



Ethnobotanical surveys for the assessment of traditional knowledge of the local flora in Tehsil Gujrat, Pakistan

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Research

Abstract

Background: Ethnobotanical studies serve as a critical bridge between indigenous wisdom and modern drug discovery. Rapid urbanization and migration of younger generations have threatened the preservation of undocumented traditional knowledge. This study aimed to document the floristic diversity and traditional knowledge from unexplored areas of tehsil Gujrat, Pakistan, an ecologically rich region between Jhelum and Chenab Rivers.

Methods: Field surveys were conducted in tehsil Gujrat, Pakistan and data was gathered from 425 respondents through structured and semi-structured interviews using purposive and snowball sampling. Quantitative indices, including UV, RFC, ICF and FL were employed to determine the medicinal importance of documented species. To assess the uniqueness, cultural exchange and intergenerational retention patterns of traditional knowledge, Jaccard's Similarity Index (JSI) and Novelty Percentage (NP) were employed.

Results: A total of 83 plant species from 40 families were documented, with herbs (40%) and the Rutaceae family being dominant. Leaves were the most utilized plant part (41%), primarily prepared through decoctions (39%). *Mentha arvensis* L. showed the highest UV (0.2565), while *Aloe vera* (L.) Burm.f. exhibited the highest RFC (0.1929) and FL (19.3%) for skin health. The highest ICF (0.481) was recorded for musculoskeletal issues. Comparative analysis revealed JSI scores ranging from 12.9% to 50.4%, indicating low to medium similarity with neighboring areas. Notably, the study recorded a high Novelty Percentage (up to 79%), largely due to the medicinal use of ornamental species like *Agave attenuata* Salm-Dyck and *Bougainvillea spectabilis* Willd.

Conclusions: The study highlights that tehsil Gujrat possesses a rich and unique ethnobotanical heritage that is dynamically adapting, as evidenced by the integration of ornamental plants into traditional medicine. The high novelty and low similarity index underscore the necessity of site-specific documentation to prevent the erosion of localized indigenous knowledge.

Keywords: Flora, Gujrat, Regions, Culture, Medicinal, Commonalities

Background

Ethnobotanical studies are vital in modern drug discovery, acting as a bridge between indigenous knowledge and scientific validation (Ishtiaq *et al.* 2024). This traditional knowledge provides information related to the use of plants to treat various diseases. Researchers can identify high potential of plants to develop new as well as improved existing pharmaceutical drugs (Chaachouay and Zidane, 2024). The old classical knowledge of plants in the medicines for the curing diseases by indigenous people is termed as the ethnomedicine (Pushpangadan *et al.* 2018). Since ancient times, people rely on the plants to fulfil their daily basic requirements, consequently they used the large number of medicinal plants at that time (Ramawat *et al.* 2009).

The overall knowledge, beliefs and practices of indigenous communities involves identification, preparation and utilization of medicinal plants to treat a multitude of health problems (Awan *et al.* 2023; Kayani *et al.* 2024). The traditional healthcare system initially developed in many societies and became primary medical resource in rural areas where advanced medical facilities are still limited (Khan *et al.* 2025). Plants containing a variety of compounds, such as alkaloids, flavonoids, terpenoids and phenolic compounds that exhibit diverse therapeutic properties (Gillani *et al.* 2024). Traditionally, medicinal plants are used to treat various disorders like digestive, respiratory, dermatological and musculoskeletal systems with various local preparation methods including decoctions, pastes, juices and powders (Jan *et al.* 2024).

Ethnobotanical knowledge is transmitted from generation to generation and in most cases, it lacks proper documentation (Ullah *et al.* 2025). Ethnobotanical surveys have helped bridge this gap enabling scientists to explore various regions and document traditional knowledge worldwide. However, areas that remain unexplored are at high risk of losing their traditional knowledge, which urgently needs to be preserved (Lamy, 2024). Rapid urbanization and the migration of young generations overseas have further threatened this continuity and preservation of this knowledge (Arjona-García *et al.* 2021). It is therefore essential to take strict conservation measures immediately to protect this valuable traditional knowledge and ensure sustainable utilization, which is crucial for human well-being and survival (Ayoub *et al.* 2026). Consequently, studies should be conducted regularly to record undocumented uses, species and practices, ensuring the preservation and wider dissemination of traditional knowledge across the world (Sinthumule, 2023).

Tehsil Gujrat, Punjab, Pakistan is situated between the Chenab and Jhelum Rivers. The area of Gujrat is 3,192 square kilometers and it has three districts; Sarai Alamgir, Gujrat, Kharian (Hussain *et al.* 2026). Gujrat is an ancient city of Pakistan that is highly fertile because of the Chenab River. Gujrat district has moderate climatic conditions with a maximum temperature of 45°C in summer and the minimum temperature falls to 2°C in winter (Rehman *et al.* 2020). The land of Gujrat is highly fertile and supports rich plant diversity, therefore, this area has consistently attracted significant interest and attention from ethnobotanists (Iqbal and Ali, 2025). Such areas mostly remain a hotspot for most of the research due to diverse vegetation and community processes substantial cultural and therapeutic significance (Gillani *et al.* 2024).

Local communities worldwide use medicinal plants as herbal healing resources to treat multiple diseases. The pharmaceutical industry employs raw plant resources in manufacturing processes. In Pakistan, there exist multiple varieties of medicinal plants, with some receiving extensive research attention and others requiring further detailed studies (Hussain *et al.* 2008). Patients often utilize herbs alongside routine medical treatment. The care of patients who use products outside of medical prescription or recommendation is managed by all medical professionals, irrespective of their specialty or personal medical interests (Winslow and Kroll, 1998). People generally assume that plants are harmless while approximately one-third of our medications are derived from herbal sources (Singh *et al.* 2012). Ethnomedicinal remedies produced in a locality by elderly community members are often considered more effective than medicinal knowledge developed by younger generations (Qari *et al.* 2024).

Based on the above description, the primary research question was: how does the distribution of traditional knowledge vary among local demographic groups in tehsil Gujrat? To address this question, this study is hypothesized that ethnobotanical knowledge in tehsil Gujrat is not uniformly distributed across demographic groups and exhibits significant novelty compared to other regions. The main objectives of this study were:

- To document the traditional knowledge and quantitative assessment using ethnobotanical indices to find the importance and consistency in traditional knowledge of tehsil Gujrat
- To assess cross-cultural and cross-regional variations among the reported ethnobotanical knowledge to determine whether the study area of Gujrat possesses a distinct floristic diversity with its utilization

Materials and Methods

Study site

The current study was conducted in tehsil Gujrat, Punjab, Pakistan situated between two rivers, Chenab and Jhelum Rivers. Geographically, tehsil Gujrat is located at latitude 32° 34' 47" North of equator and longitude 74° 4' 11" East of the Prime Meridian. The area features subtropical climate, situated between the Jhelum and Chenab Rivers, making the soil highly fertile to support flourishing flora and crops (Fig.1). The visited areas were Muslimabad, Al-Nabi Colony, Qila Dar, Khepranwala Village, Airport Chowk, Chak Manju and Biowali. The population of the district is 2,756,110 persons consisting of 46.2% males and 53.8% females. Out of which 30.1% population is urban and 69.9% is rural.

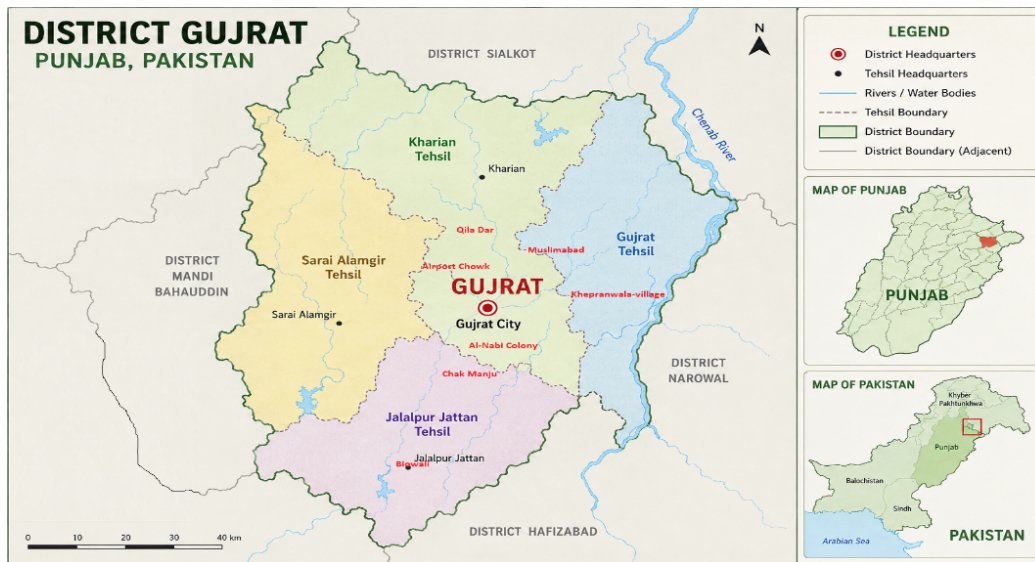


Figure 1. Geographic location and sampling sites within tehsil Gujrat, Pakistan

Meteorological data

Meteorological data for temperature and rainfall for the year 2025 are given in Table-1. During December, January to March, temperature remains low while it becomes high during May-September, where it can reach up to 101°F. Maximum rainfall was noted in July-August that was 6.8".

Table 1. Meteorological data of tehsil Gujrat, Punjab, Pakistan during 2025

Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
High Temp.	65°F	70°F	79°F	91°F	101°F	102°F	96°F	94°F	93°F	87°F	78°F	69°F
Average Temp.	52°F	58°F	67°F	78°F	88°F	92°F	88°F	86°F	83°F	75°F	64°F	55°F
Low Temp.	42°F	47°F	55°F	65°F	74°F	79°F	80°F	79°F	74°F	63°F	51°F	43°F
Rainfall	1.0"	1.7"	1.8"	1.4"	0.9"	2.1"	6.8"	6.2"	2.5"	0.7"	0.3"	0.6"

Community and Socio-demographic Information

The community and socio-demographic information of the 425 respondents included majority were males (53.8%) and 46.2% were females from two dominant religious groups, 93.8% Muslims followed by 6.2% Christians. The majority of the respondents were Punjabi speaking (68%) and 28% were Urdu speakers (Table-2). Regarding occupation, housewives (18.3%) comprised the largest group, followed by laborers (16.1%). The dominant age group was 41-50 years (21.5%) followed by 61-70 years (20%). In terms of educational level, the highest proportion of respondents were Higher Secondary category (27.3%). Eight caste groups were recorded, Kashmiri (19.5%) forming the largest group, followed by Sheikh (19%), Jatt (13%) and Rajput (12.5%).

Table 2. Community and socio-demographic information of tehsil Gujrat

Study locations	Variables	Categories	No. of respondents	Percentage
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Muslimabad	Gender	Males	229	53.8
		Females	196	46.2
Al-Nabi Colony	Religion	Islam/Muslims	399	93.8
		Christians	26	6.2
Qila Dar	Language	Urdu	119	28.0
		Punjabi	289	68.0
Khepranwala-village	Occupations	Kashmiri	17	4.0
		Farmers	64	15.0
Airport Chowk	Occupations	Hakeems	50	11.7
		Housewives	78	18.3
Chak Manju	Occupations	Students	57	13.3
		Doctors	21	5.0
Biowali	Occupations	Shopkeepers	64	15.0
		Drivers	24	5.6
Biowali	Occupations	Laborers	67	16.1
		Age	20-30 years	47
Biowali	Age	31-40 years	68	16.0
		41-50 years	91	21.5
Biowali	Age	51-60 years	68	16.0
		61-70 years	85	20.0
Biowali	Age	71-80 years	66	15.5
		Education Level	Illiterate	29
Education Level	Primary		54	12.7
	Education Level	Middle	59	13.9
Education Level		Higher Secondary	116	27.3
	Education Level	Graduation	95	22.4
Education Level		Higher education	72	17.0
	Education Level	Ethnic groups	Gujjar	51
Education Level		Ethnic groups	Arian	30
	Education Level	Ethnic groups	Jatt	55
Education Level		Ethnic groups	Kashmiri	83
	Education Level	Ethnic groups	Syeds	28
Education Level		Ethnic groups	Awan	45
	Education Level	Ethnic groups	Rajpoot	53
Education Level		Ethnic groups	Sheikh	80

Field Data Collection

Ethnobotanical data regarding the local name, uses, part used and preparation methods of local plant species in tehsil Gujrat was collected through various field visits during 2025. Data were documented using questionnaire platform through structured and semi-structured interviews from 425 local inhabitants from diverse demographic groups as age, religions, gender and ethnic groups. Purposive sampling method was employed to select respondents with relevant traditional knowledge of local plant species. Respondents were selected from multiple localities of Gujrat to ensure representation of a diverse group of participants. Key respondents were selected based on their expertise and traditional knowledge from varied occupations and educational levels with recommendations of local guides. Snowball sampling was additionally used to identify other knowledgeable participants.

Plant Identification

Plant specimens collected were identified with the help of Flora of Pakistan (Ali and Qaiser, 1986) after initial identification through vernacular name and morphological description. To ensure the accuracy of vernacular names, cross-verification protocol based on triangulation was used. For taxonomic accuracy, names were cross referenced with the world flora online (<https://www.worldfloraonline.org/>) and families were authenticated through Angiosperm Phylogeny Group (APG-IV). Plant specimens were processed following standard herbarium techniques and deposited at Herbarium of Department of Botany, University of Gujrat, Pakistan, assigned voucher codes. To ensure the quality of specimens, they were re-examined and ensured the presence of leaves, flowers and fruits, where it was possible. Walk-in-the-woods interviews were also conducted where fresh specimens were presented to informants in situ. Since both the collection sites and the herbarium repository are located within the same country (Pakistan), there was no transboundary movement of genetic resources. Consequently,

no specific Access and Benefit-Sharing (ABS) permits or documentation under the Nagoya Protocol were required for this study.

Quantitative Data Analysis

During these surveys, collected information for local name, uses, part used, preparation methods were employed for quantitative analysis. Data collected during this study were further analyzed quantitatively to calculate the various ethnobotanical indices. The ethnobotanical indices calculated were:

Use Value (UV)

Use Value (UV) was calculated by dividing the total number of uses (U) of a specific plant species by the total number of respondents (N) as described by Ali et al. (2020).

$$UV = \sum U / N$$

Where, U was the total number of uses of plant; N was the total number of respondents participating in the study.

Family Use Value (FUV)

FUV was used to determine the medicinal and traditional importance of a specific plant family within study area. FUV was calculated by following formula as used by Zougagh et al (2019):

$$FUV = \sum UV (\text{species}) / N$$

Where, UV was the sum of use value of all the species within a particular family; N was the total number of species present in the family.

Relative Frequency of Citation (RFC)

Relative Frequency of Citation (RFC) was used to assess a plant's citation frequency and its relative importance or popularity (Sharma et al. 2024). Following formula was used to calculate RFC:

$$RFC = FC / N$$

Here, FC was the number of respondents of specific plant species and N was the total number of respondents of whole survey.

Informant Consensus Factor (ICF)

Informant Consensus Factor (ICF) was calculated using the following equation as described by Hussain et al. (2026).

$$ICF = (Nur - Nt) / (Nur - 1)$$

Here, Nur was the number of respondents reported for same species of use for specific disease category and Nt was the total number of species used for specific disease category.

Fidelity Level (FL %)

Fidelity Level (FL) was determined by dividing the total number of respondents for same type of use of specific category (N_p) by the total number of respondents of all the same species involved in that specific category (N) following Kayani et al. (2024).

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

Comparative Analysis

Ethnobotanical information collected from tehsil Gujrat was compared for cross-cultural and cross-regional commonalities and differences using Jaccard's Similarity Index (JSI) and Novelty Percentage (NP). The collected data was cross-referenced with previously published ethnobotanical studies of Gujrat regions obtained from Web of Science, Scopus and Google Scholar databases.

Jaccard's Similarity Index (JSI)

Jaccard's Similarity Index (JSI) was used to compare the similarity of species of study area of tehsil Gujrat with previously published literature for adjacent areas. Following formula was used according to Eddouks et al. (2017).

$$JSI = c / (a+b-c) \times 100$$

Where, a=number of species recorded in the study area, b= number of species recorded in compared area, c= number of species common in both areas.

Novelty Percentage (NP)

Novelty Percentage (NP) was used to determine the percentage of new or previously undocumented medicinal uses of plants with other regions of Punjab. NP was calculated using following formula as described by Ahmad et al. (2017).

$$NP = N_u / T_u \times 100$$

Here, N_u = number of new uses or plants recorded for the first time (not found in literature), T_u was the total number of uses or plants in tehsil Gujrat.

Results

During these ethnobotanical surveys in tehsil Gujrat, information collected about the various plant species and data analysis is interpreted below.

Life Form of Identified Plants

Identified plant species were arranged alphabetically according to botanical names. Plants were organized with local names along with family, part used, mode of usage and dosage, along with their reported uses. A total of 83 plant species including herbs, shrubs and trees were documented. The collected plants species included 40% herbs, 25% shrubs, 31% trees and 4% climbers (Fig. 2).

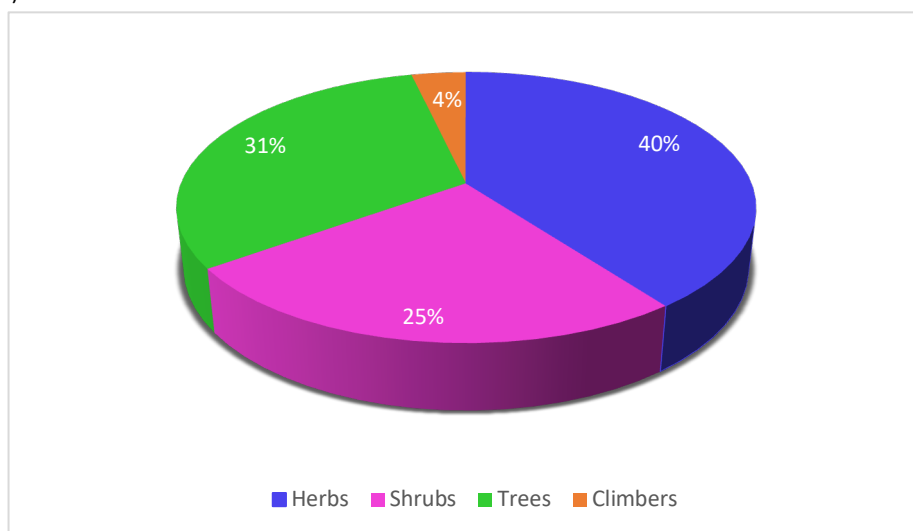


Figure 2. Distribution of plant growth habits among documented area

Family Index

The collected plant species from the study areas belonged to 40 families based on number of species recorded (Fig. 3). The dominant family was Rutaceae with 7 represented species, followed by Fabaceae, Moraceae and Poaceae (5 species each). Asteraceae, Malvaceae, Myrtaceae and Rosaceae were represented by 4 species each, while all other families were represented with 1-3 species.

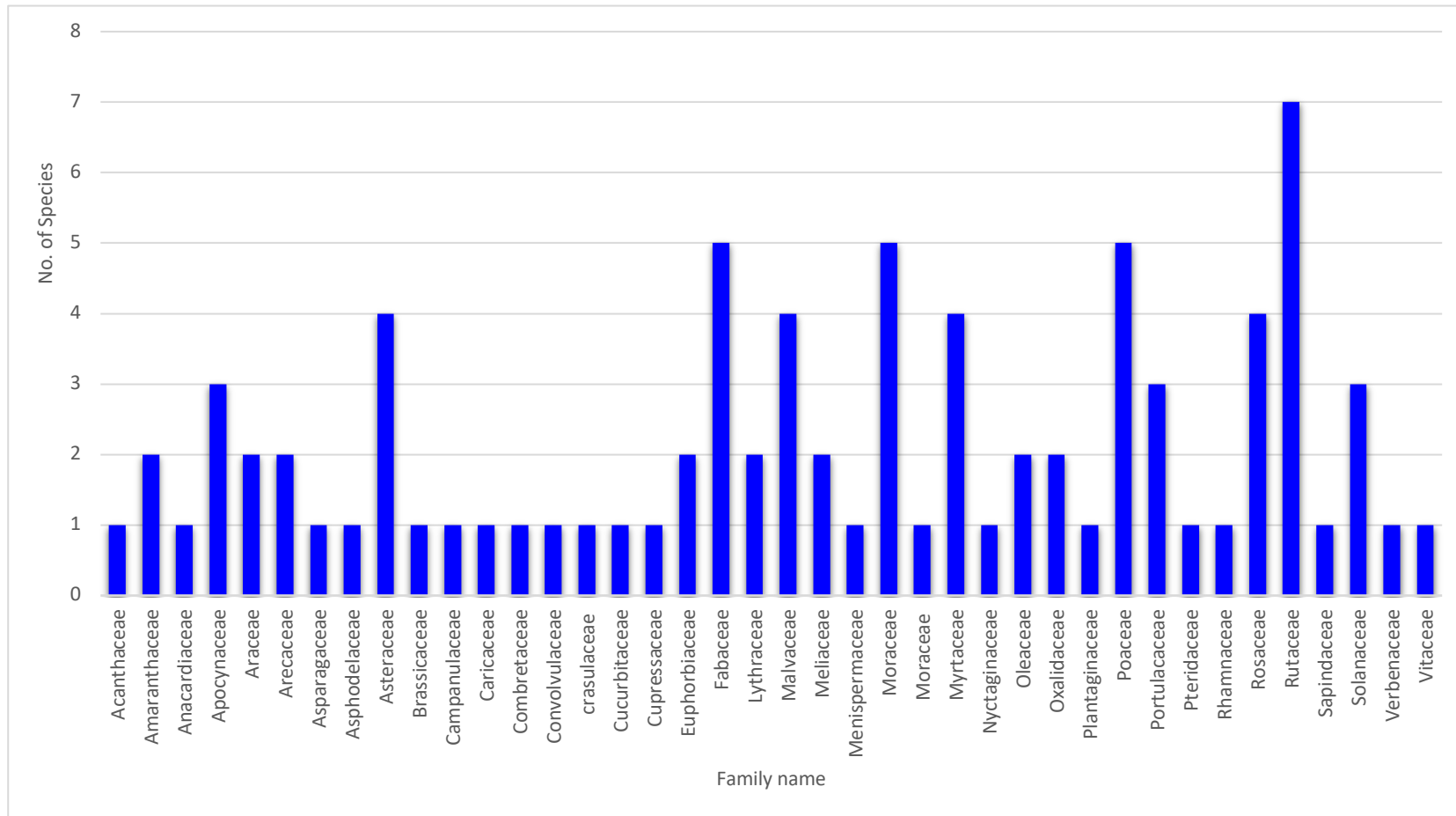


Figure 3. Family index based on number of species for each documented family in the study area

Part used and mode of use

In the current study, it was noted that leaves (41%) were the most frequently used part of the plants for the preparation of home remedies in tehsil Gujrat (Fig. 4). Other parts used were, fruit, flowers, seeds, bark, root, latex and whole plant. Fruits were 18% and 9% seeds were used in traditional medicines that were frequently reported by the local community.

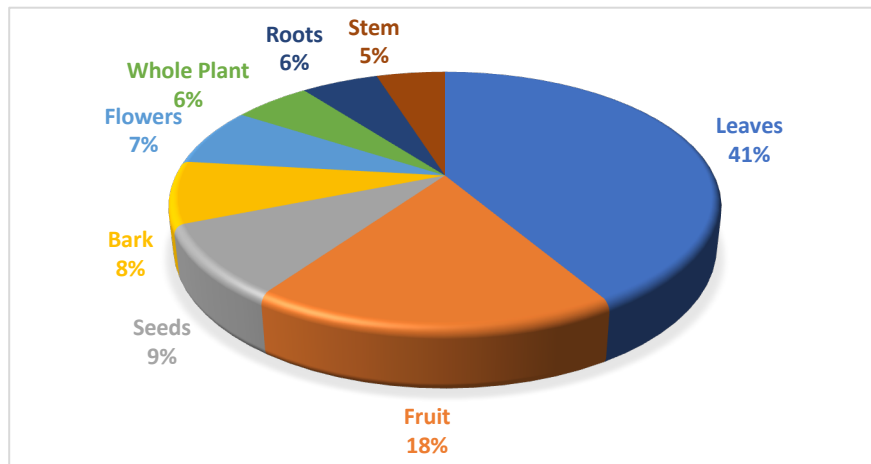


Figure 4. Proportion of plant part utilization in traditional medicines

Local preparation methods

Based on the ethnobotanical information in the study area, it was documented that local community uses diverse preparation methods (Fig. 5). Community primarily relies on different parts of the plant with most prevalent preparation methods, decoction (39%) was the most frequently reported method, followed by paste forming (22%). Other common local preparation methods including powder (15%), juice or extract (11%), oil (6%), herbal tea (5%) and raw use (3%). Local preparation methods vary among religious and ethnic groups, while age, occupations and education level showed only minor variations. The predominance of decoction reflected the strong reliance of local communities on traditional boiling techniques for extracting therapeutic constituents from medicinal plants.

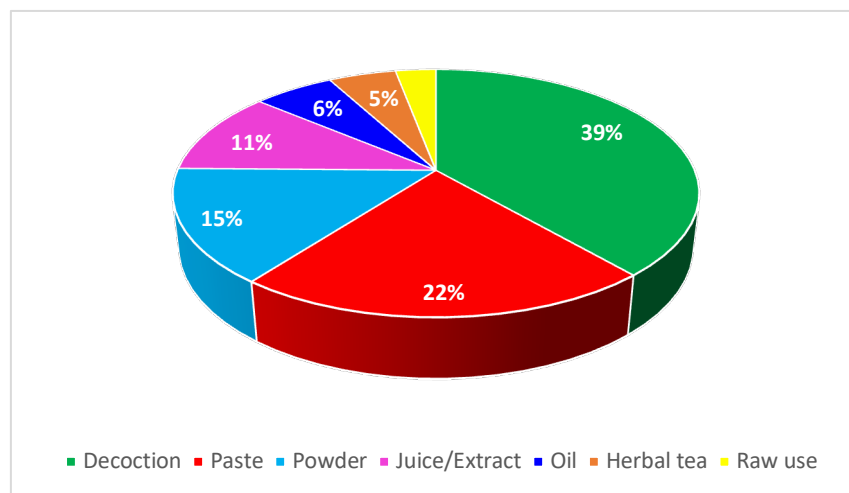


Figure 5. Primary mode of preparation for documented traditional remedies

Ethnomedicinal uses

Based upon the traditional information provided by the local community, plant species were used to treat a wide range of diseases (Table-3). The main disease categories and uses were the following.

Respiratory disorders

Many plant species documented are utilized for their ability to treat respiratory issues. *Adiantum capillus-veneris* L., *Alstonia scholaris* (L.) R. Br., *Bougainvillea spectabilis* Willd. and *Eucalyptus globulus* Labill. are frequently used in decoction to manage asthma and persistent cough. *Callistemon citrinus* (Curtis) Skeels, *Ficus carica* L. and *Punica granatum* L. are used to soothe

sore throats and common cold. *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb. are specifically noted for treating general respiratory infections and bronchitis.

Dermatological uses

External applications of paste and juice are common for dermatological needs. *Aloe vera* (L.) Burm.f., *Azadirachta indica* A.Juss., *Citrus limon* (L.) Burm.f. and *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb. are used to cure skin infections, acne and pigmentation. *Agave attenuata* Salm-Dyck, *Euphorbia hirta* L. and *Lawsonia inermis* L. are applied to wounds, cuts and burns to promote wound healing. *Aloe vera* (L.) Burm.f., *Hibiscus rosa-sinensis* L. and *Murraya koenigii* (L.) Spreng are used for hair loss and to treat dandruff.

Gastrointestinal problems

A significant number of species are targeted to treat gastrointestinal problems. *Achyranthes aspera* L., *Carica papaya* L., *Ficus carica* L. and *Vitis vinifera* L. are used to improve digestion and relieve constipation. *Alstonia scholaris* (L.) R. Br., *Bauhinia variegata* L. and *Oxalis corniculata* L. are used to treat diarrhea, stomach aches and dysentery.

Cardiovascular problems

It was reported by the informants that *Adiantum capillus-veneris* L., *Digitalis thapsi* L., *Olea europaea* L. and *Phoenix dactylifera* L. support heart health and regulate blood pressure. *Alstonia scholaris* (L.) R. Br., *Amaranthus viridis* L. and *Tinospora cordifolia* (Willd.) Miers are utilized to boost immune system and as blood purifier.

Urinary problems

Based upon traditional knowledge, *Malvaviscus arboreus* Cav. (Turk's Cap), *Achyranthes aspera* L., *Citrullus lanatus* (Thunb.) Matsum. & Nakai and *Portulaca oleracea* L. are used to treat urinary tract infection and kidney stones.

Musculoskeletal issues

Many plant species were reported to treat musculoskeletal issues as *Vachellia nilotica* (L.) P.J.H.Hurter & Mabb., *Agave attenuata* Salm-Dyck, *Bambusa vulgaris* Schrad. ex J.C.Wendl. and *Ricinus communis* L. are used to reduce joint pains and inflammation. *Eclipta prostrata* L., *Jasminum sambac* (L.) Aiton and *Melia azedarach* L. are used to treat headaches and general body aches.

Specialized uses

Alstonia scholaris (L.) R. Br., *Azadirachta indica* A.Juss. and *Ficus benghalensis* L. are specifically cited for treating fevers and malaria. *Ficus benjamina* L. and *Syzygium cumini* (L.) Skeels are administered for gum infections and toothaches. *Melia azedarach* L. is considered helpful to expel intestinal worms. *Azadirachta indica* A.Juss., *Catharanthus roseus* (L.) G.Don and *Ficus benghalensis* L. are documented for their role in managing blood sugar level.

Use Value (UV)

Use Value (UV) was calculated to evaluate the relative ethnobotanical importance of each recorded plant species. *Mentha arvensis* L. (podina) which is used to resolve digestive issues showed highest UV (0.2565). The calculated UV revealed that majority of the wild plants had higher UV than cultivated plants, reflecting wild plant's importance in traditional medicines (Table-3).

Family Use Value (FUV)

The Family Use Value (FUV) analysis revealed that variation among the plant families. The highest FUV (0.0191) was recorded for Acanthaceae, Amaranthaceae, Campanulaceae and Cucurbitaceae demonstrated higher ethnobotanical importance within study area. Families such as Asphodelaceae, Combretaceae, Lythraceae, Oxalidaceae and Plantaginaceae also showed comparatively high FUV values (0.0167), reflecting frequent citation by informants. On the other hand, Crassulaceae exhibited the lowest FUV (0.0048), suggesting limited traditional utilization.

Relative Frequency of Citation (RFC)

Relative frequency of citation (RFC) was calculated to determine the relative importance of each plant species based on the frequency of citation by informants. It also reflects the level of traditional knowledge associated with that plant in the study area. In the present study, the RFC values of all recorded plant species were less than 1 (Table-3). The highest RFC value (0.1929) was recorded for *Aloe vera* (L.) Burm.f. indicating its widespread use and high ethnobotanical significance among the local community. The high citation frequency of this species indicates its popularity and strong dependency by the inhabitants for medicinal and domestic purposes.

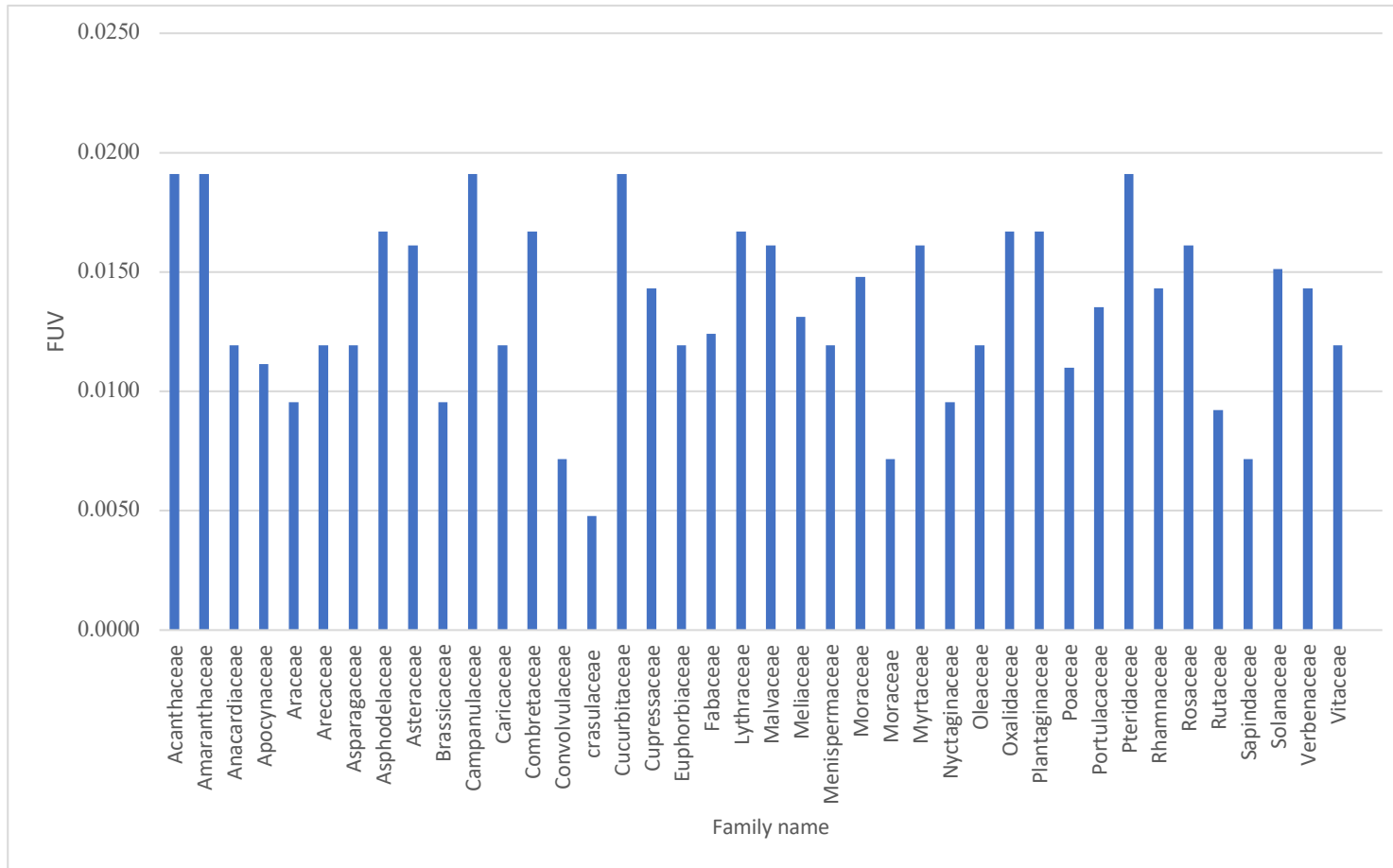


Figure 6. Comparative Family Use Value across recorded botanical families in tehsil Gujrat, Pakistan

Table 3. Taxonomic inventory and quantitative Ethnomedicinal profile of documented plant species in tehsil Gujrat, Pakistan

Botanical Name	Local Name	Family name	Voucher codes	Traditional Uses and Preparations	UV	RFC
<i>Achyranthes aspera</i> L.	Puth Kanda	Amaranthaceae	16-Ama-25	Decoction, leaf paste, or powder is used once or twice daily for joint pain, inflammation, skin and hair issues, kidney problems, appetite, constipation, digestive issues, and abdominal colic.	0.0541	0.0353
<i>Adiantum capillus-veneris</i> L.	Parsoshaan	Pteridaceae	19-Pte-25	Decoction, powder, or infusion is used twice daily for cardiac problems, cough, asthma, anti-dandruff, inflammation, menstrual health, jaundice, and bronchitis.	0.0400	0.0282
<i>Agave attenuata</i> Salm-Dyck	Foxtail Agave	Asparagaceae	22-Asp-25	Leaf sap or boiled leaves used as a compress are applied externally once or twice daily for burns, skin infections, joint pain, hair growth, and wounds.	0.0118	0.0118
<i>Aloe vera</i> (L.) Burm.f.	Kanwar ghandal	Asphodelaceae	15-Asp-25	Gel or juice is used orally and applied to hair and skin for burns, constipation, liver issues, hair fall, acne, and joint pain, once weekly for dandruff.	0.2447	0.1929
<i>Alstonia scholaris</i> (L.) R. Br.	Dita Bark	Apocynaceae	25-Apo-25	Bark decoction (1 cup once daily) or leaf paste (applied twice daily) is used for fever, malaria, asthma, cough, skin infections, blood purification, and stomach disorders.	0.0235	0.0188
<i>Amaranthus viridis</i> L.	Green Amaranth	Amaranthaceae	89-Ama-25	Extracted juice is taken as food (1 small bowl daily) for constipation, cooling effect, urinary infections, anemia, and blood purification.	0.0282	0.0235
<i>Azadirachta indica</i> A.Juss.	Neem	Meliaceae	13-Mel-25	Leaf decoction (1 cup daily) and leaf paste (applied twice daily) are used for skin problems, malaria, fever, diabetes, wound healing, and immunity boosting.	0.0447	0.0329
<i>Bambusa vulgaris</i> Schrad. ex J.C.Wendl.	Golden Bamboo	Poaceae	30-Poa-25	Boiled shoots and leaf decoction are used once daily for joint pain, cough, fever, bone strength, and as a diuretic.	0.0141	0.0141
<i>Bauhinia variegata</i> L.	Kachnar	Fabaceae	18-Fab-25	Bark decoction or flower tea (half cup once daily) is used for digestive issues, diarrhea, liver support, skin diseases, and goiter.	0.0424	0.0306
<i>Bombax ceiba</i> L.	Simbal	Malvaceae	32-Mal-25	Root powder or decoction is taken 1-2 cups daily for fever, diarrhea, skin problems, inflammation, cough, respiratory issues, and strength.	0.0212	0.0165

<i>Bougainvillea spectabilis</i> Willd.	Bougainvillea	Nyctaginaceae	79-Nyc-25	Powder, juice, or flower tea is used daily for asthma, sore throat, diarrhea, respiratory infections, warts, and wound healing.	0.0141	0.0118
<i>Bromus inermis</i> Leyss.	Smooth Brome/Brome Grass	Poaceae	44-Poa-25	Root decoction or leaf paste is used once daily or as needed for urinary infection, kidney discomfort, fever, indigestion, and wound healing.	0.0094	0.0094
<i>Caladium bicolor</i> (Aiton) Vent.	Elephant's Ears	Araceae	17-Ara-25	Leaf tea or paste, 1 cup daily, for respiratory diseases, asthma, cough, and skin diseases.	0.0118	0.0118
<i>Callistemon citrinus</i> (Curtis) Skeels	Bottle brush	Myrtaceae	81-Myr-25	Leaf paste or boiled corms are used externally once or twice daily for swelling, abscess, pain, and digestion.	0.0188	0.0141
<i>Carica papaya</i> L.	Papita	Caricaceae	53-Car-25	Fruit, juice, or leaf powder is used for acne, pigmentation, digestion, heart health, immunity, dengue, and constipation (as per given daily/weekly amounts).	0.1129	0.0824
<i>Catharanthus roseus</i> (L.) G. Don	Sadabahar	Apocynaceae	55-Apo-25	Leaf paste (3-4 leaves daily) is used for diabetes, wound healing, stomachache, and hypertension.	0.1224	0.0965
<i>Chamaedorea elegans</i> Mart.	Parlor palm	Arecaceae	20-Are-25	Leaf/stem decoction, leaf paste, or seed powder is used daily for respiratory problems, fever, immunity, skin infections, and constipation.	0.0118	0.0118
<i>Citrullus lanatus</i> (Thunb.) Matsum. & Nakai	Watermelon	Cucurbitaceae	47-Cuc-25	Seed powder, pulp, or fruit is used once or twice daily for constipation, digestion, toxin flushing, kidney issues, cooling effect, blood pressure, and heart health.	0.0518	0.0471
<i>Citrus aurantium</i> L.	Sour Orange	Rutaceae	35-Rut-25	Peel powder or tea is used once or twice daily for acne, digestion, bloating, fever, sore throat, metabolism, weight loss, blood pressure, and cholesterol.	0.0329	0.0259
<i>Citrus limetta</i> Risso	Mosambi or Meetha	Rutaceae	63-Rut-25	Fruit, juice, or peel powder is used daily for immunity, digestion, acne, pigmentation, cold, flu, heart, and kidney health.	0.0753	0.0659
<i>Citrus limon</i> (L.) Burm.f.	Lemon	Rutaceae	36-Rut-25	Leaf tea or fruit juice is used (1 glass daily) for kidney stones, acne, heart disease, stomach acidity, and anxiety.	0.1882	0.1506
<i>Citrus reticulata</i> Blanco	Kinow	Rutaceae	84-Rut-25	Leaf/peel tea or fruit juice is used once daily for immunity boosting, chest congestion, cough, and digestion problems.	0.0659	0.0541
<i>Citrus sinensis</i> (L.) Osbeck	Malta	Rutaceae	48-Rut-25	Peel tea or juice is used for digestive issues, ulcers, respiratory problems, kidney	0.0871	0.0753

				stones, and immunity (1 cup twice weekly, 1 glass daily).		
<i>Cymbopogon citratus</i> (DC.) Stapf	Lemon grass	Poaceae	51-Poa-25	Leaf tea or oil is used once or twice weekly (1 cup) for skin fungal infection, fever, cold, anxiety, and stomach bloating.	0.0588	0.0424
<i>Dalbergia sissoo</i> Roxb.	Sheesham	Fabaceae	66-Fab-25	Leaf and bark decoction is used once or twice daily for blood purification, fever, skin rashes, eczema, wounds, body pain, and swelling.	0.0447	0.0329
<i>Datura metel</i> L.	Indian thorn apple	Solanaceae	80-Sol-25	Smoked leaves, paste, or seed oil is used externally once daily or occasionally for asthma, cough, toothache, skin boils, and pain relief.	0.0282	0.0212
<i>Digitalis thapsi</i> L.	Spanish Foxglove	Plantaginaceae	69-Pla-25	Leaf paste or tea is used as needed (2-3 sips daily) for heart problems, digestion, skin conditions, inflammation, blood purification, and wounds.	0.0141	0.0094
<i>Eclipta prostrata</i> L.	False Daisy (Bhringraj/Bhangra)	Asteraceae	37-Ast-25	Leaf juice with oil is applied on the scalp twice weekly for hair blackening, fever, liver problems, wound healing, headache, blood pressure, and body pain.	0.0588	0.0424
<i>Epipremnum aureum</i> (Linden & André) G.S.Bunting	Money plant	Araceae	42-Ara-25	Leaf decoction (½ cup daily) or leaf juice (twice daily) is used for skin infections, minor burns, cough, cold, fever, and headache.	0.0141	0.0141
<i>Eriobotrya japonica</i> (Thunb.) Lindl.	Loquat	Rosaceae	59-Ros-25	Fruit or juice is used (5-10 fruits daily) for stomach disorder, nausea, chronic diseases, diabetes, digestion, constipation, asthma, and cough.	0.0329	0.0259
<i>Eucalyptus globulus</i> Labill.	Eucalyptus	Myrtaceae	91-Myr-25	Boiled leaf inhalation once daily and oil application twice daily are used for cold, cough, headache, joint pain, and asthma.	0.0424	0.0329
<i>Euphorbia hirta</i> L.	Asthma Plant (Dodhak)	Euphorbiaceae	85-Eup-25	Leaf decoction or powder with honey is used twice daily for 1-2 weeks for hemorrhoids, asthma, cough, dysentery, and skin problems.	0.0494	0.0329
<i>Ficus benghalensis</i> L.	Banyan (Barghad/Bohr)	Moraceae	61-Mor-25	Bark decoction once daily and latex as needed (with honey or externally) are used for diabetes, wounds, toothache, cough, flu, jaundice, and skin diseases.	0.0612	0.0447
<i>Ficus benamina</i> L.	Weeping Fig	Moraceae	70-Mor-25	Leaf decoction or paste is used once or twice daily for cough, asthma, wounds, cuts,	0.0235	0.0188

				dysentery, swelling, joint pain, gums, and toothache.		
<i>Ficus carica</i> L.	Edible Fig	Moraceae	23-Mor-25	Fresh or dried fruits, latex, or leaf tea is used for constipation, sore throat, diabetes, digestive disorders, and warts (2-3 fruits daily, latex once daily).	0.0659	0.0518
<i>Ficus religiosa</i> L.	Peepal	Moraceae	67-Mor-25	Bark decoction (½ cup twice daily), leaf juice once daily, or leaf powder (1 teaspoon daily) is used for respiratory problems, diabetes, digestion, heart health, fever, and infections.	0.0776	0.0588
<i>Hibiscus rosa-sinensis</i> L.	China Rose Hibiscus (Gul e Gurhal)	Malvaceae	38-Mal-25	Flowers paste, decoction, or oil is used twice weekly for hair growth, strengthening, cough, menstrual balance, and blood purification.	0.0471	0.0376
<i>Ipomoea alba</i> L.	Moon flower/Cha ndni bel	Convolvulaceae	24-Con-25	Leaf/flowers decoction (½ cup daily for 4-5 days) or leaf paste (twice daily) is used for wound healing, skin, constipation, and respiratory problems.	0.0094	0.0094
<i>Jasminum sambac</i> (L.) Aiton	Arabian Jasmine (Motia)	Oleaceae	49-Ole-25	Flowers oil or paste is used once daily for headache, pain, and hair strengthening.	0.0353	0.0306
<i>Juniperus virginiana</i> L.	Eastern Red Cedar	Cupressaceae	41-Cup-25	Leaf decoction or berry tea is used (½ cup twice daily) for cough, cold, skin infection, stomach cramps, and indigestion.	0.0141	0.0118
<i>Kalanchoe pinnata</i> (Lam.) Pers.	Pathar Chat	Crassulaceae	07-Cra-25	Leaves are applied in wound healing and skin irritation. Leaf juice helps to manage inflammation, respiratory issues and kidney stones.	0.0471	0.0353
<i>Lantana camara</i> L.	Lantana (Gul-e- Khardar)	Verbenaceae	60-Ver-25	Leaf paste or flowers decoction is used twice daily until healed for skin infections, kidney stones, wound healing, and as a diuretic.	0.0706	0.0494
<i>Lawsonia inermis</i> L.	Henna	Lythraceae	33-Lyt-25	Leaf paste is applied externally once daily for cooling, headache, hair dyeing, skin diseases, and burns.	0.0118	0.0094
<i>Lepidium didymum</i> L.	Jangli grass	Brassicaceae	56-Bra-25	Leaf powder or extract (3-4 leaves, 1-2 teaspoon) is used for cancer, haemorrhoids, digestive problems, cough, fever, and skin diseases.	0.0282	0.0212
<i>Litchi chinensis</i> Sonn.	litchi	Sapindaceae	65-Sap-25	Dried peel tea, leaf paste, fruit, or juice is used (1 cup once or twice weekly) for skin disease, smallpox, neurological disorders, and gastric problems.	0.1012	0.0776

<i>Malus domestica</i> Borkh.	Apple (Saib)	Rosaceae	26-Ros-25	Raw fruit or juice or leaves burnt in oil is used (1-2 apples daily) for iron deficiency, muscle weakness, cholesterol, weight loss, heart disease, liver issues, and whipworms.	0.0329	0.0282
<i>Malvaviscus arboreus</i> Cav.	Turk's Cap	Malvaceae	54-Mal-25	Leaves and flowers paste is used twice weekly or once-twice daily for urinary, skin, hair, fever, respiratory, piles, gonorrhoea, and diuretic purposes.	0.0235	0.0188
<i>Mangifera indica</i> L.	Mango/Aam	Anacardiaceae	43-Ana-25	Leaf/bark decoction (1 cup daily), seed powder twice daily, or 1 fruit daily is used for respiratory problems, digestion, immunity, blood sugar, diarrhea, bleeding gums, and wound healing.	0.0282	0.0235
<i>Melia azedarach</i> L.	Chinaberry Tree (Dhareek)	Meliaceae	68-Mel-25	Bark/leaf decoction or leaf/fruit paste is used once daily for 3-5 days for skin disease, piles, blood purification, itching, inflammation, intestinal worms, and headache.	0.1388	0.1059
<i>Mentha arvensis</i> L.	Podina	Lamiaceae	43-Lam-25	Leaves are used to make a decoction or juice/extract. Local informants report consuming 1 cup of leaf tea or decoction once or twice daily to alleviate these digestive complaints.	0.1835	0.2565
<i>Morus alba</i> L.	White mulberry/Shehtoot	Moraceae	77-Mor-25	Leaf powder, decoction, paste, or 9-10 raw fruits are used for heart health, constipation, immunity, digestion, anemia, brain health, memory, and skin problems.	0.2565	0.1835
<i>Morus rubra</i> L.	Red mulberry/Laal shehtoot	Moraceae	50-Mor-25	Fruit, leaf, or bark decoction is used (10-15 fruits, 1 cup decoction, or 1 glass juice daily) for digestion, immunity, blood sugar, constipation, fever, and sore throat.	0.2329	0.1741
<i>Murraya koenigii</i> (L.) Spreng.	Curry pata	Rutaceae	82-Rut-25	Leaf paste or 5-10 fresh leaves are used daily (or paste applied twice daily) for digestion, diabetes, hair fall, dandruff, and appetite.	0.0212	0.0165
<i>Murraya paniculata</i> (L.) Jack	Orange jasmine/Kamini	Rutaceae	28-Rut-25	Leaf/root decoction, bark powder, or leaf paste is used daily for digestion, wounds, pain, fever, cough, stomach-ache, and oral infections.	0.1976	0.1388
<i>Nerium oleander</i> L.	Kaner/Oleander	Apocynaceae	72-Apo-25	Leaf decoction, juice, or paste is used for skin infections, pain, heart problems, malaria, fever, wounds, and gum infections.	0.0918	0.0729
<i>Olea europaea</i> L.	Olive/Zaitoon	Oleaceae	57-Ole-25	Fruit (4-6 daily), seed oil/powder twice weekly, or	0.0847	0.0682

				leaf decoction (1 cup daily) is used for heart health, constipation, blood pressure, immunity, fever, skin infections, and brain health.		
<i>Oxalis corniculata</i> L.	Creeping Wood sorrel (Khati Booti)	Oxalidaceae	65-Oxa-25	Paste, infusion, or decoction is used twice daily for warts, headache, itchy eyelids, fever, wounds, constipation, stomach-ache, inflammation, piles, dysentery, and diarrhea.	0.0165	0.0141
<i>Parthenium hysterophorus</i> L.	Carrot Weed	Asteraceae	71-Ast-25	Dried leaf paste with water is applied twice daily for skin allergies, eczema, wounds, and fever.	0.1106	0.0894
<i>Phoenix dactylifera</i> L.	Date Palm / Khajoor	Areaceae	27-Are-25	Fruit (3-5 dates daily), soaked in milk, or seed powder (½ teaspoon daily with honey) is used for energy, anemia, weakness, fertility, constipation, and heart health.	0.0259	0.0188
<i>Physalis minima</i> L.	Ground Cherry (Mamoole)	Solanaceae	52-Sol-25	Fresh fruit (4-5 daily) or leaf decoction once daily is used for fever, cough, inflammation, urinary infections, and as a liver tonic.	0.1459	0.1035
<i>Pluchea indica</i> (L.) Less.	Indian fleabane	Asteraceae	64-Fab-25	Seed oil, bark powder, or root juice (1-2 teaspoon) is used for skin diseases, wound healing, gastric, and digestive problems.	0.1718	0.1224
<i>Pongamia pinnata</i> (L.) Pierre	Karanja	Fabaceae	29-Por-25	Leaves/flowers decoction (½ cup daily), herbal drink (4-5 teaspoon daily), or seed powder (1 teaspoon daily) is used for urinary problems, wounds, sunburn, rashes, constipation, and acidity.	0.0494	0.0376
<i>Portulaca grandiflora</i> Hook.	Purselane	Portulacaceae	45-Por-25	Decoction, salad, or leaf paste is used (½ glass twice daily) for urinary infection, cholesterol, heart health, stomach pain, acidity, indigestion, rashes, pimples, and diuretic effect.	0.1812	0.1435
<i>Portulaca oleracea</i> L.	Gul dupahar	Portulacaceae	74-Por-25	Decoction or leaf powder is used for skin infections, wounds, ulcers, joint pain, respiratory problems, and acne.	0.1176	0.0847
<i>Psidium guajava</i> L.	Guava (Amrod)	Myrtaceae	31-Myr-25	Leaf tea (twice daily) or fruit (once daily) is used for stomach worms, cough, appetite, blood production, haemorrhoids, digestion, diarrhea, constipation, and toothache.	0.0329	0.0259
<i>Punica granatum</i> L.	Anar (Pomegranate)	Lythraceae	87-Lyt-25	Seed or leaf paste is used twice daily for fever, cold, cough, digestion, diarrhea, joint pain, inflammation, skin issues, and wounds.	0.2212	0.1882

<i>Pyrus communis</i> L.	Pear	Rosaceae	99-Ros-25	Raw seeds, decoction, or bark paste is used twice daily for digestion, constipation, fever, body heat, skin issues, wounds, diarrhea, stomach strength, respiratory issues, and cough.	0.0165	0.0118
<i>Ricinus communis</i> L.	Castor Plant (Arind/Aran)	Euphorbiaceae	76-Eup-25	Seed oil is used externally daily and orally once weekly for constipation, joint pain, hair growth, headache, and hepatitis.	0.0376	0.0282
<i>Rosa indica</i> L.	Rose (Ghulab)	Rosaceae	40-Ros-25	Paste, powder, or boiled petals are used once or twice daily for skin issues, burning, eye itching, fever, digestion, and acidity.	0.0424	0.0353
<i>Ruellia caroliniensis</i> (J.F.Gmel.) Steud.	Carolina Wild Petunia (Ruellia)	Acanthaceae	92-Aca-25	Leaf decoction is taken twice daily until recovery for urinary infection, vomiting, cold, hypertension, fever, cardiac problems, and skin rashes.	0.1341	0.0988
<i>Sida acuta</i> Burm.f.	Common Wire Weed (Jangli Meethi)	Malvaceae	39-Mal-25	Leaf paste is applied twice daily for 5 days for fever, joint pain, blood pressure, and wound healing.	0.1859	0.1294
<i>Solanum nigrum</i> L.	Black Nightshade (Makoh)	Solanaceae	21-Sol-25	Leaf decoction, paste, or as food is used twice daily for liver problems, fever, menstrual issues, acne, wounds, stomach-ache, inflammation, and mouth ulcers.	0.2188	0.1576
<i>Stipa capillata</i> L.	Dwarf Feather Grass	Poaceae	78-Poa-25	Dried plant decoction or paste is used twice daily (externally) for wound healing, inflammation, joint pain, skin itching, and as a diuretic.	0.0753	0.0518
<i>Syzygium cumini</i> (L.) Skeels	Jammu	Myrtaceae	83-Myr-25	Seed powder or fruit juice (¼-½ teaspoon) is used for urinary problems, diarrhea, diabetes, gastric and abdominal pain, and teeth bleeding.	0.0894	0.0612
<i>Tagetes erecta</i> L.	Genda phool/ Marigold	Asteraceae	97-Ast-25	Flowers/leaves decoction (1 cup daily), flowers paste (twice daily), or root powder (½ teaspoon daily) is used for liver detox, menstrual cramps, wounds, cough, fever, acne, rashes, and digestion.	0.1624	0.1153
<i>Tamarindus indica</i> L.	Imli	Fabaceae	62-Fab-25	Fruit pulp (1-2 fruits), juice (2 teaspoon), or seed powder is used for skin irritation, constipation, fever, cough, parasitic infection, and throat infection.	0.0729	0.0565
<i>Terminalia catappa</i> L.	Indian Almond	Combretaceae	86-Com-25	Leaf extract, fruit, or seed oil is used (twice weekly or 1 cup twice daily) for cough, sore throat, blood sugar, hair	0.1035	0.0800

				growth, dandruff, digestion, and diarrhea.		
<i>Tinospora cordifolia</i> (Willd.) Miers	Giloy	Menispermaceae	75-Men-25	Stem decoction or crushed leaf juice (½ cup once or twice daily) is used for fever, immunity, diabetes, joint pain, and digestion.	0.0447	0.0306
<i>Trachelium caeruleum</i> L.	Throatwort	Campanulaceae	101-Cam-25	Decoction, leaf extract, or paste is used once or twice daily for wounds, cuts, headache, body pain, cough, fever, and mouth or gum swelling.	0.0565	0.0400
<i>Vachellia nilotica</i> (L.) P.J.H.Hurter & Mabb.	Keekar	Fabaceae	14-Fab-25	Leaves paste or decoction is used once daily for skin infections, wounds, ulcers, joint pain, respiratory problems, and acne.	0.1294	0.0918
<i>Vitis vinifera</i> L.	Grapes	Vitaceae	34-Vit-25	Fresh or dried fruit and leaf tea is used (1 cup juice or 10-15 fruits daily) for blood purification, digestion, weakness, skin health, and constipation.	0.0518	0.0376
<i>Zea mays</i> L.	Maize	Poaceae	93-Poa-25	Kernel tea (1-2 teaspoon once daily) is used for digestive problems, vomiting, nausea, kidney stones, cholesterol, urinary tract and bladder infections, heart disease, and diabetes.	0.0776	0.0659
<i>Ziziphus mauritiana</i> Lam.	Ber (Indian Jujube)	Rhamnaceae	90-Rha-25	Fruit (daily) or leaf paste (twice weekly) is used for diarrhea, energy, constipation, cough, digestion, and hair and skin issues.	0.1059	0.0706

Informant Consensus Factor (ICF)

Diseased categories were established based on similar types of use in order to find the Information Consensus Factor (Table-4). Depending on plant uses, it was divided into six main disease categories including respiratory disorders, gastrointestinal problems, dermatological uses, cardiovascular problems, musculoskeletal issues and specialized uses. The highest ICF value recorded for musculoskeletal issues that was 0.481, showing a strong agreement among informants regarding the plant species used for these ailments. On the other hand, the lowest ICF value was observed for dermatological uses that was 0.317, suggesting comparatively low consensus and wide variety of plant species used for this category.

Table 4. Informant Consensus Factor (ICF) for disease categories

Disease Category	Nur	Nt	ICF
Respiratory disorders (Cough, Asthma, Cold)	48	28	0.425
Gastrointestinal problems (Constipation, Indigestion, Stomach-ache)	52	34	0.353
Dermatological uses (Acne, Wounds, Inflammation, Infections)	61	42	0.317
Cardiovascular problems (Heart health, BP, Immunity, Blood purification)	35	22	0.382
Musculoskeletal issues (Joint pain, Headache, Body pain)	28	15	0.481
Specialized uses (Diabetes, tooth and gums problems)	32	19	0.419

Fidelity Level (FL)

Fidelity level (FL) was calculated to find the percentage of informants, agreeing for the use of a particular plant species for the same specific ailment demonstrating strong consensus among informants. Highest FL (19.3%) was observed for *Aloe vera* (L.) Burm.f. used for skin health. Whereas, most primary ailments showed 14.5% FL for general and specific uses of plant species (Table-5).

Table 5. Fidelity Level (FL) for most reported uses and plants in study area

Primary Ailment	Plant species	Np	N	FL (%)
Skin health/Burns	<i>Aloe vera</i> (L.) Burm.f.	16	83	19.3%
Hair health	<i>Eclipta prostrata</i> (L.) L.	12	83	14.5%
Diabetes	<i>Ficus benghalensis</i> L.	12	83	14.5%
Digestion	<i>Ziziphus mauritiana</i> Lam.	12	83	14.5%
Joint pain	<i>Ricinus communis</i> L.	12	83	14.5%
Respiratory/Cough	<i>Adiantum capillus-veneris</i> L.	12	83	14.5%
Stomach-ache	<i>Oxalis corniculata</i> L.	12	83	14.5%
Liver health	<i>Solanum nigrum</i> L.	12	83	14.5%
Skin infections	<i>Lantana camara</i> L.	14	83	16.9%
Diarrhea	<i>Psidium guajava</i> L.	14	83	16.9%
Iron deficiency	<i>Malus domestica</i> Borkh.	14	83	16.9%

Comparative Analysis

Comparative analysis was performed against 11 published ethnobotanical studies already conducted in other area of Gujrat and neighboring regions. This analysis utilized the Jaccard's Similarity Index (JSI) to measure the commonalities and differences and Novelty Percentage was used to quantify the percentage of unique reports found in the current study of tehsil Gujrat compared to existing reports (Table-6).

Jaccard's Similarity Index (JSI)

Comparative Jaccard's Similarity Index (JSI) score ranged 12.9-50.04%, indicating a low to medium level of similarity among ethnobotanical knowledge in tehsil Gujrat and other studies in Gujrat and neighboring regions (Table-6). Highest JSI (50.04%) was found with ethnobotanical study conducted in District Gujrat. There were 50% same species and uses but the cultural and ritual uses has not been reported in the current study as *Ocimum sanctum* and *Albizia lebbbeck* (Table-6). It shows that climatic conditions and geographical zone of district Gujrat shared many common plant species regarded as a good source of medicine. Low JSI (12.9%) highlighted that tehsil Gujrat possess a distinct micro-flora used for primary healthcare with Sialkot ethnobotanical studies, indicating a divergence is primarily environmental and geographical variations.

Novelty Percentage (NP)

To find the uniqueness in current study, Novelty Percentage (NP) was calculated that ranged 43-79% in comparison to other regional studies. Most of documented data in current study of specific species or specific medical uses have not been prominently reported in comparative literature. Highest NP (79%) with Sialkot supported, the Novelty Percentage of this study because both the region have quite different climatic conditions and plant use values (Table-6). This was due to climatic and geographical differences among these regions. Several species in current study contributed to this high novelty through ornamental plant species uses as *Agave attenuata* Salm-Dyck, *Bougainvillea spectabilis* Willd and *Chamaedorea elegans* Mart.

Table 6. Comparative assessment of plant species and ethnomedicinal uses of tehsil Gujrat with neighboring regions

Study area and reference	Total Species in recorded (b)	Common Species (c)	Species in Current Study (a)	Jaccard's Similarity Index (JSI %)	Novelty Percentage (NP %)	Similarities & Differences
District Gujrat (Ali et al. 2020)	72	41	83	35.9%	43%	High overlap in agricultural flora.
Dinga-Gujrat (Parvaiz et al. 2013)	50	32	83	31.6%	48%	Local flora and medicinal shrubs.
Kharian-Gujrat(Ajaib et al. 2014)	50	28	83	26.6%	52%	Shared use of woody medicinal trees.
Bhimber, AJK (Ishtiaq et al. 2024)	133	35	83	15.8%	61%	High diversity in wild mountain species.
Jhelum Valley (Awan et al. 2023)	113	24	83	14.2%	68%	Differences due to higher altitude flora.
Hafizabad (Umair et al. 2017)	85	18	83	15.0%	71%	Distinct ecological zone (plains).
Shakargarh-Narowal (Sardar and Khan, 2009)	102	22	83	13.5%	74%	Varied agricultural and wild mix.

Sialkot (Noreen et al. 2020).	48	15	83	12.9%	79%	Differences in wetland/grassland usage.
Mandi Bahauddin (Nisar et al. 2011).	51	19	83	16.6%	64%	Differences in invasive/alien species.
Gujrat (Hussain et al. 20206)	99	61	83	50.04%	49.6%	Differences are in cultural and ritual uses of plants

Cross-regional and cross-cultural commonalities

Current study exhibited a significant overlap with neighboring districts of Punjab, Pakistan. This indicates a shared Ethnomedicinal landscapes driven by similar ecological zones and cultural practices.

Shared Phytotherapeutic Applications: Higher RFC values for *Aloe vera* (L.) Burm.f., *Azadirachta indica* A.Juss and *Ficus benghalensis* L. with all comparative studies suggested that these species are cornerstone medicinal resources in Gujrat, Jhelum and Bhimber corridor.

Uniformity in Application: Traditional knowledge regarding the use of these plants for common ailments, specifically respiratory infections, digestive disorders, and skin inflammation is consistent across borders. This suggests that the pharmacological application of these species is a deeply rooted cultural tradition in Punjabi ethnopharmacology.

Consistency in Parts Used: Across the ten reference regions, leaves, bark, and fruit consistently emerge as the most utilized parts, underscoring a regional standardization in harvesting and preparation techniques (decoctions, pastes, and infusions).

Cross-regional and cross-cultural differences

This study revealed a distinct differences that underscore the uniqueness of the traditional knowledge and the influence of specific micro-ecological and socio-cultural factors.

Usage of ornamentals species in medicine: A significant portion of the Novelty found in this dataset (ranging from 43% to 79% depending on the region) stems from the inclusion of ornamental and garden-grown species such as *Agave attenuata* Salm-Dyck, *Bougainvillea spectabilis* Willd and *Chamaedorea elegans* Mart. Unlike traditional wild-flora surveys that focus on native shrubs, this study highlights an evolving tradition of using garden-integrated plants for medicinal purposes.

Variations in Species Richness: While studies in mountainous zones (e.g., Bhimber or Jhelum) report a wider diversity of wild, mountain-specific medicinal herbs, this study highlights a different composition of flora adapted to the alluvial plains and urban garden environments of the Gujrat district.

Local Vernacular Names: Differences in the local names (e.g., *Puth Kanda* vs. *Patherchat*) and specific, localized methods of preparation (such as the specific use of leaf sap for joint pain) represent culturally distinct knowledge gaps not fully captured in broader provincial-level surveys.

Discussion

Current study on ethnobotanical knowledge collected from tehsil Gujrat has a vast inventory of floristic composition due to the fertile land, favorable climatic and environmental conditions (Kabato et al. 2025). Gujrat district is always attain the intention of researcher to explore its flora and to document traditional knowledge (Hussain et al. 2026). Local flora of any area plays a significant role to fulfil the basic healthcare needs of the regional population through various home remedies (Amin et al. 2024). Documented medicinal plants species in a particular area act as crucial evidence of that region's biodiversity richness, ecological health and cultural significance (Ishtiaq et al. 2024). Therefore ethnobotanical studies are crucial for documentation of traditional knowledge (Ali et al. 2020). The local community possess considerable knowledge regarding the discovery, acquisition and applications of these plants for various health problems (Tufail et al. 2020). This study showed that local community relies on this flora not only for medicinal purposes but also to meet the demands of daily life activities. These plants are essential for human survival, providing nutrition, clothing, shelter and medicine, as well as playing a central role in religious and cultural festivals (Knapp, 2019).

It is widely recognized that ethnobotanical knowledge is intrinsically linked with demographic patterns, particularly age, gender and education (Farooq et al. 2019). The most specialized information, particularly regarding the treatment of chronic diseases, is primarily held by elders. This aligns with the observations that traditional knowledge is often centred within older generations compared to younger cohorts (Famo and Machate, 2003). Furthermore, gender plays a significant role, as woman and men frequently possess distinct skills and specialized knowledge of local environmental conditions. This body of

wisdom is further stratified by occupation, cultural background, tribal affiliation and religious grouping. Religious practices are often serving as a primary influence on the applications of traditional knowledge (Granderson, 2017). These variations are not static; rather, traditional knowledge is dynamic entity that is continuously adapted among various demographic groups (Hussain et al. 2026), that supports the current study.

Mode of administration and local preparation methods are influenced by deep-seated cultural practices that vary across geographic regions and demographic pattern (Ali et al. 2020). Even in areas characterized by similar floristic compositions, ethnobotanical values often differ. This inherent uniqueness necessitates thorough exploration and comparative analysis to generate new scientific evidences that can be formally documented and disseminated (Hussain et al. 2024). Local healers utilize every part of the plant in medicines including leaves, stem, flowers, bark, root, fruits, and seeds. This specific selection of plant part remains strictly dependent on the healer's objectives and inherited traditional knowledge (Kadam and Pawar, 2020). This study revealed a marked predominance in the usage of leaves local preparations reflecting a specialized knowledge tailored for home remedies. Leaves are typically the most accessible plant part (Kala, 2020).

Quantitative ethnobotanical analyses provide a rigorous, objective framework to identify the most significant medicinal plants, local consensus and prioritize species for conservation and drug discovery (Thakur et al. 2024). In the current study various ethnobotanical indices were employed including UV, RFC, ICF and FL. These analyses helped to quantify cultural significance, compare knowledge across different groups and identify potential candidate for pharmacological research (Tufail et al. 2020)

Traditional knowledge regarding local flora is deeply rooted in the practical, intergenerational transmission of wisdom concerning specific medicinal prescriptions, preparation techniques and method of administration (Cunningham, 2014). Despite its cultural depth, this heritage faces a significant threat from modernization because younger generations are increasingly reluctant to adopt practices, leading to a gradual erosion of this traditional knowledge (Banda et al. 2024). To mitigate this loss, it is essential to prioritize the continuous documentation and exploration of previously unrecorded knowledge to ensure its preservation for future. Intergenerational analysis in the current study revealed that traditional knowledge is held elderly in the current study as well as in previous studies. It is due to the rapid modernization, industrialization and shifting lifestyles that are gradually destroying indigenous knowledge among younger generations (Umair et al. 2019). Supply of wild medicinal plants is seriously threatened by overharvesting, habitat loss, agricultural development, and urbanization that also lacking transmission of knowledge (Knapp, 2019). This scenario emphasizes the need for proper documentation, sustainable harvesting practices and cultivation of medicinal plants (Ullah et al. 2025).

Cross-regional and cross-cultural commonalities and differences using Jaccard's Similarity Index and Novel Percentage across the regions helped to find the similarity among the knowledge and uniqueness of current study. Jaccard's Similarity Index score less than 50%, signifies that there is minimum overlap in the medicinal plants used. It suggested that the communities rely on distinct, localized and independent plant use traditions rather than sharing knowledge or resources (Ahmed et al. 2024). Novelty Percentage served as a vital indicator of the unique ethnobotanical and ecological data contributed by this study. Current study reported high novelty rate of 79%, indicating that a high proportion of the medicinal uses or plant species documented in a specific study are being reported for the first time relative to existing literature (Sulaiman et al. 2020). Cultural and regional interpretation of commonalities and differences confirmed that ethnobotanical knowledge in the study area was dynamic rather than static, shaped by ecological availability, cultural transmission and adaptive responses to local community for traditional uses (Gitima et al. 2025). Comparative findings of current study with other regions statistically supported the presence of localized ethnobotanical traditions and region specific knowledge system that have cross-culture and cross-regional variations (Batool et al. 2025). It supports the significant cross-culture and cross-regional variations in plant uses, therapeutic applications and traditional knowledge transmission (Ishtiaq et al. 2024).

Conclusion

The study highlights that tehsil Gujrat possesses a rich and unique ethnobotanical heritage that is dynamically adapting, as evidenced by the integration of ornamental plants into traditional medicine. The high novelty and low similarity index underscore the necessity of site-specific documentation to prevent the erosion of localized indigenous knowledge. These findings provide a valuable foundation for future pharmacological validation and conservation strategies.

Declarations

List of abbreviations: UV= Use Value; FUV=Family Use Value; RFC= Relative Frequency of Citation; ICF=Informant Consensus Factor; FL=Fidelity Level; NP= Novel Percentage; JSI= Jaccard's Similarity Index

Ethics approval and consent to participate: This study was conducted following ethical guidelines for Ethnomedicinal research from the Ethics Committee of University of Gujrat (2172/25) with prior informed consent obtained from all participants and respect given to their cultural values and traditional knowledge. Confidentiality and anonymity were maintained, and the documented knowledge was used solely for academic and research purposes. Prior informed consents were obtained from all participants before data collection, ensuring voluntary participation, confidentiality and respect for traditional knowledge and cultural values in accordance with the ethical principles outlined by the International Society of Ethnobiology (ISE) code.

Consent for publication: Not applicable

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Author contributions KH and QS: Conducted surveys and collected data and supervised the study, KN and NA: Formal analysis and writing, SZ and MAA: Proof reading and data analysis, ZA and MM: Performed comparative analysis.

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Literature cited

Ahmad KS, Hamid A, Nawaz F, Hameed M, Ahmad F, Deng J, Akhtar N, Wazarat A, Mahroof S. 2017. Ethnopharmacological studies of indigenous plants in Kel village, Neelum Valley, Azad Kashmir, Pakistan. *Journal of Ethnobiology and Ethnomedicine* 13:68. doi: 10.1186/s13002-017-0196-1

Ahmed MS, Oishe SJ, Rahman F, Meem AF, Islam S, Akter S, Rahman M. 2024. Ethnomedicinal plant diversity, traditional knowledge, and comparative analysis across regions: A study on medicinal plant utilization in Chandpur District, Bangladesh. *Journal of Angiotherapy* 8:1-19.

Ajaib M, Ashraf Z, Riaz F, Siddiqui MF. 2014. Ethnobotanical studies of some plants of tehsil Kharian, District Gujrat. *FUUAST Journal of Biology* 4:65-71.

Ali SI, Qaiser M. 1986. *Flora of Pakistan*. Karachi: Department of Botany, University of Karachi.

Ali SS, Hussain K, Nawaz K, Bhatti KH, Bashir Z, Nazeer A, Arif U, Jafar S, Siddiqi EH. 2020. Ethnobotanical knowledge and folk medicinal significance of the flora of district Gujrat, Punjab, Pakistan. *Herba Polonica* 66:37-51. doi: 10.2478/hepo-2020-0004

Amin M, Aziz MA, Manduzai AK, Rahman IU, Haq SM, Bussmann RW, Alataway A, Dewidar AZ, Al-Yafarsi MA. 2024. Standard medical ethnobotany of Kohistan, North Pakistan. *Journal of Ethnobiology and Ethnomedicine* 20:64. doi: 10.1186/s13002-024-00704-w

Arjona-García C, Blancas J, Beltrán-Rodríguez L, Reyes-García V, Sierra-Huelsz JA, Casas A. 2021. How does urbanization affect perceptions and traditional knowledge of medicinal plants? *Journal of Ethnobiology and Ethnomedicine* 17:48. doi: 10.1186/s13002-021-00473-w

Awan MS, Dar MEUI, Hussain K. 2023. Ethnomedicinal utilization and conservation status of highland flora from Western Himalayas of Azad Jammu and Kashmir, Pakistan. *Ethnobotany Research and Applications* 26:1-20.

Ayoub A, Kanwal S, Binish Z, Bashir S, Khan MA, Nisar M, Khan TH. 2026. Ethnobotanical heritage and conservation priorities of medicinal flora in a remote Himalayan border region of Azad Kashmir, Pakistan. *Scientific Reports*. doi: 10.1038/s41598-026-39964-9

Banda LOL, Banda CV, Banda JT, Singini T. 2024. Preserving cultural heritage: A community-centric approach to safeguarding the Khulubvi Traditional Temple Malawi. *Heliyon* 10:e37610. doi: 10.1016/j.heliyon.2024.e37610

Batool R, Nazar A, Adnan M, Khursheed Z, Mohsin F, Hussain W. 2025. Cross culture comparison in ethno-pharmacological uses of plants between two geographical regions of Northwest Pakistan. *Ethnobotany Research and Applications* 30:1-21.

- Chaachouay N, Zidane L. 2024. Plant-derived natural products: A source for drug discovery and development. *Drugs and Drug Candidates* 3:184-207. doi: 10.3390/ddc3010011
- Cunningham AB. 2014. *Applied ethnobotany: People, wild plant use and conservation*. London: Routledge.
- Eddouks M, Ajabli M, Hebi M. 2017. Ethnopharmacological survey of medicinal plants used in Daraa-Tafilalet region (Province of Errachidia), Morocco. *Journal of Ethnopharmacology* 198:516-530.
- Famo M, Machate M. 2003. Demographic influences on indigenous knowledge practices in Chief Albert Luthuli Municipality. *Acadlore Transactions on Applied Mathematics and Statistics* 1:77-86.
- Farooq A, Amjad MS, Ahmad K, Altaf M, Umair M, Abbasi AM. 2019. Ethnomedicinal knowledge of the rural communities of Dhirkot, Azad Jammu and Kashmir, Pakistan. *Journal of Ethnobiology and Ethnomedicine* 15:45. doi: 10.1186/s13002-019-0323-2
- Gillani SW, Shaheen H, Rehman FU, Makhkamov T, Sultana S, Ahmad M, Zafar M, Manzoor M, Waheed M, Haq SM. 2024. An insight into indigenous ethnobotanical knowledge of medicinal and aromatic plants from Kashmir Himalayan region. *Ethnobotany Research and Applications* 28:1-21. doi: 10.32859/era.28.2.1-21
- Gitima G, Gebre A, Berhanu Y, Wato T. 2025. Exploring indigenous wisdom: Ethnobotanical documentation and conservation of medicinal plants in Goba District, Southwest Ethiopia. *Scientific African* 27:e02571. doi: 10.1016/j.sciaf.2025.e02571
- Granderson AA. 2017. The role of traditional knowledge in building adaptive capacity for climate change: Perspectives from Vanuatu. *Weather, Climate, and Society* 9:547-561. doi: 10.1175/WCAS-D-16-0094.1
- Hussain B, Abbas Z, Alam J, Muhammad S, Rahman IU, Haq SM, Bussmann RW. 2024. Cross-cultural ethnobotany of the Baltis and Shinas in the Kharmang district, Trans-Himalaya India-Pakistan border. *Heliyon* 10:e28613. doi: 10.1016/j.heliyon.2024.e28613
- Hussain F, Hussain MI, Khan MA. 2008. Ethnobotanical study of medicinal plants in the Soan Valley, Salt Range, Pakistan. *Pakistan Journal of Botany* 40.
- Hussain B, Abbas Z, Alam J, et al. 2024. Cross-cultural ethnobotany of the Baltis and Shinas in the Kharmang district, Trans-Himalaya India-Pakistan border. *Heliyon* 10:e28613. doi: 10.1016/j.heliyon.2024.e28613
- Hussain K, Ansar H, Alshaqhaa MA, Nawaz K, Arshad N, Ijaz S, Alhawat Y. 2026. An ethnobotanical assessment of medicinal, cultural and ritual uses of local flora of tehsil Gujrat, Punjab, Pakistan. *Journal of Ethnobiology and Ethnomedicine* 22:39. doi: 10.1186/s13002-026-00866-9
- Ishtiaq M, Sardar T, Hussain I, Azam S, Shah MA, Mehmood S, Maqbool M, Hussain T, Thind S. 2024. Traditional ethnobotanical knowledge of important local plants in Sudhnoti, Azad Kashmir, Pakistan. *Scientific Reports* 14:22165. doi: 10.1038/s41598-024-73431-7
- Jan S, Jan G, Irfan M, Jan FG, Ullah F, Saeed M. 2024. Ethnomedicinal uses of the flora of Kohimoor Baba Valley, Tribal District Bajaur, Khyber Pakhtunkhwa, Pakistan. *Ethnobotany Research and Applications* 28:1-19.
- Kabato W, Hailegnaw N, Mutum L, Molnar Z. 2025. Managing soil health for climate resilience and crop productivity in a changing environment. *Science of the Total Environment* 1000:180460. doi: 10.1016/j.scitotenv.2025.180460
- Kadam S, Pawar AD. 2020. Conservation of medicinal plant: A review. *International Ayurvedic Medical Journal* 8:1-6.
- Kala CP. 2005. Ethnomedicinal botany of the Apatani in the eastern Himalayan region of India. *Journal of Ethnobiology and Ethnomedicine* 1:11. doi: 10.1186/1746-4269-1-11
- Kayani S, Ahmad M, Gillani SW, Manzoor M, Rehman FU, Jabeen S, Butt MA, Babar CM, Shah SAH. 2024. Ethnomedicinal appraisal of the medicinal flora among the sub-alpine and alpine indigenous communities of Palas Valley, Kohistan, Northern Pakistan. *Ethnobotany Research and Applications* 28:1-29.
- Khan ZS, Dar SA, Tyub S. 2025. Economic and ethnobotanical analysis of ethnomedicinal plant diversity in the Lower Jhelum Valley, Kashmir Himalaya. *Medicon Agriculture and Environmental Sciences* 8:21-42.
- Knapp S. 2019. People and plants: The unbreakable bond. *Plants, People, Planet* 1:26. doi: 10.1002/ppp3.4
- Lamy E. 2024. Ethnobotany: Preserving plants' cultural significance for sustainable medicine and conservation. *Medicinal and Aromatic Plants* 13:498.
- Nisar MF, Ismail S, Arshad M, Majeed A, Arfan M. 2011. Ethnomedicinal flora of District Mandi Bahauddin, Pakistan. *Middle-East Journal of Scientific Research* 9:233-238.
- Noreen F, Choudri M, Noreen S, Adil M, Yaqoob M, Mustafa AG, Cheema F, Sajjad F, Mushtaq U. 2020. Ethnomedicinal profile of flora of District Sialkot, Punjab, Pakistan. *New Trends in Medical Sciences* 1:65-83.

- Parvaiz M, Bhatti KH, Nawaz K, Hussain Z. 2013. Ethnobotanical studies of medicinal plants of Dinga, District Gujrat, Punjab, Pakistan. *World Applied Sciences Journal* 26:826-833.
- Pushpangadan P, George V, Ijnu T, Chithra M. 2018. Ethnomedicine. In *Health food and nutraceuticals—traditional wisdom of maternal and child health in India*: 113-117.
- Qari SH, Alqethami A, Qumsani AT. 2024. Ethnomedicinal evaluation of medicinal plants used for therapies by men and women in rural and urban communities in Makkah district. *Saudi Pharmaceutical Journal* 32:101881. doi: 10.1016/j.jsps.2023.101881
- Ramawat KG, Dass S, Mathur M. 2009. *Herbal drugs: Ethnomedicine to modern medicine*. Berlin: Springer. Germany
- Rehman A, Hussain K, Nawaz K, Arshad N, Iqbal I, Ali SS, Nazeer A, Bashir Z, Jafar S, Arif U. 2020. Indigenous knowledge and medicinal significance of seasonal weeds of District Gujrat, Punjab, Pakistan. *Ethnobotany Research and Applications* 20:1-19.
- Sardar AA, Khan ZD. 2009. Ethnomedicinal studies on plant resources of tehsil Shakargarh, district Narowal, Pakistan. *Pakistan Journal of Botany* 41:11-18.
- 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* 158:1160-1181.
- Singh D, Gupta R, Saraf SA. 2012. Herbs—are they safe enough? An overview. *Critical Reviews in Food Science and Nutrition* 52. doi: 10.1080/10408398.2010.512426
- Sinthumule NI. 2023. Traditional ecological knowledge and its role in biodiversity conservation: A systematic review. *Frontiers in Environmental Science* 11:1164900. doi: 10.3389/fenvs.2023.1164900
- Sulaiman S, 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* 9:1001. doi: 10.3390/plants9081001
- Thakur A, Kumari R, Kumar A, Chaudhary A. 2024. Quantitative ethnobotanical study of medicinal plants used by native people of selected areas of Chhota Bhangal, Himachal Pradesh. *Ethnobot Res and Appli*, 2024; 28:1-34.
- Tufail M, Hussain K, Nawaz K, Bhatti KH, Yasin G, Ali SS. 2020. Ethnobotanical survey of important wild medicinal plants of tehsil Gojra, District Toba Tek Singh, Punjab, Pakistan. *Ethnobotany Research and Applications* 20:1-14. doi: 10.32859/era.20.1-14
- Ullah I, Akhtar S, Adnan M, Nawab J, Ullah S, Abdullah-Al-Wadud M. 2025. Ethnobotanical knowledge and ethnomedicinal uses of plant resources by urban communities of Khyber Pakhtunkhwa, Pakistan: A novel urban ethnobotanical approach. *Journal of Ethnobiology and Ethnomedicine* 21:13. doi: 10.1186/s13002-025-00766-4
- Umair M, Altaf M, Abbasi AM. 2017. An ethnobotanical survey of indigenous medicinal plants in Hafizabad district, Punjab, Pakistan. *PLoS ONE* 12:e0177912. doi: 10.1371/journal.pone.0177912
- Umair M, Altaf M, Bussmann RW, Muhammad MA, Hussain W, Butt MA. 2019. Ethnomedicinal uses of the local flora in Chenab riverine area, Punjab province Pakistan. *Journal of Ethnobiology and Ethnomedicine* 15:7. doi: 10.1186/s13002-019-0285-4
- Winslow LC, Kroll DJ. 1998. Herbs as medicines. *Archives of Internal Medicine* 158. doi: 10.1001/archinte.158.20.2192
- Zougagh S, Belghiti A, Rochd T. et al. 2019. Medicinal and Aromatic Plants Used in Traditional Treatment of the Oral Pathology: The Ethnobotanical Survey in the Economic Capital Casablanca, Morocco (North Africa). *Nat. Prod. Bioprospect* 9:35-48. doi: 10.1007/s13659-018-0194-6