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RESEARCH

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# Displacement threatens local knowledge: plant foraging in a cross-cultural context in the Gomal area, NW Pakistan

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**Abstract**

In the context of human displacement, it is essential to study how local knowledge is reshaped, eroded, or transformed. This study sheds light on how wild plant reports are articulated after migration, retained, and kept; the research explores specifically the ethnobotanical knowledge linked to wild food plants of five ethnic communities, namely the Bettani, Ormur, Mehsud, and Miani populations living in the Gomal area of NW Pakistan, of which three are displaced communities. The study aims to record the knowledge of wild food plants and their use among generations in these communities. To better determine the impact of displacement, we have analysed the data along two trajectories: (a) cross-geographically comparing the recorded wild food plant reports with the available published literature in NW Pakistan and (b) conducting a cross-cultural comparison of the local plant knowledge among the considered groups (displaced ones: Mehsud, Ormur, and Powanda; autochthonous: Bettani and Miani) residing in the Gomal area. Via semi-structured interviews with a hundred study participants (twenty for each ethic group), the study revealed the use of 69 wild food taxa, showing a remarkable diversity of food uses, with Ormur and Powanda exhibiting several idiosyncratic reports. The research highlights that displacement may have disrupted potential pathways of knowledge transmission among the Mehsud, Ormur, and Powanda; however, local plant knowledge about their past environment remains part of the collective memory of these communities. Moreover, post-migration exposure to a new ecological system has become a challenge for the newcomers, necessitating adaptation to rearticulate their relationship with nature and plants. The broken paths have a profound impact on plant knowledge transmission to youngsters, as social structures and gatherings have been significantly altered or disrupted; these were the primary means of interaction between youngsters and their elders. The exposure to urbanisation compounds the issue of displacement, and the erosion of knowledge systems has come at the expense of hands-on experiences among the selected groups. Notably, the local plant nomenclature of Ormur is also highly threatened. We advocate incorporating local plant knowledge into local educational curricula, which may be crucial for the sustainability of natural knowledge and have profound impacts on mitigating the effects of socioecological change.

**Keywords** Ethnobotany, Gomal, Pakistan, Afghans, Mehsud, Ormur, Displacement, Wild food plants

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## Introduction

We are living in a volatile time, and political and security issues continue to impact populations and ecosystems in various parts of the world. Millions of people are forced to leave their traditional and native territories and relocate to other parts of the world [1]. Given their exposure to new social, cultural, environmental, and economic conditions in their new settlements, these relocated or migrant communities attempt to address specific challenges [2]. People reshape their connection to the local ecosystem and form social ties, and in this way, social memories change, and previous cultural knowledge and related practices are replaced with new ones. Conversely, the old ones become part of the memory.

The study of how migration or displacement affects ethnobotanical knowledge is a key area of research in ethnobiology and human ecology, a field that has been thriving for decades [3, 11]. This research is fundamental because ethnobotanical knowledge is not static; it adapts and evolves in space [12]. The influx of external ideas and cultural traits triggers cultural transformation, which in turn influences the relationship between humans and plants (as demonstrated by Aziz et al. [13]). This study is significant because it sheds light on the profound impact of displacement on ethnobotanical knowledge, underscoring the importance of this research in the field of ethnobiology.

Wild food plant (WFP) knowledge is integral to ethnobotanical expertise within a community. With the changing socioeconomic and environmental conditions, the change in' knowledge of WFPs is inevitable. Discussing the ethnobotanical knowledge of African communities relocated in urban NW Italy, Ellena et al. [14] have, for example, argued as follows:

Plant-based practices among migrant communities may reveal differences in their resilience and attitude towards change after displacement.

Resilience is heavily related to the practical uses of plants in the new environment. It is also influenced by complex cultural negotiations with other indigenous or autochthonous communities, as well as with all the different communities residing in the new sociocultural space.

The intercultural interactions that impact traditional plant knowledge rapidly evolve both spatially and temporally. Furthermore, the portrayal of plants and remedies associated with "traditions" constantly changes across generations of migrants.

Given the complex challenges that displaced communities face, it is crucial to understand their local plant knowledge. As they lose their connection to their traditional lands and adapt to a new environment, they risk losing their ancestral ethnobotanical legacies. The impact of commodification on local ecological knowledge (LEK) is particularly pronounced, presenting significant challenges for these communities in retaining their plant cultural knowledge in their new environmental territory.

During the past two decades, several scholars have undertaken the task of exploring the food systems of several ethnic communities who have displaced or migrated (for example [15, 19], and specifically their plant-related knowledge and practices [20], and references therein), particularly in the USA [21, 23], Latin America [24, 27], the UK [20, 28], and the European Union [14, 29, 32], as well as in Northern Africa [33]. To our knowledge, few studies have considered the issue of migrants' understanding of wild plants in Asia [34]. It has been noted that studying migrants' ethnobotany can help reveal general human ecological concepts underlying the universal phenomenon of human relocation [11]. Hence, considering the overall arena of research among these societies, the current study holds a significant place in ethnobiology, as it has investigated migrant communities that have been highly challenged by armed conflicts and have been forcibly relocated.

Gomal, located in the western part of the District Tank in Khyber Pakhtunkhwa, Pakistan, has been inhabited by various linguistic groups. Ethnic Pathans, divided into subtribes, primarily inhabit the areas and speak their own language. The selected groups included Mehsud, Miani, Bettani, Powanda and Ormur. Mehsud, Powanda, and Ormur are the migrant groups, while the Miani and Bettani are the local autochthonous groups in the region. We plan to investigate the foraging of wild food plants among different groups and compare their knowledge and related foraging practices in both cultural and socio-ecological contexts. Among these groups, the Powanda, who are Afghans and have settled in the area for decades, have essential lifeways and practices that may be necessary for sharing their local ecological knowledge. Diverse sociolinguistic groups may exhibit differences in plant knowledge, as they may have experienced different environmental conditions and cultural heritages, which shape their relationships with the local environment. Moreover, the current study also has an essential implication for studying the sustainability of overall ethnobotanical expertise by using Local Plant Knowledge (LPK) on WFPs as a proxy to examine changes, adaptations, and ultimately, the sustainability of LPK within a given ethnic group.

The specific objectives of the study were: to record the knowledge of wild food plant use among different ethnic groups in the Gomal area; to analyse how knowledge about wild food plants is distributed across generations; To cross-culturally compare the understanding of the different groups and interpret the data within the given critical sociocultural and ecological context.

## Materials and methods

### Study area

Gomal is a municipality (Tehsil) located in the District of Tank, Khyber Pakhtunkhwa Province, NW Pakistan (Fig. 1). The tehsil is named after the Gomal River, which flows through the area. The Gomal Tehsil is situated in the southern part of the Tank District, bordering the South Waziristan District to the west, the Dera Ismail Khan District to the east, and the Zhob District of Balochistan Province to the south. The population of the Gomal Tehsil is primarily Pathan (Pashtun), with many people engaged in agriculture and livestock rearing. Agriculture is the mainstay of the local economy, with wheat, maize, sugarcane, and cotton being the major crops grown in the area. Livestock, including cattle, goats, and sheep, are also raised, and dairy farming is a significant source of income for many households. In addition to agriculture and livestock rearing, people in Gomal Tehsil are also engaged in small-scale businesses, including grocery stores, tea shops, and restaurants. Some residents also work in the government sector or commute to nearby towns and cities for employment opportunities.

The Gomal area of District Tank in Khyber Pakhtunkhwa is characterised by semi-arid to arid ecological conditions. The region experiences hot summers, mild winters, and low, irregular rainfall primarily during the monsoon season. The terrain is mostly flat, with some hilly stretches near the Afghan border, and the soil is generally sandy to loamy, characterised by low organic content and high susceptibility to erosion, particularly during flash floods. The vegetation in the area consists mainly of dry tropical thorn forests, featuring plants such as *Acacia*, *Zizyphus*, *Prosopis*, *and Tamarix* spp. After seasonal rains, various grasses and herbs emerge, providing a rich source of forage for livestock grazing. The Gomal River, along with the Gomal Zam Dam, serves as a crucial water resource for the region, supplemented by the traditional *"karez systems"* we find in a few peripheral Asian areas: a series of well-like vertical shafts, connected by sloping tunnels, which tap into subterranean water in a manner that efficiently delivers large quantities of water to the surface by gravity, without need for pumping.

Local wildlife includes jackals, wild boars, porcupines, reptiles, and a variety of birds, though biodiversity is under pressure from overgrazing, habitat loss, and deforestation. Human activities, such as agriculture, firewood collection, and uncontrolled grazing, have significantly altered the natural landscape. These pressures, along with the effects of climate change, drought, and flash floods, pose serious challenges to the ecological balance and sustainability of the Gomal area.

### Selected communities

Ethnic Pathans, divided into subtribes, inhabit the study area and speak Pashto or related dialects. The groups examined include Mehsud, Miani, Bettani, Powanda, and Ormur. Among them, the Mehsud, Powanda, and Ormur are migrant groups, while the Miani and Bettani are local autochthonous populations. The Ormur, the only linguistic minority that was considered in this study, are often considered part of the broader Pathan population. This study investigates their plant foraging knowledge and practices within different cultural and socio-ecological contexts. The Powanda, Afghan settlers with a long

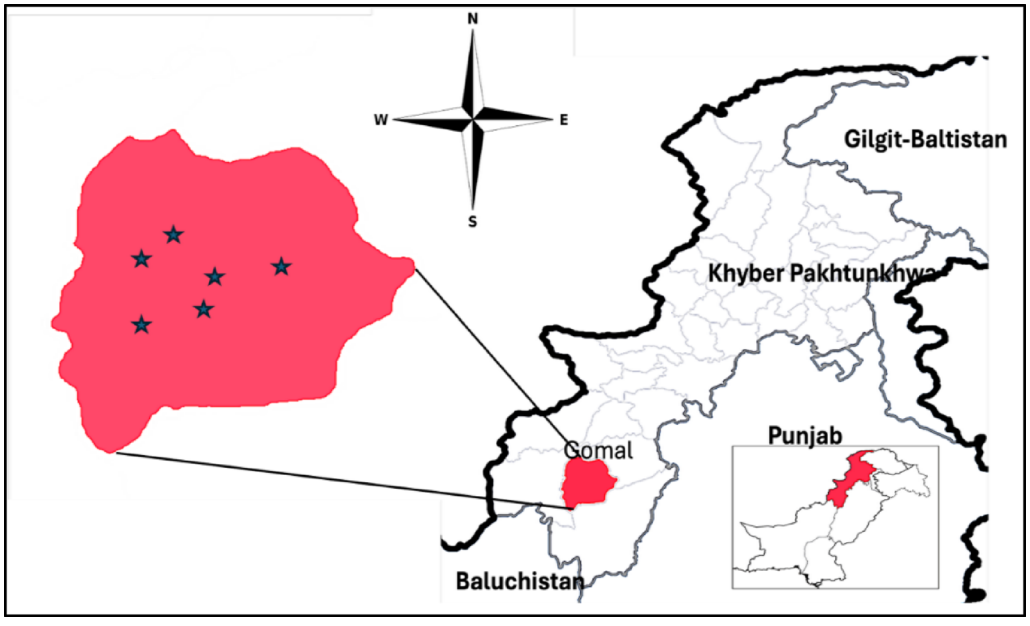


**Fig. 1** Map of the study area within Pakistan

history of seasonal migration, maintain a distinctive ecological experience and traditions shaped by their mobility between Pakistan and Afghanistan. Table 1 provides a comparative summary of the main cultural and historical features of the five groups.

## Bettani

The Bettani (also spelt Baittani or Baitani) are a Pashtun sub-tribe of the larger Gharghasht branch, long settled in north-western Pakistan. Traditionally, pastoralists involved in herding and small-scale farming speak a regional Pashto dialect distinguished by specific vocabulary yet mutually intelligible with other Pashto varieties.

## Powanda (Koochi)

Also known as Kuchi or Afghan Kuchis, the Powanda are nomadic Pashtuns inhabiting Afghanistan and Pakistan. Their livelihood centres on herding sheep, goats, and camels and migrating seasonally to find pasture. Their distinctive dress, jewellery, and music reflect a culture closely tied to mobility. Despite recent hardships—conflict, land disputes, and movement restrictions, the Powanda have shown resilience. Some have settled in towns, while others preserve their nomadic lifestyle.

**Table 1** Key features of the five ethnic groups

| Ethnic group | Origin/location | Language | Lifestyle | Migration/settlement status |
|---|---|---|---|---|
| **Bettani** | Northwestern Pakistan; sub-tribe of Gharghasht | Pashto (Bettani dialect) | Traditionally pastoral, agriculture | Settled in the study area for centuries |
| **Powanda** | Afghanistan and Pakistan | Pashto | Nomadic herders (sheep, goats, camels) | Some remain nomadic, others urban-settled |
| **Mehsud** | South Waziristan, KP | Pashto | Agriculture, animal husbandry | Migrants in the study area due to conflict |
| **Ormur** | Kaniguram, South Waziristan; possibly of Persian origin | Ormur (Iranian subgroup) | Historically settled, artisanal (blacksmiths, goldsmiths) | Migrants due to conflict; minority language speakers |
| **Miani** | KP province; sub-tribe of Khattak | Pashto | Agriculture, business, and government jobs | Mostly settled, actively involved in politics and the military |

## Mehsud

The Mehsud, among the largest Pashtun tribes, inhabit South Waziristan in Khyber Pakhtunkhwa Province. Traditionally engaged in agriculture and herding, they are known for independence and resistance to foreign rule. Regional conflicts in recent decades have displaced many Mehsud families, including those now living in the study area.

### Ormur

The Ormur are a small but significant linguistic minority, formerly concentrated in Kaniguram. Their language is the sole surviving member of the southeastern Iranian subgroup [35, 38]. Military conflict forced their migration from South Waziristan, further endangering their language and culture. Historical records suggest Persian origins—possibly from regions south of the Caspian Sea, or ancient settlement south of the Hindu Kush [35]. Bellew (1974) [39] traced them to the Barkaians of Central Asia, who later settled in Baraki Barak and Baraki Rajan (Logar District, Afghanistan). Their possible Zoroastrian background, with ritual fire as a central element, may explain their traditional professions as gold- and blacksmiths [40].

## Miani

The Miani are a Pashtun sub-tribe of the Khattak, mainly in Khyber Pakhtunkhwa, with smaller communities in Afghanistan. Known for their warrior heritage, they have long played important political and military roles and produced numerous leaders and poets. Predominantly Sunni Muslim, they follow Pashtunwali, the traditional code of ethics, and are organised into sub-clans led by maliks who maintain communal order. Today, most Miani work in agriculture, business, and public service, while retaining a distinct cultural identity.

## Post-conflict social change and outmigration

The "war on terror" in Waziristan (since 2004) has severely disrupted local livelihoods and plant knowledge. Prolonged conflict has caused large-scale displacement, destroyed infrastructure, and curtailed access to traditional lands, eroding intergenerational transmission of ethnobotanical knowledge. Many traditional healers, the primary custodians of such knowledge, were forced to flee, leaving their expertise undocumented.

Militarisation and insecurity have also limited agriculture, pastoralism, hunting, and gathering activities closely linked to plant use. Among the Ormur, linguistic and cultural erosion is particularly acute: adoption of Pashto as the lingua franca threatens their endangered language and traditional ecological knowledge. Continued outmigration further reshapes the cultural and linguistic landscape of these communities.

### Field study

A field survey was conducted in March 2022 among five ethnolinguistic and socio-cultural groups in the Gomal area of District Tank to document local knowledge of wild food plants (WFPs). WFPs were defined as naturally occurring, non-cultivated species gathered from their habitats for human consumption, including edible leaves, fruits, seeds, roots, flowers, and stems found in forests, fields, wetlands, and other ecosystems.

Data were collected through semi-structured interviews with 100 participants—20 from each group—using a mixed-method approach. Random sampling was applied initially, followed by snowball sampling as familiarity with the area increased. Due to the displacement of several communities and the lack of reliable records, locating knowledgeable participants was challenging; thus, individuals actively engaged with the local ecosystem were prioritised. Although the sample size was limited, it adequately represented household-level ecological experience and trends in food plant knowledge and transmission.

Only male participants were interviewed, as cultural and religious norms (Parda) prevented engagement with women. Prior informed consent was obtained from each participant. Interviews lasted from 15 min to several hours and were conducted in Pashto at community sites such as shops, gathering places, mosques, fields, and canal banks. The first part of the interview gathered demographic data; the second focused on the culinary use of WFPs, documenting local names, parts used, and preparation methods (e.g., cooked vegetables, teas, salads, raw snacks, and fermented foods). Younger participants were also interviewed to assess intergenerational transmission. Group discussions were organised to verify local phytonyms and cross-check plant identifications.

Additional ethnographic information was collected through observation. Plant specimens were collected after interviews; unidentified taxa were verified through folk descriptions and comparison with previous field studies. Botanical identification was performed at the Centre for Plant Sciences and Biodiversity, University of Swat, Pakistan, using the Flora of Pakistan [44, 47]. Verified specimens were deposited in the University of Swat Herbarium (acronym SWAT). Nomenclature followed World Flora Online [42], and family assignments adhered to the Angiosperm Phylogeny Website [43]. The study followed the Code of Ethics of the International Society of Ethnobiology [41].

### Data analysis

Data were arranged in MS Excel. Use reports were counted for each quoted taxon and for each of the studied communities. Use the reports referred to here to indicate the number of citations given by all informants for a specific plant use, such as food. For instance, *Amaranthus* was used in various culinary preparations, and different informants reported different food uses. For each use, we counted the number of quotations or the frequency of citations and placed them in superscript against each reported use for each ethnic group.

The bar diagram was used as a visual representation to illustrate the predominance of utilisation of gastronomic plant parts among the catalogued taxa across the selected communities. The chord diagram was generated in OriginPro (2021) to elucidate the various culinary applications of the documented plant taxa. A linear regression analysis was conducted to examine the relationship between age and local plant knowledge across all the researched groups. A similarity dendrogram was generated to show the degree of understanding between the selected communities using PAST software (version 4.16c). Furthermore, a Venn diagram was generated utilising the Bioinformatics & Evolutionary Genomics software, (http://bioinformatics.psb.ugent.be/webtools/Venn/). The purpose of this Venn diagram was to facilitate a comprehensive cross-cultural analysis across the designated groups under scrutiny.

Specifically, to sort out and quantify the possible impacts of relocation or displacement on the plant use among the displaced groups, we used a study conducted in South Waziristan among the Ormur and Mehsud. We aimed to use this for comparison to provide a clear picture of how exposure to changing ecology and plant resources is evolving in multicultural and semi-urban contexts.

## Results

### Recorded wild food plant knowledge

The study recorded 69 food plant taxa belonging to various botanical families. The main ethnobotanical table presents all the relevant details on the culinary uses of the recorded plants (Table 1). Among the recorded food plants, the most consumed parts were fruits (28 taxa), followed by aerial parts/shoots/stalks (17 taxa), leaves (16 taxa), whole plants (three taxa), roots (two taxa), bulbs (one taxon), and flowers (one taxon), as illustrated in Fig. 2. We also recorded some taxa which locals use latex or gum (two taxa). Despite continuous efforts and repeated field visits to the study sites, we were unable to collect or identify eight taxa out of 69 because they were inaccessible to us. A total of 32 botanical families were documented, with notable concentrations of species in the Amaranthaceae, Fabaceae, Brassicaceae, and Rhamnaceae. The popularity of fruits can be attributed to their appealing taste, seasonal availability, and their dual role as both food and medicine. Leaves are also commonly used because they are easily harvested, rich in micronutrients, and frequently incorporated into local diets

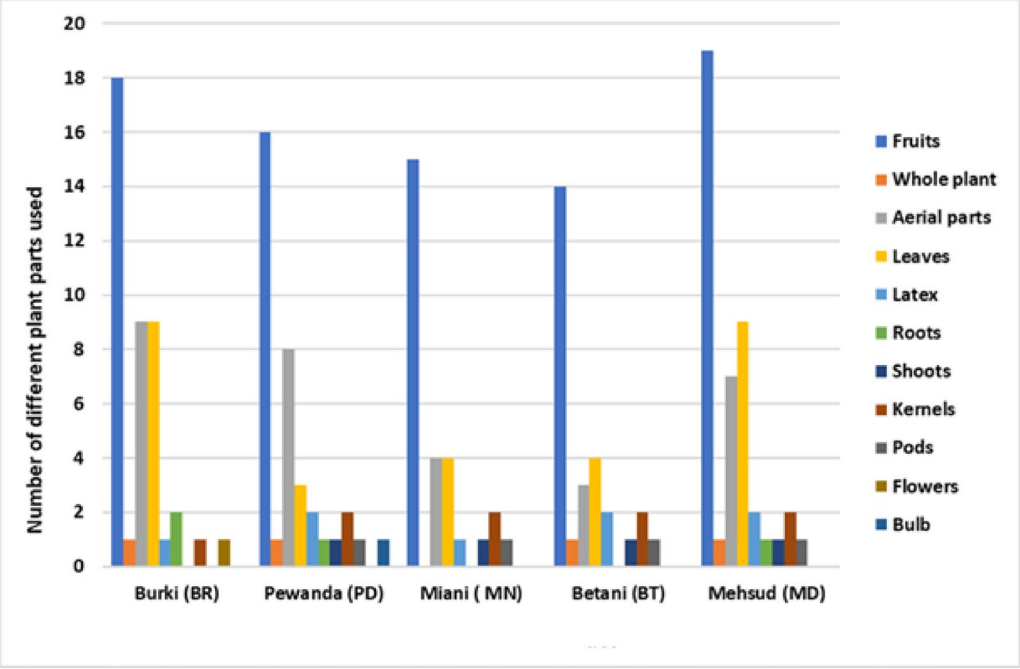


**Fig. 2** Bar diagram showing plant parts used for food by the considered communities

as cooked greens. In contrast, roots, latex, and kernels are used less often due to limited accessibility, seasonal availability, or the need for specialised knowledge for safe processing. Overall, the selection of plant parts reflects cultural preferences and ecological availability, demonstrating how communities optimise plant resources for both subsistence and health. Moreover, the reported species are generally perceived to be collected from the wild; therefore, we did not categorise them into different groups.

The survey identified the use of recorded food plants in eight distinct culinary preparations: raw snacks, cooked vegetables, salads, fermented foods, chutney, seasoning, tea, and chewing gum. Notably, raw snacks emerged as the dominant mode of food consumption among the selected communities, accounting for 47% of total food use, followed by cooked vegetables, which accounted for 30% (Fig. 3). These plant taxa were predominantly collected in anthropogenic environments, i.e., agricultural fields and areas surrounding houses.

Some of the most prominent plant taxa used as raw snacks were *Capparis decidua* Edgew., *Celtis australis* L., *Chenopodium foliosum* Asch., *Cotoneaster racemiflorus* (Desf.) Schltdl., *Ehretia obtusifolia* Hochst. ex DC., *Elaeagnus trifloral* Roxb., *Ficus palmata* Forssk., *Medicago monantha* (C.A.Mey.) Trautv., *Quercus floribunda* Lindl. ex A.Camus, *Salvadora oleoides* Decne., *Malva neglecta* Wallr., *Pinus gerardiana* Wall. ex D.Don, *Strigosella africana* (L.) Botsch., and *Vicia sativa* L. Similarly, for those taxa that were consumed in as cooked vegetables, included *Chenopodium murale* L., *Convolvulus arvensis* L., *Cucumis melo* L., *Lepidium draba* L., *Malva neglecta*, *Nasturtium officinale* R.Br., *Pinus gerardiana*, *Polygonatum verticillatum* (L.) All., *Quercus floribunda*, *Salvadora oleoides*, *Strigosella africana*, and *Vicia sativa.*

Wild food plants (WFPs) predominantly comprised synanthropic weeds, used in varying proportions across the communities studied. Among the documented species, herbs were the dominant growth form (about 55–60%), followed by shrubs (20–25%) and trees (15–20%), with a few climbers and grasses also represented. The prevalence of herbs reflects their abundance in the local environment, ease of access, and rapid regeneration after harvest, which makes them a reliable source for daily food and medicinal needs. Shrubs and trees, though fewer in number, are highly valued for their fruits, bark, and long-term resource stability, but their use is often limited to seasonal availability or longer maturation cycles. This distribution highlights how communities rely on easily accessible herbaceous species while also maintaining knowledge of perennial woody plants that support cultural and dietary diversity.

The analysis revealed that more than 50% of the quoted taxa were reported by less than 50% of the participants.

### Cross-geographical and cross-cultural comparisons

The heterogeneity of food knowledge among the five ethnic groups offers insight into the historical specificities of traditional knowledge, which has been shaped over

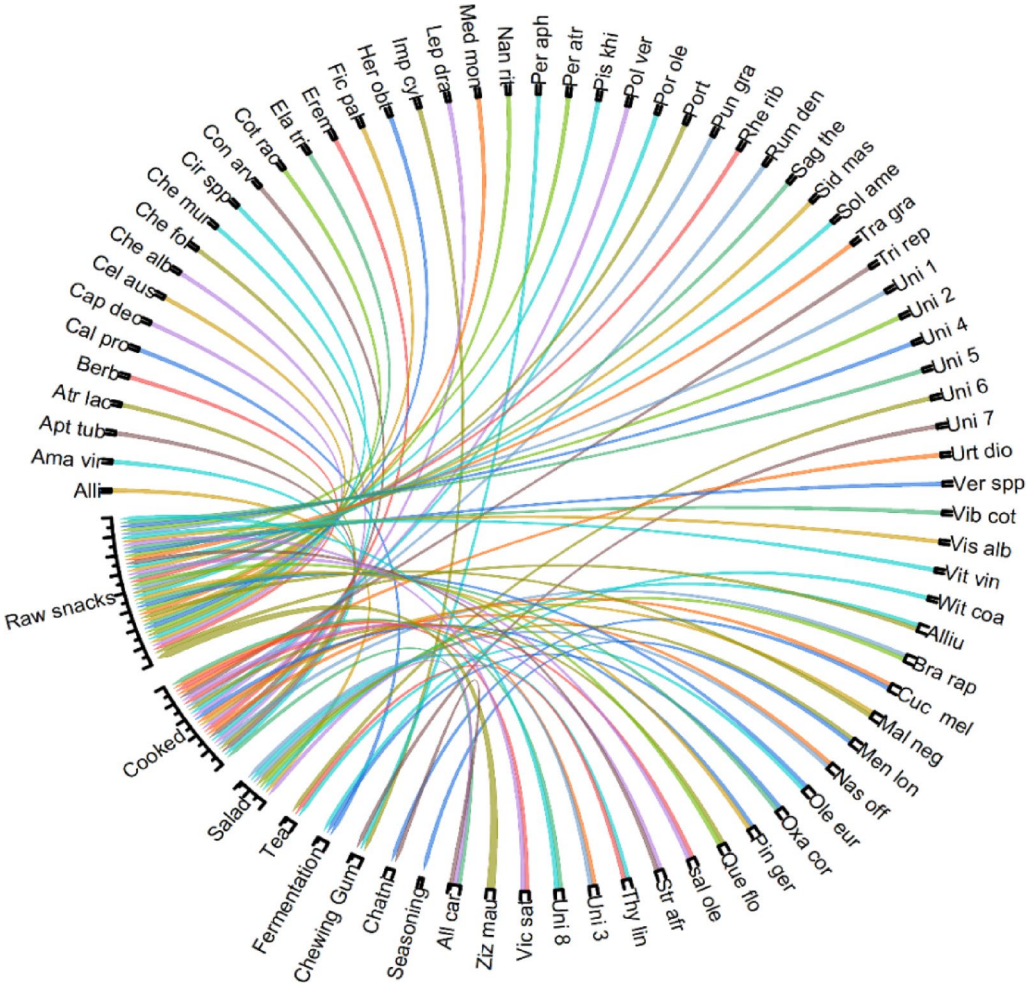


**Fig. 3** Chord diagram illustrating the various gastronomic uses of the documented wild plant taxa. For the abbreviations of plant taxa, see Table 2

centuries by the selected groups, influenced by various social, cultural, ecological, and environmental factors. Moreover, the idiosyncrasy of the uses of the quoted plant taxa across the selected groups helps explain the phenomenon that each culture has experienced its surrounding environment in its own way and has articulated it and its biological environment differently. For instance, the predominance of WFP knowledge within the Ormur community can be attributed to their historical ties to the local environment and cultural heritage, despite being a linguistic minority group. In our previous studies, Ormur have been found to have an idiosyncratic use of their reported plants compared to Mehsud (Pathans) [48], which suggests that local plant knowledge has been a crucial part of their memory of the past. Previous research has shown that the Ormur and Mehsud people possess a profound understanding of WFPs [48] and medicinal plants [49] in their natural habitats. Moreover, the cross-cultural findings can be attributed to the geographical location of the Mehsud population, their access to different foraging areas in the near past, and similar factors affecting the Bettani tribe, which also inhabits various geographical regions across the region.

Aziz et al. [48] reported in their ethnobotanical survey that three-quarters of the WFP use recorded among the Ormur is also commonly quoted among the Pathans and the Ormur linguistic groups. Our current study suggests that 36 plant species among the reported plants (excluding unidentified plant taxa) have already been reported in our previous study conducted in the same area [48]. The most common cited wild food plants species included *Allium* spp., *Amaranthus viridis* L., *Berberis* sp., *Celtis australis*, *Chenopodium album* L., *Chenopodium foliosum*, *Cirsium* spp., *Convolvulus arvensis*, *Cotoneaster racemiflorus*, *Elaeagnus triflora*, *Eremurus* species, *Ficus palmata*, *Lepidium draba*, *Malva neglecta*, *Medicago monantha*, *Mentha longifolia* (L.) L., *Nannorrhops ritchiana* (Griff.) Aitch., *Nasturtium officinale*, *Olea europaea* L., *Oxalis corniculate* L., *Periploca aphylla* Decne., *Perovskia atriplicifolia* Benth., *Pinus gerardiana*, *Polygonatum verticillatum*, *Portulaca oleracea* L., *Quercus floribunda*, *Rumex dentatus* L., *Solanum americanum*

**Table 2** Wild food plants gathered and consumed by the selected groups in the study area

| Botanical name; family; voucher numbers; | Abbreviations | Local name | Parts used | Recorded gastronomic uses | Earlier reported |
|---|---|---|---|---|---|
| *Acacia* sp.; Fabaceae; SWAT003061 | Aca sp | Kikre[MN, PD, BT] | Fruits | Raw snacks[BT(4), MN(4), PD(16)] | |
| *Allium carolinianum* Redouté; Amaryllidaceae; SWAT003062 | All car | Pezokai[PD] | Whole plant | Seasoning[PD(12)] | |
| *Allium* spp.; Amaryllidaceae; SWAT003063 | All car | JangliPayaz[MN, BT] | Whole plant | Cooked[BT(6)]<br>Chutney[BT(6)]<br>Salad[MN(8)] | Aziz et al. 2021<br>Aziz et al. 2020<br>Aziz et al. 2020 |
| | Alli | Beecha[MD] | Aerial parts | Salad[MD(2)] | |
| | Alliu | Khokh[MD]<br>Youvre[MD] | Whole plant | Raw snacks[OR(2), MD(3)]<br>Salad[OR(2)] | |
| *Amaranthus viridis* L.; Amaranthaceae; SWAT003064 | Ama vir | Ranjaka[MD]<br>Sakaak[OR] | Aerial parts | Cooked[OR(2), MD(5)] | Aziz et al., 2021<br>Abbas et al., 2020 |
| *Apteranthes tuberculata* (N.E.Br.) Meve & Liede; Apocynaceae; SWAT003065 | Apt tub | Pamanai[MD, MN, OR, PD, BT] | Aerial parts | Cooked[OR(2), MD(15), BT(11), MN(11), PD(4)] | |
| *Atriplex laciniata* L., Amaranthaceae, SWAT003066 | Atr lac | Shurkai[MD]<br>Shorakai[MN, BT] (Warkhrai) | Leaves | Cooked[MD(5), MN(5)] | |
| *Berberis* sp.; Berberidaceae; SWAT003067 | Berb | Kerai [MD, OR]<br>Kawarai[PD] | Fruits | Raw snacks[OR(1), PD(2)] | |
| *Brassica rapa* L.; Brassicaceae; SWAT003068 | Bra rap | Ganhla[MN, BT] | Leaves (young and fresh) | Cooked[BT(3), MN(4)]<br>Salad[MN(4)] | |
| *Calotropis procera* (Aiton) Dryand.; Apocynaceae; SWAT003069 | Cal pro | Sapalme [MD]<br>Sapalmaka [PD, BT] | Latex | Fermentation[MD(4), BT(2), PD(1)] | |
| *Capparis decidua* Edgew.; Capparaceae; SWAT003070 | Cap dec | Krira or Karira[MD, MN, BT] | Fruits | Raw snacks[MD(4), BT(3), MN(6)] | |
| *Celtis australis* L.; Cannabaceae; SWAT003071 | Cel aus | Teerawan[MD]<br>Togha[OR]<br>Tagh [OR]<br>Inzar [PD] | Fruits | Raw snacks[OR(2), MD(5), PD(2)] | Aziz et al., 2021<br>Aziz et al., 2020 |
| *Cirsium* spp.; Asteraceae; SWAT003072 | Cir spp. | Spiozir[OR] | Roots | Raw snacks[OR(3)] | |
| *Chenopodium album* L.; Amaranthaceae; SWAT003073 | Che alb | Khar saak[OR] | Aerial parts | Cooked[OR(1)] | Aziz et al., 2021<br>Aziz et al., 2020 |
| *Chenopodium foliosum* Asch.; Amaranthaceae; SWAT003074 | Che fol | Koresh[MD]<br>Saree[MD] | Fruits | Raw snacks[MD(4)] | Aziz et al., 2021<br>Aziz et al., 2020 |
| *Chenopodium murale* L.; Amaranthaceae; SWAT003075 | Che mur | Saarma [PD] | Aerial parts | Cooked[PD(2)] | |
| *Convolvulus arvensis* L.; SWAT003076 | Con arv | Parwatiay[OR] | Leaves | Cooked[OR(2)] | Aziz et al., 2021<br>Abbas et al., 2020 |
| *Cotoneaster racemiflorus* (Desf.) Schltdl.; Rosaceae; SWAT003077 | Cot rac | Sherawa[MD, MN, OR, PD] | Fruits | Raw snacks[OR(2), MD(15), MN(8), PD(4)] | Shah et al., 2015<br>Aziz et al., 2021 |
| *Cucumis melo* L.; Cucurbitaceae SWAT003078 | Cuc mel | Chubar[MN, PD, BT] | Fruits | Cooked[BT, MN(5), PD(2)]<br>Chutney[BT(5)] | |
| *Ehretia obtusifolia* Hochst. ex DC.; Boraginaceae; SWAT003079 | Her obt | Gunde [BT] (yellow in colour) | Fruits | Raw snacks[BT(3)] | |
| *Elaeagnus triflora* Roxb.; Elaeagnaceae; SWAT003080 | Ela tri | Sanzala[OR] | Fruits | Raw snacks[OR(2)] | |
| *Eremurus* M.Bieb.; Asphodelaceae; SWAT003081 | Erem | Shiziay[PD]<br>Nanazrang[OR] | Young aerial parts | Cooked[PD(2)] | |
| *Ficus palmata* Forssk.; Moraceae; SWAT003082 | Fic pal | Tugha[MD]<br>Tugha[MN]<br>Inzir[OR]<br>Inzar [PD] (two types) | Fruits | Raw snacks[OR(9), MD(12), BT(4), MN (4), PD(6)] | Shah et al., 2015<br>Aziz et al., 2021 |

**Table 2** (continued)

| Botanical name; family; voucher numbers; | Abbreviations | Local name | Parts used | Recorded gastronomic uses | Earlier reported |
|---|---|---|---|---|---|
| *Imperata cylindrica* (L.) P.Beauv.; Poaceae; SWAT003083 | Imp cyl | Sarmagho[MN, BT] | Shoots | Chewing Gum[BT(2), MN(4)] | |
| *Lepidium draba* L.; Brassicaceae; SWAT003084 | Lepdra | Bashka [MD]<br>Ghurghwast[OR] | Aerial parts | Cooked[OR(12), MD(4)] | Aziz et al., 2021<br>Abbas et al., 2020 |
| *Malva neglecta* Wallr.; Malvaceae; SWAT003085 | Mal neg | Teekali[MD]<br>Poske[MN, BT]<br>Puchke[MN]<br>Techi[OR] | Fruits<br>Leaves | Rawsnacks[OR(13)]<br>Cooked[MD(2)] | Aziz et al., 2012<br>Abbas et al., 2020<br>Shah et al., 2015 |
| *Medicago monantha* (C.A.Mey.) Trautv.; Fabaceae; SWAT003086 | Med mon | Batlakay[OR] | Aerial parts | Raw snacks[OR(12)] | Aziz et al., 2020<br>Aziz et al., 2021 |
| *Mentha longifolia* (L.) L.; Lamiaceae; SWAT003087 | Men lon | Welanai[MD, MN, PD, BT]<br>Ghwan[OR]<br>Shinshubaye[PD] | Aerial parts | Seasoning[OR(2), BT(3), MN(2), PD(5)]<br>Salad[MD(15)] | Aziz et al., 2020<br>Aziz et al., 2020<br>Aziz et al., 2021 |
| *Nannorrhops ritchiana* (Griff.) Aitch.; Arecaceae; SWAT003088 | Nan rit | Mazarai[MD, OR, PD,<br>Sakrey[PD]<br>Patmoor[PD] | Fruits<br>Roots | Root: Raw snacks[OR(2), MD(5)]<br>Fruits: Raw snacks[PD(3)] | Aziz et al., 2021 |
| *Nasturtium officinale* R.Br.; Brassicaceae; SWAT003089 | Nas off | Tarmira[OR] | Aerial parts | Cooked[OR(2)]<br>Salad[OR(2)] | Azizi et al., 2020<br>Azizi et al., 2021 |
| *Olea europaea* L.; Oleaceae; SWAT003090 | Ole eur | Shawan[MD, MN, PD, BT]<br>Shalwanai[OR] | Fruitsandleaves | Fruits: Raw snacks[OR(2), BT(18), MN(18), PD(17), MD(14)]<br>Leaves: Tea[BT, OR] | Shah et al., 2015<br>Aziz et al.,2021 |
| *Oxalis corniculata* L.; Oxalidaceae; SWAT003091 | Oxacor | Tarveekai[MD]<br>Tuftufak[OR] | Leaves | Fermentation[OR(2)]<br>Raw snacks[MD(2)] | Aziz et al., 2021 |
| *Periploca aphylla* Decne.; Apocynaceae SWAT003092 | Per aph | Barare[MD, MN, OR, PD, BT] | Latex or gum | Chewing-gum[OR(2), MD(7), BT(3), MN(3), PD(4)] | Aziz et al., 2021 |
| *Pinus gerardiana* Wall. ex D.Don; Pinaceae; SWAT003093 | Pin ger | Zarghuzai[MD, MN, PD, BT]<br>Zughak[OR] | Kernels | Cooked[OR(2)]<br>Raw snacks[MD(5), BT(6), MN(6), PD(4)] | Aziz et al., 2020<br>Aziz et al., 2021 |
| *Pistacia khinjuk* Stocks; Anacardiaceae; SWAT003094 | Piskhi | Shanee[MD, OR, PD, BT] | Fruits | Raw snacks[OR(6), MD(6), BT(4), PD(5)] | |
| *Polygonatum verticillatum* (L.) All.; Asparagaceae; SWAT003095 | Pol ver | Miralam[OR] | Aerial parts | Cooked[OR(2)] | Aziz et al., 2021<br>Abbas et al., 2020 |
| *Portulaca* L.; Portulacaceae; SWAT003096 | Port | Tarveekai[PD] | Aerial parts | Raw snacks[PD(12)] | |
| *Portulaca oleracea* L.; Portulacaceae; SWAT003097 | Por ole | Sormai[MD, OR<br>Lorank[MN, BT]<br>Paikharrai[PD] | Aerial parts | Cooked[OR(2), MD(4), BT(3), MN(3), PD(2)] | |
| *Punica granatum* L.; Lythraceae; SWAT003098 | Pun gra | Jangle Nargosa[MD, OR, PD]<br>JangliAnar[MN, BT] | Fruit | Raw snacks[OR(2), MD(8), BT(5), MN(6), PD(3)] | |
| *Quercus floribunda* Lindl. ex A.Camus; Fagaceae; SWAT003099 | Que flo | Cherre[MD, MN, PD, BT]<br>Chat[OR]<br>Sat[OR] | Kernels | Raw snacks[OR, MD(17), BT(8), MN(17), PD(5)]<br>Cooked[OR(18)] | Aziz et al., 2021<br>Aziz et al., 2020 |
| *Rheum ribes* L.; Polygonaceae; SWAT003100 | Rhe rib | Pshayiee[PD] | Shoots/stalks | Raw snacks[PD(1)] | |
| *Rumex dentatus* L.; Polygonaceae; SWAT003101 | Rum den | Zando[OR] | Leaves | Cooked[OR(2), MD(2)] | Aziz et al., 2021<br>Aziz et al., 2020<br>Aziz et al., 2020 |
| *Sageretia thea* (Osbeck) M.C.Johnst.; Rhamnaceae; SWAT003102 | Sag the | Mamorye[MD]<br>Mamare[MN, BT] | Fruits | Raw snacks[MD(5), BT(6), MN(6)] | |
| *Salvadora oleoides* Decne.; Salvadoraceae; SWAT003103 | sal ole | Paliman[MD, MN, BT] | Fruits or leaves | Leaves: Cooked[MD(2)]<br>Fruit: Raw snacks[BT(8), MN(8)] | |
| *Sideroxylon mascatense* (A.DC.) T.D.Penn.; Sapotaceae; SWAT003104 | Sid mas | Gargora[MD, MN, OR]<br>Gorgora[PD, BT] | Fruits | Raw snacks[OR(17), MD(14), BT(6), MN(2), PD(4)] | |

**Table 2** (continued)

| Botanical name; family; voucher numbers; | Abbreviations | Local name | Parts used | Recorded gastronomic uses | Earlier reported |
|---|---|---|---|---|---|
| *Solanum americanum* Mill.; Solanaceae; SWAT003105 | Sol ame | Malgebai[MD] Woolang[MD] Chikhrof[OR] | Fruits | Raw snacks[OR(2), MD(2)] | Aziz et al., 2021 Aziz et al., 2020 |
| *Strigosella africana* (L.) Botsch.; Brassicaceae; SWAT003106 | Str afr | Khatool[MD, MN, PD, BT] | Leaves and pods | Raw snacks[MD(3), MN(3)PD(13)] Cooked[BT(3)] | |
| *Thymus linearis* Benth.; Lamiaceae; SWAT003107 | Thy lin | Marveeja[MD] Izbuk[OR] Mizbuk[OR] | Aerial parts | Tea[OR(1)] Salad[OR(1)] | Aziz et al., 2021 Aziz et al., 2020 |
| *Tragopogon gracilis* D.Don; Asteraceae; SWAT003108 | Tra gra | Shabye[MD, OR] | Leaves | Raw snacks[OR(1)] | Aziz et al., 2021 Abbas et al., 2020 |
| *Trifolium repens* L.; Fabaceae; SWAT003109 | Tri rep | Shawtala[MD, MN, PD, BT] | Aerial parts | Cooked[MD(4), BT(3), MN(3), PD(16)] | |
| *Perovskia atriplicifolia* Benth.; Lamiaceae; SWAT003110 | Per atr | Shanshubai[OR] | Flowers | Flowers: Raw snacks[OR(1)] | |
| *Urtica dioica* L.; Urticaceae; SWAT003111 | Urt dio | Dhur[OR] | Leaves | Cooked[OR(2)] | Aziz et al., 2021 Aziz et al., 2020 Aziz et al., 2020 |
| *Verbascum* spp.; Schrophulariaceae; SWAT003112 | Ver spp. | Zakhta[MD, OR, PD] | Leaves | Raw snacks[OR(7), MD(2),PD(2)] | Aziz et al., 2021 |
| *Viburnum cotinifolium* D.Don; Viburnaceae; SWAT003113 | Vib cot | Margharava[MD] Margharrova[OR] | Fruits | Raw snacks[OR(4), MD(3)] | Aziz et al., 2021 Shah et al., 2015 |
| *Vicia sativa* L.; Fabaceae; SWAT003114 | Vic sat | JangliMatar[MD., OR] Sarkari Matar[MN, PD, BT] | Fruits | Cooked[OR(2), MD(2), MN(2)] Raw snacks[OR(2), MD(2), MN(2)] | |
| *Viscum album* L.; Santalaceae; SWAT003115 | Vis alb | Warghusti[OR] | Fruits | Raw snacks[OR(4)] | Aziz et al., 2021 |
| *Vitis vinifera* L.; Vitaceae; SWAT003116 | Vit vin | JangliAngeer[MD] JangliAngoor[MN, OR, PD, BT] | Fruits | Raw snacks[OR(2), MD(7), BT(14), MN(14), PD(7)] | |
| *Withania coagulans* (Stocks) Dunal; Solanaceae; SWAT003117 | Wit coa | Khamazora[MN, OR, PD] Khamazeera[BT] | Fruits | Fermentation-[OR(4), BT(2), MN(1), PD(3)] | Aziz et al., 2021 |
| *Ziziphus mauritiana* Lam.; Rhamnaceae; SWAT003118 | Ziz mau | Beera[MD, MN, OR, PD, BT] | Fruits | Raw snacks[OR(16), MD(6), BT(5), MN(5), PD(15)] | |
| *Ziziphus nummularia* (Burm.f.) Wight & Arn.; Rhamnaceae; SWAT003119 | Ziz mau | Karkanre[MD, MN, PD, BT] | Fruits | Raw snacks[MD(2), BT(3), MN(5), PD(6)] | |
| Unidentified SWAT003120 | Uni 1 | Tarwoski[BT] | Leaves | Raw snacks[BT(3)] | |
| Unidentified SWAT003121 | Uni 2 | Zanrke[MD] (Kharge) | Fruits | Raw snacks[MD(5)] | |
| Unidentified; SWAT003122 | Uni 3 | Shamolai[PD] | Leaves | Salad[PD(2)] Cooked[PD(2)] | |
| Unidentified; SWAT003123 | Uni 4 | Ghureeza[PD] (yellow fruit) | Fruits | Raw snacks[PD(1)] | |
| Unidentified; SWAT003124 | Uni 5 | Gul Sheeza[MD] | Leaves | Raw snacks[MD(4)] | |
| Unidentified; SWAT003125 | Uni 6 | Karashka[MD, OR] | Leaves | Tea[OR(1)] | |
| Unidentified; SWAT003126 | Uni 7 | Markhairrai[PD] | Bulb | Chewing-gum[PD(1)] | |
| Unidentified; SWAT003127 | Uni 8 | Makhlak[MD] Makhilak[OR] | Leaves | Cooked[OR(2)] Raw snacks[MD(4)] | |

(MD = Mehsud; MN = Miani; OR = Ormur; BT = Bettani; PD = Powanda)

Mill., *Thymus linearis* Benth., *Tragopogon gracilis* D.Don, *Urtica dioica* L., *Verbascum* spp., *Viburnum cotinifolium* D.Don, *Viscum album* L., and *Withania coagulans* (Stocks) Dunal. Most of the reported plant species are used for the same food processing method. However, a few species were documented for different processing methods by all study communities living in the study area.

It is fascinating to note that approximately 22 plant-based food ingredients were reported as novel, as they had not been previously documented in our ethnobotanical studies conducted in the same area [48]; these novel wild food species included *Acacia* sp., *Allium carolinianum* Redouté, *Apteranthes tuberculata* (N.E.Br.) Meve & Liede, *Atriplex laciniata* L., *Brassica rapa* L., *Calotropis procera* (Aiton) Dryand., *Capparis decidua*,

*Chenopodium murale*, *Cucumis melo*, *Ehretia obtusifolia*, *Imperata cylindrica* (L.) P.Beauv., *Pistacia khinjuk* Stocks, *Punica granatum* L., *Rheum ribes* L., *Sageretia thea* (Osbeck) M.C.Johnst., *Salvadora oleoides*, *Sideroxylon mascatense* (A.DC.) T.D.Penn., *Strigosella africana*, *Trifolium repens* L., *Vicia sativa*, *Vitis vinifera* L., *Ziziphus mauritiana* Lam., and *Ziziphus nummularia* (Burm.f.) Wight & Arn. Most of the plant species mentioned in the study area reappeared, having previously been reported as extinct in ethnobotanical studies.

The commonalities among the food knowledge of the two selected groups confirm some form of cross-cultural interaction between Pashtuns and Ormur speakers, who have shared the same socio-ecological space for centuries. Barth [50] described the socio-cultural adaptations among Pashtuns and non-Pashtuns in North-West Pakistan well. The results here also highlight the socio-cultural negotiations among these ethnically diverse groups, which can be linked to symbiotic relationships and pluralism, as seen in the case of cultural groups in northern Pakistan [51, 52].

The case of Powanda is emblematic; they have been involved in cross-border migration along the Pakistani-Afghan border and have traversed different cultural and ecological landscapes. The Powanda group in the study area, originating from Afghanistan, has recently obtained permanent residence in Gomal and retains knowledge of WFP collection practices in high-altitude pastures. For example, study participants from Powanda cited *Allium carolinianum*, *Rheum ribes*, and two other unidentified taxa they mentioned growing in Afghanistan. We have observed that knowledge of plants gathered in Afghanistan was part of the memory of elderly community members. At the same time, upon investigation, it becomes apparent that younger community members lack traditional knowledge. This group has a long historical tendency to rely on seasonal migration trajectories that extend across national borders into Afghanistan, along with the associated fluctuations in resource availability. Local practices of transhumance involve moving livestock to alpine pastures nestled within the Afghan terrain during the summer, with a subsequent return to their adjacent territories in Pakistan during the inclement winter months. Within the compass of our present inquiry, meticulous scrutiny has unveiled the articulation of specific plant taxa, primarily endemic to higher altitudes within the Afghan precinct, within the discursive narratives of the Powanda community.

Likewise, the Mehsud and Ormur communities engage in seasonal migrations to mountainous regions, and their idiosyncratic plant usage is linked to specimens collected in Waziristan. Contrarily, the Bettani and Miani populations exhibit distinct social attributes. The findings underscore that shared language does not guarantee the transmission of local plant knowledge across groups; instead, these differences are contingent on socio-cultural interactions and intermarriage.

On average, participants from the Mehsud community retained the highest level of knowledge of the relevant plant taxa, followed by those from the Bettani community (Fig. 4). Statistical analysis revealed high heterogeneity in knowledge distribution ($p < 0.05$), suggesting variations in knowledge transmission and culinary practices across groups. Cluster analysis identified two primary clusters based on similarity in knowledge of relevant plant taxa. Cluster 1 comprised the Mehsud

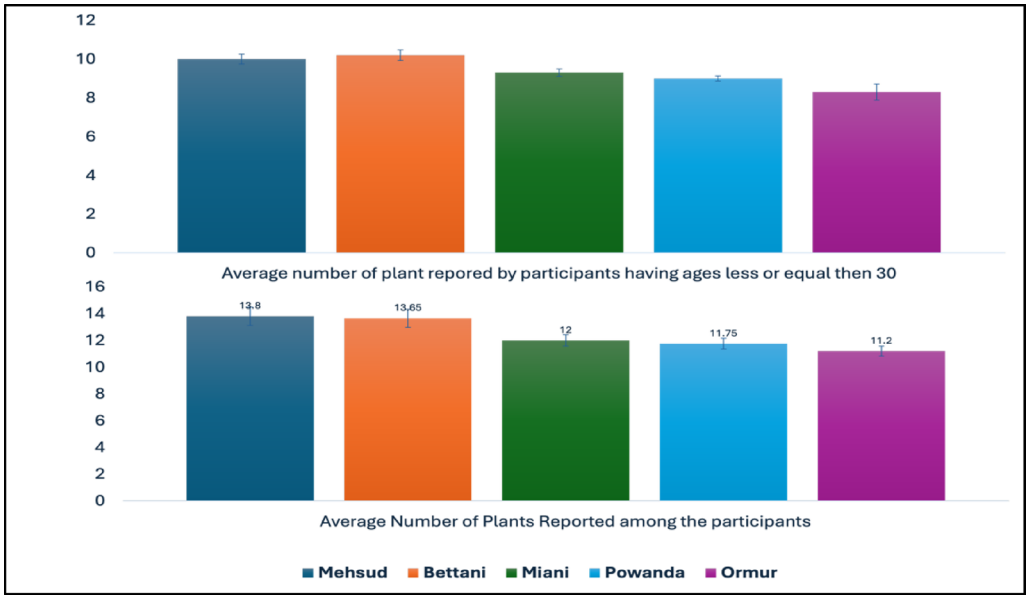


**Fig. 4** Distribution of knowledge across the different ages of the five selected communities

and Bettani communities, indicating shared ethnobotanical knowledge. Cluster 2 included all other studied communities. The Ormur (also known as Burki) community formed a distinct outlier cluster due to its significantly divergent plant knowledge compared to other groups (Fig. 5).

Among the researched communities, the Mehsud reported the highest average number of plant species (13.8 taxa), as shown in Fig. 4. Statistical analysis (error bars shown in percentage) reveals a comparatively high concentration of local plant knowledge in Ormur, Miani, and Powanda. In contrast, for Bettani and Mehsud, the knowledge was less concentrated or dispersed.

Similarly, we observed that participants under 30 reported a higher average number of plants in Bettani than in other groups (Fig. 4). However, the difference was not as pronounced as that between the selected groups. The results show that local plant knowledge among the younger generation of Ormur was less concentrated, suggesting an unreliable or ineffective transfer of expertise within this group.

Our quantitative analysis has raised several points regarding the uneven distribution of local knowledge about wild food plants across generations (Fig. 6). Linear regression analysis ($R^2$) revealed a relatively strong relationship between age and local plant knowledge across all research groups, with the Miani community showing the highest correlation. The results suggest that the local plant nomenclature of the Ormur community is influenced by the vocabulary of the dominant neighbouring Pashtun culture, as reflected in the third column of the main ethnobotanical table, where both communities share similar local names for specific taxa.

Cross-cultural comparison revealed that food knowledge among different groups varies, and, to a lesser extent, the uses of the quoted plants have been homogenised. The results of the cross-cultural analysis are shown in the Venn diagrams (Fig. 7). Several idiosyncratic plants and their uses were observed among the different ethnic groups. Among the selected groups, the highest incidence of idiosyncratic uses was observed among the Ormur community, followed by the Powanda community. Similarly, remarkable homogeneity was observed among the frequently mentioned plant uses (quoted by more than 50% of informants).

## Discussion

### The conundrum of displacement and plant knowledge

Displacement has distanced communities from their traditional land practices and natural resource management, undermining the core of local plant knowledge (LPK) among the studied groups. Although much traditional food knowledge remains, it is under severe threat. Relocation due to conflict has disrupted cultural plant

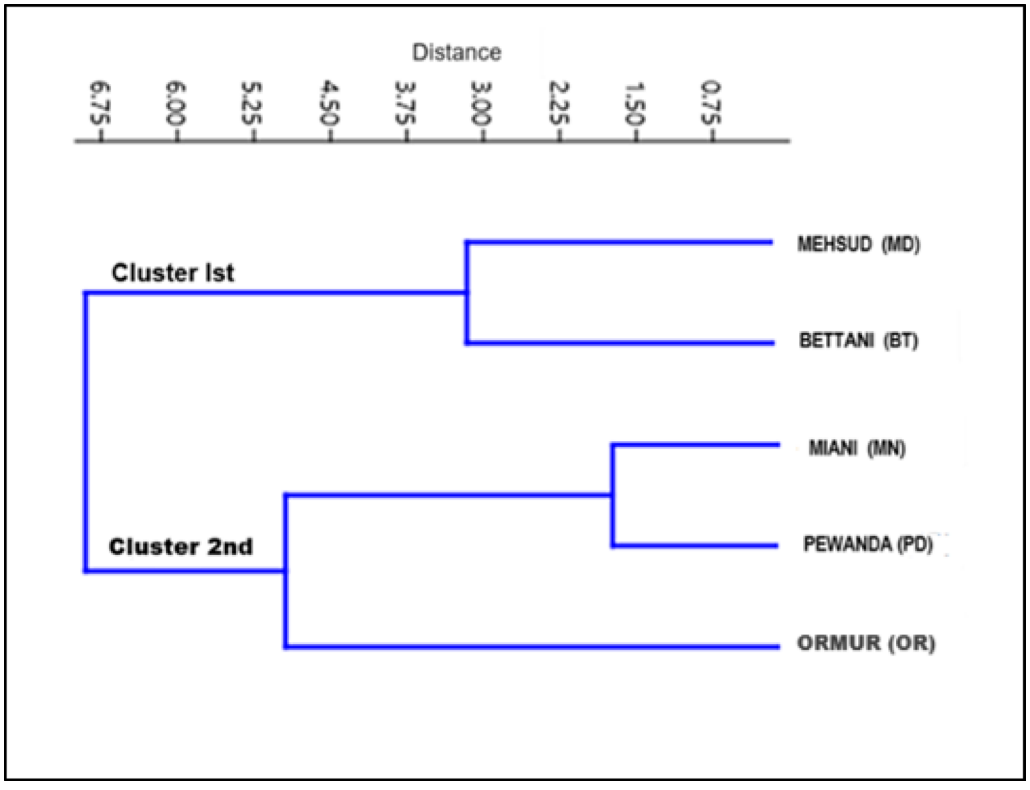


**Fig. 5** Similarity dendrogram depicting relationships among the studied communities based on the shared WFPs knowledge

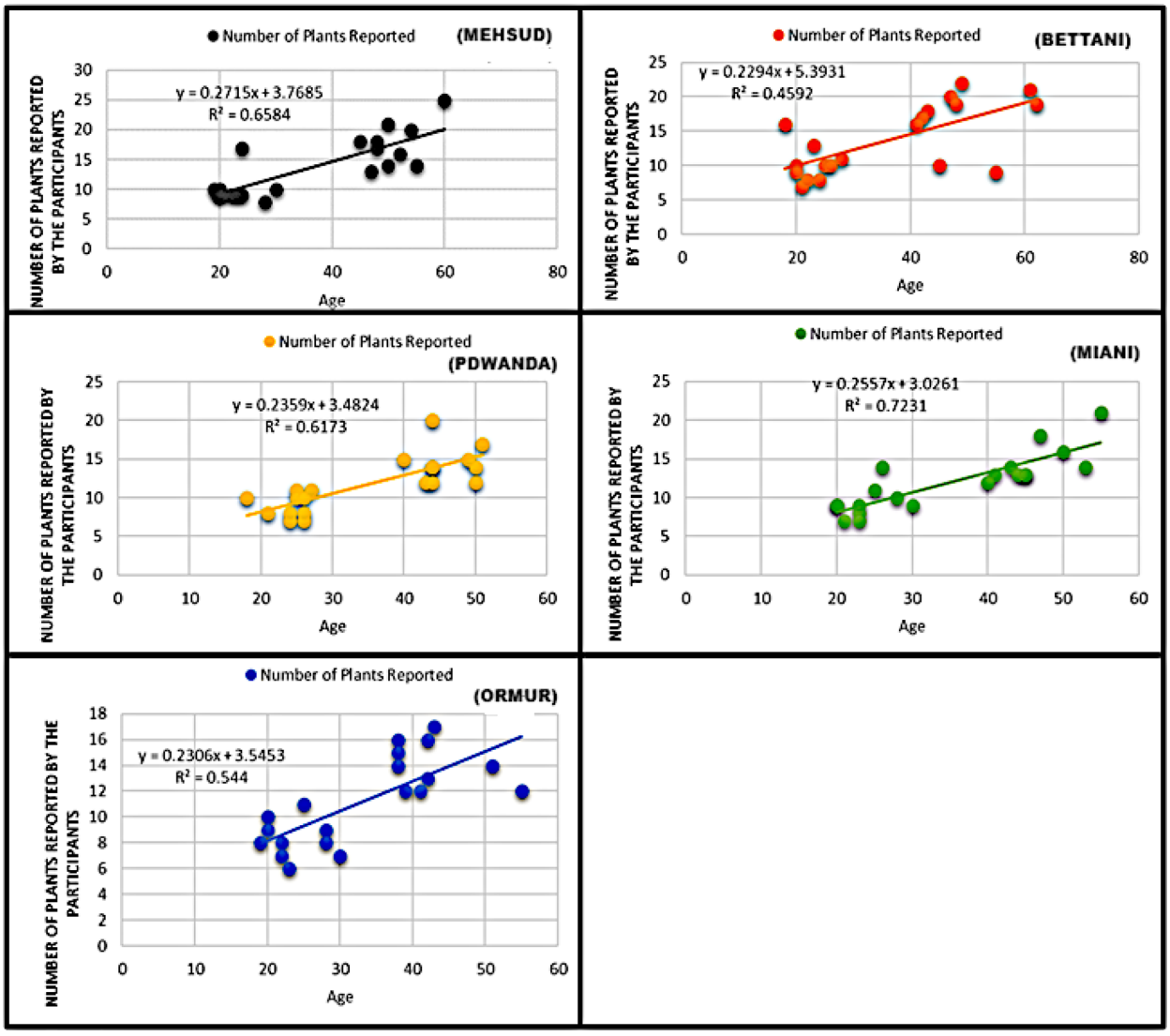


**Fig. 6** WFPs' knowledge among the diverse ages among the different ethnic groups (Linear regression analysis)

knowledge among the Ormur, Mehsud, and Powanda. Military operations forced these ethnic groups to flee their ancestral lands, and insecurity in western Pakistan and adjacent Afghanistan continues to endanger LPK. Displacement severed people's connection to traditional ecological practices, drastically affecting local resource management.

The Mehsud and Ormur, once settled in Waziristan, maintained herding, farming, and forest use, but migration to Gomal and nearby areas has disconnected them from these ecological traditions and altered cultural codes of environmental management. As culture is rooted in nature, losing that bond jeopardises its very survival.

The Powanda, Afghan Pashtuns with a long history of pastoral nomadism, have also faced economic and cultural hardships. Their forced relocation remains a political issue for both Afghanistan and Pakistan. When people are removed from familiar ecosystems, cultural communication and environmental practices collapse, leading to disorientation and loss of memory. Among the Afghan diaspora, such disruptions have fractured social networks, beliefs, and values.

Historically, Powanda's mobility sustained resilient plant knowledge, but tightened border controls now prevent seasonal crossings. Younger Powanda increasingly forgets the names and uses of plants once common in Afghanistan, showing a breakdown in intergenerational transmission.

The sustainability of LPK now depends on peace and security in South Waziristan and Afghanistan. Prolonged instability has left villages abandoned and younger generations unfamiliar with local flora. Without change, much of this knowledge will soon vanish. Sustained peace is

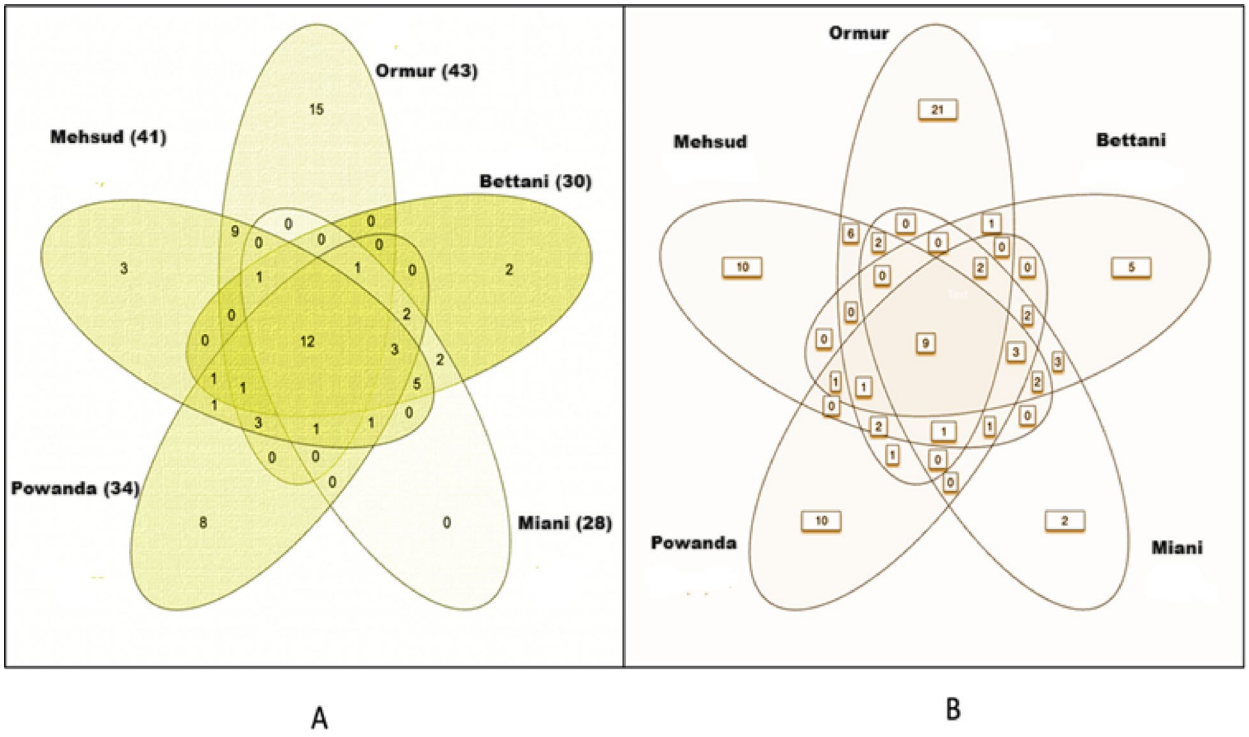


**Fig. 7** Venn diagram revealing the cross-cultural knowledge referred to (**a**) the overall recorded plant taxa and (**b**) the taxa reported by more than 50% of the informants

essential for preserving the Ormur and Mehsud traditions, while greater cross-border mobility could help the Powanda maintain cultural resilience.

### The erosion of local plant nomenclature

Language transformation among minority groups profoundly shapes their perception of plants, as naming and classifying taxa are deeply embedded in culture and language. Local plant names embody cultural, ecological, and practical meanings; thus, they are expressions of identity and heritage. Accurate nomenclature fosters a strong connection to the land and an understanding of the environment. However, preserving plant names among minorities in multicultural societies is increasingly complex.

The Ormur minority, under intense cultural and linguistic pressure from the Mehsud Pathans, has suffered significant erosion of plant knowledge [48, 53]. Historically endogamous and sharing the Sunni faith, both groups have recently experienced frequent intermarriages, accelerating linguistic homogenisation. Morgenstierne [36] noted that Ormur speakers in Kaniguram and Logar freely borrowed Pashto words, while Kieffer [54] found the language confined to domestic use and rapidly declining. Our data confirm that Pashto plant names have largely replaced Ormur terms, as shown in the ethnobotanical tables and previous studies [48]. Most participants could name plants in Pashto but not in Ormur, signaling a profound linguistic shift.

As one interviewee stated:

> *"Military conflicts drove us to cities, where frequent interaction with Pashtuns weakened our language. Our youth are losing their mother tongue—how could they know the names of wild food plants when they no longer see or use them?"*

This erosion, reminiscent of "linguicide" [55], reflects displacement and forced assimilation caused by prolonged conflict. Similar patterns were documented by Aziz et al. [48] and others [36, 54]. The weakening of the mental lexicon of plant names underscores the interconnectedness of language, culture, and knowledge. Recognising community-specific taxonomies is vital for cultural preservation, ecological awareness, and sustainable development. In multicultural contexts, dominant languages reshape the linguistic and ethnobotanical systems of minorities, hastening the loss of traditional terminology.

### Generational changes

Traditional plant knowledge among the Mehsud, Ormur, and Powanda communities is in grave decline due to displacement and urbanisation, which disrupts cultural and ecological continuity. The Bettani and Miani, though less affected by displacement, confront similar threats

from expanding urbanisation. Younger generations are increasingly detached from nature-based activities such as foraging and identifying wild food plants (WFPs), weakening intergenerational transmission [48, 51, 52].

Urban migration has altered perceptions of wild food resources. Changing family structures and the reduced role of elders further weaken knowledge transfer. Commodification of food has replaced foraging traditions; participants recalled WFP collection as a "practice of the past." Yet species like *Chenopodium album*, *Rumex dentatus*, *Urtica dioica*, and *Malva neglecta* once formed key parts of the local diet [48, 56]. Their abandonment signals a loss of gastronomic heritage. Detachment from nature also erodes the tacit knowledge that links body, mind, and environment [57].

Foraging, long stigmatised as a sign of poverty, now varies culturally. While in Pakistan it declines with industrialisation and urbanisation, in Western societies it has re-emerged as an ethical and sustainable practice. In Pakistan, reduced foraging is also tied to climate change and declining WFP growth. Over half the reported species were cited by fewer than half of the participants, indicating erosion of biocultural heritage. Unlike sporadically used medicinal plants, food taxa once integrated into daily life; their disappearance from young people's knowledge highlights a break in "school-like" transmission systems.

The fading of food plants from diets demonstrates that knowledge loss is not abstract but tangible. The declining reporting of WFPs and their absence from contemporary practices confirm a significant contraction of biocultural heritage among the studied groups.

### Future educational initiatives for revitalising ethnobotanical knowledge

Modern, decontextualised education systems have devalued local plant knowledge and weakened youth connections to their environment. Integrating ethnobotanical content into formal curricula is essential to counter this decline. Teaching local plant names and uses can strengthen cultural identity and promote biodiversity conservation.

Revitalising endangered languages and traditions requires community participation to enhance intergenerational transmission of LPK. Local populations should be encouraged to reconnect with ecosystems and rely on native food resources rather than commercial products. Community-based research, cultural contests, and government support for traditional land management could foster sustainable practices and knowledge transfer.

Combating the erosion of plant nomenclature demands coordinated cultural, educational, and policy measures. In South Waziristan, attitudes toward foraging vary with cultural norms and economics [48]. Given the impacts of climate change and the need for ecological transition, foraging offers sustainable food alternatives. In Western societies, renewed interest in wild edibles reflects growing concern for local, diverse, and healthy diets. Whether similar trends emerge in Pakistan remains to be seen.

Knowledge held by mountain groups such as the Powanda, Mehsud, and Ormur remains vital for biodiversity conservation and sustainable land management. Valuing this knowledge can foster collaboration between local communities and researchers, promoting deeper ecological understanding. Proactive initiatives—community programs, documentation, and co-research—are essential for safeguarding traditional plant knowledge while recognising cultural dynamism.

Furthermore, cross-cultural dialogue is necessary to bridge local nomenclature with scientific taxonomy, advancing both conservation and societal appreciation of ethnobotanical wisdom through interdisciplinary collaboration.

### Limitations of the study

Certain limitations affected the findings. Women's plant knowledge could not be documented due to cultural restrictions, so recorded LPK reflects only male perspectives. Displacement and trauma may also have impaired memory recall, particularly among the Powanda, who migrated decades ago. Lastly, surveys among the Bettani and Miani were conducted in a single season, potentially excluding taxa that are important at other times of the year.

## Conclusion

Our study sheds light on the profound impact of forced delocalisation, societal transition, and urbanisation on the mutual relationships between humans and their local wild food plants. The erosion of ethnobotanical knowledge becomes evident when communities lose their ancestral connections to the landscapes that have shaped their traditions for generations. Given the diversity of the knowledge, the study gathered sufficient local plant knowledge, providing valuable insights into the intricacies of intergenerational transmission and cultural resilience. Cross-cultural comparisons revealed diversity in the utilisation of these plants, highlighting the uniqueness of each ethnolinguistic group's knowledge.

Nevertheless, our study has also revealed that forced displacements due to militarisation and ecological shifts undermine intergenerational transmission among the Ormur, Mehsud, and Powanda communities. Similarly, urbanisation has further exacerbated the situation, as the attachment to industrial food and the commodification of food materials have diminished newcomers' and younger indigenous generations' hands-on experiences with nature.

In addition, the linguistic minority of Ormur is facing a challenge to their local plant nomenclature, as it has been influenced by the dominant Pathan culture, leaving them in a puzzling situation regarding the protection of their cultural heritage. In this crisis, we must advocate for the inclusion of contextualised nature knowledge, encompassing the local wild food plant knowledge of these diverse groups, in local educational curricula. This will not only revive ethnobotanical heritage but also foster locals' ability to shape their sustainable future in the current turbulent context.

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**Author contributions**
MAA designed the project and, along with AU, conducted the fieldwork. MAA, AU, and MUH compiled and curated the field data. ZU identified the botanical taxa; MAA and MUH analysed the data; MAA, MUH, and AM wrote the first manuscript draft; AP commented on and improved the original draft and finalised it with all the other authors for journal submission. All authors read and approved the final version.

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**Data availability**
All the required data are provided in the article.

## Declarations

**Ethical approval and consent to participate**
All the participants provided oral Prior Informed Consent before each interview. The ISE Code of Ethics (https://www.ethnobiology.net/what-we-do/core-programs/ise-ethics-program/code-of-ethics/) was strictly followed.

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare no competing interests.

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