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Plant Foundations of the Home: Key plant species provide food, income, and Economic Development potential to Indigenous Pakistani families of Dir Lower, Pakistan

Latif Ahmad [1,3] , Andrew J Semotiuk [2] , Muhammad Zafar [3] , Mushtaq Ahmad [3] , Quan-Ru Liu* [1] ,Imran Khan [1] , Paras Mazari [1]
[1] College of Life Science, Beijing Normal University, Beijing100875, China
[2] Department of Botany and Plant Sciences, University of California, Riverside, California, 92507 U.S.A
[3] Department of Plant Science, Quaid-i- Azam University, Islamabad 45320, Pakistan
*Corresponding author's email liuquanru@bnu.edu.cn

ABSTRACT
Many families of the Lower Dir district in Northwest Khyber Pakhtunkhwa, Pakistan depend on wild food plants for nutrition as well as income. Previous researchers have indicated that wild food plants may be used for projects to support nutrition and livelihoods, but success of these initiatives is elusive. The aim of this study was to identify significantly distinguishable local wild food plant and fungus species that show promise for marketing through their use prevalence and monetary value. Field surveys, questionnaires, inquiries and group discussion were carried out from March 2014 to August 2015 to collect data from local people and market vendors in seven study sites. Ethnobotanical data were analyzed using use-report (UR), cultural importance index (CI), informant agreement ratio (IAR), relative frequency of citation (RFC) and cluster analysis. A total of 64 wild food plants from 37 families and 47 genera were reported, with some previously unreported uses. This study provides for the first time comprehensive ethnobotanical data on uses of wild food plants as food, and economic importance to the indigenous communities of Dir Lower. It also reveals key species and groups of species that may serve to guide development initiatives aimed at sustainable and culturally local projects. Future work may include using skills like biotechnology, breeding, land use, and carbon credit programs to improve yield of wild or cultivated fruits, vegetables, and spices thus further sustaining the livelihoods of families in Dir Lower.
Keywords: Ethnobotany, Smallholder, Wild Food Plants, Economic Values, Lower Dir

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INTRODUCTION

The first item listed on the United Nations Millennium Development Goals is to "Eradicate extreme poverty and hunger" [1].According to estimates by the Food and Agricultural Organization of the United Nations (FOA), millions of people in many developing countries do not have enough food to meet their daily requirements; furthermore, people are often deficient in one or more micronutrients [2], and this trend continues [3,4]. Wild food plants provide a significant contribution to balanced nutrition, especially in rural communities of developing countries [5,6]. In addition to nutrition, wild food plants provide potential for development projects aimed to improve family livelihoods [7,8]. Many wild food plants can be gathered and marketed to provide additional income and/or cultivated and incorporated into the crops grown on smallholder farms. A bout 30,000 plant species are edible, but of these, only 5,000–7,000 are used as human food resources [9,10].

Lower Dir, Pakistan offers an optimum field site to study the potential of wild food plants for development initiatives. Here, family-based gatherers and smallhold farmers both consume and sell local species. They take the surplus to nearby markets in indigenous villages and sometimes to distant markets in larger towns. In spite of this trade, overall family income remains low. It has been suggested that investment in small family farms would do much more to reduce poverty and hunger than larger projects [11]. The farmers and gatherers of Lower Dir exemplify this concept of family-based gathers and

smallhold farmers, and this region serves as an ideal site to study the dynamics of possible projects aimed at the marketing of wild plants and agriculture endeavors of local species.

It has been suggested that projects involving wild plant products may help support marginalized people and improve livelihoods [7,12], yet this has been challenged as being difficult and of no sure guarantee [13,14]. Furthermore, success of any venture must be measured by local stakeholder culture and needs rather than by a pure measure of the products consumption or sales [8, 15]. Wild-gathered products may not only serve as an income source, but as a necessary safety net that protects people from falling into poverty or malnutrition due to economic swings [16]. Therefore, in this study, we examined gathering and cultivation of local edible plant and fungi species, market prices, and uses of these species within the community. We clustered species to identify candidates for development project initiatives aimed at reducing hunger and poverty. Using Lower Dir as a model, we hypothesize that wild food plants include distinguishable species for culturally and economically valuable development projects.

MATERIALS AND METHODS

Geo-ethnographical Overview of the Study Area

Surveys on plant and fungi harvest, cultivation, use, and sales were carried out in the district of Lower Dir, Khyber Pakhtunkhwa, Pakistan. Lower Dir is 124 km from Peshawar, the capital of Khyber Pakhtunkhwa and shares an international boundary with Afghanistan in the west. Lower Dir is situated in the lesser Hindukush range and lies between 35°-10' to 35°-16' N latitude and 71°-50' to 71°-83' E longitude, with an area of about 1,583 km squared [17], and total population of about 1,544,000 [18]. The elevation of this district ranges from 1,200 m to 2,800 m above sea level and the climate largely depends on altitude [17]. The district receives its highest rainfall of 243.2 mm in March and its lowest in July, October, and November **(Fig. 1).**

The ethnic composition of Dir Lower is mostly Pashtun and the primary local language in the area is Pashto. A large number of Afghanistani immigrants settled in the area during times of violence in Afghanistan during the 1980s and early 2000.

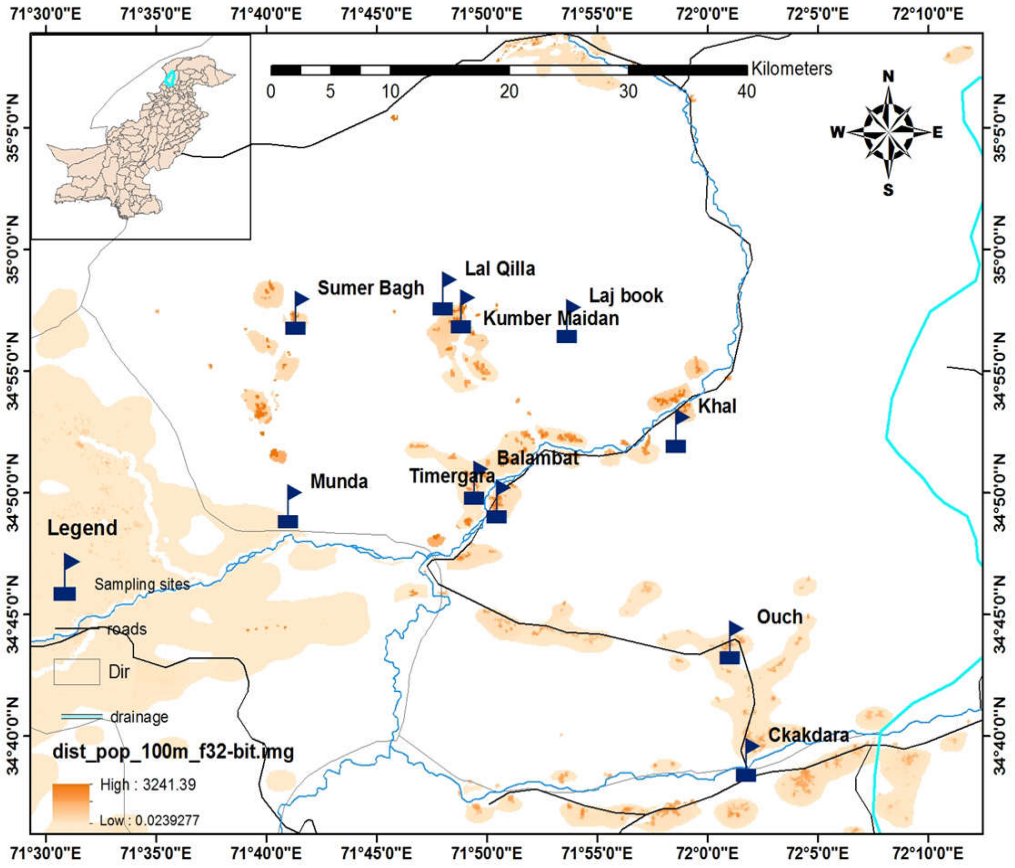

Fig. 1 Map of Study area showing the *tehsils* around Lower Dir

Informant Interviews and Field Study

We traveled to the study area to obtain ethnobotanical information regarding wild food plants from March 2014 to August 2015. We interviewed 140 local people from seven *tehsils* (administrative subdivisions): Timergara, Munda, Lalqilla, Khal, Adenzai, Balambat, and Sumerbagh. We visited villages and local markets to contact people for interviews.

We interviewed the elder local people in villages, while in local markets we mostly interviewed those who sold wild food plants. The local language Pashto was spoken during interviews and group discussions. Using guides from the standard method of [19] and [20]for ethnobotanical interviews, we conducted group discussions and asked questions regarding the local name of the plants, categories of use, parts of the plants used, collection times, modes of consumption, and price per kilogram when sold in the local markets. Interviews were conducted with informed consent following the International Society of Ethnobiology guidelines [21]. In order to act with respect and benevolence in the communities, we followed cultural norms when contacting potential informants. According to local cultural and societal norms, it is the most polite to send a written invitation with schoolchildren to take home to their mothers. Therefore, we distributed an invitation to schoolchildren who took the invitation home to their mothers. While this was the most respectful way to invite a woman, the most respectful way to invite a man, was to approach them in a common area like markets and roadways and verbally invite them.

Plant Collection, Identification and Deposition in Herbarium

Wild food plants were collected from within the seven *tehsils* (22 villages). Regular field trips to the study area were arranged according to the fruiting or flowering seasons. We collected whole plants in the field sites. These plants were pressed, dried, and mounted on standard herbarium sheets. When seasonality of fruiting and flowering prevented collection of all plant parts, we specifically ensured that the edible portion was included.During group discussions and interviews, we showed fruit, branches, and sometimes images of wild food plants to the local informants as visual aids. We identified all food plants at the Quaid-i-Azam University Herbarium of Pakistan and stored them in a special collection of indigenous edible plants with corresponding voucher numbers of this collection.

Classification

After collecting specimens along with the corresponding ethnobotanical information of wild food resources, we grouped the collected data into five main categories. These were (1) cooked vegetables, (2) spices and condiments, (3) herbal teas, (4) salads, and (5) wild fruits. Herbal teas were included in the food list even though they may be strictly considered as tea rather than as food [22]. Use-report (UR) was calculated as the number of informants who mentioned a particular species during the ethnobotanical interviews and group discussions [22, 23,24].

Cultural Importance Index and Cultural Importance of Families

The cultural importance index (CI) was used to indicate the cultural significance of each species. The CI of each species was evaluated for each location as the sum of the use reports (UR) in every use category mentioned for a species divided by the total number of survey participants (N) in that locality [25, 26]. It can be assumed that the CI index is a proficient tool for highlighting those species with a high-agreement for uses within the culture, and that it is indicative of the shared knowledge of the people [26]. Another important advantage of the CI index is that it is valid for comparing the botanical knowledge of different regions studied with a varying number of interviewees [25]. CI was calculated using the following formula [27].

$$CI = \sum_{i=1}^{i=NU} \frac{URi}{N}$$

URi = Use report for each category of use

N = total number of participants

Informant Agreement Ratio

To estimate the variability of the use of wild food plants, the informant agreement ratio (IAR) was used. It is one widely used method for analysing quantitative data in ethnobotany[28, 24, 29]. This factor ranges from 0 to 1. A high value (close to 1) indicates that relatively few taxa are used by a large proportion of the informants, while a low value indicates that the informants disagree on the taxa's use within a category [30]. It is also called the informant consensus factor ([24] and calculated as follows:

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

Nur = number of use-reports in each category

Nt = number of taxa used in each category

Relative Frequency of Citation

We calculated the relative frequency of citation (RFC) values in order to quantitatively determine the agreement between the informants on the use of wild food plants in the study area. Generally, RFC does not consider the variable *u* (use-category). Rather, it is obtained by dividing the number of informants, who mentioned the use of the species, by the number of informants who participated in the study [27]. RFC was calculated using the following formula

$$RFC = \frac{FC}{N}$$

$$(0 < RFC > 1)$$

FC = the number of informants who mentioned the species

N = the total number of informants participating in the survey

Cluster Analysis

To identify groups of wild food plant species with similar prices and cultural index, species were clustered using price and cultural index as predictors in a two-variable species array. The Density Based Clustering of Applications with Noise (DBSCAN) package [31] in the R programming language [32] was used to carry out a density-based scan of this array to compare both price and cultural index for each cluster.

RESULTS AND DISCUSSION

Lower Dir is a hilly region where most of the people live in isolated villages and rely on plants for various purposes. In this ethnobotanical study, a total of 140 local inhabitants were interviewed. Out of these, 95 were male (67.85%) and 45 were female (32.15%). The lesser number of female informants may be due to cultural norms where women are reluctant to talk with people outside of their family [33]. While informant ages ranged from 30 to 100 years old, we observed that most of the informants belonged to an age between 51–80 years (Table 1). It was also noted that it was common for informants to comment that women have more knowledge regarding wild food plants that are used as cooked vegetables, while men know more knowledge about wild edible fruits. Furthermore, most informants were uneducated, with only 23% having a complete elementary school education, 15% a complete high school education, and 7% a complete college education.

Table 1: Number of informants of each area in ethnobotanical surveys

Survey Site	Timergara	Adenzai	Khal	Munda	Balambat	Sumerbagh	Lalqilla
Total informants	24	11	21	17	13	26	28
Total males (n)	14	8	16	11	8	19	19
Elder	4	3	9	7	3	11	13
Marketvendor	10	5	7	4	5	8	6
Women (n)	10	3	5	6	5	7	9
Age range	30–75	35–70	45–80	40–80	35–80	50–85	45–100

A total of 64 wild food plant species and 3 taxa of fungi from 47 genera belonging to 37 botanical families were investigated **(Table 2).** Rosaceae was the most represented family with 6 species providing food resources, followed by Moraceae, Rhamnaceae, Fabaceae and Polygonaceae **(Fig. 2).**

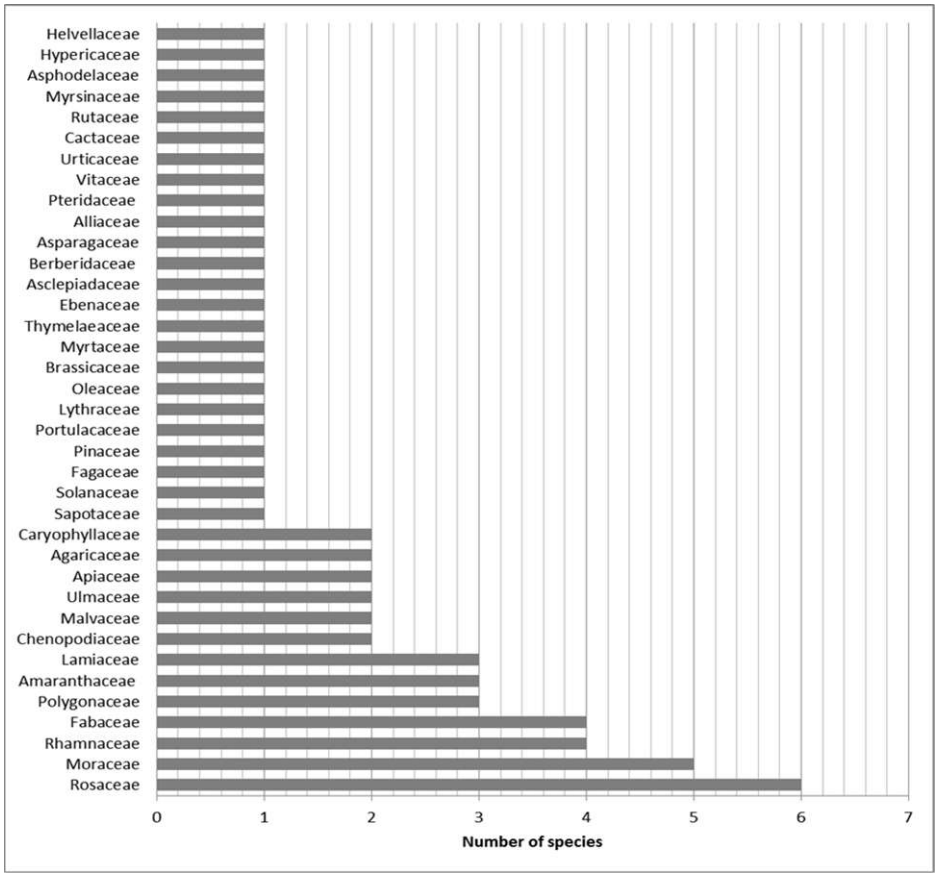

Fig. 2 Number of wild food plant species in each family

Life Form and Used Parts of the Wild Food Plants

The most common life forms of WFP were herb (35 species), shrub (16 species), and tree (13 species)**.** The plant parts most commonly consumed as food were fruits (31 species), leaves (14 species), and aerial parts (13 species) **(Fig. 3).**

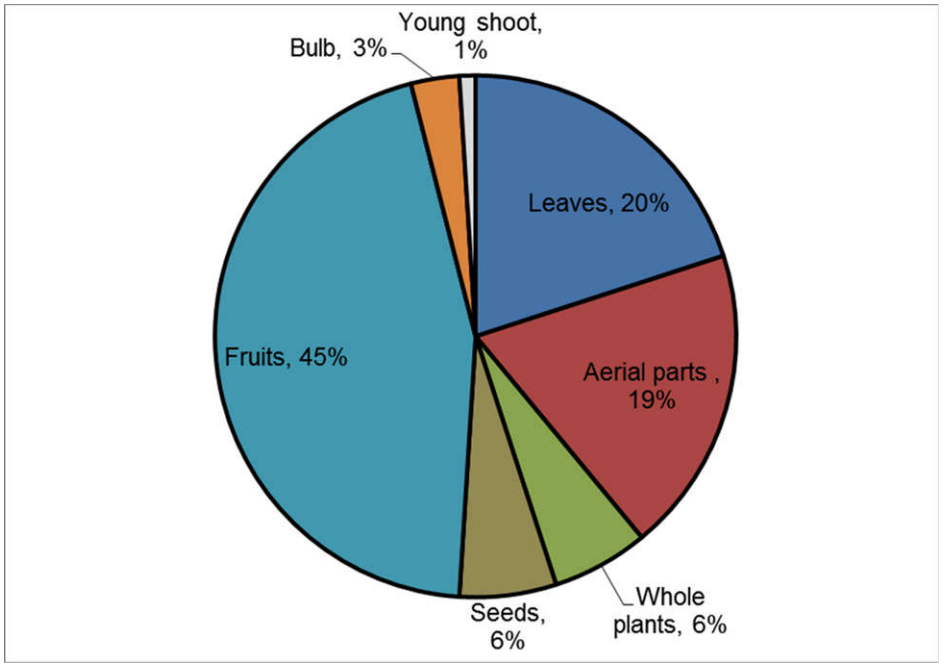

Fig. 3 Percentage of used wild food plants in Lower Dir

Use-report and Use Categories of the Wild Food Plants

A total of 2,345 use-reports were recorded from the local people of Lower Dir **(Table 2).** According to [34], the use category values give indication of importance of these species in the study area. Using the standard method of [27], we summed the use reports for all informants in the appropriate use category for each species. In Lower Dir, the most important food categories with the highest number of use reports were ripe fruits followed by cooked vegetables, green tea, salads, and spices **(Fig. 4).** Wild fruits are abundantly available in the summer so local people collect, shade-dry, and take them to local markets for sale.

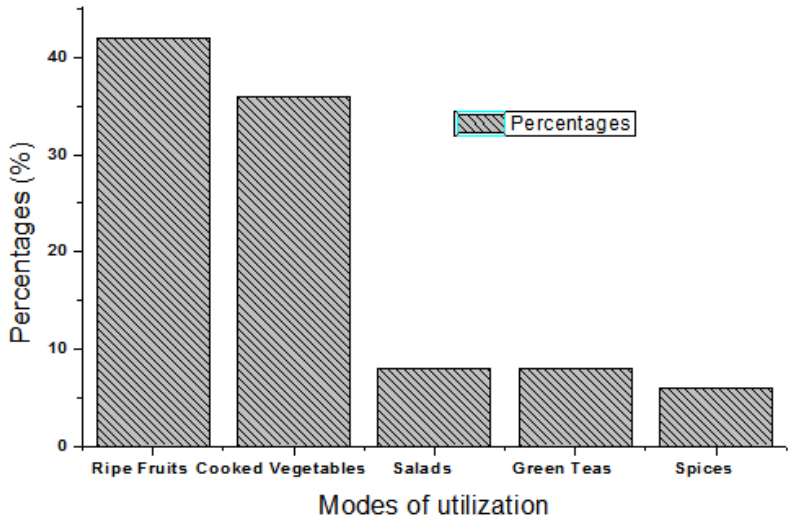

Fig. 4 Mode of utilization for each food category

Local Market Values of the Wild Food Plants

Income derived from the sale of wild food plants is very important in order for low-income households to meet basic needs [35]. The residents of Lower Dir have a monthly personal cash income of 10,000 to 15,000 rupees ($96 to $142 USD) or less, and the area is largely undeveloped. Local people collect wild food plants like *Morus alba* L., *Ficus palmata* Forssk., *Ziziphusjujuba* Mill., *Punicagranatum*L., *Diospyros lotus* L., *Sideroxylonmascatense*A.DC., *Myrtuscommunis*L., *Malvasylvestris*L., *Amaranthusviridis*L., *Zanthoxylumarmatum*DC. Roxb.and sell them in local markets, thus earning their livelihood. *Morchellaesculenta*(L.) Pers., the most popular edible morel in Dir, Swat, Palas Valley, Chitral, and Azad Kashmir, is sold in the local markets for up to 50 USD per kilogram [36]. The economic values for species available in local markets was determined in the local currency of the Pakistani Rupee and converted to US dollars **.**

Table 2 : Identified wild food plants consumed in Lower Dir

Scientific name / (voucher no.)	Local name	Growth form	Status	Part Used[a]	Use categories	Local markets sales ($ per Kg)	UR [b]	CI[c]	CIf[d]
Rosaceae									**0.67**
*Fragariavesca*L. var.*nubicola*	Zmakay Toot	Herb	Wild	Fr	Ripe fruits are eaten.	No	9	0.06	
Lindle. exHook.f. (LA-01)									
Duchesneaindica (Jacks.) Focke (LA-02)	Zmakay Toot	Herb	Wild	Fr	Ripe fruits are eaten.	No	7	0.05	
*Rubusellipticus*Sm. (LA-03)	Gooraj	Shrub	Wild	Fr	Ripe fruits are eaten.	No	25	0.17	
*Rubusvestitus*Weihe (LA-04)	Karwara	Shrub	Wild	Fr	Ripe fruits are eaten.	No	23	0.16	
*Rubusdistans*D.Don (LA-05)	Baganra	Shrub	Wild	Fr	Ripe fruits are eaten.	No	15	0.1	
*Pyruspashia*Buch.-Ham. exD.Don.(LA-06)	Batangi	Tree	Wild	Fr	Ripe fruits are eaten.	Yes ($0.31)	19	0.13	
Moraceae									**2.22**
*Morusnigra*L. (LA-07)	Torthooth	Tree	Wild	Fr	Ripe fruits are eaten.	No	21	0.15	

Morus alba L. (LA-08)	SpenThooth	Tree	Wild	Fr	Ripe fruits are eaten.	Yes ($ 0.51)	105	0.75	
*Morusmacroura*Miq. (LS-09)	Shahthooth	Tree	Wild	Fr	Ripe fruits are eaten.	Yes ($0.57)	24	0.17	
Ficuscarica L. (LA-10)	Inzar	Tree	Wild	Fr	Ripe fruits are eaten.	No	69	0.5	
*Ficuspalmata*Forssk.(LA-11)	Inzar	Tree	Wild	Fr	Ripe fruits are eaten.	Yes ($0.50)	91	0.65	
Rhamnaceae									**1.02**
*Ziziphusmauritiana*Lam. (LA-12)	MadaBera	Shrub	Wild	Fr	Ripe fruits are eaten.	No	43	0.31	
*Ziziphusjujuba*Mill.(LA-13)	Markhanry	Tree	Wild	Fr	Ripe fruits are eaten.	Yes ($0.45)	77	0.55	
*Rhamnusthea*Osbeck(LA-14)	Mamanra	Shrub	Wild	Fr	Ripe fruits are eaten.	No	13	0.09	
*Ziziphusoxyphylla*Edgew.(LA-15)	Elanai	Shrub	Wild	Fr	Ripe fruits are eaten.	No	11	0.07	
Fabaceae									**1.35**
*Lathyruscicera*L.(LA-16)	WaraChilo	Herb	Wild	AP	Cooked as vegetable	No	21	0.15	
*Lathyrusaphaca*L. (LA-17)	Kukarmanay	Herb	Wild	AP	Cooked as vegetable	No	19	0.13	
*Viciafaba*L.(LA-18)	Merghaikhpa	Herb	Wild	Fr	Ripe fruits are eaten.	No	67	0.47	
Medicagopolymorpha L. (LA-19)	Shpastary	Herb	Wild	AP	Cooked as vegetable	Yes ($0.30)	85	0.61	
Polygonaceae									**0.74**
*Rumex dentatus*L. (LA-20)	Shalkhai	Herb	Wild	Lv	Cooked as vegetable	Yes ($0.35)	89	0.65	
Rumex hastatus D. Don (LA-21)	Tarukay	Herb	Wild	Lv	Salads	No	9	0.06	
*Rumex crispus*L.(LA-22)	Shalkhai	Herb	Wild	Lv	Cooked as vegetable	No	5	0.03	
Amaranthaceae									**0.85**
*Amaranthusspinosus*L.(LA-23)	Ganhar	Herb	Wild	Lv	Cooked as vegetable	Yes ($0.37)	9	0.06	
Amaranthuscaudatus L. (LA-24)	Chalwairay	Herb	Wild	AP	Cooked as vegetable	Yes ($0.37)	11	0.07	
*Amaranthusviridis*L. (LA-25)	Cholayai	Herb	Wild	AP	Cooked as vegetable	Yes ($0.37)	99	0.71	
Lamiaceae									**0.65**
*Salvia mukerjee*iBennet&Raizada(LA-26)	Kianar	Herb	Wild	Lv	Cooked as vegetable	No	4	0.03	
*Menthaarvensis*L. (LA-27)	Phodena	Herb	Wild	AP	Salads and green tea.	Yes ($0.60)	59	0.42	
Menthalongifolia(L.) L. (LA-28)	Venalay	Herb	Wild	AP	Salads and green tea.	Yes ($0.30)	20	0.14	
Chenopodiaceae									**0.19**
Chenopodium album L. (LA-29)	NariSarmai	Herb	Wild	AP	Cooked as vegetable	Yes ($0.24)	23	0.16	
*Chenopodiummurale*L. (LA-30)	Sarmai	Herb	Wild	AP	Cooked as vegetable	No	5	0.03	
Malvaceae									**0.61**
*Malvasylvestris*L.(LA-31)	Samchal	Herb	Wild	Lv	Cooked as vegetable	Yes ($0.35)	76	0.54	
*Malvaneglecta*Wallr.(LA-32)	Paneerak	Herb	Wild	Lv	Cooked as vegetable	Yes ($0.35)	10	0.07	
Ulmaceae									**0.4**
Celtiseriocarpa Decne. (LA-33)	Taghaga	Tree	Wild	Fr	Ripe fruits are eaten.	No	39	0.27	
*Celtisaustralis*subsp. *Caucasica*(Willd.) C.C.Towns.Willd.(LA-34)	Tagha	Tree	Wild	Fr	Ripe fruits are eaten.	No	9	0.13	
Apiaceae									**0.37**
*Carumcarvi*L. (LA-35)	Zankai	Herb	Wild	Se	Spices and Salad	Yes ($0.40)	7	0.05	

Foeniculumvulgare Mill. (LA-36)	Kaga	Herb	Wild	Se	Spices and green tea	Yes ($0.70)	46	0.32	
			Cultivated	Lv	Cooked as vegetable				
Agaricaceae									**0.4**
Agaricuscampestris L. (LA-37)	Kharairhy	Herb	Wild	WP	Cooked with vegetable	Yes ($1.20)	36	0.25	
*Lycoperdonpratense*Pers.(LA-38)	GhraAndaiy	Herb	Wild	WP	Cooked with vegetable	No	22	0.15	
Caryophyllaceae									**0.119**
*Sileneconoidea*L. (LA-39)	Mangotey	Herb	Wild	Fr	Ripe fruits are eaten.	No	14	0.1	
				Lv	Cooked as vegetable				
Stellaria media (L.) Vill.(LA-40)	Oulalai	Herb	Wild	Lv	Cooked as vegetable	No	3	0.02	
Sapotaceae									**0.73**
Sideroxylon mascatense (A.DC.)	Gwargurah	Shrub	Wild	Fr	Ripe fruits are eaten.	Yes ($0.57)	103	0.73	
T.D.Penn. (LA-41)									
Solanaceae									**0.05**
*Solanumnigrum*L. (LA-42)	Kach Machu	Herb	Wild	Lv	Cooked as vegetable	No	7	0.05	
Fagaceae									**0.04**
*Quercusincana*Bartram (LA-43)	Tor Banj	Tree	Wild	Se	Ripe seeds are eaten.	Yes ($0.70)	6	0.04	
Pinaceae									**0.05**
*Pinusroxburghii*Sarg. (LA-44)	Nakhtar	Tree	Wild	Se	Ripe seeds are eaten.	No	8	0.05	
Portulacaceae									**0.25**
*Portulacaoleracea*L.(LA-45)	Zangali Warkhrhay	Herb	Wild	AP	Cooked as vegetable	Yes ($0.35)	35	0.25	
Lythraceae									**0.7**
*Punicagranatum*L. (LA-46)	Anangori	Shrub	Wild	Fr	Ripe fruits are eaten.	Yes ($0.40)	98	0.7	
					Dried fruits use in spice				
Oleaceae									**0.1**
*Oleaferruginea*Wall. ex Aitch. (LA-47)	Khona	Tree	Wild	Fr	Ripe fruits are eaten.	No	16	0.1	
				Lv	Green tea				
Brassicaceae									**0.66**
Nasturtium officinale R.Br. (LA-48)	Talmera	Herb	Wild	WP	Cooked as vegetable	Yes ($0.35)	93	0.66	
Myrtaceae									**0.72**
*Myrtuscommunis*L. (LA-49)	Manrho	Shrub	Wild	Fr	Ripe fruits are eaten	Yes ($0.55)	102	0.72	
				Lv	Green tea.				
Thymelaeaceae									**0.02**
*Daphne mucronata*Royle (LA-50)	Lighonay	Shrub	Wild	Fr	Ripe fruits are eaten	No	3	0.02	
Ebenaceae									**0.58**
Diospyros lotus L. (LA-51)	Tor Amlok	Tree	Wild	Fr	Ripe fruits are eaten	Yes ($0.40)	82	0.58	
Apocynaceae									**0.27**
Carallumaedulis(Edgew.) Benth.	Pamankay	Herb	Wild	AP	Cooked as vegetable	Yes ($0.47)	38	0.27	
exHook.f.(LA-52)									
Berberidaceae									**0.48**
Berberis lycium Royle (LA-53)	Kwaray	Shrub	Wild	Fr	Ripe fruits are eaten.	Yes ($0.60)	68	0.48	
Asparagaceae									**0.15**

*Asparagus asiaticus*L. (LA-54)	Tendorli	Shrub	Wild	YS	Cooked as vegetable	No	22	0.15	
Amaryllidaceae									**0.34**
*Allium jacquemontii*Kunth(LS-55)	Ogakai	Herb	Wild	Bu	Salads	No	48	0.34	
Dennstaedtiaceae				AP	Cooked as vegetable				**0.22**
Pteridiumaquilinum(L.) Kuhn(LA-56)	Kwanjay	Herb	Wild	AP	Cooked as vegetable	Yes ($0.35)	31	0.22	
Vitaceae									**0.3**
*Vitisheyneana*Roem. &Schult.(LA-57)	Gadherkwar	Shrub	Wild	Fr	Ripe fruits are eaten.	Yes ($0.65)	41	0.3	
Urticaceae									**0.05**
Debregeasiasaeneb(Forssk.) Hepper&J.R.I.Wood(LA-58)	Ajalai	Shrub	Wild	Fr	Ripe fruits are eaten.	No	7	0.05	
Cactaceae									**0.03**
Opuntiadillenii(Ker Gawl.) Haw.var.	Zaqoom	Herb	Wild	Fr	Ripe fruits are eaten.	No	5	0.03	
tehuantepecana Bravo (LA-59)									
Rutaceae									**0.64**
*Zanthoxylumarmatum*DC.Roxb.(LA-60)	Dambara	Shrub	Wild	Fr	Spices	Yes ($0.70)	90	0.64	
Primulaceae									**0.02**
*Myrsineafricana*L. (LA-61)	Marorang	Shrub	Wild	Fr	Ripe fruits are eaten.	No	3	0.02	
Xanthorrhoeaceae									**0.11**
Asphodelus fistulosus L.subsp.	Piazakai	Herb	Wild	Bu	Salad	No	16	0.11	
tenuifolius(Cav.) Baker (LA- 62)									
Hypericaceae									**0.14**
*Hypericumperforatum*L.(LA-63)	Shain Chai	Herb	Wild	Lv	Green tea	No	20	0.14	
Helvellaceae									**0.31**
Morchellaesculenta (L.) Pers.(LA-64)	Khosay	Herb	Wild	WP	Cooked with	Yes ($45 to 55)	46	0.31	
					vegetable				

Parts a Used:Leaves= Lv, Seed = Se, Fruit = Fr, Young shoot= YS, Aerial part = AP, Whole plant=WP, Bulb= Bu
URb = Use-Reports; CIc= Cultural Importance Index; CIf^d= Cultural Importance of Families

Informant Agreement Ratio

The informant agreement ratio (IAR) gives information about the agreement or uniformity of the informants indications as to the usage of a certain use-category, e.g. salads or green teas. We compared the number of use reports, the number of species in each category of use, and IARs in the seven different study areas **(see Table 2 and Table 3).**

Spices or condiments obtained a high factor of informant agreement ratio with a value of 0.97. *Punicagranatum*L. showed 98 use reports and *Zanthoxylumarmatum*DC. Roxb.showed 90 in this use category. These plants are used in daily life and utilized all over the district. For wild fruits, the most use reports per species were for *Morusalba*L., *Sideroxylonmascatense*(A.DC.), and *Myrtus communis* L. with 105, 103, and 102 use reports respectively.

Table 3: Number of wild food species and of use reports (UR) among food- categories at each survey sites

Use Categories	Number of taxa							Number of use-reports (UR)						
	Timergara	Adenzai	Khal	Munda	Balambat	Sumerbagh	Lalqilla	Timergara	Adenzai	Khal	Munda	Balambat	Sumerbagh	Lalqilla
Ripe Fruits	27	22	29	26	23	26	28	208	89	197	146	85	216	259
Cooked vegetables	22	16	22	23	17	26	26	140	54	105	95	45	164	202
Salads	5	3	4	6	4	4	6	16	5	10	18	6	13	24
Green Teas	5	2	6	3	2	5	6	16	7	22	8	4	19	24
Spices	3	3	3	3	3	4	4	24	13	25	20	10	24	33

Table 4: Informant agreement ratio (IAR) for each food-category

	Informant agreement ratio (IAR)						
Use Categories	**Timergara**	**Adenzai**	**Khal**	**Munda**	**Balambat**	**Sumerbagh**	**Lalqilla**
Ripe Fruits	0.87	0.76	0.85	0.82	0.73	0.88	0.89
Cooked vegetables	0.84	0.71	0.79	0.76	0.63	0.84	0.87
Salads	0.73	0.5	0.66	0.7	0.4	0.75	0.78
Green Teas	0.73	0.83	0.76	0.71	0.66	0.77	0.78
Spices	0.91	0.83	0.91	0.89	0.77	0.86	0.9

Cultural Importance Index

We used the standard method of [27]to find the CI of each species. This additive index takes into account for seven different localities of the study area over the number of informants for each species and the diversity of its uses **(See Additional File:Table 1).**

In the present study, the CI values of the seven study sites of Lower Dir were determined. The CI values ranged from 0.75 to 0.02, and on the basis of CI value they were also categorized into four classes **(See Additional File 1: Table 2).** The first class included 15 species (CI: 0.75 to 0.48); the second class included 16 species (0.47 to 0.16); the third class had 17 species (0.15 to 0.07); and the fourth class included 16 species (0.06 to 0.02). The most important species, on the basis of CI are within the first class (**Fig. 5).**

First class species on the basis of CI were cited in all seven study sites. Among them were *Morus alba* L., *Sideroxy lonmascatense* (A.DC.), *Myrtus communis* L., *Punicagranatum* L., *Ficus palmata* Forssk.,*Diospyros lotus* L., *Amaranthusviridis*L., *Nasturtium officinale* R.Br., *Rumex dentatus*L., *Malvasylvestris* L. and *Zanthoxy lumarmatum* DC. Roxb. The local people used these in their homes as well as selling them in the local markets in every region. A common cultural background may explain these similarities.

Fig. 5 Cultural importance index (CI) of the top 15 species in the Dir Lower

Cultural Importance of the Families

To measure the cultural importance of the families (CIf), the CI of the species of each family was added **(Additional File 1: Table 1).** In CIf, the most culturally important families were: Moraceae followed by Fabaceae, Rhamnaceae, Amaranthaceae, Polygonaceae and Sapotaceae**(Table 2)**

Relative Frequency of Citation

Relative frequency of citation (RFC) does not consider the diversity of uses. The value of RFC theoretically ranges from 0 (when nobody refers to the plant as useful) to 1 (if all the informants mention the use of the same species).

According to [27], when a species has only one use, the RFC would be equal to CI. In our present study, a large number of species (56, 87.5%) had a single use, so RFC and CI indices attain the same value **(See Additional File: Table 1).** Figure 6, lists CI and RFC of those species that have more than one use (mostly two).

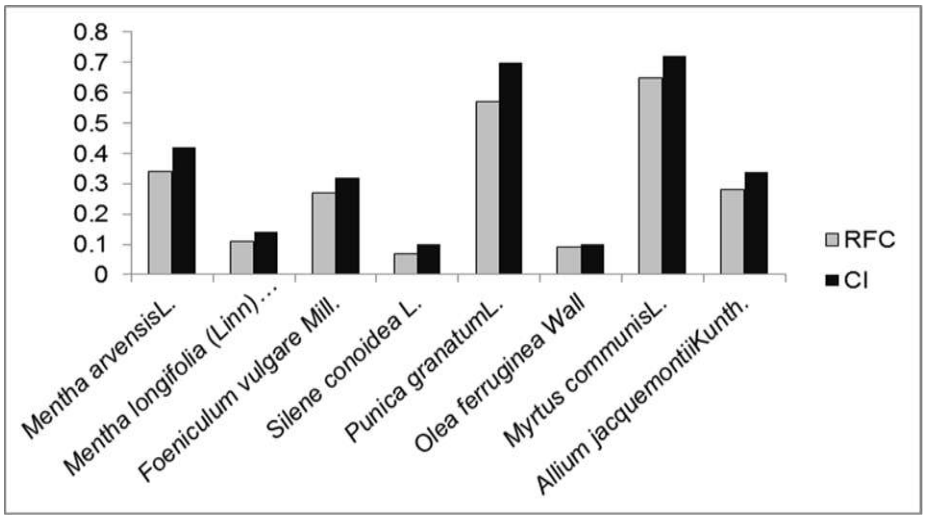

Fig. 6 Relative frequency of citation and cultural importance index of wild food plants which have more than one use

Cluster Analysis of Wild Food Plants

Cluster analyses revealed groupings of species based on price and CI (Figure 7). Species with both high price and cultural index were revealed. We also observed that some species sell for a high price in markets, yet are not commonly used as reflected in their lower cultural index**.** In addition to clustered groups, some species had such a high price or CI that they were outliers from all clusters. The clusters and individual species that stand out in respect to price or CI are shown in Table 5**.**

Table5: Clusters' species are grouped based on significantly higher price, CI or price and CI. Individual species falling outside of a cluster are placed into the table based on their unique value.

Clustered				Individual			
Cultivated		Wild harvested		Cultivated		Wild harvested	
Price	**Price & CI**	**Price**	**Price & CI**	**Price**	**CI**	**Price**	**Price & CI**
M. nigra	*F. palmata*	*P. aquilinum*	*S. mascatense*	*A. campestris*	*F. carica*	*C. carvi*	*B. lycium*
P. roxburghii	*Z. jujuba*	*C. album*	*M. communis*			*Q. incana*	*Z. armatum*
O. ferruginea	*D. lotus*		*P. granatum*				*M. esculenta*
O. dillenii	*A. viridis*		*R. dentatus*				
	M. sylvestris		*N. officinale*				
	M. polymorpha						
	M. alba						

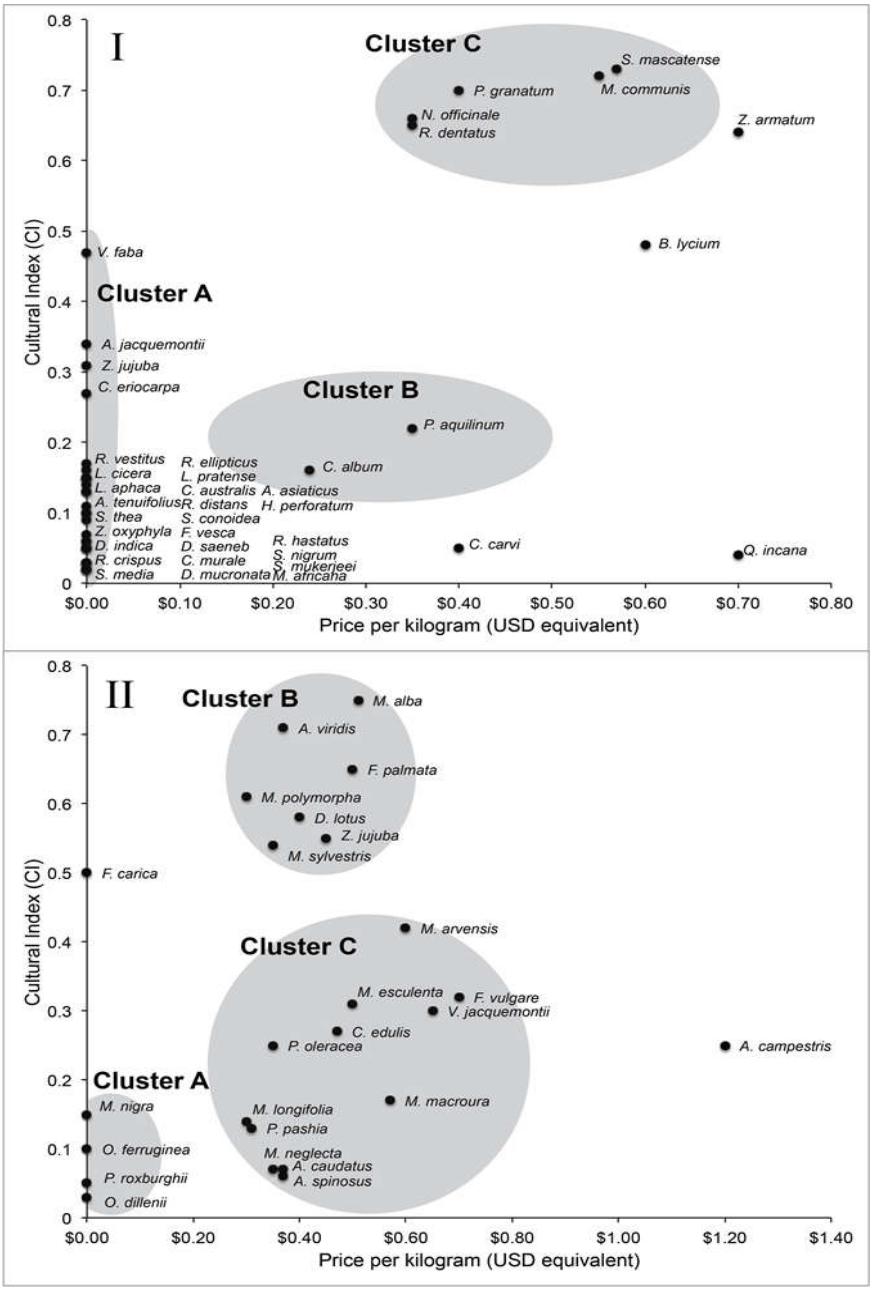

Fig. 7 Cluster analysis of species-specific price and cultural index scatterplot for wild-harvested (I) and cultivated (II) edible plant species. Species were clustered into groups A, B, and C using the DBSCAN Clustering Package (Hahsler 2015, R-Core Team 2015). These clusters are indicated by the shaded areas and corresponding labels. Species outside the bounds of a cluster are also labeled and addressed in the text (see text for cluster analysis details)

Most of the inhabitants of Lower Dir depend heavily on wild edible plants and mushrooms for their nutrition and livelihoods. Taking the example of the tomato, in June and July of 2015 the price soared to $1.00 USD per kilogram in local markets. In this situation, the local people used the dried fruits of *Punica granatum*L. as an alternative to tomatoes for cooking with vegetables. In spring, villagers of the district rely on wild vegetable plants like *Amaranthus viridis*L., *Nasturtium officinale* R.Br.,*Rumex dentatus*L., *Malva sylvestris* L., *Medica gopolymorpha* L. and *Chenopodium album* L. to supplement their diet. In March and April, the local people purchase less vegetable from markets and consume the above mentioned wild green vegetables. In the present study, we examined the relationship between use prevalence and market price for species that grow wild and can also be cultivated. We found that (1) clusters of significantly higher market price and cultural index, and also just market price occur. 2) Outliers of even higher market price and cultural index, and just market price occurred for isolated species. 3) Local informants revealed many uses for wild plant and fungi species previously unreported in the literature.

Previous studies indicate that identifying profitable wild-crafted species is challenging [13, 14]. Even if successful candidates are found, they may not be in line with the mission of funding agencies [37]. Our recent studies in Lower Dir, in which cultural index and market value were used to cluster species, demonstrate that diverse species of culturally important and high monetary value plants can be easily identified. These may provide increased probability of reaching the goals of elevating livelihoods, maintaining cultural practices in the communities, and providing options for funding proposals. Consistent with these findings, wild foods, especially wild fruits, lower the amount of money families must spend at markets. We observed that when the wild fruits e.g., *Morus alba* L., *Sideroxy lonmascatense* (A.DC.), *Myrtus communis* L., *Punica granatum* L., *Ficus palmata* Forssk., *Diospyros lotus* L. became ripe, the local people were less dependent on fruits sold in the markets. Given the finding that clusters of species showed groups with both high cultural index and market value, these species may be used to fit the needs of development initiatives as income sources that prove beneficial for local nutrition and livelihoods. Because the choosing of wild products for long-lasting income-generating initiatives within a community is a critical and difficult decision needed for success [37], it may be that selecting from clusters with high market value and cultural index will give rise to promising candidates.

In addition, we found that previously unreported uses for local species were conveyed by local informants (Table 2). The fruit of *Myrtus communis* is well known to be edible [38,39], and our study showed that local inhabitants use the leaves in black tea (milk tea) to give it an aromatic smell. In the case of *Portulaca oleracea,* the aerial parts and leaves are used as salad [38, 40]. Additional anecdotes from the study showed its use as a cooked vegetable (Table 2). According to Khan and Ahmad [39], the fruits of *Oleaferruginea* are edible and used for stomach problems. Additionally, local seniors used the fresh leaves of *Olea ferruginea* to make a green tea, saying that it removed tiredness and depression. The fresh fruits of *Punica granatum* are eaten raw and given to the children to improve digestion [40, 39]. Additionally, this study showed that the dried fruits of *Punica granatum* are used by the local people as a spice. The aerial parts of *Foeniculum vulgare* are used as a cooked vegetable [41, 38]. In our study, we observed that local people mix the aromatic seeds with other condiments for making aromatic *biryani* (a rice dish).

CONCLUSION

In the present study, we collected information about wild food plants in indigenous communities of the Lower Dir district in Northwest Khyber Pakhtunkhwa, Pakistan. From this study, we identified 64 wild food plant species that are used by the local indigenous people. Local people use these wild food plants in their homes and sell them in the local markets. Based on clustering of cultural indices and market values of these species, the resulting groups narrow the array of candidate species for potential development initiatives that can seamlessly enter the cultural and economic framework in Lower Dir, thus helping support family livelihoods and nutritional well-being (Table 5).

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CONFLICT OF INTEREST

None Declared.

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REFERENCES

1. United Nations. (2016). We can end poverty: Millenium development goals and beyond. Available at: http://www.un.org/millenniumgoals. Accessed 10 March 2016.
2. FAO. (2004).The State of Food Insecurity in the World: Monitoring the Progress Towards the World Food Summit and Millennium Development Goals. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO). Available at: http://www.fao.org/3/a-y5650e.pdf. Accessed 15 May 2016.
3. FMFA. (2011).Nutrition in Developing Countries: Strategic Guideline Document. Paris, France: Ministry of foreign and European Affairs.
4. UNICEF/WHO/World Bank Group. (2016).Levels and Trends in Child Malnutrition. Available at: http://www.who.int/nutgrowthdb/jme_brochure2016.pdf?ua=1. Accessed 24 October 2016.
5. Abbasi, A. M., &Guo, X. (2015). Proximate Composition, Phenolic Contents and in vitro Antioxidant Properties of *Pimpinellastewartii* (A Wild Medicinal Food). J. FOOD. NUTR.,3: 330-336.
6. Maurizio, A. (1926). *Pożywienieroślinne w rozwojudziejowym.* Warszawa: KasaMianowskiego; 1926.
7. Dove, M. R. (1993). A revisionist view of tropical deforestation and development. Environ. Conserv.,20(1): 17-24.
8. Marshall, E., Newton, A.C.,&Schreckenberg, K. (2003). Commercialisation of Non-timber Forest Products: First Steps in Analysing the Factors Influencing Success.Int. For. Rev., 5(2): 128-137.
9. Royal Botanic Gardens. (2016).State of the Worlds Plants. Kew, England: Royal Botanic Gardens.
10. FAO. (2009).The State of Food Insecurity in the World. Rome, Italy: Food and Agriculture Organization. Available at: http://www.fao.org/docrep/012/i0876e/i0876e00.htm. Accessed 15 July 2016.
11. Holt-Gimenez, E., Altieri, M., &Rosset, P. (2006).Ten reasons why the Rockefeller and the Bill and Melinda Gates Foundations' Alliance for another green revolution will not solve the problems of poverty and hunger in Sub-Saharan Africa. Food First/Institute for Food and Development Policy. Available at:http://www. policyinnovations.org /ideas/policy_library/data/01403. Accessed 07 March 2016.
12. Shanley, P., A.R. Pierce, S. A. Laird, C. LópezBinnqüist, and M. R. Guariguata. (2016).From Lifelines to Livelihoots: Non-timber Forest Products in the Twenty-first Century. In: Tropical Forestry Handbook. The Netherlands: Springer.
13. Wollenberg, E., & Angles, A. (1998).Incomes from the forest: Methods for the development and conservation of forest products for local communities. GrafikaDesaPutera, Indonesia: Center for International Forestry Research.
14. Arnold, M.J.E. & Pérez, M. R. (2001).Can Non-timber Forest Products Match Tropical Forest Conservation and Development Objectives**?** Ecol. Econ.**,** 39 (3): 437-447.
15. Schreckenberg, K., Newton, A., & Marshall, E. (2006).Defining success: an introduction to the thematic analysis.In Marshall, E., Schreckenberg, K. and Newton, A.C. (Ed).*Commercialization of non-timber forest products: Factors influencing success lessons learned from Mexico and Bolivia and policy implications for decision-makers*. pp. 65-70. Cambridge, UK: UNEP World Conservation Monitoring Centre.
16. Shackleton, C., &Shackleton, S. (2004). The importance of non-timber forest products in rural livelihood and security and as safety nets: a review of evidence from South Africa. S. Afr. J. Sci.,100:658-664.
17. Khan, N., Ahmed, M., Wahab, M., Ajaib, M., &Hussain, S.S. (2010).Studies Along an Altitudinal Gradient in *Monothecabuxifolia* (falc.) Ad, Forest, District Lower Dir, Pakistan. Pak. J. Bot., 42: 3029-3038.
18. Khyber Pakhtunkhwa Official Gateway to Government.N.D. Area and populations.Available at: http://www.khyberpakhtunkhwa.gov.pk/aboutus/Area-Population.php.Accessed 10 December 2015.
19. Cotton, C.M. (1996). Ethnobotany: Principles and Applications Chichester. John Wiley and Sons Ltd, New York.
20. Martin, G. J. (1995). Ethnobotany: A Method and Manual. Champan and Hall, London.
21. 21.International Society of Ethnobiology. (2006).International Society of Ethnobiology Code of Ethics (with 2008 additions). Available at: http://ethnobiology.net/code-of-ethics/. Accessed 17 December 2015.
22. Abbet, C., Mayor, R., Roguet, D., Spichiger, R., Hamburger, M., &Potterat, O. (2014). Ethnobotanical Survey on Wild Alpine Food Plants in Lower and Central Valais (Switzerland).J. Ethnopharmacol., 151:624–634.
23. Giovannini, P., &Heinrich, M. (2009). Xkiyoma' (our medicine) and xkitienda (patent medicine) Interface between Traditional and Modern Medicine Among the Mazatecs of Oaxaca, Mexico. J. Ethnopharmacol., 121: 383-399.
24. Heinrich, M., Edwards, S., Moerman, D. E., &and Leonti, M. (2009). Ethnopharmacological field studies: A critical assessment of their conceptual basis and methods.J. Ethnopharmacol., 124: 1-7.
25. Pardo-de-Santayana, M., Tardío, J., Blanco, E., Carvalho, A. M., Lastra, J. J., Miguel, E. S., & Morales, R. (2007).Traditional Knowledge on Wild Edible Plants in the Northwest of the Iberian Peninsula (Spain and Portugal): A Comparative Study. J. Ethnobiol. Ethnomed.,3: 3-27.
26. Abbasi, A.M., Khan, M. A., Shah, M. H., Shah, M. M., Pervez, A., &Mushtaq, A. (2013).Ethnobotanical Appraisal and Cultural Values of Medicinally Important Wild Edible Vegetables of Lesser Himalayas-Pakistan. J. Ethnobiol. Ethnomed., 9 : 66.
27. Tardio, J., &Pardo-De-Santayana., M. (2008).Cultural Importance Indice: a Comparative Analysis based on the Useful Wild Plants of Southern Cantabria (Northern Spain). Econ. Bot.**,** 62: 24–39.

28. Trotter, R.T., & Logan, M. H. (1986).Informant consensus: a new approach for identifying potentially effective medicinal plants. In Etkin, N.L. (Ed).*Plants in indigenous medicine and diet*.pp 91-112. Bedford Hill, New York: Redgrave Publishing Company.
29. Inta, A., Shengji, P., Balslev, H., Wangpakapattanawong, P., &Trisonthi, C. (2008). A Comparative Study on Medicinal Plants used in Akha's Traditional Medicine in China and Thailand, Cultural Coherence or Ecological Divergence?J. Ethnopharmacol.,116: 508-517.
30. Heinrich, M., Inta, A., Frei, B., Weimann, C., &Sticher, O. (1998).Medicinal Plants in Mexico: Healers' Consensus and Cultural Importance. Soc. Sci. Med.,47: 1859-1871.
31. Hahsler, M. (2015).dbscan: Density Based Clustering of Applications with Noise (DBSCAN) and Related Algorithms. R package version 0.9-6.Available at: https://CRAN.Rproject.org/package=dbscan. Accessed 21 July 2016.
32. R Core Team. (2015).R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.URL https://www.R-project.org/.Accessed 25 April 2016.
33. Ahmad, L., Semotiuk, A., Zafar, M., Ahmad, M., Sultana, S., Liu, Q.R., Zada, M.P., Abidin, S. Z., &Yaseen, G. (2015).. Ethnopharmacological Documentation of Medicinal Plants Used for Hypertension among the Local Communities of DIR Lower, Pakistan. J. Ethnopharmacol., 175: 138–146.
34. Inta, A., Trisonthi, P., &Trisonthi, C. (2013).Analysis of Traditional Knowledge in Medicinal Plants Used by Yuan in Thailand.J. Ethnopharmacol.,149: 344-51.
35. Balemie, K., &Kebebew, F. (2006).Ethnobotanical Study of Wild Edible Plants in Derashe and Kucha Districts, South Ethiopia. J. Ethnobiol. Ethnomed., 2: 53.
36. Sher, H., A. Aldosari, &Bussmann, R. W. (2015). Morels of Palas Valley, Pakistan: A Potential Source for Generating Income and Improving Livelihoods of Mountain Communities. Econ. Bot., 69: 345–359.
37. de Jong, W. & R. Utama, R. (1998). Turning Ideas into Action: Planning for Non-timber Forest Product Development and Conservation.In Wollenberg, E. and A. Ingles (Ed).*Incomes from the forest: Methods for the development and conservation of forest products for local communities*. pp. 43-55. GrafikaDesaPutera, Indonesia: Center for International Forestry Research.
38. Della, A., Paraskeva-Hadjichambi, &Hadjichambis, A. C. (2006). An Ethnobotanical Survey of Wild Edible Plants of Paphos and Larnaca Countryside of Cyprus.J. Ethnobiol. Ethnomed.,2: 34.
39. Khan, M.P.Z., & Ahmad., A. (2015).Traditional Preference of Wild Edible Fruits (WEFs) for Digestive Disorders (DDs) among the Indigenous Communities of Swat Valley-Pakistan. J. Ethnopharmacol.,174: 339-354.
40. di Tizio, A., Łuczaj, L. J., Quave, C. L., Redžić, S., &Pieroni, A. (2012).Traditional food and herbal uses of wild plants in the ancient South-Slavic diaspora of Mundimitar/Montemitro (Southern Italy). J. Ethnobiol. Ethnomed.,8: 21.
41. Pieroni, A. (1999).Gathered wild food plants in the upper valley of the Serchio River (Garfagnana), Central Italy. Econ. Bot., 53: 327-341.

Supplement File

Table 1. Wild food plants traditionally consumed, Frequency of Citation (FC), Relative Frequency of Citation (RFC), Cultural importance Index (CI), and number of Use-Reports of each plant in each study sites. While the number of informants (total informants 140) are also represented in 7 different study sites like Timergara 24 informants, Adenzai 11, Khal 21, Munda 17, Balambat 13, Sumerbagh 26, and Lalqilla 28.

RFC		0.06	0.05	0.17	0.16	0.1	0.13		0.15
FC		9	7	25	23	15	19		21
CIf	0.67							2.22	
Lalqilla (28)		3/140= 0.021	2/140	4/140	5/140	3/140	4/140	0.35	2/140
Sumerbagh(26)		1/140= 0.007	2/140	3/140	4/140	5/140	6/140	0.385	3/140
Balambat 13)		1/140= 0.007	—	2/140	1/140	1/140	—	0.171	2/140
Munda (17)		2/140= 0.014	1/140	2/140	6/140	2/140	2/140	0.285	5/140
Khal (21)		2/140= 0.014	1/140	7/140	3/140	3/140	4/140	0.357	3/140
Adenzai (11)		3/140= 0.021	2/140	4/140	2/140	1/140	1/140	0.185	2/140
Timergara(24)		1/140= 0.007	1/140	3/140	2/140	—	2/140	0.47	4/140
Family/Species	***Rosaceae***	***Fragaria nubicola Lindl.ex Lacaita***	***Duchesnea indica (Andr.) Focke***	***Rubus ellipticus Smith***	***R. fruiticosus Hk.F. non L.***	***R. niveus Thumb. non Wall***	***Pyrus pashia Buch-ham ex.Don.***	***Moraceae***	***Morus nigra L.***

0.75	0.17	0.5	0.65		0.31	0.55	0.09	0.07		0.15	0.13
105	24	69	91		43	77	13	11		21	19
				1.02					1.35		
21/140	1/140	11/140	14/140	0.271	13/140	21/140	3/140	1/140	0.228	4/140	7/140
19/140	1/140	10/140	21/140	0.24	17/140	15/140	2/140	—	0.25	3/140	4/140
8/140	—	7/140	7/140	0.064	2/140	6/140	—	1/140	0.057	—	1/140
12/140	1/140	11/140	11/140	0.157	5/140	11/140	4/140	2/140	0.114	3/140	2/140
17/140	8/140	12/140	10/140	0.114	1/140	13/140	1/140	1/140	0.221	2/140	1/140
9/140	—	7/140	8/140	0.05	2/140	4/140	—	1/140	0.131	3/140	1/140
19/140	13/140	11/140	20/140	0.128	3/140	7/140	3/140	5/140	0.235	6/140	3/140
Morus alba L.	***Morus lavaegata Wallich. Ex Brandis.***	***Ficus carica Czern. and Ray.***	***Ficus palmata Forssk.***	***Rhamnaceae***	***Zizyphus mauritiana Lam.***	***Zizyphus sativa Gaertn***	***Sageretia thea (Osbeck) M.C.***	***Zizyhus oxyphyla Edgew***	***Fabaceae***	***Lathyrus cicera L.***	***Lathyrus aphaca L***

0.47	0.61		0.65	0.06	0.03		0.06	0.07	0.71		0.028
67	85		89	9	5		9	11	99		4
		0.74				0.85				0.65	
9/140	12/140	0.162	20/140	1/140	2/140	0.2	1/140	4/140	23/140	0.042	1/140
15/140	13/140	0.148	18/140	2/140	1/140	0.2	2/140	1/140	25/140	0.14	1/140
3/140	4/140	0.042	6/140	—	—	0.057	—	1/140	7/140	0.028	—
9/140	21/140	0.098	11/140	2/140	1/140	0.119	1/140	3/140	13/140	0.126	2/140
11/140	17/140	0.098	12/140	1/140	1/140	0.078	3/140	—	8/140	0.071	—
7/140	7/140	0.035	5/140	—	—	0.035	—	1/140	4/140	0.0214	—
13/140	11/140	0.14	17/140	3/140	—	0.028	2/140	1/140	19/140	0.049	—
Vicia faba L.	***Medicago denticulata Willd.***	***Polygonaceae***	***Rumex dentatus L.***	***Rumex hastatus L.***	***Rumex crispus L.***	***Amaranthaceae***	***Amaranthus spinosus L.***	***Amaranthus caudatus L.***	***Amaranthus viridis L.***	***Lamiaceae***	***Salvia lanata Roxb.***

0.34	0.11				0.16	0.03		0.54	0.07
48	16				23	5		76	10
	3/140 (Green Tea)	3/140 (Green Tea)		0.19			0.61		
15/140 (Salad)			1/140(Salad)	0.028	3/140	1/140	0.14	20/140	1/140
14/140(Salad)	2/140 (Green Tea)	2/140 (Green Tea)	1/140(Salad)	0.035	4/140	1/140	0.133	17/140	2/140
2/140 (Salad)	3/140(Green Tea)	1/140 (Salad)	1/140 (Green Tea)	0.021	3/140	—	0.028	3/140	1/140
9/140 (Salad)		3/140(Green Tea)	1/140 (Salad)	0.057	6/140	2/140	0.057	5/140	3/140
5/140 (Green Tea)	2/140 (Green Tea)	2/140(Salad)	1/140(Green Tea)	0.014	2/140	1/140	0.07	9/140	1/140
2/140 (Salad)	1/140 (Green Tea)	1/140 (Salad)		0.007	1/140	—	0.042	7/140	—
1/140 (Green Tea)	2/140 (Salad)	4/140(Green Tea)	1/140(Salad)	0.028	4/140	—	0.119	15/140	2/140
Mentha arvensis L.		***Mentha longifolia (Linn) Huds.***		***Chenopodiaceae***	***Chenopodium album L.***	***Chenopodium murale L.***	***Malvaceae***	***Malva sylvestris L.***	***Malva neglecta Wallr.***

	0.27	0.13		0.05	0.27			0.25	0.15	
	39	9		7	38			36	22	
0.4			0.37			2/140 (Green Tea)	0.4			0.73
0.085	9/140	3/140	0.064	3/140 (Spices)	4/140(Spices)		0.1053	10/140	5/140	0.0147
0.042	5/140	1/140	0.085	2/140 (Spices)	6/140(Green Tea)	4/140(Spices)	0.098	8/140	6/140	0.133
0.014	1/140	1/140	0.021	1/140 (Salad)	2/140 (Spices)	1/140 (Green Tea)	0.014	1/140	1/140	0.078
0.042	5/140	1/140	0.05	1/140(Salad)	5/140(Spices)		0.05	4/140	3/140	0.085
0.064	7/140	2/140	0.064	—	5/140(Green Tea)	4/140(Spices)	0.035	3/140	2/140	0.105
0.021	3/140	—	0.057	—	6/140(Green Tea)	2/140(Spices)	0.021	2/140	1/140	0.042
0.07	9/140	1/140	0.035	—	4/140 (Green Tea)	1/140(Spices)	0.085	8/140	4/140	0.133
Ulmaceae	***Celtis eriocarpa Decne.***	***Celtis australis L.***	***Apiaceae***	***Carum carvi L.***	***Foeniculum vulgare Mill.***		***Agaricaceae***	***Agaricus compestris L.***	***Lycoperdon pratensePerse***	***Sapotaceae***

0.73		0.07		0.021		0.05		0.04		0.05	
103		11		3		7		6		8	
	0.12	1/140 (Fruit eat)			0.05		0.04		0.05		
21/140	0.014			1/140	0.0014	2/140	0.021	3/140	0.021	3/140	
19/140	0.021	2/140 (Cooked as	vegetable)	1/140	0.007	1/140		—		—	
11/140	0.007	1/140 (Fruit eat)		—	0.007	1/140		—		—	
12/140	0.014	2/140 (Cooked as	vegetable)	—		—	0.007	1/140		—	
15/140	0.035	4/140(Frui t eat)		1/140	0.007	1/140	0.007	1/140	0.014	2/140	
6/140	0.007	1/140(Frui t eat)		—		—		—		—	
19/140	0.021	3/140 (Cooked as	vegetable)	—	0.014	2/140	0.007	1/140	0.021	3/140	
Monotheca buxifolia (Falc) A.DC.	***Caryophyll aceae***	***Silene conidia L.***		***Stellaria media (L.). Cyr.***	***Solanaceae***	***Solanum nigrum Auct.***	***Fagaceae***	***Quercus dilatata Lindl. Ex Royle***	***Pinaceae***	***Pinus roxburghii Sargent.***	

	0.25		0.57			0.09			0.66
	35		81			13			93
0.25		0.7			0.1	4/140 (Green Tea)		0.66	
0.078	11/140	0.14	3/140(Spice,	17/140(Fruits)	0.028		2/140 (Fruits)	0.157	22/140
0.064	9/140	0.112	4/140 (Spice)	12/140(Fruits)	0.021	3/140 (Fruits)		0.133	19/140
0.028	4/140	0.078	8/140 (Fruit)	3/140 (Spices)	0.007	1/140 (Fruits)		0.05	7/140
0.014	2/140	0.071	4/140 (Spice,	6/140(Fruits)	0.007	1/140(Fruits)		0.085	12/140
0.014	2/140	0.098	8/140(Spice, Fruit)	6/140(Spices)	0.014	1/140 (Green Tea)	1/140(Fruits)	0.078	11/140
0.007	1/140	0.049	4/140 (Fruit)	3/140(Spices)	0.014	2/140 (Fruits)		0.064	9/140
0.042	6/140	0.142	11/140 (Fruit)	9/140(Spices)	0.021	3/140 (Green Tea)	2/140 (Fruits)	0.091	13/140
Portulacaceae	***Portulaca oleracea L.***	***Punicaceae***	***Punica granatum L.***		***Oleaceae***	***Olea ferrginea Royle***		***Brassicaceae***	***Nasturtium officinale R. Br.***

	0.65			0.021		0.58		0.27		0.48	
	91			3		82		38		68	
0.72			0.02		0.58		0.27		0.48		0.15
0.133	19/140(Fruits,	Green Tea)		—	0.164	23/140	0.057	8/140	0.15	21/140	0.014
0.119	17/140 (Fruits,	Green Tea)		—	0.057	8/140	0.042	6/140	0.091	13/140	0.021
0.064	9/140 (Fruits)	3/140 (green tea)	0.007	1/140	0.05	7/140	0.014	2/140	0.014	2/140	0.007
0.091	13/140 (Fruits,	Green Tea)		—	0.071	10/140	0.057	8/140	0.028	4/140	0.028
0.105	15/140 (Fruits,	Green Tea)	0.007	1/140	0.091	13/140	0.077	11/140	0.105	15/140	0.014
0.064	9/140 (Fruits)			—	0.064	9/140	0.007	1/140	0.014	2/140	0.007
0.142	20/140 (Green Tea,	Fruits)	0.007	1/140	0.084	12/140	0.014	2/140	0.077	11/140	0.064
Myrtaceae	***Myrtus communis L.***		***Thymeleaceae***	***Daphne macronata Royle.***	***Ebenaceae***	***Diospyrus lotus L.***	***Asclepiadaceae***	***Caralluma edulis Edgew.***	***Berberidaceae***	***Berberis lyceum Royle.***	***Asparagaceae***

0.15		0.29			0.22		0.3		0.05		0.03
22		40			31		41		7		5
	0.34		5/140 (Vegetable)	0.22		0.3		0.05		0.03	
2/140	0.057	3/140 (salad)		0.064	9/140	0.119	17/140	0.021	3/140		—
3/140	0.064	6/140 (salad)	3/140 (Vegetable)	0.049	7/140	0.0576	8/140	0.007	1/140	0.007	1/140
1/140	0.014	2/140(salad)		0.007	1/140	0.007	1/140		—		—
4/140	0.021	3/140 (salad)	5/140 (Vegetable)	0.014	2/140	0.014	2/140		—	0.014	2/140
2/140	0.049	2/140 (salad)		0.077	11/140	0.064	9/140	0.014	2/140		—
1/140	0.042	6/140(Vegetable)			—	0.007	1/140		—	0.007	1/140
9/140	0.091	9/140 (salad)	4/140 (Vegetable)	0.007	1/140	0.021	3/140	0.007	1/140	0.007	1/140
Asparagus gracilis Royle	***Alliaceae***	***Allium jacquemontii Kunth, Enum***		***Pteridaceae***	***Pteridium equilinum L.***	***Vitaceae***	***Vitis jacquemontii Parker, For.***	***Urticaceae***	***Debrrgesia salicifolia D.Done.***	***Cactaceae***	***Opuntia dillenii (KerGawl.) Haw***

	0.64		0.02		0.11		0.14		0.31
	90		3		16		20		46
0.64		0.02		0.11		0.14		0.31	
0.164	23/140	0.007	1/140	0.014	2/140	0.035	7/140	0.112	16/140
0.098	14/140		–	0.021	3/140	0.021	5/140	0.035	5/140
0.035	5/140		–	0.007	1/140	0.014	–	0.007	11/40
0.077	11/140		–	0.014	2/140	0.007	–	0.014	3/140
0.105	15/140	0.014	2/140	0.042	6/140	0.0576	8/140	0.098	14/140
0.057	8/140		–	0.007	1/140		–	0.007	–
0.098	14/140		–	0.007	1/140	0.007	–	0.049	7/140
Rutaceae	***Zanthoxylum armatum DC.***	***Myrsinaceae***	***Myrsine africana Linn.***	***Asphodelaceae***	***Asphodelus tenuifolius Cav.***	***Hpericaceae***	***Hypericum perforatum Linn.***	***Helvelaceae***	***Morchella esculenta L.***

Table 2:Classification of wild plants species on the basis of Cultural Importance Index (CI) values.

Class 1		**Class 3**	
Plant Name	**CI**	**Plant Name**	**CI**
Morus alba	0.75	*Lathyrus cicera* L.	0.15
Monotheca buxifolia	0.73	*Morus nigra* L.	0.15
Myrtus communis	0.72	*Asparagus gracilis* Royle	0.15
Amaranthus viridis	0.71	*Lycoperdon pratense*Perse.	0.15
Punica granatum	0.7	*Mentha longifolia* (Linn) Huds.	0.14
Nasturtium officinale	0.66	*Hypericum perforatum* Linn.	0.14
Ficus palmata	0.65	*Pyrus pashia* Buch-ham ex.Don.	0.13
Rumex dentatus	0.65	*Lathyrus aphaca* L	0.13
Zanthoxylum armatum	0.64	*Celtis australis* L.	0.13
Medicago denticulata	0.61	*Asphodelus tenuifolius* Cav.	0.11
Diospyrus lotus	0.58	*R. niveus* Thumb. non Wall	0.1
Zizyphus sativa	0.55	*Silene conidia* L.	0.1
Malva sylvestris	0.54	*Sageretia thea* (Osbeck) M.C.	0.09
Ficus carica	0.5	*Olea ferrginea* Royle	0.1
Berberis lyceum	0.48	*Amaranthus caudatus*L.	0.07
		Malva neglecta Wallr.	0.07
		Zizyhus oxyphyla Edgew	0.07
Class 2		**Class 4**	
Scientific name	**CI**	**Scientific name**	**CI**
Vicia faba L.	0.47		
Mentha arvensis L.	0.42	*Rumex hastatus* L.	0.06
Allium jacquemontii Kunth, Enum	0.34	*Amaranthus spinosus*L.	0.06
Foeniculum vulgare Mill.	0.32	*Fragaria nubicola* Lindl.ex Lacaita	0.06
Zizyphus mauritiana Lam.	0.31	*Solanum nigrum* Auct.	0.05
Vitis jacquemontii Parker, For.	0.3	*Duchesnea indica* (Andr.) Focke	0.05
Morchella esculenta L.	0.31	*Pinus roxburghii* Sargent.	0.05
Caralluma edulis Edgew.	0.27	*Debrrgesia salicifolia* D.Done.	0.05
Celtis eriocarpa Decne.	0.27	*Carum carvi* L.	0.05
Portulaca oleracea L.	0.25	*Quercus dilatata* Lindl. Ex Royle.	0.04
Agaricus compestris L.	0.25	*Opuntia dillenii (KerGawl.)Haw*	0.03
Pteridium equilinum L.	0.22	*Rumex crispus* L.	0.03
*Morus lavaegata*Wallich. Ex Brandis.	0.17	*Chenopodium murale* L.	0.03
Rubus ellipticus Smith	0.17	*Salvia lanata* Roxb.	0.028
R. fruiticosus Hk.F. non L.	0.16	*Stellaria media* (L.). Cyr.	0.021
Chenopodium album L.	0.16	*Daphne macronata* Royle.	0.021
		Myrsine africana Linn.	0.02

Figure. Author taking ethnobotanical interviews with local elder peoples.

Figure. Plants collection

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