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 Ahmad[1*], Muhammad Riaz[2], Hammad Ahmad Jan[3], Andrew J. Semotiuk[4], Imran Ahmad[1], Imran Khan[1], Fayaz Ali[1], Wajid Rashid[5] and Rainer W. Bussmann[6]

[1]Department of Botany, Shaheed Benazir Bhutto University, Upper Dir, Pakistan
[2]Department of Pharmacy, Shaheed Benazir Bhutto University Sheringal Dir Upper, Pakistan
[3]Department of Botany, University of Buner, Pakistan
[4]Independent researcher
[5]Department of Environmental and Conservation Sciences University of Swat
[6]Department 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; 2015Lulekal *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 plant 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 be 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 aboutv 45 km from Kumrat valley and is used as the launching point for trips to Kumrat. In Kumrat the elevatiuon 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.

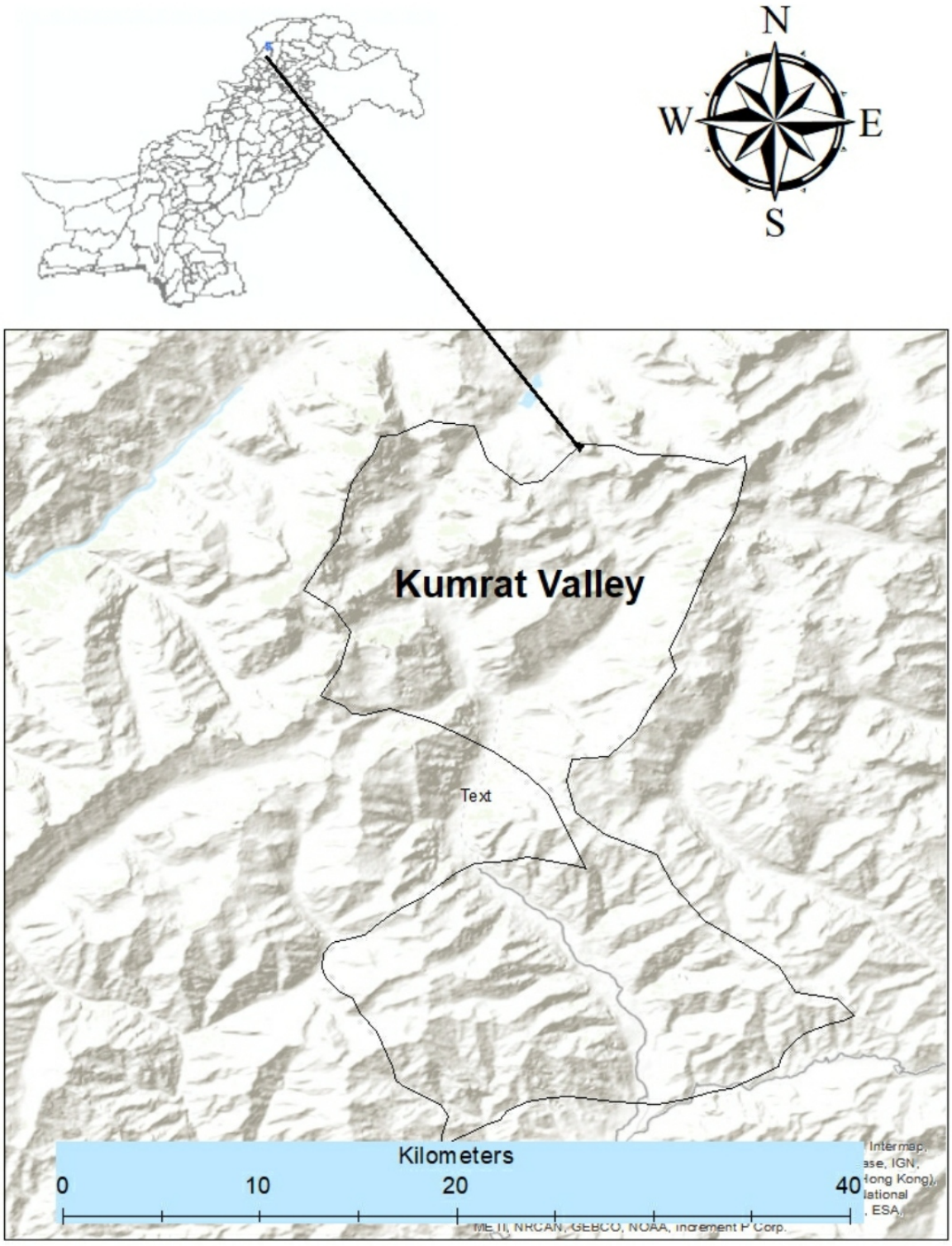

Figure 1. Map of the study area

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:

$UV = (\sum Ui) / N$

where *Ui* is the number of used reports mentioned by each participant and *N* is the total number of respondents interviewed for a given plants 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.

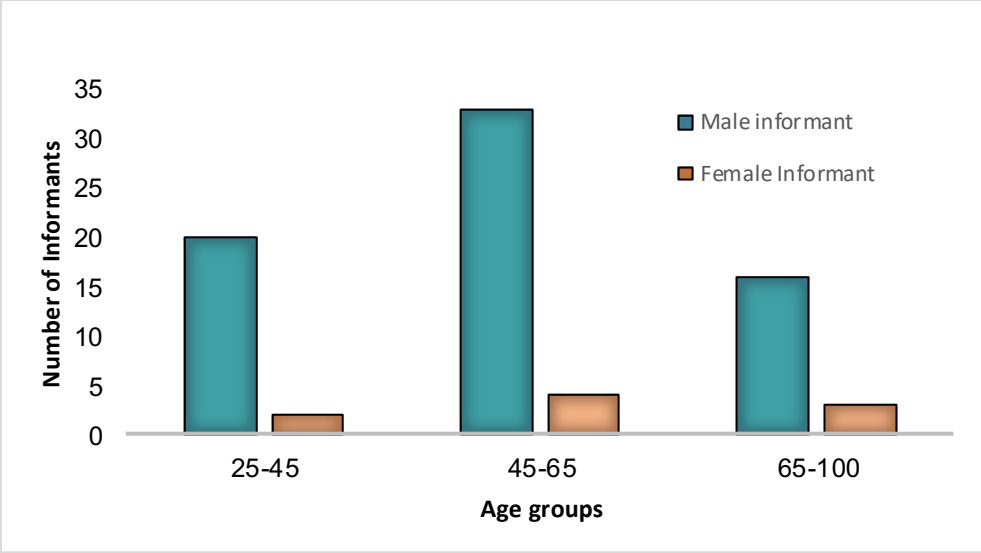

Figure 2. Age distribution of the informants interviewed

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).

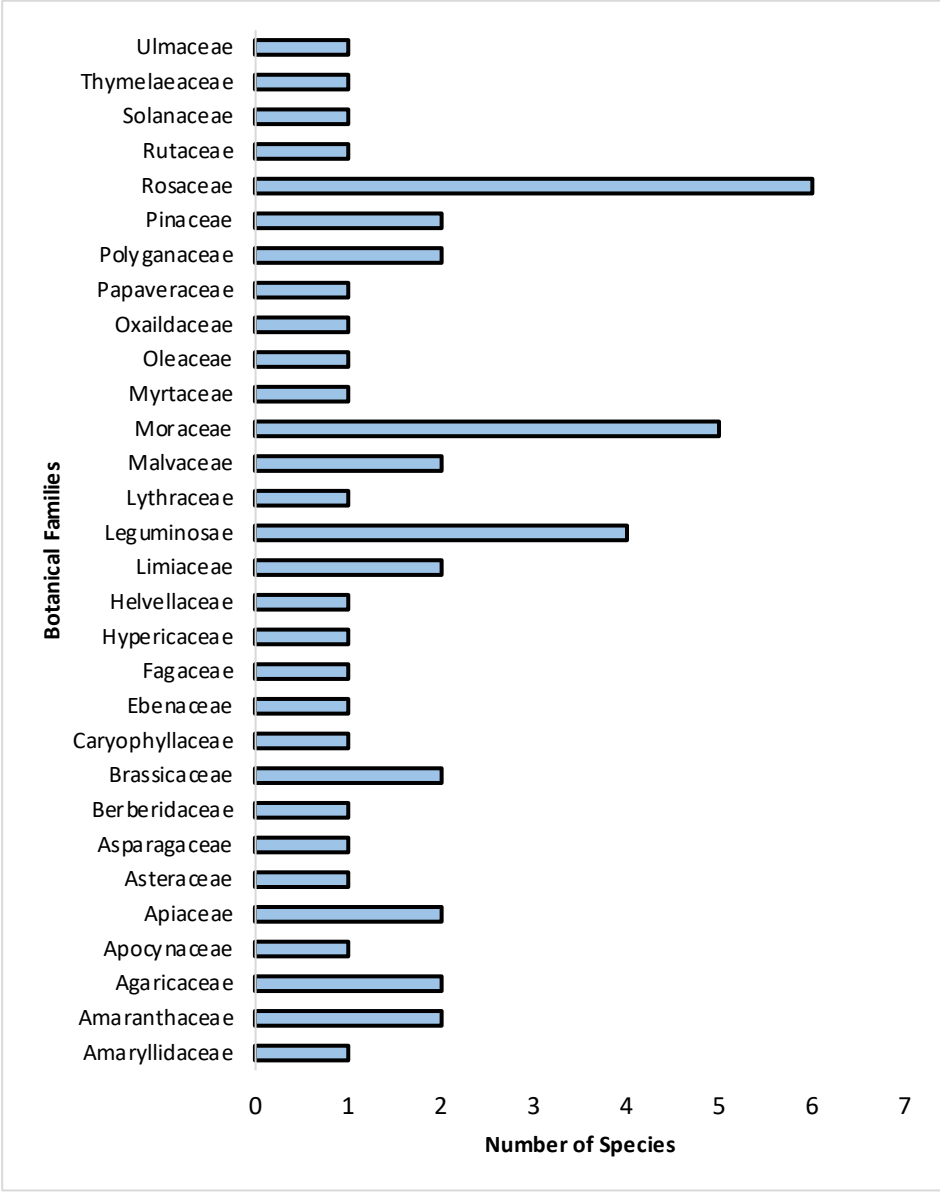

Figure 3. Number of plant species in different families

Table 1. Identified wild food plants consumed in Kumrat valley

Scientific name	Local name	Life form	Part used	Used categories	Therapeutic uses	UV[b]	FC[c]	RFC[d]
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

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
				Used as spice				
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

Moraceae								
Ficus palmata Forssk.	Inzar	Tree	FR	Used as fruit	Demulcent, emollient, and laxative	0.3	18	0.23
Ficus carica L.	Anjeer	Tree	FR	Used as fruit	gastrointestinal and respiratory problems	0.2	15	0.19
Morus alba L.	speen toot	Tree	FR	Used as fruit	Antibacterial activity	0.06	9	0.11
Morus nigra L.	Tor toot	Tree	FR	Used as fruit	Antibacterial and fungicidal activity	0.07	10	0.12
Morus macroura Miq.	Shah toot	Tree	FR	Used as fruit	Anti-inflammatory and diuretic	0.04	6	0.07
Myrtaceae								
Myrtus communis L	Manhro	Shrub	FR	Used as fruits	Diarrhea, dysentery, rheumatism	0.8	47	0.6
Oleaceae								
Olea ferrugineo Wall. ex Aitch	Khona	Tree	FR	Used as fruit	Fever, headaches, and sore throat	0.5	28	0.35
			LV	Green tea				
Oxaildaceae								
Oxalis corniculata L.	Taroky	Herb	LV	Used fresh leaves as food	Anthelmintic, depurative, and diuretic	0.08	9	0.11
Papaveraceae								
Papaver rhoeas L.	Soor Gulay	Herb	LV	Cooked as vegetable	Treating cough	0.03	4	0.5
Polyganaceae								
Rumex dentatus L.	shalkhy	Herb	LV	Cooked as vegetable	Astringent, diuretic, laxative and refrigerant	0.03	11	0.14
Rumex hastatus D. Don	Taroukey	Herb	LV	Used as salad	Increase appetite	0.05	13	0.16
Pinaceae								
Pinus roxburghii Sarg.	Nakhter	Tree	SE	Used as fruit	Antiseptic, diuretic, and vermifuge	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	Treat sore throats, mouth ulcer	0.04	6	0.07
Rubus. distans D.Don	Banganra	Tree	FR	Used as fruit	Diabetes mellitus and diarrhea	0.06	8	0.1

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	Spice and salad	Asthma, bronchitis, indigestion	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		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[a]: Seed = SE, Leaves= LV, Young shoot= YS, Whole plant=WP, Fruit = FR, Aerial part = AP, Bulb= BL; UV[b] = Use Value; FC[c] = Frequency of Citation; RFC[d] = Relative Frequency of Citation

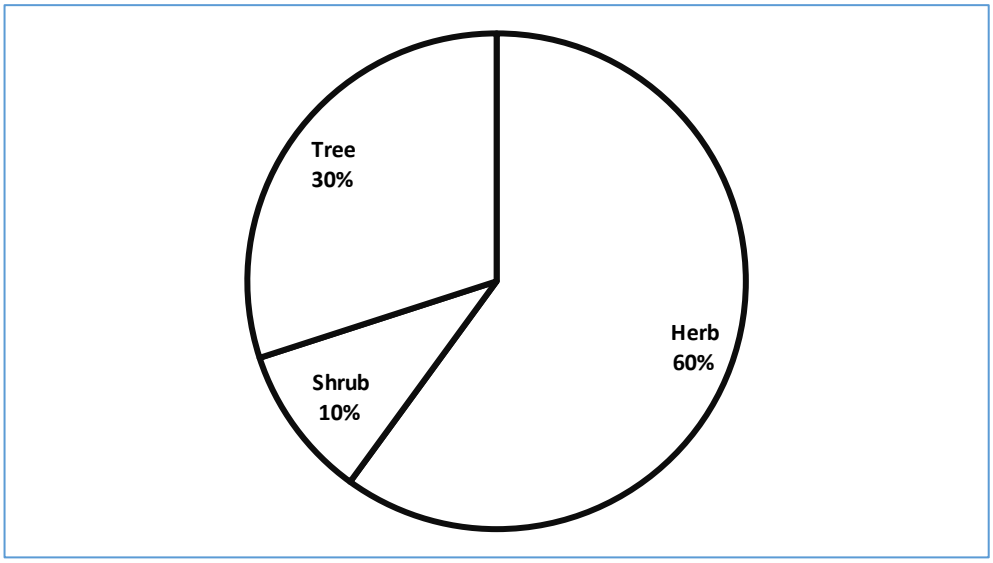

Figure 4. Growth form of medicinal plants in the study area

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 commolyn 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 othres werre 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).

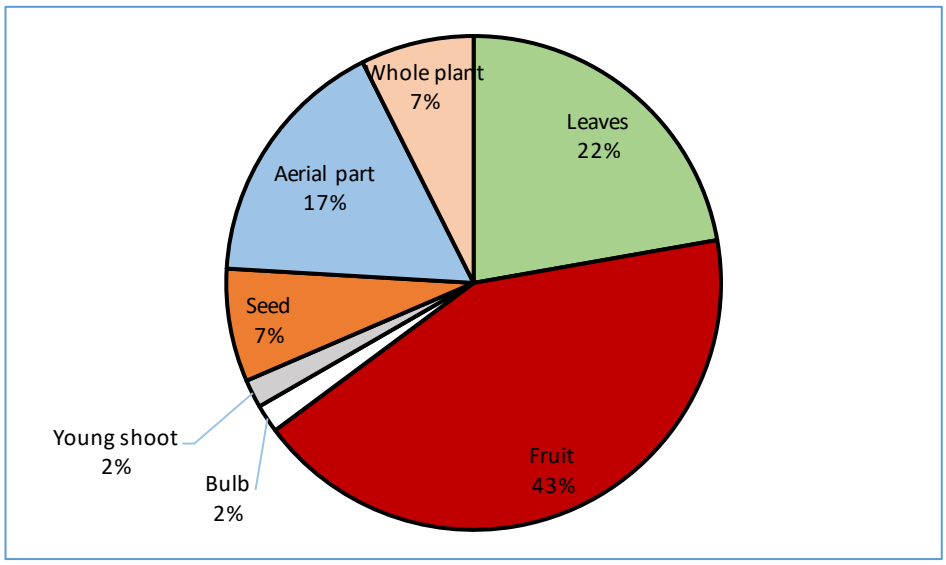

Figure 5. Percentage of plant part used of the WFP

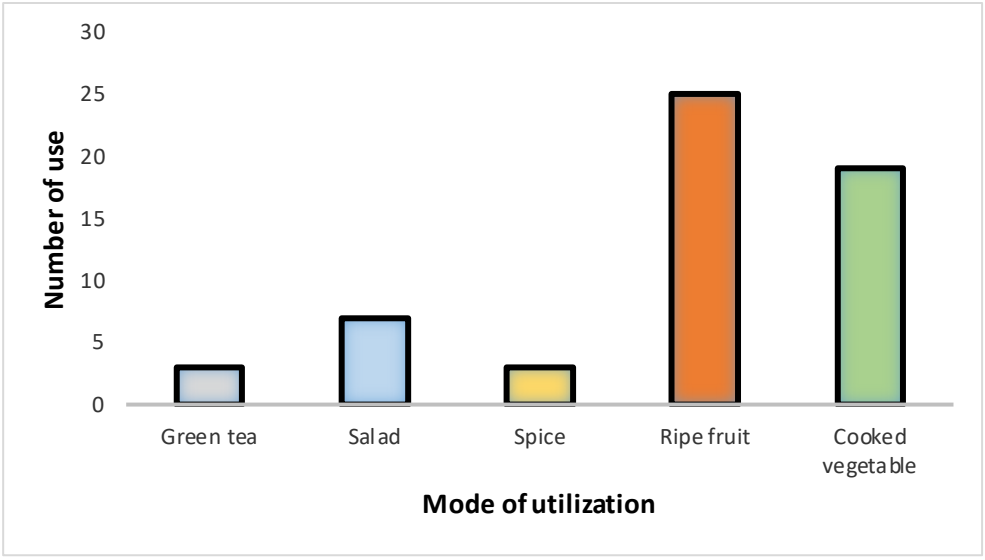

Figure 6. Mode of utilization for each food category

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 interest 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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