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RESEARCH

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Wild food plant knowledge in multicultural peri-urban area of North-Western Punjab, Pakistan

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Abstract

The use of wild food ingredients has been inextricably linked to each human culture; therefore, any cultural shift or transformation also mutates the knowledge. Particularly cross-cultural interactions have been playing a significant role in reshaping the knowledge within a given community. The study aimed to cross-culturally research the use of wild food plants among four different ethnolinguistic groups, i.e. Muhajir, Pathans, Punjabi, and Saraiki residing in the peri-urban area of Mianwali district, Punjab Pakistan. Data were taken through semi-structured interviews, and the results of cross-cultural comparison were visualized through Venn diagrams and statistically tested through Jaccard index. A total of 59 plants were recorded, which were used mostly as cooked vegetables (29 species) and snacks (21 species). About one-fourth of the quoted plants were commonly used by all the studied groups. High similarity on the use of the quoted plants was found among Muhajir, Punjabi, and Saraiki. Punjabi reported higher numbers of plants, and Pathans quoted comparatively lesser number. Pathans reported a comparatively high number of idiosyncratic foods uses followed by Muhajir. Punjabi, Muhajir, and Saraiki have a very close affinity and have comparatively rich knowledge after comparing those food uses which were reported by more 50% of participants. Punjabi frequently reported some plant uses which were rarely reported by the other four groups. Additionally a large number of plants were also quoted along with their medicinal uses which were prepared in the same way for both food and medicine. Despite the fact that most of the food ingredients were prepared in a simialr way but still the distinct names of several plants were retained across the studied groups. In the current context, the ethnobotanies of the studied communities are a blend as they might have learned the knowledge on the use of these plants from one another. It is concluded that since the knowledge is still in the memory of the people and has no serious threat to its extinction at hand, however it is necessary to frame policy programs in order to use this knowledge for the sustainability of future food and medical system otherwise it may be lost.

Keywords Wild food ethnobotany, Local knowledge, Cross-cultural ethnobotany, Pathans, Saraiki, Punjabi, Muhajir

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Introduction

Ethnobiology provides clear evidence that every society has historically articulated their local biological environment including the use of plants and retained a cumulative body of knowledge known as local ecological knowledge. This specific body of knowledge including plant knowledge is crucially based on peoples' local experiences and their needs which has always been subjected to change or mutation [1, 2], and the mutating utilitarian aspect of these local resources has potentially been based on diverse driving forces [3–6]. Linguistic diversity acts as a refuge for local plants knowledge (LPK). Language and culture most often go together, and therefore, any change in language is a crucial indicator to understand the dynamism of local plant knowledge within a given culture or society [7]. It is also believed that each ethnolinguistic group retains specific plant knowledge and is highly need-based, involving certain other factors and it has been seen most often that this goes beyond the cultural borders in multicultural settings in the time of crises [5–10].

Pakistan is home to tremendous multicultural and linguistic diversity. More than seventy local languages are spoken within the country. Major languages are Punjabi, Pashtu, Balochi, Sindhi, and Saraiki. There are many minority languages whose speakers are scattered across the country, i.e. from the coastal areas of Arabian sea in the south to the high mountain pastures of Hindukush–Karakoram–Himalayan region in the north. Urdu is spoken as *lingua franca* across the country. Punjab that accommodates a major population of the country stands out as a hub where traditional plant knowledge is highly intersects with the process of urbanization although the region is not only a transitional zone but is rich in biocultural diversity as shown by some recent ethnobotanical studies in the region [11]. Given the dynamic social, cultural, and linguistic spectrum of the region, in this study we have focused on the area located in northwestern region of Punjab. Studies have been carried out in some parts of Punjab; however, among the many facets of the local or traditional knowledge, the subject of wild food plants (WFPs) places a specific position [11, 12]. In the contemporary time, food commodification that has invaded almost every corner of the country has undervalued the foraging of WFPs and the devaluation is further exacerbated by the naïve and unsustainable behaviour of the local communities towards using the available wild food resources which in turn negatively affect the local ethnobotanical knowledge as reported by the literature [13]. It is worth mentioning that in many parts of the region, especially rural horticulturists, some important food plants are hidden part of their local food basket [14] and some have been seen in the market too [15]. Knowledge around these natural resources has been passed down through oral means within the framework of the local languages but it is unfortunate that the rapid urbanization of the peri-urban areas poses a significant threat to the ancestral ethnobotanical knowledge on these wild food resources [16] as these localities are places of cultural or lingual pluralism that facilitate sociocultural negotiations and learn and share the knowledge across the different ethnic groups. It is validated through scientific literature that in multicultural settings, knowledge is shared in varying proportions among different cultural groups as this knowledge is not considered as an identitarian element of a specific social group or community [17]. Therefore, in this context, the current study has been planned to determine that how does LPK related to WFPs vary across different ethnolinguistic groups and what is the role of gender in retaining this knowledge in the peri-urban area of District Mianwali, Pakistan? We have chosen the four study groups who speak Pashto, Saraiki, Punjabi, and Muhajir—an Urdu-speaking group—for the cross-cultural ethnobotanical study which is the first scientific study in the region with the specific scientific approach.

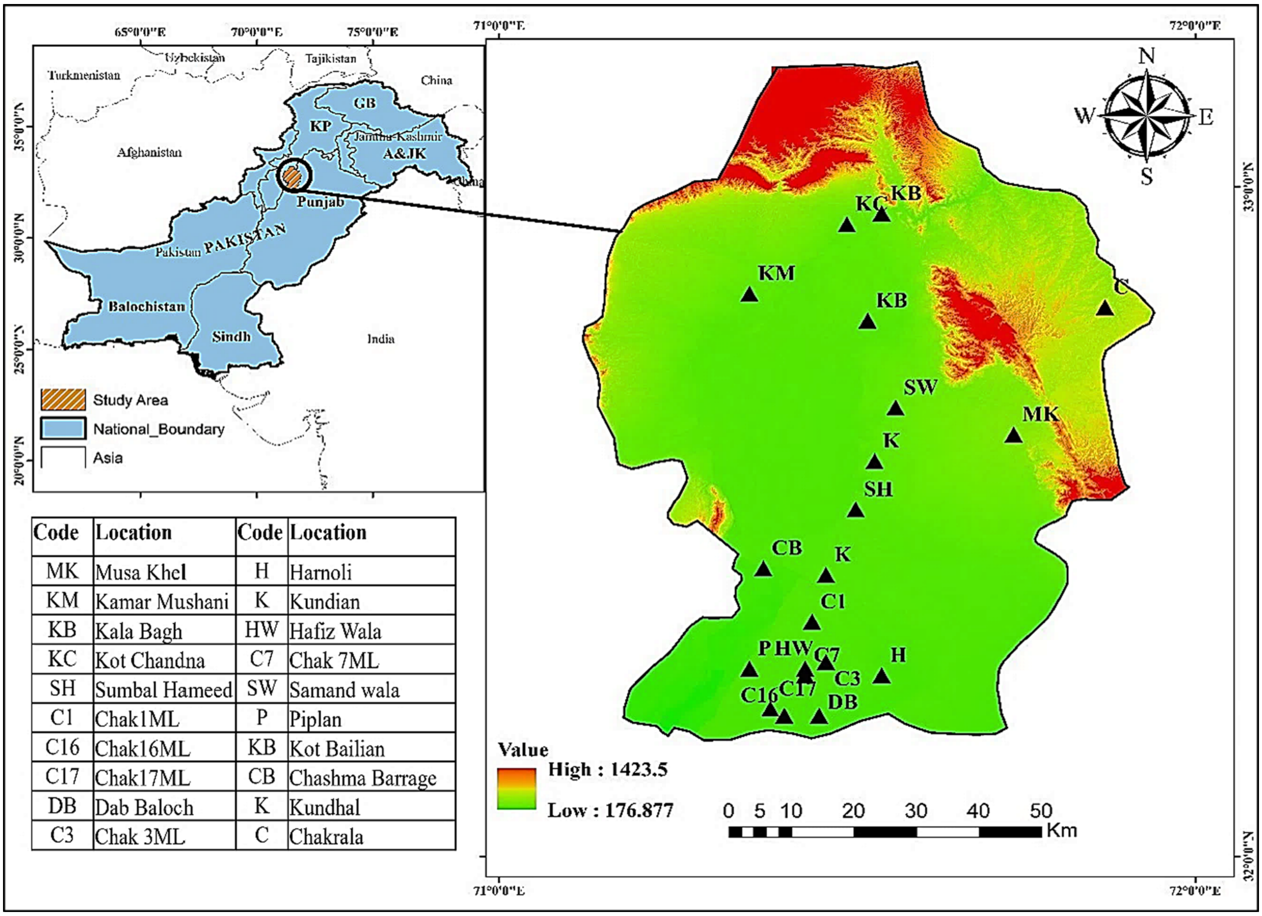
The specific objectives of the study are:

a. To document the knowledge on wild plant uses among the study groups and cross-culturally compare the quoted uses among the different ethnic groups;
b. To analyse the distribution of the local knowledge related to WFPs across the two genders.

Material and methods

Study area

Present study was conducted in 20 villages (as illustrated in Fig. 1) of Mianwali district inhibited by Saraiki, Pashto, Punjabi, Hindko, and Urdu linguistic groups. Mianwali is a border district between northwest region of Punjab and Khyber Pakhtunkhwa (KP) provinces of Pakistan. According to the census of 2023, the district covers an area of 5840 km^2 with population of 1, 798, 268 individuals [18]. Male inhabitants account for 51% of population, and female inhabitants account for the remaining 49%. The vegetation of this regions mainly influenced by arid to semi-arid climate, and the Indus River that runs through the district. For instance, drought-resistant xerophytic shrubs and small trees, including *Acacia* spp. and *Prosopis* spp., are common. Grasslands, thorny bushes, aquatic vegetation, and reeds such as *Phragmites* are found along riverbanks and irrigation canals. The common flora includes *Rhazya stricta*, *Reptonia buxifolia*, *Prosopis juliflora*, *Ziziphus jujuba*, *Dalbergia sissoo,* and



Code	Location	Code	Location
MK	Musa Khel	H	Harnoli
KM	Kamar Mushani	K	Kundian
KB	Kala Bagh	HW	Hafiz Wala
KC	Kot Chandna	C7	Chak 7ML
SH	Sumbal Hameed	SW	Samand wala
C1	Chak1ML	P	Piplan
C16	Chak16ML	KB	Kot Bailian
C17	Chak17ML	CB	Chashma Barrage
DB	Dab Baloch	K	Kundhal
C3	Chak 3ML	C	Chakrala

Fig. 1 Map of the study area

Acacia nilotica. Agriculturally, Mianwali is known for wheat and cotton cultivation [19]. The area is mainly saline, but has many valuable medicinal plants like *Buxus papillosa, Eclipta prostrata*, and *Withania coagulans*, among others [20]. The salt range of Mianwali hosts three forest types: thorny evergreen forests, subtropical semi-evergreen forests, and scrub forests. The dry tropical perennial forest predominantly features *Salvadora oleoides, Capparis decidua*, and *Acacia nilotica*, while the subtropical evergreen forests at higher elevations showcase *Acacia modesta, Dodonaea viscosa*, and *Olea ferruginea*. Scrub species in the area face ecological pressure and grazing pressure [21].

Studies communities

The current study has been conducted with four different linguistic groups living in the district, and their details are given below:

Pathans

The Pashtun tribe, also known as Pathans or Pashtuns, is a major ethnic group in Afghanistan and Pakistan, with communities in India and other countries. Originating from West Pakistan and Afghanistan, they follow a code called "Pashtunwali", emphasizing hospitality, honour, and respect [22]. Their native language is Pashto, and they are primarily Sunni Muslims. Organized into tribes and clans, Pathans have a rich history, playing pivotal roles during the Mughal era, British colonial period, and recent Afghan conflicts. Their economic activities span from farming to trade. In District Mianwali, Punjab, Pakistan, Pashto speakers trace their ancestry to ancient Afghan kings and biblical figures. These tribes, like Niazi and Orakzai, see themselves as distinct groups within the broader Pathan race, subdivided further into clans with common ancestry [23].

Punjabi

The Punjabi people hail from the Punjab region, split between India and Pakistan [24]. They are among South

Asia's largest ethnic groups, speaking Punjabi and primarily following Sikhism, Hinduism, and Islam, with other religious minorities. Punjab boasts rich musical, dance, and culinary traditions, with Bhangra, Giddha, and dishes like butter chicken gaining global popularity. Known as the "Granary of India", Punjab plays a crucial role in agriculture, but Punjabis also excel in business, academics, and arts. Historically significant, Punjab witnessed various empires, including the Indus Valley and Mughal empires, and was deeply impacted by the 1947 partition. The Indo-Aryan migration influenced the Punjabi language's evolution, with the Mughal Empire further enriching its culture. Punjabi is the predominant language in Pakistan's Punjab province.

Saraiki

The Saraiki people predominantly reside in southern Punjab, Pakistan, but are also found in other parts of Pakistan and India [24]. They speak Saraiki, an Indo-Aryan language related to Punjabi and Sindhi. Their culture is distinct, enriched with unique music, poetry, and arts. Sufi shrines, music, and poetry are pivotal to Saraiki heritage, alongside celebrated folk songs about love, valour, and justice. The Saraiki region, traversed by the Indus River, is agriculturally significant, known for cotton and wheat. Despite its fertility, challenges like water scarcity have prompted migration and social shifts. Saraikis often seek greater autonomy within Punjab, with some advocating for a separate province to address underdevelopment. The Saraiki language's origin, tied to Mianwali, is debated but is recognized as part of the Indo-Aryan family, sharing ancient linguistic connections with Pashto within the Indo-European family.

Muhajirs or Urdu-speaking people

Mianwali is home to various ethnic and linguistic groups, potentially including Urdu-speaking Muhajirs from India. The name "Muhajir" has special meaning and is applied to migrants' communities. "Indian Muhajir" denotes Urdu-speaking Muslims, during 1947s partition, millions of Indians migrated to Pakistan [24]. Muhajirs are mainly settled in cities like Karachi, and some might have chosen Mianwali. In a primarily Punjabi-speaking area, Muhajirs would have distinct social and cultural experiences. Their integration might pose challenges due to linguistic and cultural disparities, but Urdu (Pakistan's national language) could bridge this gap. Bringing their rich cultural legacy, including Urdu literature and cuisine, a fusion of cultures would be inevitable over time. Yet, the Muhajirs' experiences in Mianwali would be influenced by various factors, such as migration timing and community interactions, leading to diverse individual experiences. The 1947 partition saw massive population shifts, with the influx of Muhajirs in Punjab and Sindh counterbalancing the departure of Hindus and Sikhs [25].

Ethnobotanical survey

Field ethnobotanical survey was conducted in October to November 2022 and March to April 2023 among the different ethnolinguistic groups by the first author who is a trained and young female ethnobotanist. Data were collected through semi-structured interviews among the study participants. Our study recorded local plant knowledge of food plants from both genders. Following the previously reported methods [26, 27], among each study group, 25 participants (elderly people) were selected for the interviews. Participants were chosen based on their long-time experiences with nature and the local environment. The demographic characteristics of the study participants are given in Table 1.

The survey was guided by a local guide that we approached at each study site. Participants were randomly chosen among each of the study groups, and prior oral consent was taken from each participant. The interviews were conducted in their local languages with the help of an interpreter. To each of the study participants, we explained the purpose, main objectives, and theme of the study to get their trust for reliable information. The duration of the interview was verified and ranged from 20 to 80 min. Interviews were taken in fields, and at homes. We mainly

Table 1 Demographic characteristic of the studies groups

Linguistics and communities	Average age	Number of interviews	Endogamic and exogamic	Main occupation
Pashto/Pushtoon	64	25 (10 females and 15 males)	Endogamic in past now exogamic towards others	Transporters, Horticulturists, Shopkeepers, Government employees
Punjabi/Punjabi	63	25 (10 females and 15 males)	Exogamic towards others	Farmers, Horticulturists, Shopkeepers, Government employs
Urdu/Muhajir	65	25 (10 females and 15 males)	Endogamic in past	Transporters, armed forces, shepherd, Politicians, Labourers, Government employees
Saraiki/Saraiki	61	25 (10 females and 15 males)	Endogamic in past	Farmers, Armed forces, Politicians, Businessman

enquired data about the use of wild food and their possible medicinal uses, and then, the discussions were supplemented by other necessary qualitative information. The free list method was also used to help participants recall the local plants as we felt it necessary; for instance, in most cases the participants needed help in recalling the local plant taxa used in food and medicine [4].

In the interviews, different questions were asked regarding the use of the recorded plants in different culinary preparations such as cooked vegetables, teas, seasoning, dairy products, raw snacks, and fermentations as well as their use for medicinal purposes. Data were taken on the ecological attributes of the quoted plants such as the gathering seasons, gathering areas, habits, habitat, and commercialization of the plants reported in the study. We have taken pictures of the different plant taxa in the field. During the study, the code of ethics given by the International Society of Ethnobiology [28] was followed**.** Plants were identified with the help of the third author who is a taxonomist at the Department of Botany, University of Swat Pakistan. Botanical nomenclature for each of the taxon was verified the by online database the World Flora Online [29], and the respective families were checked to make them consistent with the Angiosperm Phylogeny Website [30].

Data analysis

The recorded data through the interventions were digitalized and entered the MS Excel spreadsheet. Data were processed into two different forms to make the cross-cultural comparison of the quantitative data: a) Venn diagram and b) statistical data analysis.

Cross-cultural comparison

To make a cross-cultural comparison of the use of the recorded wild food and medicinal plants among the four ethnic groups, the number of the plants and their uses were counted for each of the individual ethnic groups. Aftermath the recorded data of all ethnic groups were mutually compared to see the similarities and differences on the use of wild food and medicinal plants among the selected ethnic groups. To visualize the cross-cultural comparison, data were subjected to proportional Venn diagrams (freely available at http://bioinformatics.psb.ugent.be/web tools/Venn/).

Statistical analysis

Each of the plant species was provided along with its food uses and was assigned use reports (in brackets in front of each of the relevant food use) (See Table 2). To determine the similarity in the local plant uses among the different groups, data were subjected to the Jaccard index (JI) which highlights the level of similarity among the uses of reported plant species [31].

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|}$$

where A indicates the number of set A, and B indicates the number of the elements of set B.

Results

Diversity and uses of wild food and medicinal plant

A total of 59 wild food were recorded, which are presented in Table 3. Most of the plants belonged to the Fabaceae (6 taxa) followed by Moraceae (5 taxa), Cucurbitaceae (4 taxa), Boraginaceae (3 taxa), and Amaranthaceae (3 taxa). Leaves (36 taxa) and fruits (34) were the frequently used plant parts. Most of the plants were herbs (34 taxa), trees (19 taxa), and shrubs (6 taxa). The quoted plants were used in different culinary practices such as cooked vegetables (29), raw snacks (21), fermentation (6), herbal drinks (5), tea (4), chatni (4), seasoning (2), chewing gum (2), halwa (2), food additive (1), and salad (1).

Some of the important plants which were used as snacks and quoted by more than 40% of all the studied communities were *Cordia bifurcata, Capparis decidua, Zygophyllum indicum, Phoenix sylvestris, Morus alba*, and *Morus nigra.* Similarly, only *Apteranthes tuberculata* was the frequently reported plant which was quoted by more than 40% of the participants in each of the studied groups which reveals the acceptability of the plants across the region. It has been seen that this plant is available in the local vegetable market brought from the different areas across the region.

Among the reported plants, 38 were used as a food and for therapeutic purpose as given in the ethnobotanical table (Table 2). For instance, *Apteranthes tuberculata* used as anti-diabetic agent; *Amaranthus polygamus* as carminative; *Senegalia laeta* used for treating joint and muscles pain; *Vachellia nilotica* is effective for wound healing; *Brassica nigra* is considered good for digestion; *Kalanchoe* sp. used for kidney diseases; *Cannabis sativa* as cooling agent;, *Cucumis melo* for kidney stone; *Cucumis melo* for kidney stone; *Chenopodium album* agianst constipation; *Cordia myxa* and; *Cordia bifurcata* as anti-diabetic), *Cymbopogon jwarancusa* for curing the typhoid fever; *Capparis decidua* for seasonal fever; *Cichorium intybus* for joints pain; *Cotoneaster nummularius* as cooling agent; *Digera muricata for* kidney problems; *Zygophyllum indicum* as anticancer agent and anti-diabetic agent; *Ficus benghalensis* as healthy food;, *Moringa oleifera* is considered effective for paralysis; *Sideroxylon mascatense* as a cooling agent;

Table 2 The local gastronomic uses of the quoted food plants among the researched communities

Botanical Taxon; Family; Voucher Number	Local Name	Parts Used	Recorded Gastronomic Uses	Perceived Medicinal Uses/ Treated Illness	Previously Reported as Food in Pakistan
Agave americana subsp. *americana*; Asparagaceae; SWAT002523	Kanwar gandal$^{\text{Pu}}$ Kanwar phara$^{\text{S}}$ Kanwar botti$^{\text{U}}$	Leaves, latex	Cooked $^{(12),\ \text{S}(15)}$: this is used as a dessert (halwa). First, sugar is dissolved in ghee and then semolina is added along with leaves extract. Cooked for 10–15 min, ready to eat		[32]
Amaranthus polygamus L.; Amaranthaceae; SWAT002522	Chulai$^{\text{S, U}}$	Leaves	Cooked $^{(11),\ \text{U}(9)}$: after mixing with fried and seasoned onion	Carminative$^{(2)}$	
Apteranthes tuberculata (N.E.Br.) Meve & Liede; Apocynaceae; SWAT002521	Pawana$^{\text{Pa}}$ Chungaa$^{\text{Pu, S, U}}$	Aerial parts	Cooked $^{\text{PA}\ (15),\ \text{Pu}(13)\ \text{S}(10),\ \text{U}(12)}$: first the Chunga is fried in oil and then mixed with fried and seasoned onion and cooked as per required	Anti-diabetic $^{\text{PA}(2),\ \text{Pu}\ (2),\ \text{S}(4),\ \text{U}(3)}$ Carminative$^{\text{PA}(6),\ \text{Pu}\ (6),\ \text{S}(4),\text{U}(5)}$	[33]
Brassica nigra var. incana (L.) Dosch & J. Scriba; Brassicaceae; SWAT002524	Jangli kanola$^{\text{Pu}}$ Jamahun$^{\text{S}}$ Tara mera$^{\text{U, S}}$	Young flowers, young leaves, Fruit (oil)	Cooked $^{(16),\ \text{S}(19),\ \text{U}(15)}$: young flowers are fried and seasoned on a griddle. Young leaves $^{\text{Pu}(16),\ \text{S}(19),\ \text{U}(15)}$: are boiled with seasoned onions then grounded and mixed with butter fried garlic-ginger paste (cuisine dish Saag). Oil $^{\text{Pu}(16),\ \text{S}(15)}$: is used for cooking various cuisine dishes	Keep stomach healthy $^{\text{Pa}(9),\ \text{S}(15),\ \text{U}(12)}$, Back bone pain $^{\text{U}(3)}$, Skin dryness $^{\text{Pu}(7)}$	
Canna indica L.; Fabaceae; SWAT002531	Jangli herdaal$^{\text{S}}$ Jangli Lobia$^{\text{U}}$ Jangli Rawan$^{\text{Pu, S}}$	Fruits	*Cooked $^{(11),\ \text{S}(9),\ \text{U}(11)}$: fruit is mixed with fried and seasoned onions and cooked accordingly		
Cannabis sativa L.; Cannabaceae SWAT002526	Bhung$^{\text{Pu, S,U}}$ Bhung/Kam$^{\text{Pa}}$	Leaves	Herbal drink $^{\text{Pa}(7),\ \text{Pu}(14),\ \text{S}(6),\ \text{U}(5)}$: boiled and dried so that a little quantity of moisture remained. Then the leaves are grinding with Almond, a small quantity of poppy seeds, black pepper, salt into a mud pot and a small quantity of water in steps until it turns into a dilute liquid	Cooling agent $^{\text{Pa}(7),\ \text{Pu}(14),\ \text{S}(6),\ \text{U}(5)}$	[32]
Capparis decidua Edgew.; Capparaceae; SWAT002534	Kari$^{\text{Pu, S}}$ Kuhr$^{\text{U}}$ Kirrir$^{\text{Pa}}$	Fruits	Raw snacks$^{\text{Pa}(15),\ \text{Pu}(19),\ \text{S}(17),\ \text{U}(18)}$ Cooked$^{\text{Pa}(15),\ \text{U}(18)}$: fresh fruits are soaked into water for half an hour then boiled after mixing with fried and seasoned onions, Pickle (*Cordia myxa*)	Seasonal fever$^{\text{S}(2)}$	[34]

Table 2 (continued)

Botanical Taxon; Family; Voucher Number	Local Name	Parts Used	Recorded Gastronomic Uses	Perceived Medicinal Uses/ Treated Illness	Previously Reported as Food in Pakistan
Chenopodium album L.; Amaranthaceae; SWAT002529	Bathu$^{\mathrm{Pu,\,S}}$ Bathwa$^{\mathrm{U}}$	Leaves	Cooked $^{\mathrm{Pu(20),\,S(19),\,U(17)}}$: First of all leaves are boiled with seasoned onions, and the spinach leaves are mashed. After that garlic and ginger paste is fried in butter and added to vegetables	Constipation $^{\mathrm{Pu(3)}}$ Stomach problems$^{\mathrm{(8),\,S(12),\,U(8)}}$	[33, 35]
Cichorium intybus L Asteraceae SWAT002536	Kasni$^{\mathrm{U}}$	Leaves	Chatni$^{\mathrm{U(8)}}$: fresh leaves are grinding with mint, salt green chillies and seasoned tomato paste	Leaves powder$^{\mathrm{U(3)}}$: is effective for fever Chatni$^{\mathrm{U(5)}}$: is used for joints pain	[33, 35]
Citrullus colocynthis (L.) Schrad; Cucurbitaceae SWAT002530	Kortuma$^{\mathrm{Pu,\,S,\,U}}$ Tarkha$^{\mathrm{Pa}}$	Fruits, Roots, Seeds	Cooked $^{\mathrm{Pu(9)\ U(13)}}$: Fruits soaked in lime water 3–4 h. Then washed with distilled water. This process is repeated 3–4 times. Later it was mixed with fried and seasoned onions Jam$^{\mathrm{Pu(9),\,S(17),\,U(13)}}$: lime water is applied to the fruit, and then it is mixed with a sugar solution Pickle $^{\mathrm{Pu(9),\,S(17),\,U(13)}}$: after lime water treatment, fruits are seasoned with vinegar for pickles	Seeds$^{\mathrm{Pa(9)}}$: used for stomach pain Dried Fruits$^{\mathrm{Pu15),\,S(12),\,U(11)}}$: grinded with ajwain used for stomach pain. Root$^{\mathrm{Pu(3),\,S(5),\,U(2)}}$: used as toothache	
Citrullus lanatus (Thunb.) Matsum. & Nakai; Cucurbitaceae SWAT002574	Kaalkaan$^{\mathrm{Pu,\,S,\,U}}$	Fruits	Cooked$^{\mathrm{Pu(13),\,S(15),\,U(10)}}$: boiled after mixing with seasoned onions		
Cucumis melo L.; Cucurbitaceae SWAT002527	Chibhr$^{\mathrm{Pu,\,S}}$ Akhrot bail$^{\mathrm{U}}$	Fruits	Cooked $^{\mathrm{Pu(6),\,U(8)}}$: boiled after mixing with fried and seasoned onions Food additives $^{\mathrm{Pu(4),\,U(4)}}$: Helps in minimizing the cooking time of meat Raw snacks $^{\mathrm{Pu(3),\,S(20),\,U(6)}}$	Anti-tumour $^{\mathrm{Pu(2),\,U(1)}}$ Kidney stone $^{\mathrm{Pu(6),}}$	[34]
Cucumis melo L.; Cucurbitaceae SWAT002528	Kharibrh$^{\mathrm{U}}$ Sindhi kachari$^{\mathrm{U}}$	Fruits	Raw snacks $^{\mathrm{U(13)}}$	Anti-tumour $^{\mathrm{U(2),}}$ Weight loss $^{\mathrm{U(9)}}$	[36]

Table 2 (continued)

Botanical Taxon; Family; Voucher Number	Local Name	Parts Used	Recorded Gastronomic Uses	Perceived Medicinal Uses/ Treated Illness	Previously Reported as Food in Pakistan
Cordia myxa Forssk.; Boraginaceae; SWAT002532	Lasuri$^{\mathrm{U}}$ Lasora$^{\mathrm{Pu, U}}$	Fruits	Pickle$^{\mathrm{Pu(15), U(12)}}$: unripe fruits boiled, dried, no moisture content remaining mixed with pickle seasoning agents, cooked oil is added and left for 2–3 days. After that it will be ready for use Raw snacks$^{\mathrm{Pu(15), U(12)}}$	Anti diabetic$^{\mathrm{Pu(11), U(10)}}$	[34]
Cordia bifurcata Roem. & Schult.; Boraginaceae; SWAT002533	Lasura$^{\mathrm{Pa, Pu, S,U}}$	Fruits	Raw snacks$^{\mathrm{Pa(10), Pu(18), S(18), U(19)}}$, Pickle$^{\mathrm{Pa(10), Pu(18), S(18)}}$: unripe fruits boiled, dried, no moisture content remaining mixed with pickle seasoning agents, cooked oil is added and left for 2–3 days. After that it will be ready for use	Anti-diabetic$^{\mathrm{Pa(3), S(11), U(12)}}$	
Cotoneaster nummularius Fisch. & C.A.Mey.; Rosaceae; SWAT002537	Mamoona$^{\mathrm{Pa}}$	Fruits	Fermented $^{(12)}$: pickle is prepared as *Cordia myxa*, Chatni$^{\mathrm{Pa(12)}}$: Fresh leaves are grinding with green chillies, mint coriander and seasoned tomatoes Raw snacks$^{\mathrm{Pa(12)}}$	Cooling agent$^{\mathrm{Pa(8)}}$	[33]
Cymbopogon jwarancusa (Jones ex Roxb.) Schult.; Poaceae; SWAT002535	Khavi$^{\mathrm{S, U}}$	Flowers, Leaves	Recreational tea$^{\mathrm{S(10), U(13)}}$		[36]
Digera muricata Mart.; Amaranthaceae; SWAT002538	Tandula$^{\mathrm{U}}$ Tandla$^{\mathrm{S}}$ Kech-Mech$^{\mathrm{Pu}}$	Leaves	Cooked$^{\mathrm{Pu(15),S(11), U(14)}}$: boiled after mixing with seasoned onions	Healthy for Kidney, problems$^{(5)}$	[32, 35]
Ehretia obtusifolia Hochst. ex DC.; Boraginaceae; SWAT002539	Gondi$^{\mathrm{S, Pu}}$	Fruits	Raw snacks$^{\mathrm{Pu(14), S(17)}}$		
Ficus carica L.; Moraceae; SWAT002540	Anjeer$^{\mathrm{Pu, U}}$ Khabara$^{\mathrm{S}}$	Fruits	Cooked$^{\mathrm{S(13)}}$: boiled after mixing with seasoned onions, Raw snacks$^{\mathrm{Pu(11), S(2), U(14)}}$	Cough$^{\mathrm{Pu(6), U(6)}}$ Asthma$^{\mathrm{Pu(1)}}$	[37]
Ficus benghalensis L.; Moraceae; SWAT002541	Boher$^{\mathrm{Pu}}$	Fruits	Raw snacks$^{\mathrm{Pu(11)}}$	Healthy food$^{\mathrm{Pu(3)}}$	[36]
Ficus populifolia Vahl; Moraceae; SWAT002542	Pipal$^{\mathrm{S}}$	Fruits	*Raw snacks$^{\mathrm{U(11)}}$		[36]

Table 2 (continued)

Botanical Taxon; Family; Voucher Number	Local Name	Parts Used	Recorded Gastronomic Uses	Perceived Medicinal Uses/ Treated Illness	Previously Reported as Food in Pakistan
Grewia tenax (Forssk.) Fiori; Malvaceae; SWAT002543	Inzer[Pa] Ghungeer[S]	Fruits	Raw snacks[Pa(16), S(10)]		[34]
Kalanchoe Adans.; Crassulaceae SWAT002525	Pathar chatt[Pu]	Leaves	*Salad [Pu(3)]: along with bread or with other dishes	Effective for Kidney stone Treatment [Pu(3)]	
Lathyrus aphaca L.; Fabaceae SWAT002544	Jangli matri[Pu, S, U]	Fruits	*Cooked[Pu(10), S(11), U(17)]: boiled after mixing with seasoned onions		[33]
Lathyrus sativus L.; Fabaceae SWAT002545	Jangli matri[S, U]	Fruits	Cooked[S(16), U(18)]: boiled after mixing with seasoned onions		[32]
Mentha longifolia (L.) L.; Lamiaceae; SWAT002547	Jangli podina[Pu, S, U]	Leaves	Chatni[Pu(15), S(12), U(12)], Recreational tea[U (12)]	Kept the gastrointestinal, tract healthy (Chatni) [Pu(15), S(12), U(7)], Effective for flu and cough, as (herbal tea)[U(5)]	[33]
Moringa oleifera Lam.; Moringaceae; SWAT002546	Sohanjna[Pu, S, U]	Fruits, flowers, Roots	Cooked[Pu(19), U(16)]: young flowers are boiled after mixing with fried and seasoned onions Pickle[S(17), U(16)]: unripe fruits boiled, dried then mixed with seasoned vinegar preferably in a glass pot. Pickle[Pu(19)]: Roots are peel off, boiled, free from moisture content then mixed with seasoned vinegar	Effective for paralysis[Pu(11), U(12), S(10)] Anti-diabetic[Pu(2)]	
Morus alba L.; Moraceae; SWAT002548	Shahtoot[Pa, Pu, S, U]	Fruits	Raw snacks[Pa(11), Pu(16), S(12), U(10)]		[33, 35]
Morus nigra L.; Moraceae; SWAT002549	Toot[Pa, Pu, S, U]	Fruits	Raw snacks[Pa(13), Pu(15), S(13), U(17)]		[33, 35]
Impatiens balsamina L.; Balsaminaceae; SWAT002550	Jangli kareli[Pa, Pu, S, U]	Fruits	Cooked[Pa(7), Pu(13), S(14), U(12)]: Mixed salt after cutting and left for 1–2 h then boiled with fried and seasoned onions	Anti-diabetic[Pa(1), S(4)] helpful for digestion[S(2), U(7)]	
Nelumbo nucifera Gaertn.; Nelumbonaceae; SWAT002551	Kanwa Ibail[U] Saal booti[S]	Fruits, Stem	Cooked[S(7), U(11)]: Boiled mashed and mixed with seasoned onions		

Table 2 (continued)

Botanical Taxon; Family; Voucher Number	Local Name	Parts Used	Recorded Gastronomic Uses	Perceived Medicinal Uses/ Treated Illness	Previously Reported as Food in Pakistan
Nothoscordum bivalve var. bivalve; Amaryllidaceae SWAT002552	Pyazi$^{Pu, U}$	Leaves	Cooked$^{U(15), Pu(14)}$, onions are fried, seasoned and mixed	Diuretic$^{Pu(4), U (1)}$, leaves latex is used, for ringworm	
Oxalis corniculata L.; Oxalidaceae; SWAT002553	Jangli Methi$^{Pu, U}$	Leaves	*Seasoning$^{Pu(10), U(11)}$: used for seasoning in other dishes. Dry leaves are used for bread making after mixing wheat flour		[33, 35]
Olea europaea subsp. cuspidata (Wall. & G.Don) Cif.; Oleaceae; SWAT002554	Shuwan^{Pa}	Leaves	*Recreational tea$^{Pa(12)}$		
Ocimum basilicum L.; Lamiaceae SWAT002555	Jangli Niazbo^{Pu}	Leaves	Chatni$^{Pu(10)}$	Indigestion$^{Pu(8)}$ stomach ulcer$^{Pu(2)}$	
Periploca aphylla Decne.; Apocynaceae; SWAT002556	Barara$^{Pa, S}$	Fruits	*Raw snacks$^{Pa(7), S(8)}$		[38]
Plantago ovata Forssk.; Plantaginaceae; SWAT002557	Shabghul^{Pa} Isapaghul^{S}	Leaves husk	Herbal drink$^{Pa(9), S(11)}$	Cooling agent (herbal drink), Diarrhoea$^{Pa(9),S(11)}$	
Phoenix sylvestris (L.) Roxb.; Arecaceae; SWAT002558	Jangli Khajuur$^{Pa, Pu, S, U}$	Fruits	Raw snacks $^{Pa(10), Pu(14), S(11), U(11)}$	Effective for Joints pain^{S}, Healthy food $^{Pa(10), Pu14), S(11) U(11)}$	[34]
Podaxis pistillaris; Agaricaceae;	Khumbi$^{Pa, Pu, S}$ Khumba^{U}	Aerial parts	Cooked$^{Pa(9), Pu(8), S(11), U(13)}$: fried with seasoned onion soup. Soup$^{Pu(5)}$: vegetable is boiled for one hour by adding salt and black pepper	Soup used for fever/flu$^{Pu(5)}$	
Portulaca oleracea L.; Portulacaceae; SWAT002559	Kulfa^{U} Kulfa-loonak$^{Pu, S}$ Turka/Tarookey^{Pa}	Leaves	Cooked$^{Pa(3), Pu(7), S(4), U(8)}$: boiled after mixing with fried and seasoned onions	Kidney stone (cooked)$^{Pu(2), S(1), U(4)}$	[39, 35]
Portulaca quadrifida L.; Portulacaceae; SWAT002560	Loonak$^{Pu, S, U}$	Leaves	Cooked$^{Pu(2), S(5)}$: boiled after mixing with fried and seasoned onions Raw snacks$^{U(3)}$	Kidney stone(cooked)or raw snacks$^{S(2), U(1)}$	[38]
Rumex dentatus L.; Polygonaceae; SWAT002561	Jangli Palak$^{Pu, S}$	Leaves,	*Cooked$^{Pu(6), S(5)}$: boiled after mixing with fried and seasoned onions	Used for joints and muscles pain$^{Pu(3)}$	[39, 35]

Table 2 (continued)

Botanical Taxon; Family; Voucher Number	Local Name	Parts Used	Recorded Gastronomic Uses	Perceived Medicinal Uses/ Treated Illness	Previously Reported as Food in Pakistan
Salvadora persica L.; Salvadoraceae; SWAT002562	Peluwan^{Pa} Jaal^{S} is used for the tree. Pelu^{S} Peelak^{Pu}	Branches, Fruits	Raw snacks$^{Pa(5), Pu(7), S(7)}$		[32]
Senegalia laeta (R.Br. ex Benth.) Seigler & Ebinger; Fabaceae SWAT002563	Phulai^{Pa}	Gums	Raw snacks$^{Pa(15)}$: taken as raw snacks along with milk	Healthy for joints and muscles$^{Pa(13)}$	
Sideroxylon mascatense (A.DC.) T.D.Penn.; Sapotaceae; SWAT002564	Gurgura^{Pa} Jangli falsa$^{Pu, S, U}$	Fruits	Herbal drink: Fruits are soaked into water for a night then seeds are removed and fruits pulp is grounded with dry fruits$^{Pa(20), Pu(11)}$ Raw snacks$^{Pa(20), Pu(11), S(9), U(7)}$	Cooling agent$^{Pu(9), S(5), U(6)}$ Improve digestion$^{Pa(11)}$	
Solanum americanum Mill.; Solanaceae SWAT002565	Mako^{Pu} Kali Kutlaal^{S} Kali Babulin^{U}	Fruits, Leaves	Cooked$^{Pu(1)}$: leaves are boiled after mixing with fried and seasoned onions. Raw snacks$^{Pu(7), S(8), U(8)}$	Effective for lower level anxiety$^{Pu(3), S(3)}$	[40]
Taraxacum officinale F.H.Wigg.; Asteraceae; SWAT002571	Poli^{Pu}	Leaves	Cooked$^{Pu(13)}$: boiled after mixing with seasoned onions	Joints pain$^{Pu(3)}$	[35]
Tribulus terrestris L.; Zygophyllaceae; SWAT002566	Puthkanda$^{Pu, U}$, Chita bakhra^{S}	Fruits, Leaves	Cooked$^{Pu(8), U(5)}$: fruit flour is mixed with corn flour for making bread. Halwa$^{Pu(8), U(5)}$: fruit flour is mixed with water socked semolina then cooked with oil and brown sugar. Recreational tea$^{U(5)}$: leaves or fruits are also used in tea. Raw snack$^{S(4)}$: fruit powder is taken with water or milk	Back bone pain$^{Pu(5), S(1), U(1)}$, Infertility problem in Human (bread)$^{Pu(3), U(2)}$ used after pregnancy (halwa)$^{U(1)}$ Cough suppressant (recreational tea)$^{U(1)}$	[32]
Trianthema portulacastrum L.; Aizoaceae SWAT002567	It-sit$^{S, U}$	Stem, leaves	Cooked$^{S(5), U(8)}$: fresh leaves are boiled after mixing with seasoned onions		[36]
Terminalia arjuna (Roxb. ex DC.) Wight & Arn.; Combretaceae; SWAT002568	Arjun^{U}	Stem, bark, flowers	Herbal tea$^{U(8)}$	Heart disease (herbal tea)$^{U(5)}$	
Typha angustifolia L.; Typhaceae; SWAT002569	Konder (Buri)$^{Pa, Pu, S,}$	Flowers	Cooked$^{Pa(5), Pu (7), S(8)}$: fresh flower husk is cooked on steam by adding sugar to make a cuisine culture sweet dish Buri		

Table 2 (continued)

Botanical Taxon; Family; Voucher Number	Local Name	Parts Used	Recorded Gastronomic Uses	Perceived Medicinal Uses/ Treated Illness	Previously Reported as Food in Pakistan
Tripidium bengalense (Retz.) H.Scholz; Poaceae; SWAT002570	Saar[S]	Leaves	*Herbal tea[S(7)]	Seasonal fever[S(2)]	
Vachellia nilotica (L.) P.J.H. Hurter & Mabb.; Fabaceae SWAT002575	Watni Kekar[Pa] Babul[U] Janglikekar[Pu, S]	Young pods, Flowers, Young leaves	Cooked[Pu(13), S(11), U(13)]: young pods are boiled after mixing with fried and seasoned onions. Raw snacks[U(13)]: Young leaves		[36]
Vicia sativa L.; Fabaceae; SWAT002572	Jangli mattar[U] Raari[S]	Fruits	*Cooked[S(13), U(9)]: fried after mix-ing with seasoned onions		[32]
Withania coagulans (Stocks) Dunal; Solanaceae; SWAT002573	Akri/Paneer[Pu, S], Khamzoora[Pa], Paneer[U]	Fruits, Aerial parts	Cooked[Pu(6), S(5)]: aerial parts of the young plant bearing fruits are boiled, strained then boiled by adding brown sugar until it becomes thick, let it cool and make small spherical shaped balls and then eat(cuisine culture food). Herbal drink[Pa(13), Pu(8), S(10), U(9)]: Fruit is soaked into water for12 hours after that it is strained, ready for drinking	Cooling agent[Pu(3),, S(3)] Effective for skin infection[Pa(12), Pu(5)]	[32]
Ziziphus jujuba Mill.; Rhamnaceae; SWAT002576	SeoBair[Pu] JangliBair[U] Bra Baira[Pa]	Fruits, leaves	Raw snacks[Pa(14), Pu(17), U(16)]		[33]
Ziziphus nummularia (Burm.f.) Wight & Arn.; Rhamnaceae; SWAT002577	Bair[Pa, Pu, S, U]	Fruits, leaves	Raw snacks[Pa(6), Pu(21), U(14), S(15]		[34]
Zygophyllum indicum (Burm.f.) Christenh. & Byng; Zygophyllaceae; SWAT002578	Dhaman[Pu, S, U] Spinach-zey[Pa]	Aerial parts, fruits	Herbal drink[Pa(11), Pu(16), S(17), U(15)]: aerial parts of young plants are grinding by adding a pinch of salt, cardamom fennel and water (step wise) so that it become a dilute liquid. Herbal tea[Pa(2)]: herbal tea is prepared with fruits seasoned with sugar, fennel and cardamom	Skin infection[Pa(5), Pu(10), S(6), U(7)] Anti-cancer[Pa(1)], Anti-diabetic[Pu(1), S(2)] Cooling agent for digestive system[Pa(6), Pu(5), S(5), U(8)]	

*: Indicate the abandoned uses of the given plants among the studied communities

Table 3 Gendered ethnobotanical knowledge on WFPs among the ethnolinguistic groups

Use categories	Studied groups							
	Pathan		Punjabi		Saraiki		Muhajir	
	Male	Female	Male	Female	Male	Female	Male	Female
Food uses	156	119	299	322	303	242	308	246

Mentha longifolia is effective for flu and cough; *Impatiens balsamina* is used as anti-diabetic; *Ocimum basilicum* for stomach ulcer; *Plantago ovata* for diarrhoea; *Phoenix sylvestris* is effective for Joints pain; *Portulaca oleracea* is used againstKidney stone; *Portulaca quadrifida* for kidney stone; *Rumex dentatus* joints and muscles pain; *Solanum americanum* is effective to decrease anxiety; *Tribulus terrestris* is considered effective in infertility problem in men; *Trianthema portulacastrum* as cooling agent; *Terminalia arjuna* for heart diseases; *Tripidium bengalense* for treating seasonal fever; *Taraxacum officinale* is used for treating joints pain; *Podaxis pistillaris* is effective sfor fever/flu; *Withania coagulans* for skin infection; and *Ziziphus nummularia* is eaten during pregnancy to facilitate normal childbirth.

There were some food plants which were also frequently reported for their medicinal uses among the groups and reported by almost half (50%) of the participants that were *Senegalia laeta, Agave americana subsp. americana*, *Vachellia nilotica*, *Brassica nigra*, *Cannabis sativa*, *Citrullus lanatus*, *Cymbopogon jwarancusa*, *Mentha longifolia. Kalanchoe* sp., *Cichorium intybus*, *Periploca aphylla*, *Portulaca oleracea*, *Portulaca quadrifida*, *Rumex dentatus*, *Salvadora persica*, *Solanum americanum*, *Tribulus terrestris*, *Trianthema portulacastrum*, *Terminalia arjuna*, *Typha angustifolia*, and *Tripidium bengalense.* We have observed that there were a few taxa such as *Amaranthus polygamus*, *Kalanchoe* sp., *Capparis decidua*, *Ficus benghalensis*, *Portulaca quadrifida*, *Rumex dentatus*, *Solanum americanum*, *Tripidium bengalense, and Taraxacum officinale* that were reported by less than three 3 participants in all groups.

We have also analysed the traditional knowledge among men and women which was one of the important objectives of the research study. Our study has revealed that women shared more knowledge on food plants among the Punjabi community, while for the rest of the groups men reported more uses than women (Table 3).

Cross-cultural comparison

Cross-cultural comparisons revealed that almost one-fourth of the plants were commonly reported by all the studied groups (Fig. 2). High similarity was found among Muhajir, Punjabi, and Saraiki, while the higher number of plants was reported by Punjabi and comparatively lesser number of plants was quoted by Pathans.

The results could be justified by the fact that the three groups are living in proximity and went through certain sociocultural negotiations which may have become a factor for knowledge sharing among them. More particularly these three groups went in intermarriages with each other and have kinship relationships which are one of the most important ways of sharing cultural knowledge horizontally. It is worth mentioning that the three linguistic groups, i.e. Muhajir, Punjabi and Saraiki, and these three languages are linguistically similar, making them relatively easy for learners to acquire knowledge and share cultural information with each other.

Here, Pathans reported a comparatively high number of idiosyncratic foods uses followed by Muhajir. Our results also showed that the ethnobotany of the Pathans is quite different as compared to other groups and this their peculiar historical stratification and their past ancestral migration from other areas which in turn has impacted their traditional knowledge on the local resources. Many Pathans participants were blind to important local food plants existed in their vicinities which were reported and used by the other groups. We have specifically compared the overall plant use among the studied groups which reported by more than 50% participants among each of the individual groups (Fig. 3). We found that Punjabi, Saraiki, and Muhajir have very close affinity and have comparatively rich knowledge about these WFPs.

In the same way, the food uses for the 50% reported plants we have seen that the overlap was higher among the three groups, while Punjabi frequently reported some plant uses which were rarely reported by the other groups (Fig. 4).

Muhajir, Punjabis, and Saraiki are mostly horticulturists and have extensive knowledge of agricultural weeds and the other plants that grow in their vicinity which they have historically used as food plants. As far as Pathans are concerned, historically they are pastoralists and their knowledge on food plants is limited as their ancestors did migrate to the area from closing parts of the Khyber Pakhtunkhwa. In the study area, Pathans keep cattle at home and as a source of livelihood.

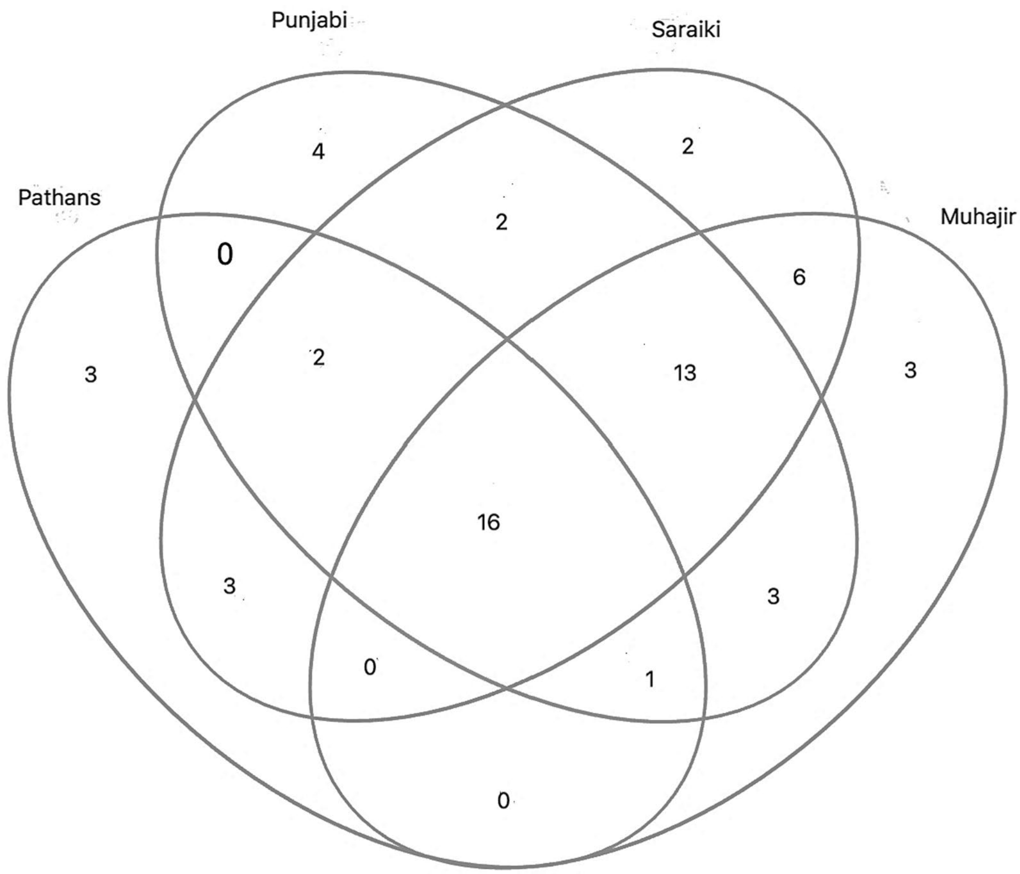


Fig. 2 Comparison of overall plant use among ethnic groups

Jaccard similarity index has shown that Saraiki and Punjabi have shown more affinity on the use of the recorded plants (Table 4). Moreover, these two groups have reported a high number of uses as compared to Saraiki and Pathans. Pathans reported the least number of medicinal uses. It is important to note that all the groups have reported idiosyncratic medicinal uses in which the Muhajir and Punjabi show higher than the other two groups.

Following are some of the important plants reported by the study participants, which revealed convergences and divergences of different cultural food system:

1. *Vachellia nilotica:* The young pods of the plant are cooked by boiling, mixing with fried and seasoned onions. This is a famous dish among Punjabi, Saraiki, and Muhajir.
2. *Brassica nigra* var. *incana:* Young leaves are boiled with seasoned onions and then grounded and mixed with butter and fried garlic-ginger paste. This is a famous dish among Punjabi, Saraiki, and Muhajir.
3. *Chenopodium album:* It is a famous wild vegetable among Punjabi, Saraiki, and Muhajir.
4. *Citrullus lanatus:* Limewater is applied to the fruit, and then, it is mixed with a sugar solution and jam is produced. This is also only practised by Punjabi, Saraiki, and Muhajir. The plant is also used in making pickle, and this gastronomic practice is famous among Punjabi, Saraiki, and Urdu speakers.
5. *Cordia myxa:* Among Muhajir and Punjabi this plant is used in Pickle. The unripe fruits are boiled and dried until no moisture content remains and mixed with pickle seasoning agents; cooked oil is added and left for 2–3 days. After that it is ready for use.
6. *Cordia bifurcata:* This plant is used by all the studied groups for doing the process of fermentation.
7. *Tribulus terrestris:* Halwa is made from the plant and is a famous dish among Muhajir and Punjabi.
8. *Ocimum basilicum:* It is used for seasoning by Punjabi.
9. *Cotoneaster nummularius:* Pathans used this plant for Fermentation, i.e. for making pickles. It is used

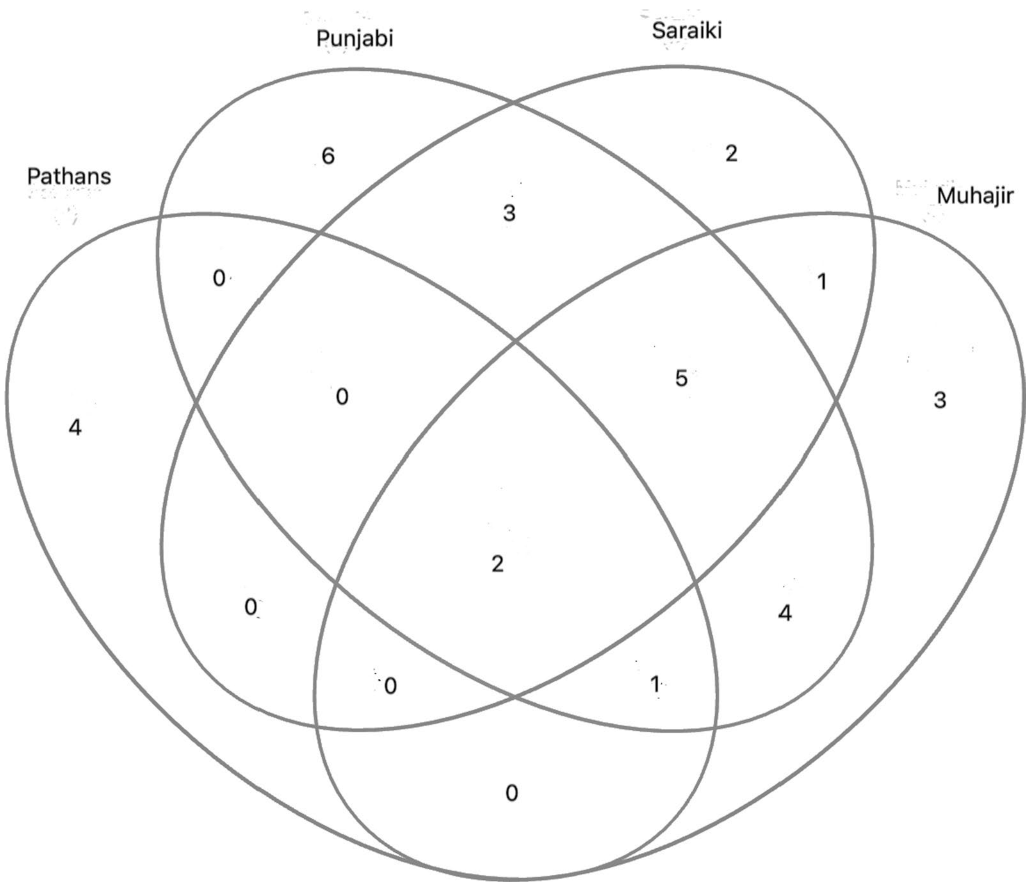


Fig. 3 50% over all plant use among the four linguistic groups

for making chatni where fresh leaves are ground along with green chilies, mint coriander, and seasoned tomatoes.

10. *Capparis decidua:* Similarly, this is only used by Pathans and Muhajir for making pickles.
11. *Cichorium intybus:* Muhajir used to make chatni where the fresh leaves are grinding with mint, salt green chilies, and seasoned tomato paste.
12. *Moringa oleifera:* The culinary use of this plant is famous among Muhajir and Saraiki, and they have quoted it for making pickles.

We also include images of some important foods documented in this study (Fig. 5). Moreover, to have a glance of the similarities and differences, Table 5 gives a better understanding in this regard.

Ecological attributes of the reported taxa and plant foraging

Looking at the ecological attributes of the reported plants, we have found that most of the plants were collected from hillsides and fields (Table 5). Study participants mentioned that in the foraging of these food and medicinal plants, men, women, and children are involved. There were a few plants such as *Apteranthes tuberculata, Citrullus lanatus, Cotoneaster nummularius, Portulaca oleracea, Typha angustifolia, Withania coagulans, Citrullus lanatus, Ziziphus jujuba*, and *Plantago ovata* that are gathered and sold in the local vegetable markets. The quoted plants were collected in different seasons of the year. People have mentioned that due to various reasons the availability of the reported plants has significantly decreased. However, we also reported a decline in the availability of certain plants due to factors such as weedicide use, intensive agricultural practices, drought conditions, uneven grazing, deforestation, and population growth.

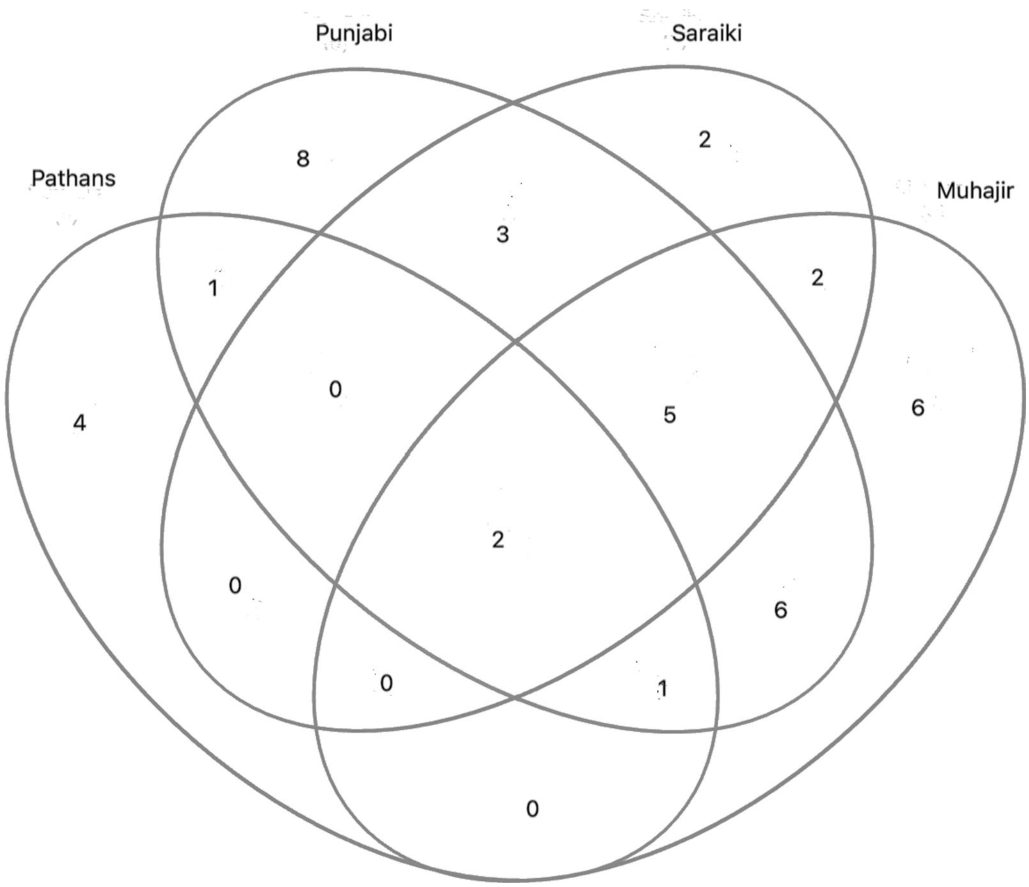


Fig. 4 The 50% food use among the four linguistic groups

Table 4 Jaccard similarity indexes for the overall recorded plant uses and frequently reported uses (more than 50%of the participants) among the considered groups

Study groups	Overall plant use				Frequently reported uses			
Muhajir	Muhajir	Pathans	Punjabi	Saraiki	Muhajir	Pathans	Punjabi	Saraiki
	X	21.3	22.95	9.68	X	7.4	14.7	7.40
Pathans	21.3	X	1.7	20.83	7.4	X	6.7	5
Punjabi	22.95	1.7	X	31.58	14.7	6.7	X	30
Saraiki	9.68	20.83	31.58	X	7.40	5	30	X

Discussion

Diversity of WFPs

The current food ethnobotanical survey recorded a huge stock of local plant knowledge on food plants along with several important medicinal uses which show the reliance of the local communities on these natural resources across generations. This is the first scientific study that has been carried out in West Pakistan, and second study across the country, reporting several underutilized food plants along with their possible medicinal uses being researched in multicultural settings.

Speaking of the diversity of plants being used by the ethnic groups, it has been seen that the quoted taxa were highly scattered across different botanical families and their use was also quite heterogeneous. From the perspective of food use of the recorded plants, the diversity of food ingredients or culinary preparations is dominated by cooked vegetables. The wider acceptability of these plants as cooked vegetables may be due

Fig. 5 Traditional dishes featuring **A** cooked *Brassica nigra*, **B** *Agave americana* halwa, **C** an herbal *Cannabis* drink, **D** *Tribulus terrestris* bread, and cooked *Rumex dentatus*, **E** chutney made from *Mentha longifolia* and *Ocimum basilicum*

to their availability in anthropogenic environments [40]. According to research gathering environments are highly important in determining the nature of food ethnobotany within a cultural group and most often anthropogenic environments offer the best possible habitats for WFPs to grow [41]. It is argued that weeds have high ecological amplitude [42, 43] and they have been reported frequently in most of the food ethnobotanies across the different part of the globe. Rather than focusing exclusively on taxon numbers, researchers have always considered the scope of the WFPs' gathering environment [44].

To handle food scarcity and achieve sustainable nutritional goals, weeds are suggested as a better alternative [45–47] hence the local communities might have evolved their traditional food system in accordance with the availability of these plant taxa during the feminine time. From North Pakistan [48] has been reported that different ethnic groups in the Northwest Frontier Province of Pakistan frequently eat wild vegetables made from weeds.

Raw snacks are another highly reported food category, as reported by several ethnobotanists, which is also an interesting phenomenon in food anthropology [49–51]. It has been argued that the emergence of dominance of raw snacks in food ethnobotany took place with the emergence of mobile pastoralism.

From medicinal perspective, based on emic perception, about 80% WFPs have shown the potential to treat various ailments, and this fact strengthens the idea that these quoted plants could offer a potent source of functional food.

Comparing the quantitative data on URs for the quoted taxa, we have found that a significant portion of local food knowledge is still alive among the elder members of the studied groups, while the practicality of ethnobotanical heritage on the quoted plants is highly threatened due to the remarkable social and the destruction of social structures that facilitated the transmission of the LPK. For instance, various drivers that hamper the sustainability of local plant knowledge either directly or indirectly include globalization, food and medical products commodification, climate change, and ecological degradation [52]. Researchers have claimed that the sustainability of local plant knowledge has been greatly affected by generation gap among the elderly people and younger generations due to the changing lifestyle [53–56]. Our findings are also in line with the previous ethnobotanical literature that has already seen great loss in local ethnobotanical knowledge [57, 58]. Ethnobotanical studies have reported that the traditional ethnobotanical knowledge has drastically decreased or changed [59–66].

Due to the remarkable social change, local populations tend to devalue the foraging of the natural resources; especially the foraging of wild plant resources is considered a sign of unprivileged households. Most of the informants perceived the foraging practices as outdated

Table 5 The ecological attributes of the recorded plants in the study area

Botanical Taxon	Habit	Gathering area	Collectors	Gathering season	Commercialization	Availability within the local environment
Apteranthes tuberculata	Herb	Mountain	Male and Female	August–October	Yes	No significant increase or decrease has been observed.
Amaranthus polygamus	Herb	Fields	Male and Female	April–May	No	Somehow decreased as people percieved that due to weedicide spray and other modern equipment of agriculture.
Agave americana subsp. americana	Herb	River, canals, bank, and marshy places	Male and Female	Whole year	No	Somehow decrease has been observed due to the anthropogenic activities such as the-cleanliness of River canals.
Brassica nigra var. incana	Herb	Plains (uncultivated land) Desert	Male and Female	December–February	No	The herb is cultivated.
Canna indica	Shrub	Plains (Uncultivated land, along roadsides)	Male and Female	December–February	No	Widely grows in the local environment.
Cannabis sativa	Herb	Mountains Forest and Fields Side	Male and Female	May–August	No	Its growth is reduced and the possible reason behind this was percieved as deforestation.
Capparis decidua	Shrub	Plains, Mountains, Desert	Children, Male, and Female	August–November	No	The participants did not report any increase or decrease in its availability.
Cucumis melo	Herb	Fields (Cotton Green grams Sugar cane)	Male and Female	May–July	No	Herbicide spray has potentially decreased its availability.
Cucumis melo	Herb	Fields (Cotton, green Grams, Sugar cane crops)	Children, Male, and Female	May–July	No	Herbicide spray has potentially decreased its availability.
Chenopodium album	Herb	Fields (Wheat and Mustard crops)	Male and Female	January–February	No	No significant increase or decrease has been recorded.
Citrullus colocynthis	Herb	Desert, Mountains, Plains (fields: green beans, Cluster beans, and Gawar crops),	Male and Female	July–September	Yes	The herb is cultivated.
Cichorium intybus	Herb	Fields (Grasses)	Male and Female	October–November	No	The participants did not report any increase or decrease in its availability.
Citrullus lanatus	Herb	Desert, Plains (Green beans, Guar crops)	Children, Male, and Female	July–September	Yes	The participants did not report any increase or decrease in its availability.
Cordia bifurcata	Tree	Plains areas	Children, Male, and Female	March–May	No	Population expansion has reduced its growth in the local environment.
Cordia myxa	Tree	Plains areas	Children, Male, and Female	May–June	No	Population expansion has reduced its growth in the local environment.

Table 5 (continued)

Botanical Taxon	Habit	Gathering area	Collectors	Gathering season	Commercialization	Availability within the local environment
Cotoneaster nummularius	Tree	Mountains	Children, Male, and Female	April–June	Yes	Its growth and availability have declined due to deforestation.
Cymbopogon jwarancusa	Shrub	Throughout in this region on uncultivated land	Male and Female	January–April	No	Its growth and availability have decreased due to population growth and intensified agricultural practices.
Digera muricata	Herb	Fields (Sugar cane, green beans, Cotton crops)	Male and Female	August–October	No	No significant increase or decrease has been recorded.
Ehretia obtusifolia	Tree	Desert, Plains	Children, Male, and Female	June–July	No	Its growth and availability have decreased due to population increase, deforestation, and superstitions.
Ficus benghalensis	Tree	Plains areas (usually at water wells)	Children and Male	February–April	No	Its growth and availability have decreased due to deforestation.
Ficus populifolia	Tree	Plains, Desert	Children	April–May	No	The plant has some serious threats and local people believe that it could loss its existence in the region.
Ficus carica	Tree	Bank of river canals	Male, Female, and Children	August–October	No	Its growth and availability have decreased due to deforestation.
Grewia tenax	Shrub	Mountains	Male, Female, and Children	February–August	No	No significant increase or decrease has been recorded.
Impatiens balsamina	Herb	Plains (bank of water canals), Desert (Guar, Green beans crops)	Male and Female	August–October	No	Its growth has increased due to the availability of water.
Kalanchoe sp.	Herb	Bank of river canals	Male and Female	Whole year	No	Grazing and other anthropogenic disturbances also disturb the growth of the species.
Lathyrus aphaca	Herb	Wheat crop	Male and Female	December–February	No	No significant increase or decrease has been recorded.
Lathyrus sativus	Herb	Riverain area (Wheat crop)	Male and Female	January–February	No	It is now widely available due to the increase in riverain area (delta of Indus River)
Mentha longifolia	Herb	Bank of River canals	Male and Female	Whole year	No	Its growth and availability have decreased due to uneven grazing practices.
Moringa oleifera	Tree	River canals bank and water well	Male and Female	March–April	No	Its growth and availability have increased due to cultivation.
Morus alba	Tree	Throughout in this region	Children, Male, and Female	May–July	No	The availability of the plant has decreased due to deforestation.

Table 5 (continued)

Botanical Taxon	Habit	Gathering area	Collectors	Gathering season	Commercialization	Availability within the local environment
Morus nigra	Tree	Throughout in this Region	Children, Male, and Female	May–July	No	The availability of the plant has decreased due to deforestation.
Nelumbo nucifera	Herb	Lake and slow-moving river water	Male and Female	April–May	No	The availability has increased due to the expansion of riverine areas and water lakes.
Nothoscordum bivalve var. bivalve	Herb	Chickpea fields	Male and Female	December–February	No	Its growth has decreased due to the increase in drought conditions.
Ocimum basilicum	Herb	Fields sides and uncultivated wet land	Male and Female	November–December	No	No significant increase or decrease has been recorded.
Olea europaea subsp. cuspidata	Tree	Mountains	Male and Female	Whole year	No	Its growth has increased due to government efforts to protect it from deforestation.
Oxalis corniculata	Herb	Bank of river canals	Male and Female	Whole year	No	Its growth and availability have declined as population levels have risen.
Plantago ovata	Herb	Mountains	Male and Female	August–September	Yes	The increase in drought conditions has led to a decline in its growth and availability.
Podaxis pistillaris	Herb	Anywhere in this Area	Male and Female	April–August	No	No significant increase or decrease has been recorded.
Portulaca oleracea	Herb	Mountains, Plains (Sugar cane, cotton crop)	Male and Female	March–May	Yes	The growth is affected by the herbicide spray.
Portulaca quadrifida	Shrub	Mountains	Children	April–May	No	No significant increase or decrease has been recorded.
Phoenix sylvestris	Tree	Desert, Plains, Mountains	Children, Male, and Female	July–September	No	Somewhat declined due to increase in population and deforestation.
Rumex dentatus	Herb	Waterlogged land, Waterlogged uncultivated land	Male and Female	December–January	No	Drought conditions and weedicide spray have led to a decline in its growth and availability.
Salvadora persica	Tree	Desert, Plains, Mountains	Children, Male, and Female	May–June	No	Its growth and availability have decreased due to deforestation.
Senegalia laeta	Tree	Mountains	Male and Female	August–November	No	No significant increase or decrease has been recorded.
Sideroxylon mascatense	Tree	Mountain	Children, Male, and Female	June–July	No	Its growth has decreased due to deforestation.
Solanum americanum	Shrub	Plain areas,	Children, Male, and Female	March–June,	No	No significant increase or decrease has been recorded.

Table 5 (continued)

Botanical Taxon	Habit	Gathering area	Collectors	Gathering season	Commercialization	Availability within the local environment
Taraxacum officinale	Herb	Fields (Wheat crop)	Male and Female	December–February	No	No significant increase or decrease has been recorded.
Terminalia arjuna	Tree	Plains (river water canals, water wells)	Male and Female	Whole year	No	Its growth and availability have somewhat increased due to cultivation efforts.
Trianthema portulacastrum	Herb	Found everywhere in the area	Male and Female	Whole year	No	No significant increase or decrease has been recorded.
Tribulus terrestris	Herb	Throughout in this area,	Male and Female	April–May	No	No significant increase or decrease has been recorded.
Tripidium bengalense	Herb	Desert, Mountains, Plains	Male and Female	Whole year	No	No significant increase or decrease has been recorded.
Typha angustifolia	Herb	Riverain area	Female	July–September	Yes	Availability has increased due to the expansion of riverine areas.
Vachellia nilotica	Tree	Throughout in this area	Male and Female	March–May	No	No significant increase or decrease has been recorded.
Vicia sativa	Herb	Fields (Wheat crop)	Male and Female	January–February	No	Its growth has decreased due to the application of weedicide sprays on crops.
Withania coagulans	Herb	Mountains, Desert	Male and Female	July–October	Yes	The availability has decreased due to population growth and intensified agricultural practices.
Ziziphus jujuba	Tree	Mountains, Desert	Children, Male, and Female	July–September	Yes	Availability has decreased due to deforestation.
Ziziphus nummularia	Tree	Plain areas	Children and Male	April–May	No	No significant increase or decrease has been recorded.
Zygophyllum indicum	Herb	Mountains, Plains, Desert	Male and Female	Whole year	No	Increased due to improved water availability.

ecological practices. Hence, young villagers seem to view local plant knowledge as old-fashioned and something that requires too much time, as [67] reported. According to them, there is an "unlearning debt" when explicit knowledge of local practices survives in the memory of the elderly but will disappear over time from the younger generations. Moreover, a typical view of traditional vegetables is that they are food for the poor and used by the uneducated, so the younger generation does not care to learn about them [68].

The role of gender was also analysed, and it was found that mostly men were more knowledgeable than women and it could be the fact that in these areas women most often stay at home and do not go foraging therefore they have comparatively lesser knowledge. Our research results do align with the work of [69] who reports from Sargodha, which is the nearby region, that the women possess much less knowledge than men because high involvement in domestic activities and have very few chances to go out and interact with their surrounding environment. However, there is much evidence from ethnographic studies that woman have more knowledge on both food and medicinal plants than men as also reported from Chitral, Pakistan [70], along with many certain examples that highlight the importance of this heritage among women [71–77]. Specifically, if we discuss the local knowledge retained by women, it is evident that women are mainly responsible of providing household health care [71, 73], consequently, they have extensive knowledge of local herbal therapies, as part of their labour and domestic activities [71, 72, 76]. As a result, women knowledge on medicinal plants increases [71, 73, 75]; thus, there is a possibility that their knowledge is different from men in context of epistemological perspective [72].

Abbas et al. [78] reported in a study that there has been some erosion of the cultural knowledge of WFPs. It was found that more than one-third of the participants mentioned most of the plants that were quoted. Similarly, local inhabitants are still carrying the LEK of WFPs in their memory and practices, such as those living around Takht-e Sulaiman Hills in NW Pakistan [79], in the same way a significant amount of traditional knowledge about WFPs has been preserved in the Hindu Kush mountains in north Pakistan [41, 59]. We observed that even among elderly individuals, several informants had difficulty in recalling their memories and experiences and reporting the use of the plants, which clearly reveals the erosion of foraging and collection practices linked to wild food and medicinal taxa in the study area. A huge number of floras have been vanished from the local food system such as *Kalanchoe* sp., *Canna indica, Ficus populifolia, Lathyrus aphaca, Oxalis corniculata, Periploca aphylla, Rumex dentatus*, and *Vicia sativa.*

Throughout contemporary economic practices and development policies, there are threats to biocultural heritage that can erode human communities' knowledge and capacity to live within ecological limits [80]. Most of the wild vegetables have disappeared from the local food system including *Nothoscordum bivalve var. bivalve, Vachellia nilotica, Kalanchoe* sp., *Canna indica, Lathyrus aphaca, Oxalis corniculata, Rumex dentatus, Vicia sativa*. Some of the plants are not available in the area, for instance, *Nothoscordum bivalve var. bivalve,* Kalanchoe sp., *Ficus benghalensis* but others have lost their value such as *Ficus populifolia, Lathyrus aphaca, Oxalis corniculata, Olea europaea, Periploca aphylla, Rumex dentatus, Tripidium bengalense, and Vicia sativa*; however, they are available in their respective habitat but people do not collect them; therefore, their inclusion in the traditional food system has been affected by various socio-environmental drivers. Globalization, social change, and environmental change are all factors contributing to the disappearance of these taxa.

Cross-cultural comparison

Cross-cultural comparison has revealed that the knowledge is highly heterogeneous and the commonalities among the four groups were quite low. However, the three groups Punjabi, Saraiki, and Muhajir showed close affinities on sharing the local plant knowledge. This could be since these people have gone through remarkable social cultural negotiations. Culture and knowledge of ethnobotany are integral parts of any society, and ethnobotany is highly incorporated into everyday practices and influenced by a multifaceted combination of sociocultural factors as well [59]. One of the prominent factors is the existence of sociocultural negotiations that are mostly taking place in multicultural settings among different ethnic groups in an area [15].

People tend to intermarry with each other and in this context a significant number of intermarriages have been seen in the recent past. The transmission of traditional knowledge either vertically or horizontally is affected by kinship relationships [81]. Study participants have confirmed that there are several intermarriages among these three groups. As far as Pathans are concerned, they have a very different social and cultural stratification, strictly endogamous, very little exogamous (Table 1), which ultimately put an impact on the transmission of cultural knowledge including local plant knowledge among these groups as confirmed by other researchers belong to various region of the globe [82].

The relationship of local plant knowledge transmission to the intermarriages has been reported by other scientists. In North Pakistan, there are several examples indicating that intermarriage can lead to commonalities in plant use between ethnic groups, since a significant knowledge especially on food plants is shaped by transmission and is passed down from mothers to daughters or to the next generations [83–86]. This variable should be evaluated to determine the impact of this variable on knowledge transmission; individuals of the studied groups were also assessed qualitatively as to their kinship relationships. Despite the findings of the study, participants did not acknowledge the existence of endogamic rules; despite almost everywhere in the world, the transmission of LEK and LFK systems regarding food plants (and especially wild vegetables) passes primarily from mothers to daughters. It is also important that the observed idiosyncrasy on the utilization of wild food and medicinal plants could not only be associated to the social and cultural aspects of any given groups, but it also closely links to the floral characteristics and vegetation structure of the area. The communities around the Takht-e-Sulaiman Hills, NW Pakistan, for instance, have a better understanding of wild ingredients where this heritage still exists [87]. Moreover, as pervasiveness of industrialized food, food security status, and socioeconomic condition are considered, the impact is obvious and makes comparative analysis of the ground situation among each of the individual groups in the domain of food plants. It also confirms that culture has an important role to play in protecting the local plant knowledge based on the idiosyncrasies of food and medicine use among the different groups. Moreover, we can also confirm that ecology has also played a significant role in reshaping local ecological knowledge as also confirmed by our previous study [88] where ecology played an important role in shaping the local food ethnobotanies.

Linguistic diversity and LPK

Language is the way of communication, and it is an enclave for knowledge embedded in a specific culture. In our context, language has a very relationship with local plant knowledge. All the information is encoded in language. Since plant knowledge is a very wide category, each language retains a distinct body plant knowledge which include the plant nomenclature, information of their uses, coining terms, defining interpretations, methods of cultivation, and other featured vocabularies related to plants or vegetations and perfectly offer nuanced insights into biodiversity. Therefore, here we are just giving an example of local plants nomenclature. Each linguistic or cultural group used dentin names; therefore, linguistic diversity is directly linked to the diversification of LEK. The more diverse the language landscape, the higher the potential for a rich fabric of local plant knowledge and traditional ecological wisdom. Therefore, both local plant knowledge and linguistic diversity are linked and function as ripostes for ecological and cultural knowledge. In the ongoing context, the linguistic diversity in some brings negative impacts to the local plant nomenclature if these different groups do live together as the dominant cultural or linguistic groups in one or another impacting the local nomenclature of the recessive group. We have observed that there were certain taxa whose local names were commonly shared by the studied groups: for instance, that the studied groups have used common names to some extents are given a brief note in the following passage:

1. Some specific plants were reported by a single common name among all the groups, for instance, *Phoenix sylvestris* was described as Jangli Khajuur, *Podaxis pistillaris* was referred as Khumbi, *Ziziphus nummularia* was quoted as Bair; *Morus alba* was given the name Shahtoot., *Impatiens balsamina* as Jangli kareli by all the studied groups.
2. *Punjabi, Saraiki and Muhajir: Typha angustifolia* (Konder); *Citrullus lanatus* (Kortum); *Portulaca quadrifida* (Loonak); *Portulaca oleracea* (Kulfa-loonak); *Sideroxylon mascatense* (Jangli falsa); *Moringa oleifera* (Sohanjna); *Lathyrus aphaca* (Jangli matri); *Zygophyllum indicum* (Dhaman); *Cannabis sativa* (Bhung); *Apteranthes tuberculata* (Chungaan); *Citrullus lanatus* (Kaalkaan); *Mentha longifolia* (Jangli podina); and *Withania coagulans* (Paneer).
3. *Punjabi and Urdu: Ficus carica* (Anjeer); *Nothoscordum bivalve var. bivalve* (Pyazi); *Cordia myxa* (*Lasora*); and *Oxalis corniculata* (Jangli Methi).
4. *Saraiki and Urdu: Chenopodium album* (Bathu); *Cucumis melo* (Chibhr); *Amaranthus polygamus* (Chulai); *Cymbopogon jwarancusa* (Khavi); *Digera muricata* (Tandla); *Lathyrus sativus* (Jangli matri); *Trianthema portulacastrum* (It-sit); and *Cucumis melo* (Chibhr).
5. *Punjabi and Saraiki: Rumex dentatus* (Jangli Palak); *Capparis deciduas* (Kari); and *Ehretia obtusifolia* (Gondi).
6. *Pathan and Saraiki: Periploca aphylla* (Barara).

The above-mentioned names recorded for some of the selected taxa revealed that the commonalities on the naming of the reported species among the different groups could be the fact that they live close for centuries and therefore the minority linguistic group has adopted the dominant local name that has been popular among the majority group. Here, we also could say that the close relationship in terms of kinship or the close geographical existences might have affected the respective food plant use among the researched communities. Returning to the subject of interact linguistic interaction, I would say that intra-language interaction is a complex phenomenon, and as a guide for our discussion, we want to emphasize that linguistics generally recognizes the mental lexicon as more than just a list of vocabulary. It includes free morphemes, bound morphemes, constructions (for instance, “the more (I read), the more (I understand)”), and idioms (for example, “to spill the beans”) [89]. As far as traditional knowledge or LEK is concerned, grammar morphemes cannot stand alone as vocabulary items because they are encoded in grammatical structures; to classify nouns referring to things in the world, languages use 198 kinds of functional morphemes [89]. We strongly believe that the language shift either towards Khowar or Pashto is an important phenomenon whose role in affecting LEK cannot be overlooked, as language is a crucial source of communication and all the knowledge of a specific culture is accumulated, encoded, and expressed through it.

The language shift has also been seen in adopting the exotic nomenclature for certain species. For instance, in Chitral and Gilgit-Baltistan, [41, 59] it has been found that dominant language impacts local plant nomenclature among the ethnic minorities.

In ethnobotany, it always comes first to employ a multidisciplinary approach including the linguistic analysis for understanding the complex and multifaceted relationship between language and ecology. For instance, it is important to understand the fact that the linguistic framework does not only influence people with their environment but at the same time it also covers the cultural significance of any plant. Information is stored in a particular language about plants; therefore, if a language becomes endangered, then automatically the information is also at the verge of extinction. In our study, we have observed a distinct nomenclature of local plants but there were some cases of language adaptability in naming particular spice. It is mentioned that the adoption of common names for plants is due to sociolinguistic adaptability. Any language or linguistic term related to plants that die off from the lexicon is a threat to local ecological knowledge and biodiversity. We are in the modern and globalised time, where local knowledge is facing a treated with a double-edged sword: one the one hand, standardization of languages promotes homogenization of knowledge, while on the other hand cross-cultural exchange makes a blend of knowledge and information that are a toxic process for the protection of biocultural diversity.

Food, Health, and Environmental Conservation *Nexus*

The current research study has the potential to contribute to the local food security, public health issues, and environmental conservation. Several underutilized plants reported here have the potential to use as alternative food ingredients in the time of crises. In the local market, we have seen that there are certain plants that people have started to cultivate in their kitchen gardens. As a general observation, many economically marginal societies are facing some serious challenges that are expected to be more severe soon. One of the challenges is the food scarcity across the globe, and especially people in developing countries still face inequality in getting access to healthy food. Poor people do not have proper access to nutritious food ingredients. Policy makers in the food sector are striving to ensure the availability of food to everyone but due to limited resources it is always hard to make something concrete that helps the poor segment of society in this regard. The subject of WFPs is quite vibrant, and this could play a central role in ecological transition in the domain of food if proper harvest and management is approached. WFPs are growing in many places without any human care but the main issue in this global time is to pay attention towards these apparently inexpensive and nutritious sources of food otherwise overlook their utilization by mainstream middle-income household. As a result, the Food and Agriculture Organization (FAO) also acknowledges "nutrition and biodiversity converge to a common path leading to food security and sustainable development" and that "wild species and intra-species biodiversity have key roles in global nutrition security" [90].

As far as the public health is concern, many of the plants have been quoted as medicinal plants as described above which is a positive indicator for developing culturally accepted and easily available medicinal products. In addition, it is imperative to understand the value of local knowledge around these food plants and encourage through certain incentives the local communities to better manage the harvest of the local wild plant-centered food and medicinal ingredients.

In the current study, most of the plants we recorded were cooked vegetables and these could be used as functional food. *Cordia* spp. is considered useful *for diabetes; Digera muricata* improves kidney function; *Ficus carica* for asthma; *Moringa oleifera* is effective for paralysis; *Tribulus terrestris* is highly effective in healing in post childbirth infections. Reports have shown that nearly 7000 plant species are edible [91] and many of them have been passed through pharmacological studies and proven their medicinal use too thus providing a sound ground for generating functional food [73, 92]. Shikov et al. [92] further reported that only a small number of WFPs have been subjected to pharmacology. Gammerman & Grom [93] reported WFPs are not only selected for their good taste or smell but have also been chosen for their important pharmacological properties [94].

A 60-year-old Pathan man explained the concept of healthy food as: *"Zygophyllum indicum"* is a healthy drink that prevents numerous diseases especially from cancer and diabetes and skin allergies. But now the younger generation dislikes it. A person who had been at the end stage of cancer was recovered by the continuous use of this drink". In the same way, a 70-year-old Muhajir was told during a survey gave his views: "*Vachellia nilotica* was used as healthy food during 1947 independence (migration) and as best for wound healing".

Pruess et al. [95] have reported that WFPs are folk functional food as they have been recognised as depurative which means that these plants have nutritional value or sometimes, they are eaten for pleasure and have positive impacts on health. Aziz et al. [70] reportedly claimed, however, based on his review of the literature that most of the WFPs still must pass through pharmacological as well as toxicological investigations. They reported more than 50 plants in which half of the plants were not verified pharmacologically. Survey has indicated that also some of the plants used in food-medicine in other regions of Pakistan [40].

With respect to conservation point of view, proper attention is needed to create awareness among the people to supplement their food system with WFPs and ensure sustainable harvest of some of the important local food plants. There are many examples of the exploitation of these natural resources in their local habitat. Tiwari et al. [96] reported that natural resources are gradually depleting across the Hindu Kush Himalayan region, which has already come at the expense of several ecosystems. Land use has been recognized as a hazard for depleting the wild food resources therefore proper management-based strategies are required to ensure future food security for resource-based communities. It is highly imperative to formulate concrete policy frameworks to be prepared for any future food related critical situation. The relevant stakeholders who are solely responsible to reinforce nutrition-sensitive approaches in land and ecology-related policy networks to better utilize the provision of wild food ingredients.

Comparison with Pakistani food ethnobotany

Comparative assessment of reported plant species with previous studies specifically focusing food ethnobotany of Pakistan [8, 13, 14, 32–41, 59, 60, 64, 70, 78, 81, 87, 88, 97–102] revealed that out of 59 reported botanical taxa, 21 (35.5%) were recorded for the first time as food plants from this region. Among these, *Amaranthus polygamus, Brassica nigra var. incana*, *Citrullus lanatus, Cordia bifurcata, Ehretia obtusifolia, Kalanchoe* Adans, *Moringa oleifera*, *Impatiens balsamina*, *Nelumbo nucifera, Nothoscordum bivalve var. bivalve, Olea europaea subsp. Cuspidata*, *Ocimum basilicum, Plantago ovata, Podaxis pistillaris, Senegalia laeta*, *Sideroxylon mascatense*, *Terminalia arjuna*, *Typha angustifolia*, *Tripidium bengalense, Zygophyllum indicum* were commonly used in making traditional cousins. Likewise, notable variations in the use pattern of remaining botanical taxa were also observed. In the current study, application of *Agave americana* subsp. *Americana, Tribulus terrestris*, and *Withania coagulans* in traditional cuisines is different from reported previouly by different ethnic groups of Jhelum District, Punjab, Pakistan [32]. Likewise, reported food uses of *Capparis decidua* and *Cucumis melo* from central Punjab, Pakistan [34], *Cichorium intybus, Cotoneaster nummularius*, and *Oxalis corniculata* in the highlands of the eastern Hindukush, North Pakistan [33, 35], *Cucumis melo*, *Cymbopogon jwarancusa*, *Ficus benghalensis, F. populifolia*, and *Vachellia nilotica* from Bahawalpur and its adjacent regions, Pakistan [36], and *Ficus carica* from Kurram district [37] were different from reported by the inhabitants of peri-urban area of North-Western Punjab, Pakistan.

Conclusion and Recommendations

In the current research, the four studied groups possessed a diverse array of local knowledge related to WFPs which have also a wide range of medicinal uses. It is affirmed that each cultural group has a sufficient distinction in retaining local plant knowledge on the quoted taxa thus indicating that linguistic diversity is a reservoir of local food plant knowledge in the study region. Cross-cultural comparison has indicated that Muhajir, Punjabi, and Saraiki have reported more commonalities on the use of the quoted food plants. The idiosyncratic uses of the recorded plants among the studied groups reveal the impact of ecology, social interactions, and certain historical stratification on the local plant knowledge as these different factors have in one way or another way impacted the knowledge transmission among the studied communities. Since food knowledge is still in the memory and has no serious threat to its extinction right now, but as far as the medicinal uses are concerned, the knowledge is near to the periphery of extinction.

Following is some of the recommendations given in the context of food-medicine as the Pakistani ethnobotanical literature has some prominent challenges in providing sufficient literature on the subject:

1. The overlap between pharmacology and the food-medicine domain has taken on a new layer of scientific discoveries. We know that the traditional separation between “food” and “medicine” has started to blur, and therefore, there is a need of a growing body of scientific evidence to highlight the hidden potential of these plant-centred traditional practices in the future.
2. Traditional plants that were used as food-medicine should be subjected to rigorous testing that modern science demands, because these local plant remedies have been historically practiced and their knowledge often passed down orally across generations without rigor scientific and pharmacological validations.
3. From a pharmacological point of view, WFPs are one of the potent sources having rich bioactive compounds, many of which have yet to be researched. These compounds can range from alkaloids and flavonoids to complex polysaccharides, each with its own unique set of pharmacological activities.

4. The food-medicine domain emphasizes the role of diet in health and disease prevention. Foods rich in vitamins, minerals, and other essential nutrients contribute to overall well-being, but the bioactive compounds found in wild plants may offer additional, targeted therapeutic benefits.

Limitations of the study and future opportunities

1. The study has been conducted with diverse linguistic groups, and therefore, there are some chances of some miscommunication which could have led to incomplete data collection.
2. We know that plants are used in different times and seasons, and this is crucially linked with the availability of respective plants; therefore, it is probable that some species that were not present in during the time of data collection could also be missed. Hence it is necessary to plan long-term ethnobotanical studies but often face funding and logistical challenges.
3. The third limitation is related to the interdisciplinarity of ethnobotany which makes the ethnobotanical studies highly challenging as it requires specialties from the field of botany, anthropology, ethnography, and pharmacology. Coordinating between different disciplines can be challenging due to varying methodologies, terminologies, and research goals.
4. There is always a need to research the local plant knowledge among the younger generation to determine whether is transmitting or not. Hence, the survey did not record the knowledge of the younger generation which could be considered future studies.

The study has an important role in creating awareness about the local food and medicinal plants among the local communities who have taken part in the study and shared their knowledge. The local communities will get benefits from the recorded knowledge, and here, the local ethnobotanist can play a major role in returning their knowledge in documented form to the local communities which will in turn strengthen the revitalization of local plant knowledge for future generation get social, cultural, and economic benefits.

Abbreviations

JI	Jaccard index
LEK	Local ecological knowledge
LFK	Local
LPK	Local plant knowledge
NW	Northwest
URs	Use reports
WFPs	Wild food plant species

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Author contributions
MA and MAA designed the project. AM collected the data. AM and MAA wrote the initial draft and interpreted the data. AMA commented on the initial draft and together with MAA and HA finalized the article. ZU identified the collected botanical taxa. FFB, AAA, and MKG gave expert comments on the draft and helped in improving it. MAA and MA supervised the project through its different stages. All the authors have read and approved the final manuscript.

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Availability of data and materials
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The research study proposal was approved by the Dean faculty of Sciences, Kohat University of Science and Technology, Pakistan, in 112 meeting of Advanced Studies Research Board (ASRB) held on 14 October 2023, under registration # B030211001. While conducting the field survey, the ethical guidelines as recommended by the International Society of Ethnobiology were precisely followed. All the participants provided prior oral consent before the interviews for data collection, photography, and sharing their knowledge and pictures with the public.

Consent for publication
All coauthors have read and agreed to submit the manuscript.

Competing interests
The authors declare no competing interests.

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