An ethnobotanical survey of wild food plants used by the local communities of Kumrat Valley in District Upper Dir, Pakistan

Latif Ahmad, Muhammad Riaz, Hammad Ahmad Jan, Andrew J. Semotiuk, Imran Ahmad, Imran Khan, Fayaz Ali, Wajid Rashid and Rainer W. Bussmann

Correspondence

Latif Ahmad¹*, Muhammad Riaz², Hammad Ahmad Jan³, Andrew J. Semotiuk⁴, Imran Ahmad⁵, Imran Khan⁶, Fayaz Ali⁷, Wajid Rashid⁵ and Rainer W. Bussmann⁶

¹Department of Botany, Shaheed Benazir Bhutto University, Upper Dir, Pakistan
²Department of Pharmacy, Shaheed Benazir Bhutto University Sheringal Dir Upper, Pakistan
³Department of Botany, University of Buner, Pakistan
⁴Independent researcher
⁵Department of Environmental and Conservation Sciences University of Swat
⁶Department of Ethnobotany, Institute of Botany, Ilia State University, Tbilisi, Georgia

*Corresponding Author: latifahmad1989@sbbu.edu.pk

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Databases and Inventories

Abstract

Background: Local people of the Kumrat Valley, district Upper Dir in Northwest Khyber Pakhtunkhwa, Pakistan rely on wild food plants (WFP) for nutrition, medicine, and monetary value. The present study aimed to accomplish a detailed investigation of local wild food plants and their therapeutic importance to identify innovative organic food products that show potential for local marketing through their use prevalence and monetary value.

Methods: Semi-structured interviews and group discussion, were conducted from May to September 2019. In the field survey, 78 local participants were selected using random sampling. Ethnobotanical data were analyzed using Use Value (UV), Informant Agreement Ratio (IAR), and Relative Frequency of Citation (RFC).

Results: A total of 50 species of wild food plants and 2 fungal species of 30 botanical families and 40 genera were encountered. Family Rosaceae dominated with the highest species number (6 species), followed by Moraceae and Leguminosae. With respect to life forms, herbs constituted (60%), trees (30%), and shrubs (30%). Ripe fruits (43%) were the most frequently used part of wild foods.

Conclusions: Important species may serve to guide development initiatives aimed at sustainable and culturally local projects. Traditional knowledge can be used for the synthesis of new allopathic medicines.

Keywords: Ethnobotany; Wild food plant; Medicinal uses; Kumrat Valley; Upper Dir

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Background

Plant collection and storage is a deeply rooted and shared aspect of human heritage. Around the globe, millions of the people in rural communities depend on gathering of plants for food & nutrition, medicine, fuel, construction, carpets, animal husbandry, as well as religious ceremonies and rituals (Anderson 2014). The term "wild" refers to those plants that grow without being cultivated (Seal, 2012). From a total of 350000-450,000 known higher plant species, about 5000 have been cultivated or collected for food at certain times, and only 20-30 are regarded as staple foods for humanity (Heywood, 1999). According to Marwat et al. (2009), fruits were likely used first as food. Wild Food Plants (WFP) often contain more nutrients (Ogle and Grivetti, 1985). WFP are thus a significant source of vitamins, minerals, fiber, carbohydrate, and proteins (Marwat et al. 2009), serve as staple food and offer an alternative source of cash income (Teklehaymanot and Giday, 2010). As such WFPs play an important role in ensuring food security and improve the nutrition in the diets of many people especially in developing countries (Abbasi and Guo; FAO 2004; Ghorbani et al. 2012; 2015 Lulekal et al. 2011). Moreover, WFPs are potential sources of species for domestication and provide valuable genetic traits for developing new crops through breeding and selection (Ford-Lloyd et al. 2011; Pandey et al. 2008). They can also serve as sources for income in poor communities (Ghorbani et al. 2012; Uprety et al. 2012). Humans have cultivated about 200 species of plants as food crops but only 30 contribute to 95% of the world's plant food consumption (FAO, 1996; Ghorbani et al. 2012; 2008; Shrestha and Dhillion 2006; Simpson & Ogorzaly 1995).

Since ancient times, humans have been using plants as medicine and according to some estimates, e.g. approximately 90% of the tibbi medicines are prepared from herbs. WFPs are often also used medicinally due to their nutraceutical. In this explorative study, we examined the cultivation, and collection, of local WFPs, their market values, and ethnomedicinal uses among the local communities of Kumrat valley in Upper Dir, Pakistan. The present study had two aims: First, to accomplish a detailed documentation of local WFP uses and to evaluate their potential for local marketing. Second, to identify botanical species and herbal remedies used by the local people for the treatment of human ailments.

Materials and Methods

Study area

The current survey was conducted in Kumrat Valley, located in the North East of Upper Dir, Pakistan, about 120 km from Dir Khass (Fig. 1) 35° 31’ 59.9”N - 35° 34’ 10”N and 72° 13’ 38.8” E - 72° 11’ 22”E. Thall is the nearest town at a distance of about 45 km from Kumrat valley and is used as the launching point for trips to Kumrat. In Kumrat the elevation ranges from 1371 m to 1981 m. Climatically the research area falls in a humid subtropical climate zone with four distinct seasons (winter, spring, summer and, autumn). The winter season is harsh and long. Snowfall frequently happens in mid of the winter season (December and January) at high altitudes sites of the research area. The majority of the area is covered with thick vegetation, dominated by wild Pinus spp., and Cedrus spp.

Ethnobotanical investigation

During the field work, prior informed consent was obtained from all participants, after explaining the aim of the research work. Several trips were conducted from May to September 2019. We interviewed 78 participants using a semi-structured questionnaire, after obtaining oral prior informed consent. The interviews lasted between 15 and 25 minutes, inquiring about local names of the plants, parts used, uses, and economic importance following (Jan et al. 2020).

Plant collection, identification, and preservation

A total of 50 species of WFP were collected from the study area. Species were identified in the field using Wali et al. (2019). Specimens were collected and verified in the Department of Botany, Shaheed Benazir Bhutto University using the available literature (Jan et al. 2017). Taxonomy and naming of species follow the International Plant Names Index (www.ipni.org) and The Plant List (www.theplantlist.org). The collected vouchers were submitted to the Department of Botany SBBUS.

Classification of wild food plants

Based on local uses, five basic groups of WFP were identified: I) ripe fruits, II) cooked as vegetable, III) eaten as salad, IV) used as spice, and V) prepared as herbal tea.
Quantitative ethnobotany

Use value

The use-value assesses the relative significance of each ethnomedicinal plant species based upon its relative used among respondents (Tardio et al. 2008). The use-value (UV) was calculated through the following formula:

\[ UV = \frac{\sum U_i}{N} \]
where \( Li \) is the number of used reports mentioned by each participant and \( N \) is the total number of respondents interviewed for a given plant species.

**Relative Frequency of Citation (RFC)**

To calculate the indigenous significance of each species, the RFC index was used. It is mainly based on the frequency citation of a species (Muhammad et al. 2019). The RFC was calculated using the formula:

\[
RFC = \frac{FC}{N}
\]

where \( FC \) = informants’ number for the particular species and, \( N \) = total number of participants in the study. The "N" value of RFC may be zero or 1. It will be zero in the case when no one respondent cited the significance of a plant and one if all participants report the significance of a plant.

**Informant Agreement Ratio (IAR)**

The quantitative index, informant agreement ratio (IAR), was used for the purpose to estimate the variability of the use of ethnobotanical plants. To analyze ethnobotanical data, IAR is widely used. The value of IAR ranges from 0 to 1. Values close to 1 are considered a high value (close to 1) and indicates that relatively few plants are used by a large proportion of the respondents. While a low value (close to 0) indicates that the respondents disagree on the taxa’s use within a category (Heinrich et al. 1998). Sometimes it is also called the informant consensus factor (Heinrich et al. 2009) and calculated as follows:

\[
IAR = \frac{(Nur - Nt)}{(Nur - 1)}
\]

where \( Nur \) = number of use-reports in each category, \( Nt \) = number of taxa used in each category

**Results and Discussion**

**Socio-demographic of participants**

In the present study, a total of 78 local participants were interviewed. Most participants belonged to the age group from 45-65 years (37 informants), followed by 25-45 year (22) and 65-100 (19). The majority of the interviewed respondents were men (about 90%), and only 10% were women, due to cultural restrictions (Fig. 2). Mostly participants in the study area had received little formal education. It was noted that women had more knowledge about wild edible plants used as vegetables and medicines than men, likely because they cook, while male respondents knew more about wild edible fruits.

![Figure 2. Age distribution of the informants interviewed](image)
Floristic composition of food plants
All species and their data are shown in Table 1. A total of 50 species of wild food plant belonging to 30 botanical families and 40 genera were collected. In addition, two fungi, *Agaricus campestris* and *Morchella esculenta* were documented. All these recorded species were native to study area. The highest number of WFP belonged to Rosaceae with 6 species followed by Moraceae and Leguminosae (Figure 3). The result of the present study confirmed that people tended to use preferably the plants that are easily available to them in the wild habitat. Comparative literature analysis showed that the highest diversity of WFPs (64 species) was documented from the district Lower Dir (Ahmad *et al*. 2017), whereas the lowest diversity (47) was reported in Swat district (Khan *et al*. 2015). The most common growth form of WFPs were herbs with 30 species followed by trees and shrubs (Figure 4).

![Figure 3. Number of plant species in different families](image-url)
### Table 1. Identified wild food plants consumed in Kumrat valley

| Scientific name       | Local name | Life form | Part used | Used categories         | Therapeutic uses                                                                 | UVb | FCc | RFCd |
|-----------------------|------------|-----------|-----------|-------------------------|----------------------------------------------------------------------------------|-----|-----|------|
| **Amaryllidaceae**    |            |           |           |                         |                                                                                  |     |     |      |
| *Allium jacquemontii* Kunth | Ogakai      | Herb      | BL        | Salad                   | Hypertension                                                                      | 0.7 | 23  | 0.29 |
| **Amaranthaceae**     |            |           |           |                         |                                                                                  |     |     |      |
| *Amaranthus viridis* L. | Chulai      | Herb      | LV        | Cooked as vegetable     | Abscesses, gonorrhea, hemorrhoids                                                | 0.2 | 15  | 0.19 |
| *Chenopodium album* L. | Narai Sarmai| Herb      | LV        | Cooked as vegetable     | Antichloristic and laxative                                                      | 0.3 | 19  | 0.24 |
| **Agaricaceae**       |            |           |           |                         |                                                                                  |     |     |      |
| *Agaricus campestris* L. | Kharairhy  | Herb      | WP        | Cooked as food          | Body tonic, source of protein                                                     | 0.2 | 31  | 0.39 |
| *Lycoperdon pratense* Pers. | Ghra Anday | Herb      | WP        | Cooked as food          | Source of protein                                                                | 0.1 | 21  | 0.26 |
| **Apocynaceae**       |            |           |           |                         |                                                                                  |     |     |      |
| *Caralluma edulis* (Edgew.) Benth. ex Hook.f. | Pamankay  | Herb      | AP        | Cooked as vegetable     | Use as antidiabetic                                                               | 0.8 | 43  | 0.55 |
| **Apiaceae**          |            |           |           |                         |                                                                                  |     |     |      |
| *Carum carvi* L       | Zankai     | Herb      | SE        | Spices and Salad        | Hypertension                                                                      | 0.6 | 21  | 0.26 |
| *Foeniculum vulgare* L | Kaga       | Herb      | SE        | Spices and Green tea    | Carminative, digestive, and diuretic                                              | 0.4 | 30  | 0.38 |
| **Asteraceae**        |            |           |           |                         |                                                                                  |     |     |      |
| *Lactuca sativa* L.   | Salad      | Herb      | LV        | Cooked as vegetable, salad | Antispasmodic and digestive                                                      | 0.07| 11  | 0.14 |
| **Asparagaceae**      |            |           |           |                         |                                                                                  |     |     |      |
| *Asparagus racemosus* Willd. | Tendorlai | Herb      | YS        | Cooked as vegetable     | Hypertension                                                                      | 0.3 | 33  | 0.42 |
| **Berberidaceae**     |            |           |           |                         |                                                                                  |     |     |      |
| *Berberis lycium* Royle | kwarry    | Shrub     | FR        | Used as fruits          | Diarrhea                                                                          | 0.6 | 41  | 0.52 |
| **Brassicaceae**      |            |           |           |                         |                                                                                  |     |     |      |
| *Nasturtium officinale* R. Br. | Talmera | Herb      | WP        | Cooked as vegetable     | Diuretic and purgative                                                           | 0.4 | 34  | 0.43 |
| *Eruca sativa* Mill    | Jamama     | Herb      | AP        | Used as salad           | Digestive problem                                                                 | 0.3 | 28  | 0.35 |
| Family               | Species                                      | Common Name   | Type  | Use                           | Health Benefits                                      | Value1 | Value2 | Value3 |
|---------------------|----------------------------------------------|---------------|-------|-------------------------------|-------------------------------------------------------|--------|--------|--------|
| Caryophyllaceae     | Silene conoidea L.                           | Mungotay      | Herb  | AP Cooked as vegetable        | Respiratory problems and anti-diabetic                | 0.1    | 22     | 0.28   |
|                     |                                              |               | FR    | Ripe fruits are eaten         |                                                      |        |        |        |
| Ebenaceae           | Diospyros lotus L.                           | Amlook        | Tree  | FR Used as fruit              | Used as febrifuge                                     | 0.2    | 27     | 0.34   |
| Fagaceae            | Quercus incana Bartram                      | Serlay        | Tree  | FR Used as fruits             | Gastrointestinal Disorders                            | 0.3    | 32     | 0.4    |
| Hypericaceae        | Hypericum perforatum L.                      | Sheen chai    | Herb  | LV Used as tea                | Stomach problems                                     | 0.07   | 13     | 0.16   |
| Helvellaceae        | Morchella esculenta (L.) Pers.               | Khusay        | Herb  | WP Cooked as food             | Antitumor activities                                 | 0.9    | 61     | 0.78   |
| Lamiaceae           | Mentha spicata L.                            | podina        | Herb  | AP Used as tea and salad      | Hypertension and stomachache                         | 0.5    | 36     | 0.46   |
|                     | Mentha longifolia (L.) L.                    | Inaly         | Herb  | AP Used as tea and salad      | Hypertension and stomachache                         | 0.6    | 39     | 0.5    |
| Leguminosae         | Medicago polymorpha L.                       | Shpeshtary    | Herb  | AP Cooked as vegetable        |                                                        | 0.09   | 16     | 0.2    |
|                     | Lathyrus aphaca L.                           | Kurkamanai    | Herb  | AP Cooked as vegetable        | Source of protein                                     | 0.06   | 12     | 0.15   |
|                     |                                              |               | FR    | Used as fruits                |                                                        |        |        |        |
|                     | Vicia faba L.                                | MurghayKhpa   | Herb  | AP Cooked as vegetable        | Source of protein                                     | 0.09   | 19     | 0.24   |
|                     |                                              |               | FR    | Used as fruits                |                                                        |        |        |        |
|                     | Lathyrus cicera L.                           | Chilu         | Herb  | AP Cooked as vegetable        | Source of protein                                     | 0.07   | 13     | 0.16   |
| Lythraceae          | Punica protopunica Balf.f.                   | Anangori      | Tree  | FR Used as fruits             | Digestive problem                                     | 0.3    | 16     | 0.2    |
| Malvaceae           | Malva sylvestris L.                          | Samchal       | Herb  | LV Cooked as vegetable        | Digestive problems, and inflammations                 | 0.08   | 17     | 0.21   |
|                     | Malva neglecta Wallr.                        | Paneerak      | Herb  | LV Cooked as vegetable        | Diuretic laxative                                     | 0.07   | 21     | 0.26   |
|                     |                                              |               |       |                               |                                                        |        |        |        |
| Family      | Species                        | Common Name | Plant Type | Use | Properties                                      | Code | Value 1 | Value 2 | Value 3 |
|-------------|--------------------------------|-------------|------------|-----|------------------------------------------------|------|---------|---------|---------|
| Moraceae    | Ficus palmata Forssk.          | Inzar       | Tree       | FR  | Used as fruit                                   |      | 0.3     | 18      | 0.23    |
|             | Ficus carica L.                | Anjeer      | Tree       | FR  | Used as fruit                                   |      | 0.2     | 15      | 0.19    |
|             | Morus alba L.                  | speen toot  | Tree       | FR  | Used as fruit                                   |      | 0.06    | 9       | 0.11    |
|             | Morus nigra L.                 | Tor toot    | Tree       | FR  | Used as fruit                                   |      | 0.07    | 10      | 0.12    |
|             | Morus macroura Miq.            | Shah toot   | Tree       | FR  | Used as fruit                                   |      | 0.04    | 6       | 0.07    |
| Myrtaceae   | Myrtus communis L              | Manhro      | Shrub      | FR  | Used as fruit                                   |      | 0.8     | 47      | 0.6     |
| Oleaceae    | Olea ferrugineo Wall. ex Aitch | Khona       | Tree       | FR  | Used as fruit                                   |      | 0.5     | 28      | 0.35    |
|             |                                |             |            | LV  | Green tea                                       |      |          |         |         |
| Oxalidaceae | Oxalis corniculata L.          | Taroky      | Herb       | LV  | Used fresh leaves as food                       |      | 0.08    | 9       | 0.11    |
| Papaveraceae| Papaver rhoeas L.              | Soor Gulay  | Herb       | LV  | Cooked as vegetable                             |      | 0.03    | 4       | 0.5     |
| Polyganaceae| Rumex dentatus L.              | shalkehy    | Herb       | LV  | Cooked as vegetable                             |      | 0.03    | 11      | 0.14    |
|             | Rumex hastatus D. Don          | Taroukey    | Herb       | LV  | Used as salad                                   |      | 0.05    | 13      | 0.16    |
| Pinaceae    | Pinus roxburghii Sarg.         | Nakhter     | Tree       | SE  | Used as fruit                                   |      | 0.06    | 14      | 0.17    |
|             | Pinus gerardiana Wall. ex D. Don| Chalgoza    | Tree       | SE  | Used as fruit                                   |      | 0.03    | 15      | 0.19    |
| Rosaceae    | Rubus vestitus Weihe           | Karwara     | Shrub      | FR  | Used as fruit                                   |      | 0.04    | 6       | 0.07    |
|             | Rubus. distans D.Don           | Banganra    | Tree       | FR  | Used as fruit                                   |      | 0.06    | 8       | 0.1     |
| Species                          | Parts Used | Type  | Part | Use | Conditions and Uses                                                                 | UV | FC  | RFC  |
|---------------------------------|------------|-------|------|-----|-------------------------------------------------------------------------------------|----|-----|------|
| *R. ellipticus* Sm              | Gooraj     | Shrub | FR   | Used as fruit | Coughs, fevers, colic and sore throat                                               | 0.02 | 3   | 0.03 |
| *Pyrus pashia* Buch-Ham. ex D. Don | Batangi    | Tree  | FR   | Used as fruit | Diarrhea                                                                            | 0.05 | 4   | 0.051|
| *Fragaria vesca* L.             | Strawberry | Herb  | FR   | Used as fruit | Cardiovascular disease and stroke                                                  | 0.1  | 23  | 0.29 |
| *Duchesnea indica* (Jacks.) Focke | Zmakey toot | Herb  | FR   | Used as fruit | Activate the blood circulation                                                    | 0.2  | 26  | 0.33 |
| *Rutaceae*                      |            |       |      |     |                                                                                       |     |     |      |
| *Zanthoxylum armatum* DC.       | Dambara    | Tree  | FR   | Used as fruit | Spice and salad                                                                    | 0.6  | 38  | 0.48 |
| *Solanaceae*                    |            |       |      |     |                                                                                       |     |     |      |
| *Solanum nigrum* L.             | Kermachu   | Herb  | LV   | Cooked as vegetable | Hypertension                                                                      | 0.6  | 41  | 0.52 |
| *Thymelaeaceae*                 |            |       |      |     |                                                                                       |     |     |      |
| *Daphne mucronata* Royle        | Lighonay   | Shrub | FR   | Used as fruit | Asthma, bronchitis, indigestion                                                   | 0.03 | 7   | 0.08 |
| *Ulmaceae*                      |            |       |      |     |                                                                                       |     |     |      |
| *Celtis eriocarpa* Decne        | Taghaga    | Tree  | FR   | Used as fruit | Laxative, astringent, and antioxidant                               | 0.02 | 4   | 0.05 |

**Parts Used:** Seed = SE, Leaves = LV, Young shoot = YS, Whole plant = WP, Fruit = FR, Aerial part = AP, Bulb = BL; **UV** = Use Value; **FC** = Frequency of Citation; **RFC** = Relative Frequency of Citation.
Figure 4. Growth form of medicinal plants in the study area

Part used, Use Reports, and Use Categories
In our study, the most dominantly used parts were fruits, leaves, and aerial parts (Figure 5). Based on the local uses in the Kumrat valley, raw fruits (25 species) were the most used category of WFPs, followed by cooked as vegetable (20), salad (7), spice (3), and herbal tea (3) (Figure 6). In few cases a single plant part had various uses. In current study we recorded a total of 1215 use-reports from the native residents of the Kumrat Valley (Table 2). To elucidate the importance of the WFPs in the study area, use category values were applied (Inta et al. 2013). The most significant Wild Food category were wild ripe fruits. Several species were used very commonly e.g., Morus spp., Pyrus pashia, Myrtus communis, Diospyros lotus, Berberis lycium, etc. Wild edible vegetables also played a valuable role in the daily diet of the local population, especially Carallum edulis, Nasturtium officinale, Malva neglecta, Rumex dentatus, and Medicago polymorpha, among others were cooked as vegetables in their homes. Similarly local people also used other wild plants as salads, spices, and herbal tea.

Table 2. Number use reports (UR) among food- categories at three survey sites of Kumrat Valley

| Use Categories       | Number of use-reports (UR) | Thull  | Lower Kumrat | Upper Kumrat |
|----------------------|-----------------------------|--------|--------------|--------------|
| Ripe fruits          |                             | 197    | 146          | 85           |
| Cooked vegetables    |                             | 45     | 164          | 202          |
| Spices               |                             | 15     | 34           | 20           |
| Green Teas           |                             | 105    | 95           | 45           |
| Salads               |                             | 24     | 13           | 25           |

Market value of the wild food plants
Wild plants often play a very important rule in the livelihoods of poor communities around the globe, and the trade of medicinal plants e.g., will reach $5 trillion by 2050 (Jan et al. 2020). Local markets are the places where native people traded there WFPs and so different traditional communities share knowledge regarding WFPs (de Albuquerque et al. 2007). Local people collected species like Morchella esculenta, Berberis lycium, Morus alba, Carum carvi, and Diospyros lotus, and sold them in local market.

Use Value (UV) and Relative Frequency of Citation (RFC)
In ethnobotany, to check the relative importance of single species, Use Value is employed. The values of UV range from 1 to 0, and an UV equal or near to 1 indicated high use in a region. If the UV approaches 0 a species is less important. In our study species had UV ranges from 0.9 to 0.02. The highest UV were recorded for Morchella esculenta, Mentha longifolia, Mentha spicata, Berberis lycium, Carum carvi, Caralluma edulis, Myrtus communis, Zanthoxylum armatum, and Solanum nigrum (Table 1).

Relative Frequency of Citation is used to determine the most commonly occurring spices in an area. Values ranged from 0.78 to 0.07. The plants with highest RFC were Myrtus communis, Ficus palmata, Malva neglecta, Diospyros lotus, Mentha spicata, Zanthoxylum armatum, Duchesnea indica, Solanum nigrum, and Olea ferruginea (Table 1).
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Figure 5. Percentage of plant part used of the WFP

Figure 6. Mode of utilization for each food category

Informant Agreement Ratio
The informant agreement ratio (IAR) provides information about the uniformity or agreement of the interviewed respondents in certain Use-categories, e.g., cooked vegetable or spice. In this study, we compared the number of use reports, and IARs in the three different sites of Kumrat Valley (Table 2 & 3). The results show that wild edible fruits obtained a high IAR with 0.81. The local people mostly used the wild fruits of *Pinus gerardiana*, *Myrtus communis*, *Ficus* spp., *Morus* spp., *Punica protopunica*, and *Diospyros lotus*.

Table 3. Informant agreement ratio (IAR) for each food-category

| Use Categories  | Informant agreement ratio (IAR) |
|-----------------|---------------------------------|
|                 | Thull  | Lower Kumrat | Upper Kumrat |
| Ripe fruits     | 0.75   | 0.8          | 0.9          |
| Cooked vegetables| 0.6    | 0.7          | 0.5          |
| Spices          | 0.5    | 0.4          | 0.2          |
| Herbal Teas     | 0.4    | 0.5          | 0.3          |
| Salads          | 0.3    | 0.2          | 0.15         |

Conclusions
During present research work, we recorded the useful traditional knowledge related to WFPs form the local communities of Kumrat Valley Dir Upper, Pakistan. We identified 50 WFP species commonly used by local people both for their own needs and to as sell them in local...
markets. To best of our knowledge, this is the first report from Kumrat valley, and should provide a solid basis for more detailed future research.

**Declarations**

**List of abbreviations:** N/A

**Ethics approval and consent to participate:** This ethnomedicinal study was approved by the ethical committees of the Department of Botany, of the University and Herbarium, Department of Botany Islamia College Peshawar, Pakistan and Biodiversity Action Plan (BAP-2010-2020) for Pakistan. Before conducting interviews, the individual prior informed consent was obtained from all participants. No further ethics approval was required. All work conducted was carried out under the stipulations of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. The right to use and authorship of any traditional knowledge of all participants is maintained, and any use of this information, other than for scientific publication, does require additional prior consent of the traditional owners, as well as a consensus on access to benefits resulting from subsequent use.

**Consent for publication:** Not applicable - no personal data are included in this manuscript.

**Availability of data and materials:** Please indicate if any datasets have been deposited in public repositories.

**Competing interests:** The authors declare that they have no competing interests and it is certified that we have no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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**Authors’ contributions:** LA and AKJ designed the study; AKJ, LA and HAJ conducted the fieldwork, LA, HAJ, MR and WR conducted the main statistical analysis and wrote the manuscript, RWB, AJS and HAJ revised the data analysis and the manuscript; all authors read, corrected and approved the manuscript.

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