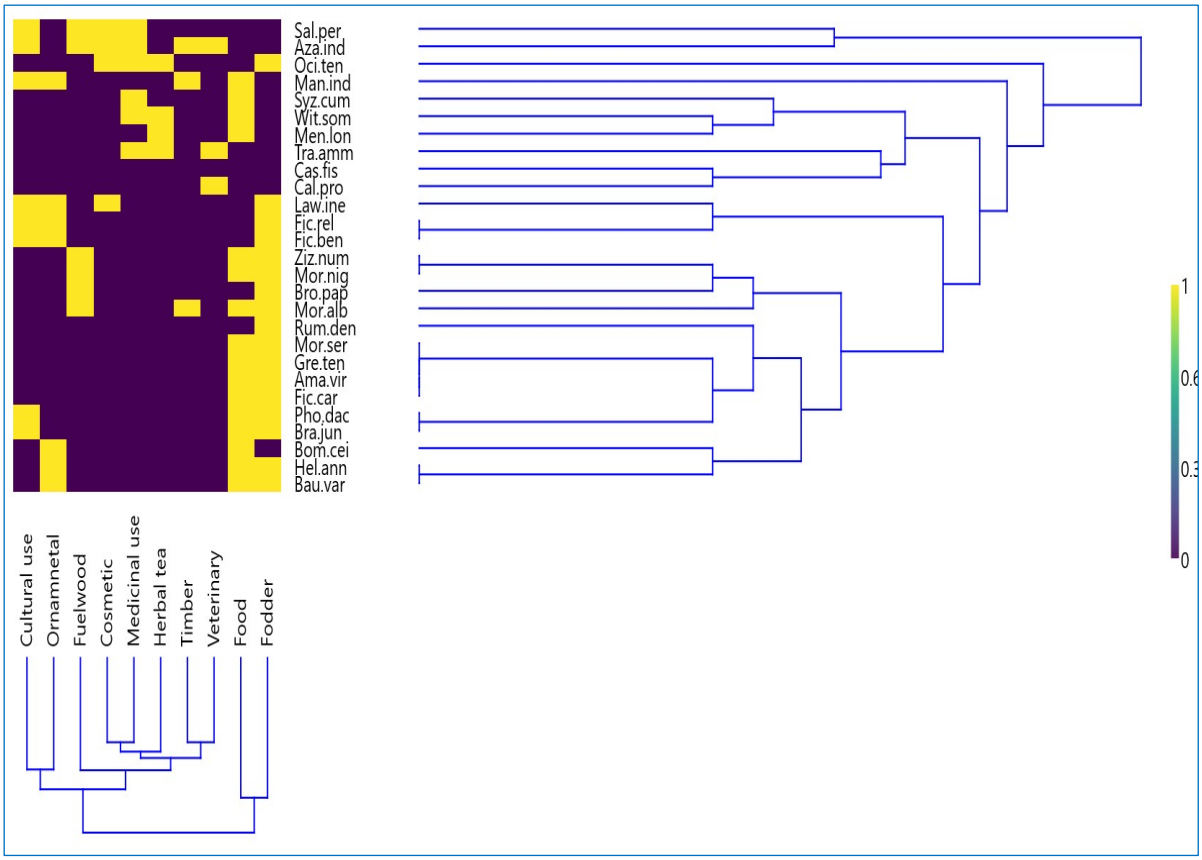


Figure 11. Heat map with cluster dendrogram based on ethnobiological use of plant resources in the study area.

Use value

The use value (UV) of the 27 described ethnomedicinal plant species ranged from 0.33 to 0.95, demonstrating wide variance in their significance and frequency of use among local informants. *Morus serrata* Roxb., had the highest UV levels (0.95), followed by *Morus nigra* L. (0.89*), Phoenix dactylifera* L. (0.88), *Syzygium cumini* (L.) Skeels (0.87), *Ficus religiosa* L. (0.85), and *Mangifera indica* L. (0.84), indicating that these species are highly valued and widely used in the community. Moderate usage values were found for *Morus alba* L. (0.71), *Broussonetia papyrifera* (L.) L'Hér. Ex Vent. (0.66), *Lawsonia inermis* L. (0.66), *Salvadora persica* L. (0.65), and *Trachyspermum ammi* (L.) Sprague (0.64). These species were identified by the informants and contributed significantly to local ethnobotanical activities, while being mentioned less frequently than the most popular species. In contrast, *Amaranthus viridis* L. (0.33), *Ziziphus nummularia* (Burm.f.) Wight & Arn. (0.36), *Ocimum tenuiflorum* L. (0.45), *Grewia tenax* (Forssk.) Fiori (0.50), and *Helianthus annuus L.* (0.52) had the lowest UV levels, indicating moderate usage. Overall, the prevalence of high UV values among fruit-bearing and multipurpose plants emphasizes their prominent involvement in local ethnomedicinal practices, as well as their potential usefulness for conservation and future pharmacological research (Haq et al., 2023b). Species with higher UV values had a higher number of reported uses across all documented categories, including medical, food, fodder, cultural, and other applications. Their relatively high valuations may represent their range of uses, familiarity, and significance in daily community activities. In contrast, species with lower UV levels may have more specialized or restricted applications.

Overall, the prevalence of high UV values in fruit-bearing and multifunctional species emphasizes their importance in local ethnomedicinal systems (Waheed et al., 2023). High-UV species are culturally important and/or widely utilized plant resources, reflecting their frequency of citation and diversity of uses among respondents. This doesn't imply that species with high UV values are threatened, rare, or conservation-priority species. Consequently, conservation priority cannot be inferred solely from UV values. Where conservation implications are discussed, the need for additional ecological data, including assessments of species availability, harvesting pressure, habitat condition, population dynamics, and regeneration potential, is explicitly highlighted.

Limitation and Future Research

This study provides ethnobotanical insights from a small sample of peri-urban groups in Lahore District; hence the results should not be regarded statistically typical of the general population. Furthermore, the study reports on plant usage and

associated traditional knowledge without examining species abundance, harvesting pressure, habitat condition, population trends, pharmaceutical efficacy, or safety. Future research should include broader and stratified sampling across different geographic and socio-cultural settings to evaluate knowledge transmission across generations, ecological assessments of culturally important and highly utilized species to determine their conservation status, and phytochemical, pharmacological, and safety evaluations of commonly used medicinal species as needed.

Conclusion

This study documented 27 plant species from 23 genera and 18 families, emphasizing their many traditional applications in the study area. The most often reported plant parts were leaves, fruits, and seeds, with frying, boiling, and paste preparation being popular ways of consumption. Medicinal applications were primarily related to digestive, musculoskeletal, and dermatological problems. These findings reflect informant-reported conventional knowledge rather than scientifically confirmed treatment efficacy. The use-value assessment and cluster analyze revealed disparities in plant usage patterns, as well as the multifunctional relevance of species like *Morus alba, Morus nigra,* and *Broussonetia papyrifera*, as well as the cultural significance of *Ficus religiosa* and *Ficus benghalensis*. The study establishes a foundation for understanding local plant consumption and related traditional knowledge. The study was limited to 35 participants and did not involve pharmacological validation, economic valuation, or direct assessments of household livelihood contributions. Nonetheless, the findings highlight the necessity of documenting traditional knowledge, encouraging intergenerational knowledge transmission, and promoting the sustainable use and conservation of locally significant plant species. More study, including ecological, pharmaceutical, and socioeconomic assessments, is needed to reinforce these efforts.

Declarations

Ethics approval and consent: The current study relied solely on field surveys rather than animal or human experiments. As a result, ethical approval and agreement to participate were not required. The International Society of Ethnobiology's Code of Ethics (http://www.ethnobiology.net/) was strictly observed. The study was carried out using prior informed consent procedures, in which all participants were told of the study's objectives, the voluntary nature of their involvement, and the planned use of the information obtained prior to conducting interviews. All respondents provided verbal consent before data collection began. The study did not involve the commercial exploitation of biological resources, the gathering of genetic material, or activities that resulted in benefit sharing responsibilities. As a result, the information was collected only for academic research reasons. The traditional knowledge documented was recorded solely for non-commercial academic research purposes. No exclusive rights, commercialization, or intellectual property claims were sought over the knowledge shared by participants. Confidentiality was maintained through the anonymization of interview records and the exclusion of personally identifiable information from the dataset and published manuscript. Therefore, no specific Access and Benefit-Sharing (ABS) permit or instrument was required for the study.

Competing interests All the authors declare no conflict of interest.

Consent for publication: All people shown in images agreed to have their images published.

Availability of data and materials: All data have been included in the manuscript.

Authors' contributions Conceptualization- Rainer W. Bussman, Muhammad Waheed; Study Design; Muhammad Azhar Jameel; Hafeeza Amna Saleem; Data collection- Hafeeza Amna Saleem, Awais Ali, Data analysis- Muhammad Waheed; Shiekh Marifatul Haq; Muhammad Waheed; Original draft writing Shiekh Marifatul Haq; Hafeeza Amna Saleem; Review and editing- Rainer W. Bussmann, Tashbaev Sherzodbek, Muydinov Nurillo Tukhtarovich, Omonbayev Oybek, Muhammad Azhar Jameel, Muhammad Waheed, Shiekh Marifatul Haq. All authors read and approved of the final manuscript.

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Supplementary Table. Species - use matrix

Scientific Name	Code	Medicinal use	Food	Fodder	Cultural use	Ornamnetal	Fuelwood	Cosmetic	Timber	Herbal tea	Veterinary
Amaranthus viridis L.	Ama.vir	0	**1**	1	0	0	0	0	0	0	0
Azadirachta indica A.Juss.	Aza.ind	1	0	0	1	0	1	1	1	0	1
Bauhinia variegata L.	Bau.var	0	1	1	0	1	0	0	0	0	0
Bombax ceiba L.	Bom.cei	0	1	0	0	1	0	0	0	0	0
Brassica juncea (L.) Czern.	Bra.jun	0	1	1	1	0	0	0	0	0	0
Broussonetia papyrifera (L.) L'Hér. ex Vent.	Bro.pap	0	0	1	0	0	1	0	0	0	0
Calotropis procera (Aiton) Dryand.	Cal.pro	1	0	0	0	0	0	0	0	0	1
Cassia fistula L.	Cas.fis	0	0	0	0	0	1	0	0	0	0
Ficus benghalensis L.	Fic.ben	0	0	1	1	1	0	0	0	0	0
Ficus carica L.	Fic.car	0	1	1	0	0	0	0	0	0	0
Ficus religiosa L.	Fic.rel	0	0	1	1	1	0	0	0	0	0
Grewia tenax (Forssk.) Fiori	Gre.ten	0	1	1	0	0	0	0	0	0	0
Helianthus annuus I	Hel.ann	0	1	1	0	1	0	0	0	0	0
Lawsonia inermis L.	Law.ine	0	0	1	1	1	0	1	0	0	0
Mangifera indica L.	Man.ind	0	1	0	1	1	0	0	1	0	0
Mentha longifolia (L.) L.	Men.lon	0	1	0	0	0	0	0	0	1	0
Morus alba L.	Mor.alb	0	1	1	0	0	1	0	1	0	0
Morus nigra L.	Mor.nig	0	1	1	0	0	1	0	0	0	0
Morus serrata Roxb.	Mor.ser	0	1	1	0	0	0	0	0	0	0
Ocimum tenuiflorum L.	Oci.ten	1	0	1	0	0	0	1	0	1	0
Phoenix dactylifera L.	Pho.dac	0	1	1	1	0	0	0	0	0	0
Rumex dentatus L.	Rum.den	0	0	1	0	0	0	0	0	0	0
Salvadora persica L	Sal.per	1	0	0	1	0	1	1	0	0	0
Syzygium cumini (L.) Skeels	Syz.cum	1	1	0	0	0	0	0	0	0	0
Trachyspermum ammi (L.)Sprague	Tra.amm	1	0	0	0	0	0	0	0	1	1
Withania somnifera (L.) Dunal	Wit.som	1	1	0	0	0	0	0	0	1	0
Ziziphus nummularia (Burm.f.) Wight & Arn.	Ziz.num	0	1	1	0	0	1	0	0	0	0