Documentation of ethnomedicinal plants used by the people living in reserved forests of semi-arid region Punjab Pakistan

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Research

Abstract

Background: Ethnobotanical investigations serve as a foundation for comprehending the intricate interplay between plants and people within specific geographical regions, while also informing conservation strategies and priorities. The present study was conducted within the marginalized communities in the reserved forests of Punjab, Pakistan's semi-arid region.

Methods: The study participants were selected using random sampling techniques, and they underwent semi-structured interviews involving open-ended questions to gather the required data.

Results: In total, 82 plant taxa were documented, representing 74 genera and 32 families. The predominant category was wild herbs (45 species), with whole plants (35 species) being commonly employed in drug preparations. These studied plants were noted for their efficacy in addressing 30 distinct ailments, with fever (33 species) and gastrointestinal disorders (28 species) being the primary conditions they were prominently used for.

Conclusions: These findings validate the substantial plant-based knowledge held by the populations residing in the semi-arid region. Nonetheless, the rapid pace of urbanization, coupled with economic growth and evolving sociocultural dynamics, has posed challenges to the preservation of traditional wisdom. A notable decline has been observed in the count of herbal practitioners, with their successors displaying diminished interest in the field due to demanding work and limited profitability. As a result, the revitalization of existing traditional practices could potentially be achieved through initiatives such as organic product development, cultivating ethnospecies in home gardens, and establishing collaborations with herbal industries.

Keywords: Ethnomedicine, Reserved Forest, local communities, semi-arid region, flora.

Background

The use of wild medicinal plants for the treatment of ailments has long been popular as a traditional approach to healthcare in many nations, particularly in undeveloped and rural areas (Hu *et al.* 2020). Herbal medicines differ from conventional

Western medicine in that they frequently adhere to local concepts and qualities (Haq *et al.* 2023). Despite the presence of scientific traits, a considerable fraction of these properties remains unproven by modern Western scientific standards (Haq *et al.* 2022). As scientific progress continues, traditional medical wisdom finds itself at a crossroads, increasingly being eclipsed by Western medicine due to its intrinsic limits (Waheed *et al.* 2021). Several examples have shown that recording, researching, and scientifically validating traditional medical knowledge can help to protect these practices while also providing new views and insights (Waheed *et al.* 2022; Haq *et al.* 2023a).

The utilization of medicinal plants within semi-arid regions has been a noteworthy practice. These regions, characterized by limited water availability and challenging climatic conditions, have witnessed the persistent use of indigenous plant species for therapeutic purposes (Arshad *et al.,* 2022; Waheed *et al.* 2023; Haq *et al.* 2023b). The traditional knowledge surrounding these plants passed down through generations, holds a rich repository of healing wisdom (Haq *et al.* 2023c). Local communities in such environments have relied upon these plants to address various health concerns due to their accessibility and compatibility with the arid ecosystem (Waheed *et al.* 2023a; Haq *et al.* 2023d). The unique adaptability of medicinal plants to the semi-arid environment has facilitated their integration into local healthcare practices (Haq *et al.* 2023e). These plants often possess compounds that are well-suited to thrive in conditions of water scarcity and high temperatures (Haq *et al.* 2022a). Additionally, the cultural significance of these plants within the community further underscores their importance (Arshad *et al.* 2022a; Waheed *et al.* 2022a).

Despite their potential benefits, the use of medicinal plants in semi-arid regions faces challenges (Mashamaite *et al.* 2022). Climate change and habitat degradation pose threats to the sustainability of these plants (Rai and Singh 2022). Overharvesting, driven by increased demand, can lead to population decline and loss of biodiversity (Jamil *et al.* 2022; Haq et al., 2023f). Scientific research plays a crucial role in identifying sustainable harvesting practices and ensuring the conservation of these valuable resources (Haq *et al.* 2022; Waheed *et al.* 2023b). Efforts to document traditional knowledge about medicinal plants in semi-arid regions are essential (Arshad *et al.* 2023). Integrating this knowledge with modern scientific research can unlock new insights into the therapeutic properties of these plants (Astutik *et al.* 2019). Collaborative initiatives involving local communities, researchers, and conservationists are instrumental in preserving these traditional practices while also exploring their potential contributions to modern medicine (Kopnina *et al.* 2022; Haq *et al.* 2023g).

In recent years, there has been rapid growth in ethnobotanical studies, leading to the availability of a wealth of literature from various regions across the country. Nevertheless, there are specific areas that remain largely unexplored, such as communities residing in remote mountainous regions, semiarid, and deserts (Haq et al., 2022c). Consequently, the botany of these semiarid areas has received limited attention (Garlick, 2018; Arshad *et al.,* 2022). The study area possesses a captivating array of flora and vegetation and supports a significant human population (Waheed *et al.,* 2020). In light of the rapid changes in socio-ecological conditions, priorities, and population movements in the study area, especially in remote areas, we hypothesized that traditional knowledge is at risk of erosion and fragmentation. Consequently, the primary aims of this study were as follows: 1) To meticulously document the plant taxa within the study area that hold medicinal value. 2)To comprehensively record the associated traditional knowledge, thereby facilitating an assessment of the conservation needs of the listed medicinal taxa.

Materials and Methods

Study area

Pakistan Punjab province is subdivided into 36 administrative districts, covering an expansive area of 205,346 square kilometers (Figure 1). The province's agro-climatic features classify it into three distinct ecological zones: the arid zone, characterized by an annual rainfall under 300 mm (encompassing Cholistan and Thal deserts); the semi-arid zone, experiencing 300–600 mm annual rainfall (encompassing Pothohar and Southern Punjab); and the dry subtropical zone, with an annual rainfall between 600–1200 mm (encompassing Northern and Central Punjab) (Arshad *et al.* 2023a). Reserved forests in Punjab, Pakistan" refers to designated areas of forest land in the Punjab province of Pakistan that are legally protected and managed for the conservation of natural resources, biodiversity, and ecosystem services (Saima *et al.* 2021). These forests are set aside from regular land use and are safeguarded against activities like deforestation, over-exploitation, and unauthorized development (Haq *et al.* 2023h). The concept of reserved forests aims to ensure the sustainable use of forest resources while also maintaining ecological balance and contributing to the well-being of local communities and the environment.

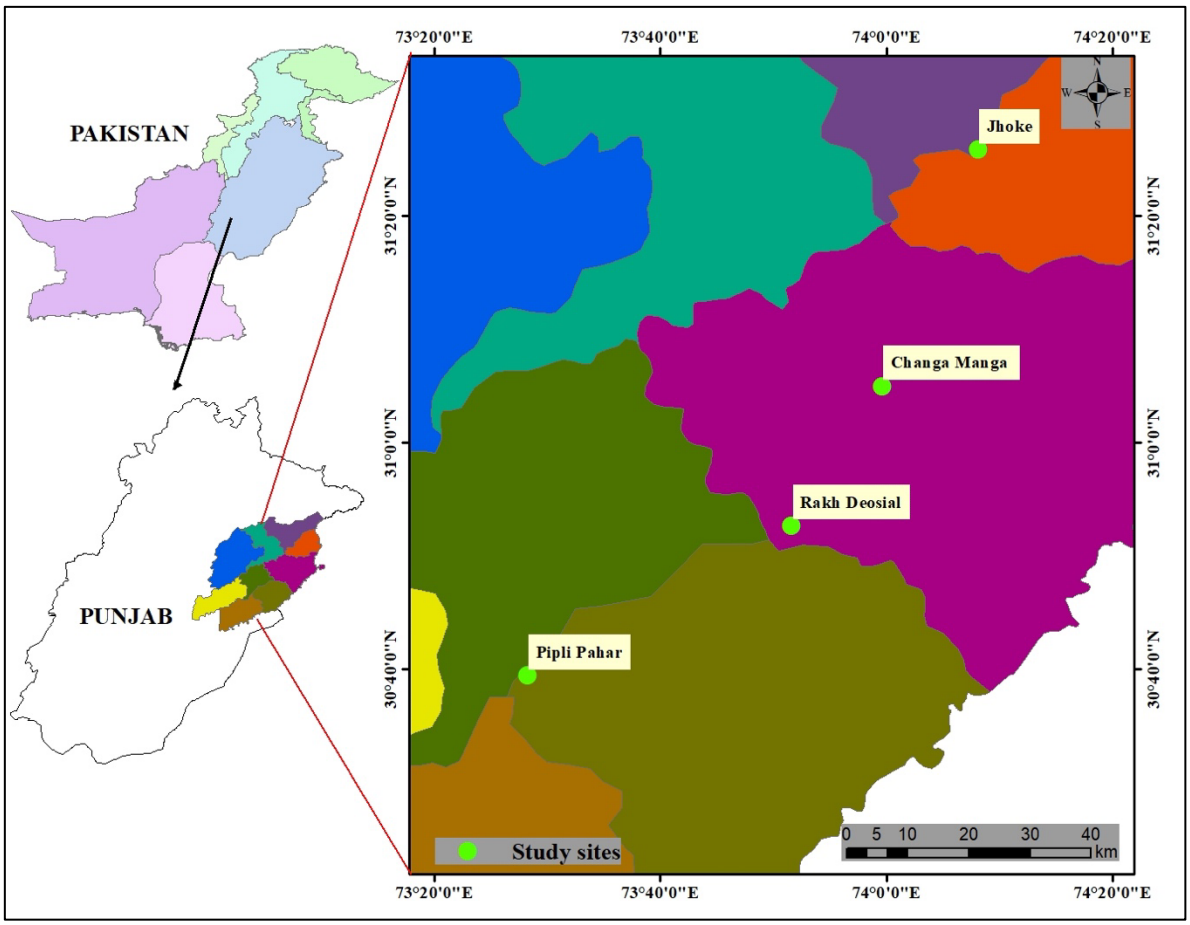

Figure 1. Study area map showing locations of Reserved forest in Punjab Pakistan.

Data collection

Field surveys were conducted from spring 2021 to winter 2022 in four forests in the semi-arid region of Punjab Pakistan (Table 1). The research strictly adhered to ethical guidelines outlined by the International Society of Ethnobiology for surveying rural and indigenous communities, as available online: www.ethnobiology.net/whatwe-do/coreprograms/ise-ethics-program/code-of-ethics. Prior to conducting interviews, explicit verbal consent was obtained from each participant, encompassing both data collection and potential publication. The study employed the Participatory Rural Appraisal (PRA) approach, as detailed in the Kyoto Protocol of 2017, with the informed agreement of the informants. Ethnomedicinal insights concerning traditional medicinal plants were gathered from local inhabitants of varying age groups, including local men, women, farmers, and shepherds. During the interviews, a range of information was solicited from the participants in their native Punjabi language. This information encompassed the vernacular names of plants, their availability, specific parts used, methods of preparation and administration, the ailments they were employed to treat, and any cultural applications associated with them.

Table 1. Location and details of forests studied for ethno medicinal

Forest Name	District	Legal Status	Area (km^2)	Forest Type	Latitude	Longitude
Rakh Deosial	Kasur	Reserved Forest	474.6963	Irrigated Plantation	30.87704	73.8563
Changa Manga	Kasur	Reserved Forest	5062.678	Irrigated Plantation	31.08166	73.99138
Pipli Pahar	Okara	Reserved Forest	2781	Irrigated Plantation	30.64203	73.46234
Jhoke	Lahore	Reserved Forest	1242.79	Riverine Forest	31.42872	74.13803

Locals from each research location led guided tours to collect fresh plant specimens in accordance with herbarium standards for later identification. Under the direction of local specialists, a sizable part of these medicinal plants were identified directly in the field using vernacular nomenclature. Reputable botanical resources including the Flora of Pakistan (Ali and Nasir, 1990-1991, 1993-2001, 2002-2019), Flora of China, and Flora of India were used to validate the identifications. Two online plant databases, The Plant List (2010) (http://www.theplantlist.org) and World Flora Online (http://www.worldfloraonline.org/), were used to double-check the botanical names and family designations to make sure they were accurate. The plant specimens were carefully labeled, stamped, and photographed after being identified.

Data analysis

Overall trends in the total citations and Used Value were expressed illustratively through Generalized Linear Regression Models (GLM) through Graph Pad Prism version 9 (Graph Pad). The Origin pro software was used to create chord diagrams displaying the species' percentage contributions to the study parameters (plant parts used, plant preparations, and disease categories) that were applied in the study (Haq *et al.* 2021).

Use Value (UV)

The Use Value index is used to calculate the relative value of each medicinal plant species used by the local population. In the current study use value was calculated using the following formula:

$$\mathrm{UV} = \mathrm{Ui}/\mathrm{N}$$

Where Ui is the total number of use reports by each informant and N indicates the total number of informants taking part in the study (Phillips and Gentry 1993). Use Value is high when there are many use reports for a given medicinal plant species and use value is low when there are very few reports associated with its use.

Results and Discussions

All the above-mentioned aims of the study were achieved systematically. Firstly we have enumerated the list of available medicinal plants in the study area and also recorded their associated traditional knowledge in terms of their medicinal uses. In addition, by estimating relative abundance, we have tried to find out conservation aspects of the listed medicinal taxa.

Participant background

A total of 86 participants were interviewed during the present research work (Table 1). The majority of the respondents were men (67%) followed by women (33%). Men eagerly took part in the interview process but only women of old ages participated in the survey and shared ample folk wisdom as reported by Reyes-Garcia *et al.* (2013). The younger women remained reclusive and showed no interest in such surveys. Islamic limitations and rural lifestyle may be the reasons behind the women reclusiveness.

The majority of informants fell within the middle-aged bracket of 40 to 60 years (50%), followed by those above 60 years of age (28%). Younger individuals, aged between 20 to 40 years, displayed a reduced inclination towards herbal treatments and the traditional wisdom of their elders, a trend noted in various ethnobotanical studies (Abbas *et al.* 2017; Bibi *et al.* 2022). Typically, these younger individuals were engaged in activities such as farming, pastoralism, wood cutting, herbal medicine gathering, or government employment, which limited their involvement. Illiteracy was common among this group. Conversely, those who were literate exhibited less knowledge compared to those deeply immersed in traditional rural occupations like farming and pastoralism. Notably, significant variations in knowledge were observed based on the socioeconomic status of informants, with herbal healers possessing more comprehensive and varied knowledge about medicinal plants. Age and gender also played a role in the depth of knowledge. Elder individuals above 60 years of age shared less information, possibly due to weaker memory. Participants under 30 years of age made no contributions to the survey. Moreover, knowledge was shared by housewives, farmers, and other community members who inherited practices from their forefathers. It's important to note that ethnobotanical knowledge can be influenced by a multitude of factors, including age, gender, ethnicity, and profession. A distinct difference in knowledge was observed between genders and ethnicities, while age also influenced the extent of knowledge, as supported by the findings of Ayantunde *et al.* (2008).

Table 2. Demographic features of interviewed people include locality, sex ratio, age, education levels, and socio-economic background.

Social Variables	Description	Men	Women	Total	%
Locality	Rakh Deosial	15	5	20	23
	Changa Manga	19	6	25	29
	Pipli Pahar	10	9	19	22
	Jhoke	15	7	22	24
Sex Ratio	Men			59	67
	Women			27	33
Age	Between 20 - 40 years	18	6	24	28
	Between 40 - 60 years	29	14	43	50
	Above 60	12	7	19	22
Social Livelihood	Farmers	15	10	25	29
	Shepherds	22	12	34	39
	Wood cutters	12	5	17	20
	Herbalists	6	0	6	7
	Local Hakims	4	0	4	5
Education Level	Illiterate	37	21	58	67
	Primary	10	4	14	17
	Middle	7	2	9	10
	Intermediate or above	5	0	5	6

Diversity of medicinal plant

Current study reported 82 plant species belonging to 74 genera and 32 families used for the treatment of various ailments (like respiratory, gastrointestinal, nervous, dermatological disorders etc.) from the study area (Table 3). All these species encountered from the study area were wild. Results reported that most of the species (n=10) belonged to family Asteraceae and Fabaceae (n=08), Poaceae (n=07), Amaranthaceae and Euphorbiaceae were co-dominating families with 5 species each. Only Brassicacaeae and Lamiaceae contributed 4 species while Convolvulaceae and Asclepiadaceae contributed 3 species each. Araceae, Chenopodiaceae, Cucurbitaceae, Cyperaceae, Malvaceae, Moraceae, Rhamnaceae, Scrophulariaceae, and Solanceae were having 2 species. The rest of the 18- families were monotypic (Table 3). Umair *et al.* (2019) and Ali *et al.* (2022) around Chenab river areas and Tareen *et al.* (2016) in Balochistan also documented Asteraceae and Poaceae among dominating families. Shah *et al.* (2020) documented Solanaeae with least number of species from the central Punjab Moreover, Iqbal *et al.* (2019) documented Poaceae and Solanaceae the dominant species while, Fabaceae as least dominant from District Sargodha. It shows the stereotype presence of different plants in different and same geographical areas. The possible reason of this dominance not only depends upon the geographical and climatic factors but now also on the anthropogenic factors; in many areas it might be possible that due to urbanization and construction of new housing societies many plants have been cut which may affect the number of plant families in different regions.

Table 3. List of plants recorded from the study area with species name, local name, part used, mode of administration, part used and ethnomedicinal uses.

Family	Scientific names	Voucher number	Species code	Local name	Part used	Mode of administration	Ethno medicinal uses	Number of Citations	UV
Aizoaceae	*Zaleya pentandra* (L.) C.Jeffrey	MPK-1	Zale-pen	Itsit	root	decoction	Use to treat influenza and Cough.	12	0.14
Amaranthaceae	*Achyranthes aspera* L.	MPK-2	Achy-asp	Pathkanda	whole plant	decoction, poultice	Diarrhea and rheumatics	10	0.12
	Aerva javanica (Burm.f.)	MPK-3	Aerv-jav	Booien	whole plant	poultice	Wounds healing and rheumatics	8	0.09
	Alternanthera sessilis L.	MPK-4	Alte-ses	Matikaduri	whole plant	decoction	Hemorrhoids and diarrhea	26	0.3
	Amaranthus viridis L.	MPK-5	Amar-vir	Chulai	whole plant	decoction	Vermifuge, dysentery, and constipation	31	0.36
	Chenopodium album L.	MPK-32	Chen-alb	bathu plant	whole plant	decoction	Constipation	17	0.2
	Chenopodium murale L.	MPK-33	Chen-mur	Karund	leaves	infusion, poultice	Inflammation of eyes	40	0.47
	Suaeda fruticosa Forssk.	MPK-6	Suae-fru	Lunak	whole plant	decoction, oil	Stomach pain	26	0.3
Apiaceae	*Foeniculum vulgare* L..	MPK-7	Foen-vul	Sounf	seeds	decoction	Stomach issues	19	0.22
Asclepiadaceae	*Alstonia scholaris* (L.)	MPK-8	Alst-sch	Chaitan	stem bark	decoction	Malaria, abdominal pain, and carminative	24	0.28
	Nerium oleander L..	MPK-9	Neri-ole	Ganderi	flowers, leaves, root	decoction, infusion	Asthma and skin infection	20	0.23
	Pentatropis spiralis (Forssk.)	MPK-10	Pent-spi	satya nasi	leaves	decoction	Painful menstruation	34	0.4
Asteraceae	*Ageratum conyzoides* (L.) L.	MPK-11	Ager-con	Neel kanth	whole plant	decoction, infusion, poultice	Wounds healing and rheumatics	31	0.36
	Cirsium arvense (L.) Scop.	MPK-12	Cirs-arv	Kandiari	root	poultice	Vermifuge and toothache	24	0.28
	Conyza bonariensis (L.) Cronquist	MPK-13	Cony-bon	Namkeen booti	whole plant	decoction	Diabetics, diarrhea, and hemorrhage	11	0.13
	Echinops echinatus Roxb.	MPK-14	Echi-ech	Uthkatara	flowers, root, seeds	infusion	Hepatic problem and cold	17	0.2
	Eclipta alba (L.) Hassk.	MPK-15	Ecli-alb	kala bhangra	whole plant	infusion, oil	Jaundice, anemia, and scorpion bite	15	0.17

	Launaea procumbens (Roxb.)	MPK-16	Laun-pro	Dodak	whole plant	infusion	Kidney issues	42	0.49
	Parthenium hysterophorus L.	MPK-17	Part-hys	Gajar booti/ghass	whole plant	decoction	Respiratory issues, fever, and diarrhea	19	0.22
	Sonchus asper All.	MPK-18	Sonc-asp	Dodak	whole plant	poultice	Skin problems and wounds	25	0.29
	Taraxacum officinale Wigg.	MPK-19	Tara-off	Hindiaba	leaves, root	decoction	Diuretic, gall stones, jaundice, and dyspepsia	16	0.19
	Xanthium strumarium L.	MPK-20	Xant-str	bandri,desi arind	root, seeds	decoction	Sedative, diuretic, and malaria fever	21	0.24
Araceae	*Colocasia esculenta* (L.) Schott	MPK-21	Colo-esc	Arvi	leaves	decoction	Wounds and appetite stomach	25	0.29
	*Phoenix dactylifer*a L.	MPK-22	Phoe-dac	Khajoor	fruit	decoction	blood production and immunity	28	0.33
Brassicaceae	*Brassica juncea* (L.) Czern.	MPK-24	Bras-jun	brown mustard	leaves, seeds	poultice, oil	Headache and hemorrhage	31	0.36
	Coronopus didymus (L.) Sm.	MPK-25	Coro-did	thandi booti	whole plant	decoction	Fever, headache, and digestive issue	16	0.19
	Rorippa indica (L.) Hiern	MPK-26	Rori-ind	saag booti	whole plant	decoction, infusion	Cough, blood circulation, and jaundice	36	0.42
	Sisymbrium irio L.	MPK-27	Sisy-iri	jangli sarson	whole plant	decoction	Throat and chest infection	14	0.16
Cannabaceae	*Cannabis sativ*a L.	MPK-28	Cann-sat	Bhang	whole plant	powder	Anthelmintic and diuretic	32	0.37
Capparidaceae	*Capparis decidua* (Forssk.) Edgew.	MPK-29	Capp-dec	Karir	fruit	powder	Asthma and bronchial problems	16	0.19
	Cleome viscosa L.	MPK-30	Cleo-vis	Kinni booti	whole plant	infusion, poultice	Wounds, carminative, and earache	24	0.3
Caryophylaceae	*Stellaria media* (L.) Vill.	MPK-31	Stel-med	Gandel	whole plant	decoction, poultice	Constipation, rheumatic, and skin diseases	30	0.35
Convolvulaceae	*Convolvulus arvensis* L.	MPK-34	Conv-arv	Lehli	flowers, fruit, leaves	decoction	Constipation, wounds, fever, and spider bite,	20	0.23
	Cuscuta reflexa Roxb.	MPK-35	Cusc-ref	Akash/amar bail	whole plant	decoction	Carminative, jaundice, and urination issue	15	0.17
	Ipomoea carnea Jacq.	MPK-36	Ipom-car	Gul-e-Abbasi	root	decoction, poultice	Rheumatism and diuretic	10	0.12
Cucurbitaceae	*Cucumis melo* L.	MPK-37	Cucu-mel	Kharboza	fruit	powder	Constipation	19	0.22
	Mukia maderaspatana (L.)	MPK-38	Muki-mad	chibhar booti	fruit, leaves	decoction, infusion	Carminative	25	0.29

Cyperaceae	*Cyperus irio* L.	MPK-39	Cype-iri	Nehri tala	whole plant	decoction	Fever, dyspepsia, and dysmenorrhea	15	0.17
	Cyperus rotundus L.	MPK-40	Cype-rot	Deela	tubers	decoction	Menstrual issues, carminative, and vermifuge	28	0.33
Euphorbiaceae	*Croton bonplandianus* Baill.	MPK-41	Crot-bon	Jamal ghota	whole plant	poultice	wounds/warts, leukemia(eye problems, hair diseases	31	0.36
	Euphorbia helioscopia L.	MPK-42	Euph-hel	chandni,dadhar booti	whole plant	decoction	Purgative and rheumatism	24	0.28
	Euphorbia hirta L.	MPK-43	Euph-hir	Dodhi	whole plant	decoction	Asthma, dysentery, and warts	26	0.3
	Euphorbia prostrata Aiton	MPK-44	Euph-pro	Doddak	whole plant	decoction	Piles	35	0.41
	Ricinus communis L.	MPK-45	Rici-com	Arind(castor oil Plant)	leaves	infusion	Constipation	15	0.17
Fabaceae	*Acacia nilotica* (L.) Delile	MPK-46	Acac-nil	Kiker	stem bark, gum	decoction	Cough, dysentery, diarrhea, and leucorrhea	18	0.21
	Albizia procera (Roxb.) Benth.	MPK-47	Albi-pro	Sirin	stem bark, gum	decoction, poultice	Rheumatism, stomachache, and wounds	37	0.43
	Cassia fistula L.	MPK-48	Cass-fis	Amaltas	fruit	powder	Constipation and stomachache	24	0.28
	Dalbergia sissoo DC.	MPK-49	Dalb-sis	Taali	leaves	infusion	Menstrual disorders	28	0.33
	Parkinsonia aculeata L.	MPK-50	Park-acu	jelly bean tree	flowers, fruit, leaves	infusion	Fever, diabetes , and rheumatism	14	0.16
	Pongamia pinnata (L.) Pierre	MPK-51	Pong-pin	Sukh chain	whole plant	decoction	Dyspepsia, cough, diabetics, and rheumatism	9	0.11
	Trifolium repens L.	MPK-52	Trif-rep	wile clover	flowers	infusion	Vermifuge, cough, fever, and cold	13	0.15
	Trigonella foenum-graecum L.	MPK-53	Trig-foe	sickle fruit	seeds	decoction	Stomach disorder	16	0.17
Lamiaceae	*Mentha arvensis* L.	MPK-54	Ment-arv	Podina	whole plant	decoction	Fever and antispasmodic	19	0.22
	Mentha royleana Wall. ex Benth.	MPK-55	Ment-roy	jangli podina	whole plant	powder	Stomachache, carminative, and diarrhea.	18	0.21
	Ocimum sanctum L.	MPK-56	Ocim-san	Tulsi/ulsi plant	leaves, seeds	decoction	Wounds, cold, and rheumatism	35	0.41
	Salvia aegyptiaca L.	MPK-57	Salv-aeg	Tukhum Malango	seeds	powder	Digestive issues, gonorrhea, and hemorrhoids	12	0.14
Malvaceae	*Bombax ceiba* L.	MPK-23	Bomb-cei	Sambal	flowers	infusion	Leucorrhea	15	0.17

	Hibiscus rosa-sinensis L.	MPK-58	Hibi-ros	shoe flower/ ching rose	flowers, leaves, root	infusion	Fever, cough, and hair growth	13	0.15
	Malva neglecta Wallr.	MPK-59	Malv-neg	chees plant	flowers, leaves, root	decoction, poultice	Diuretic, laxative, and anti-inflammatory	18	0.21
Meliaceae	*Azadirachta indica* A.Juss.	MPK-60	Azad-ind	Neem	leaves	infusion	Blood purification and diabetes.	16	0.19
Moraceae	*Ficus benghalensis* L.	MPK-61	Ficu-ben	Borh	stem bark, fruit, leaves	infusion	Diarrhea and spermatorrhea	21	0.24
	Ficus palmata Forssk.	MPK-62	Ficu-pal	Pagwarah	fruit	powder	Gall bladder issues and constipation	19	0.22
Oxalidaceae	*Oxalis corniculata* L.	MPK-63	Oxal-cor	Khati methi booti	whole plant	infusion	Vermifuge, diarrhea, and snake bite.	22	0.26
Papaveraceae	*Fumaria indica* (Hausskn.) Pugsley	MPK-64	Fuma-ind	pit papra	whole plant	decoction	Fever, diuretic, and spleen disorders.	14	0.16
Phyllanthaceae	*Phyllanthus niruri L*.	MPK-65	Phyl-nir	Jangli amla	leaves, root	infusion	Bladder stone and jaundice	16	0.19
Poaceae	*Avena sativa* L.	MPK-66	Aven-sat	Jay	seeds	infusion	Diuretic	15	0.17
	Cymbopogon citratus (DC.) Stapf	MPK-67	Cymb-cit	Lemon grass	whole plant	decoction	Digestive issues, and fever, rheumatism	24	0.28
	*Cymbopogon jwarancu*sa (Jones) Schult.	MPK-68	Cymb-jwa	Kattan	flowers, leaves, root	decoction, oil	Fever and cough	25	0.29
	Cynodon dactylon (L.) Pers.	MPK-69	Cyno-dac	Khabbal	whole plant	infusion	Piles, vomiting, and urinary irritation	16	0.19
	Desmostachya bipinnata (L.) Stapf	MPK-70	*Desm-bip*	Dabbh	root	decoction	Diuretic and diabetes	13	0.15
	Saccharum bengalense Retz.	MPK-71	Sacc-ben	Kana	root	decoction	Piles and gynecological issues	9	0.11
	Setaria viridis (L.) P.Beauv.	MPK-72	Seta-vir	Chamri ghass	seeds	powder	Skin diseases	17	0.20
Primulaceae	*Anagallis arvensis* L.	MPK-73	Anag-arv	bili booti	whole plant	infusion	Epilepsy, menstrual disorder and skin issues	13	0.15
Rhamnaceae	*Ziziphus mauritiana* Lam.	MPK-74	Zizi-mau	Ber	fruit, root, seeds	decoction, powder	Diabetes and hair fall	32	0.37
	Ziziphus nummularia (Burm.f.) Wight & Arn.	MPK-75	Zizi-num	Ber	fruit, root, seeds	decoction, powder	Diabetes	23	0.27

Salvadoraceae	*Salvadora oleoides* Decne.	MPK-76	Salv-ole	Vaan	fruit, leaves, seeds	infusion, oil	Cough, and digestive issues	38	0.44
Scrophulariaceae	*Verbascum thapsus* L.	MPK-77	Verb-tha	Gidar tambaku	flowers, leaves	infusion, powder	Diarrhea, migraine, and asthma	21	0.24
	Veronica agrestis L.	MPK-78	Vero-agr	field speed well	whole plant	decoction	Dysmenorrhea	9	0.10
Solanceae	*Lycium shawii* Roem. & Schult.	MPK-79	Lyci-sha	Kandiari	fruit	infusion	Diuretic and diabetes	19	0.22
	Nicotiana plumbaginifolia Viv.	MPK-80	Nico-plu	Jangli Tambaku	whole plant	powder	Vermifuge	23	0.27
Verbaceae	*Phyla nodiflora* (L.) Greene	MPK-81	Phyl-nod	Bukan booti	whole plant	infusion, poultice	Carminative and cold	10	0.12
Zygophyllaceae	*Tribulus terrestris* L.	MPK-82	Trib-ter	Pakhura	fruit, seeds	infusion	Diuretic and male impotency	11	0.13

Habit, part used, and mode of administration

The dominant plant habit among the cited flora was herbaceous (n=45), followed by trees (n=14), shrubs (n=11), grasses (n=7), climbers (n=3), and sedges (n=2). Previous ethnobotanical literature also documented the prevalence of medicinal species primarily as herbs (Bibi *et al.* 2022; Birjees *et al.* 2022), playing a pivotal role in shaping the phyto-cultural diversity of traditional rural medicines (Ahmad *et al.* 2014). A diverse array of plant parts was employed to address various ailments, with whole plants (n=35) being commonly used. Additionally, leaves (n=19), roots (n=16), fruits (n=14), seeds (n=13), flowers (n=10), bark (n=4), gum, and tubers (n=2) were also documented (Figure 2). In the formulation of medicinal recipes, the most frequently consumed form was decoction (n=46), followed by infusion (n=26), poultice (n=14), powder (n=12), and oil (n=5) (Figure 3). Consistent with other ethnomedicinal studies in Pakistan, decoction emerged as the most commonly utilized preparation method (Wali *et al.* 2021; Rehman *et al.* 2023). These crude drugs were administered orally (54%), and topically (36%), and topically (7%), with the use of eye drops being the least common (3%).

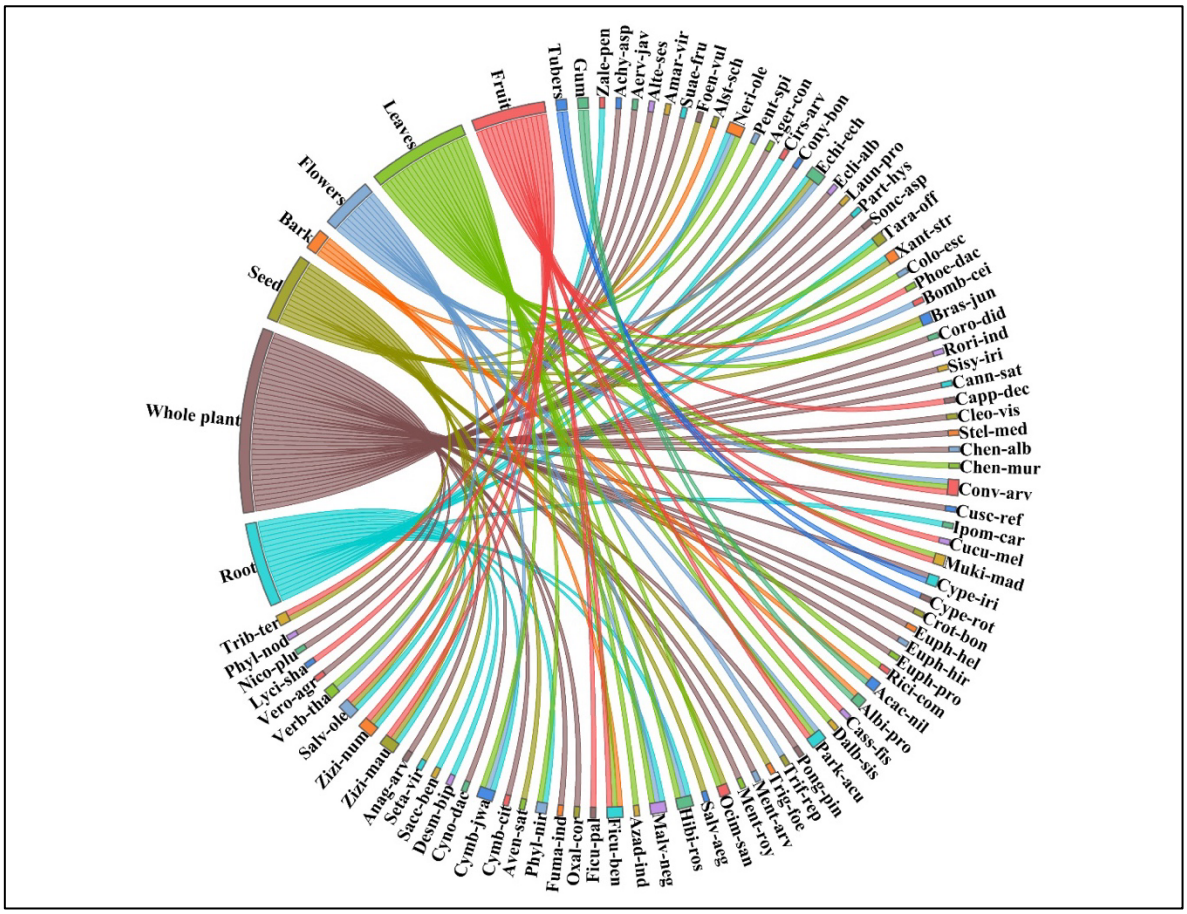

Figure 2. Chord diagram depicting the plant part and species used for ethnomedicinal purpose.

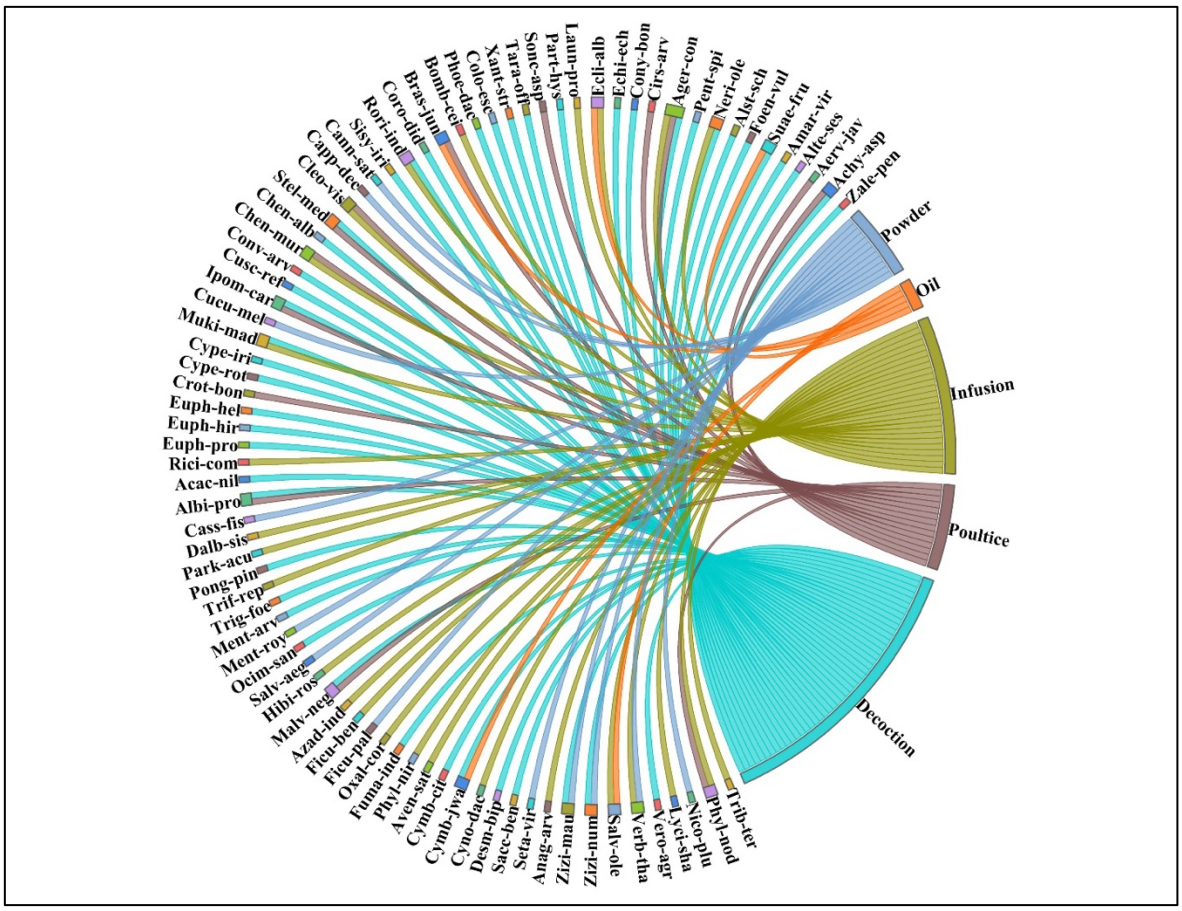

Figure 3. Chord diagram depicting the mode of administration and species used for ethnomedicinal purpose.

Ethnomedicinal uses

The recorded ethnomedicinal plants were connected to address a diverse range of 30 distinct ailments, categorized into 10 groups following the classifications proposed by Farooq *et al.* (2019) and Umair *et al.* (2019). The highest prevalence of ethnomedicinal species was observed in the treatment of fever (33 species), gastrointestinal issues (28 species), urinary ailments (18 species), and dermatological conditions (16 species). These findings harmonize with earlier ethnomedicinal literature from the Punjab region (Qureshi *et al.* 2011; Yousaf *et al.* 2014; Akram *et al.* 2009). Moreover, Qureshi *et al.* (2011) and Umair *et al.* (2019) also documented a notable prevalence of gastrointestinal disorders in the Chenab river areas. This could be attributed to inadequate sanitation practices in rural settings, where communal disregard for hygiene protocols often leads to gastrointestinal disturbances. Among the total of 82 species, 18 were exclusively used for treating single diseases, 30 species for addressing dual diseases, and 34 species were employed for managing multiple diseases (Figure 4).

The current investigation also documented an increased utilization of ethnomedicinal plants for the aforementioned ailments. Nonetheless, a minimal number of species were recorded for nervous disorders and auditory issues (1 species each). In order to assess the consensus level among the community informants in the study area concerning plant use for specific disease categories, used value (UV) values were calculated. The highest used value (UV) emerged for *Launaea procumbens, Chenopodium murale, Euphorbia prostrata, Albizia procera, Ocimum sanctum, Salvadora oleoides, Croton bonplandianus, Rorippa indica, Brassica juncea, Pentatropis spiralis, Convolvulus arvensis,* and *Cannabis sativa*, all these species as more than 30 species, while the lowest was observed for *Aerva javanica, Conyza bonariensis, Pongamia pinnata, Saccharum bengalense, Veronica agrestis,* and *Phyla nodiflora* (Figure 5). The frequency of recurring health issues, particularly gastric disorders, was attributed to subpar hygiene practices, dietary choices, and prevailing climatic conditions (Abbas *et al.* 2016; Waheed *et al.* 2023).

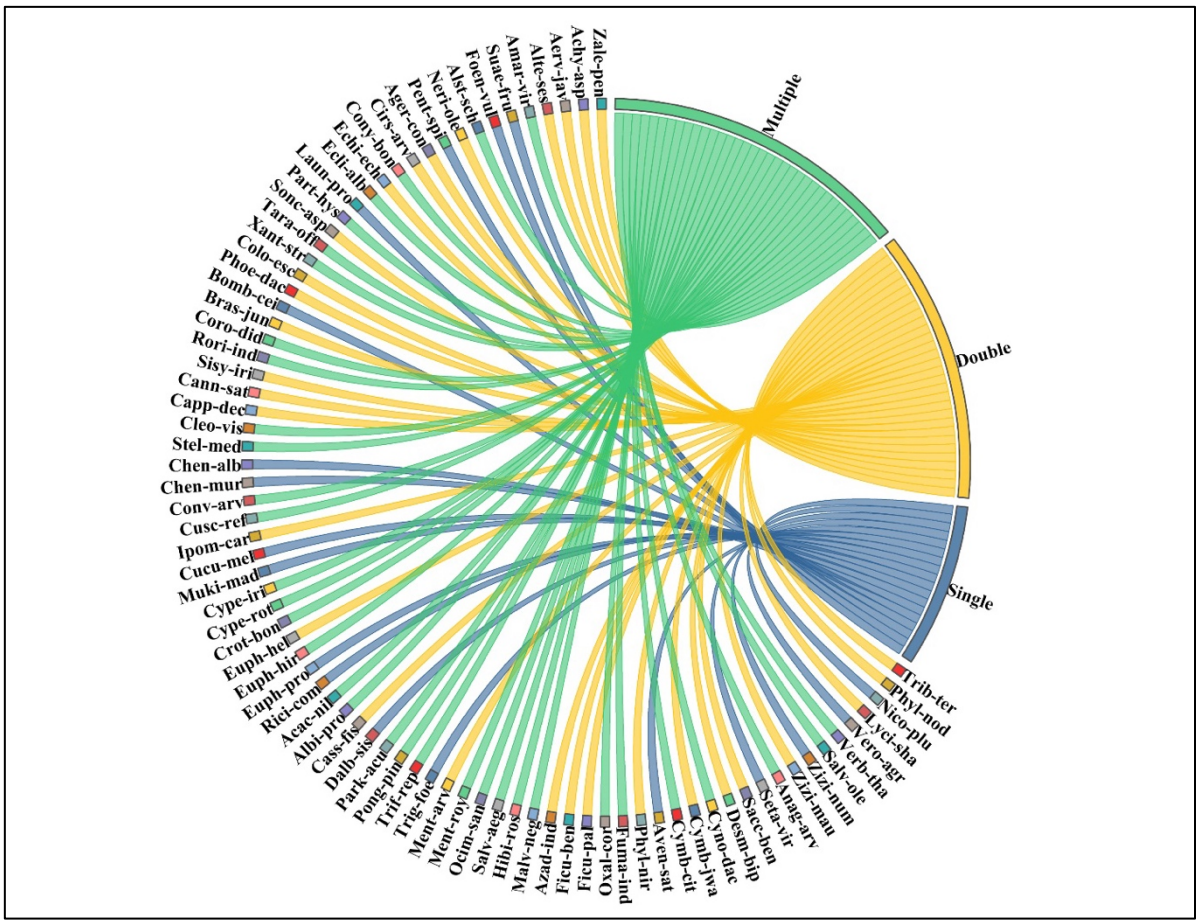

Figure 4. Chord diagram depicting the use category and species.

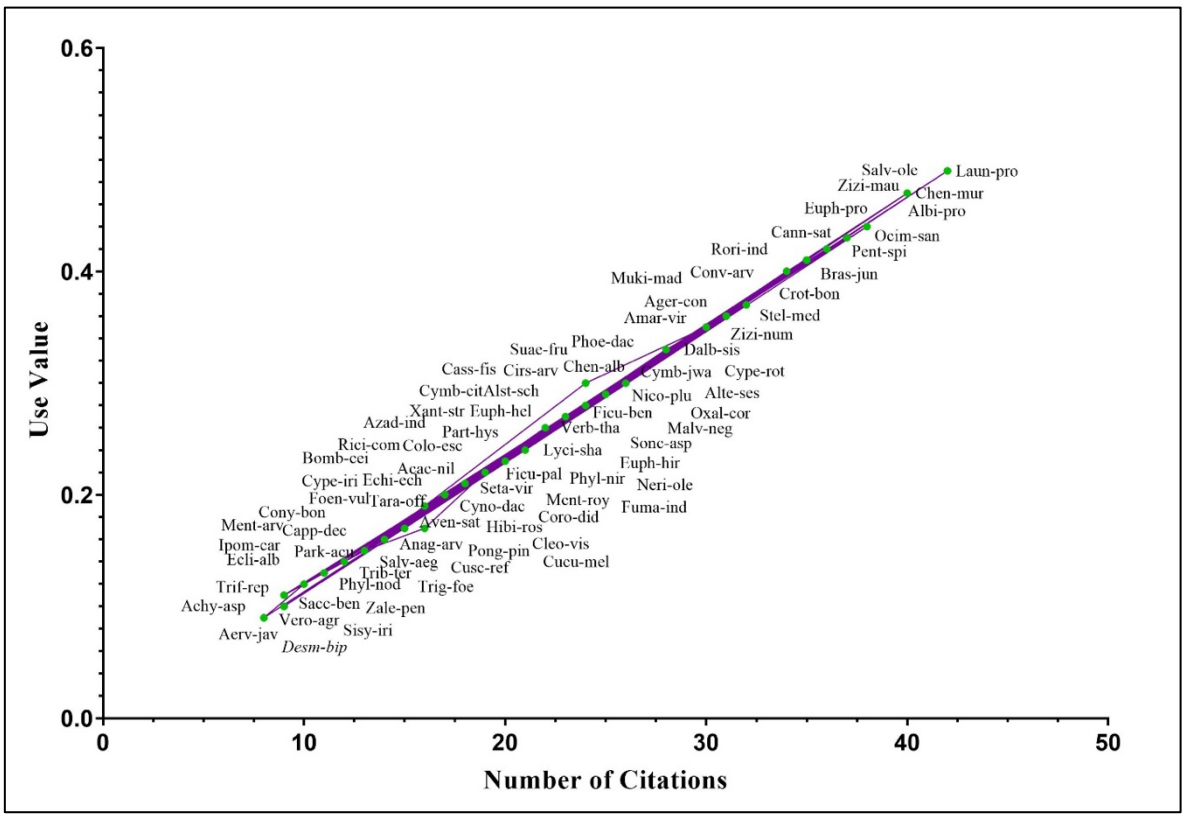

Figure 5. Use value (UV) serves as a quantitative measure of a plant's popularity within the informant community.

Findings revealed that Launaea procumbens (0.49), *Amaranthus viridis* (0.36), *Cannabis sativa* (0.37), and *Stellaria media* (0.35) were the most recognized plants among the study area's communities (Table 2). Higher UV values indicated widespread familiarity within the local populace, often attributed to a plant's easy availability and abundance (Bibi *et al.* 2022; Kushwaha *et al.* 2018). Conversely, 12 plant species exhibited minimal use values (0.013), potentially due to their limited benefits or scarcity.

Upon comparison with previously published literature, it becomes evident that 15 medicinal plants have been previously documented in available literature; however, the current study unveils their diverse medicinal applications. These include plants such as, *Suaeda fruticose, Alstonia scholaris, Pentatropis spiralis, Echinops echinatus, Eclipta alba, Bombax ceiba, Cleome viscosa, Lathyrus aphaca, Salvia plebeia, Phyla nodiflora, Cynodon dactylon,* and *Datura innoxia*. For instance, Suaeda fruticose was primarily recognized as fodder for cattle in a previous ethnobotanical study in Punjab (Zareen *et al.* 2013); however, the current study attributes this plant to treating fever and jaundice (Table 3). Similarly, *Lathyrus aphaca* was acknowledged in earlier literature (Amjad *et al.* 2020; Zareen *et al.* 2013) for its narcotic effects and fodder value, while local inhabitants in the study area utilize it for wound healing. This study also indicates the use of its leaves for treating body inflammation and malarial fever, while in other parts of Punjab, it's employed to address bleeding gums (Iqbal *et al.* 2014). Furthermore, the current study introduces one previously rarely documented medicinal plant of significance from the studied ethnomedicinal literature, *Alstonia scholaris*. Overall, the study identifies *Solanum nigrum, Cannabis sativa, Amaranthus viridis, Chenopodium murale, Euphorbia prostrata, Datura innoxia, Launaea procumbens, Cymbopogon jawarancusa*, and *Ocimum sanctum* as the most promising medicinal plants according to the local community's perception. Plants exhibiting medicinal uses and higher use value (UV) could be prioritized for further exploration of bioactive compounds and pharmacological activities, possibly leading to the discovery of novel drugs.

Conclusions

The population residing in the reserved forests of semi-arid of Punjab, Pakistan, possess a substantial repository of traditional knowledge concerning ethnomedicinal plants. The findings revealed the presence of 82 medicinal plant taxa from 74 genera and 32 families. Predominantly, these were wild herbs (45 species) utilized as whole plants (35 species) for preparing medicinal remedies by the local population. The documented plants were employed in addressing 30 different ailments, with notable focus on fever (33 species) and gastrointestinal disorders (28 species). These medicinal plants have significantly contributed to the diversity of local phytocultural practices and have bolstered traditional healthcare systems. This underscores the need for comprehensive exploration of the Traditional Ecological Knowledge (TEK) potential and the survey of medicinal flora. The collected taxonomic and ecological data of medicinal plants can serve as a foundation for initiatives aimed at fostering sustainable rural development in the study area. The conclusions drawn from this research advocate for the preservation of invaluable local knowledge systems as well as the plant diversity within the semi-arid region of Punjab, Pakistan.

Declarations

Ethics approval and consent to participate: The ethical guidelines for the survey of rural and indigenous communities provided by International Society of Ethnobiology (available online: www.ethnobiology.net/whatwe-do/coreprograms/ise-ethics-program/code-of-ethics) were carefully followed. Prior to interviews, formal verbal consent (regarding data collection and publication) of each participant was taken. The PRA (Participatory rural appraisal) approach mentioned in the Kyoto Protocol (2017) was applied with the consent of the informant.
Consent for publication: "Not applicable"
Availability of data and materials: All data generated or analyzed during this study are included in this published article.
Competing interests: The authors have no relevant financial or non-financial interests to disclose.
Funding: This paper is the part of PhD thesis of Mr. Muhammad Waheed and no funding was received from any organization for its accomplishment. Authors utilized their own resources for completion of the study.
Authors' contributions: M.W designed and supervised the entire study, M.W. conducted field surveys and collected data. F.A., M.W. and S.H.M contributed in data arrangement, presentation and analysis. S.M.H., M.A.J, and M.W played role in statistical interpretation of data and also wrote the first draft of the manuscript along with S.M.H. and F.A. R.W.B., M.A.J. and S.M.H. revised the draft manuscript and incorporated the scientific input and improved the language of the MS.

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