HARNESSING THE POTENTIAL OF MEDICINAL PLANTS USED FOR THE TREATMENT OF DIABETES IN RURAL AREAS OF AZAD JAMMU AND KASHMIR, PAKISTAN

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Abstract. This study was aimed to highlight the significance of medicinal plants, used for the treatment of diabetes from Azad Jammu and Kashmir, Pakistan. A total of 340 informants including 171 males and 169 females were interviewed through questionnaire. For reliability of medicinal knowledge, relative frequency of citation (RFC) and family importance value (FIV) were calculated. Novelty of the work was found out with the help of Jaccard index (JI). RFC and FIV were further analysed by multivariate cluster analysis. A total of 42 plant species belonging to 41 genera and 30 families were recorded during the survey. Leaves were the most commonly used plant part and decoction was the most recommended remedy preparation method. *Momodica charantia, Berberis lycium, Syzygium cumini* and *Oxalis corniculata* were the most cited species with relative frequency of citation 0.81, 0.72, 0.59 and 0.55 respectively. The highest consensus between informants and indigenous uses of family was shown by Lamiaceae with 97.44 FIV followed by Fabaceae (87.05) and Myrtaceae (85.88). Novelty index showed that *Berberis lycium, Beta vulgaris, Coriandrum sativum* and *Oxalis corniculata* were the newly documented species against diabetes. The results of present study could play vital role in conservation of traditional knowledge of study area.
Keywords: *medicinal knowledge, cluster analysis, traditional knowledge, Jaccard index, Berberis lycium*

Introduction

Diabetes is a major public health problem currently affecting 284.6 million people worldwide and according to the latest International Diabetes Federation estimates it is expected to affect 438.4 million adults by 2030 becoming one of the world's main disabler and killer (IDF, 2010). It disturbs the function of heart, eyes, kidneys and overall body. It is a major health problem that results in reduced life quality and increased illness (Wei et al., 2010). Diabetes is usually managed by diet, exercise, oral hypoglycemic agents and insulin (Ayodhya et al., 2013).

In addition to modern allopathic treatments, plants have also been used for the treatment of diabetes throughout the world in traditional systems of medicines (Donga et al., 2015). Many plants have the potential to lower the blood glucose level and to manage diabetes mellitus like *Morinda citrifolia* (Goodman and Ghafoor, 1992), *Musa sapientum* (Jain et al., 1998)), *Allium cepa* (Mossa, 1999), *Brassica juncea* (Yokozawa, 2003), *Herichrysum odoratissimum*, *Herichrysum petiolare*, *Hypoxis hemerocallidea* and *Hypoxis colchicifolia* (Masika and Afoloayan, 2003). The rural inhabitants of Azad Jammu and Kashmir are mostly depend on traditional medicines and traditional health

practitioners as the primary source of health care. There are several reports of ethnobotanical surveys in Azad Jammu and Kashmir (Ajaib et al., 2015; Ajaib and Khan, 2014; Mahmood et al., 2011) concerning use of medicinal plants for the management and treatment of diseases including diabetes mellitus. However, in Azad Jammu and Kashmir, the traditional medicinal plants that are used for the treatment of diabetes are not studied in great detail.

Pakistan is ranked 7th in the world for the diabetes prevalence. A recent diabetes prevalence survey has revealed staggering 16.98 percent prevalence of diabetes as 35.3 million people among the adult population are found diabetic in Pakistan. If awareness programs and proper treatment are not adopted, Pakistan may have double of diabetic patients by 2040 (WHO, 2016). Such high prevalence of diabetes calls for continued efforts to improve public awareness regarding the disease. Keeping in view the current scenario of diabetes, the present study was designed to document plant knowledge used exclusively for the treatment of diabetes in rural areas of Azad Jammu and Kashmir, Pakistan.

Materials and methods

Study area

The Himalaya, the emporium of biodiversity, have been variously divided into Western Himalaya, Central Himalaya and Eastern Himalaya. Azad Kashmir (34.22°N 73.28°E) is located in foothills of Western Himalaya with an area of 13,269 km^2 which is divided into two distinct geographical zones. North and East are mostly hilly and mountainous while South and West are valleys and plains (*Fig. 1*). Due to extensive topographical variations, the area supports a variety of plant species (Afshan et al., 2011). In Himalaya, about 70% of flora have medicinal value and rural population largely depends on these plants for medicines (Shaheen et al., 2012). These plants based on traditional medicine system, continue to play an essential role in health care, with about 80% of the world's inhabitants relying mainly on traditional medicines for their primary health care (Franz, 1985). Till date, 6000 species are identified from different parts of Pakistan and Azad Kashmir, and off these, more than 400 species are only dwelling only in Azad Kashmir region with high medicinal values (Shinwari and Shinwari, 2010). In remote areas about 60% of the local population is engaged in collection and processing of different medicinal herbs (Qamar et al., 2010).

Field study

A wide-ranging survey in rural and remote areas was carried out during 2013-15. Information was gathered using open and close ended questioners. A sum of 340 informants including 171 males and 169 females were interviewed after initial survey and many group discussions with the native people. Selection criteria of choosing informants were based on the individual's expertise in the collection and utilization of medicinal plants for diabetes. Prior Informed Consent was obtained from informants involved in interviews and plant collection walks. Ethical approval was not required for this study as research participants were only interviewed on knowledge of plant species used for medicinal purposes. Participants were not subjected to any treatment, were not part of any clinical trials, and no information is presented here that could identify individual participants. Plant samples were collected, pressed with the help of plant

presser and dried at room temperature. Completely dried plant specimens were mounted on the herbarium sheets. For long term preservation and to avoid fungal attack, each mounted sample was treated with 1% $HgCl_2$ preservative. Plants were identified by the plant taxonomist at The Department of Botany and further clarification was done through herbaria comparison and available taxonomic literature. The International Plant Name Index (IPNI), Scopus, Web of Science and Google Scholar, Catalog of vascular plants of West Pakistan and Kashmir (Ali and Nasir, 1970-2002) were also consulted to obtain correct botanical names. Plant specimens with voucher number were deposited in Herbarium of University of the Poonch Rawalakot.
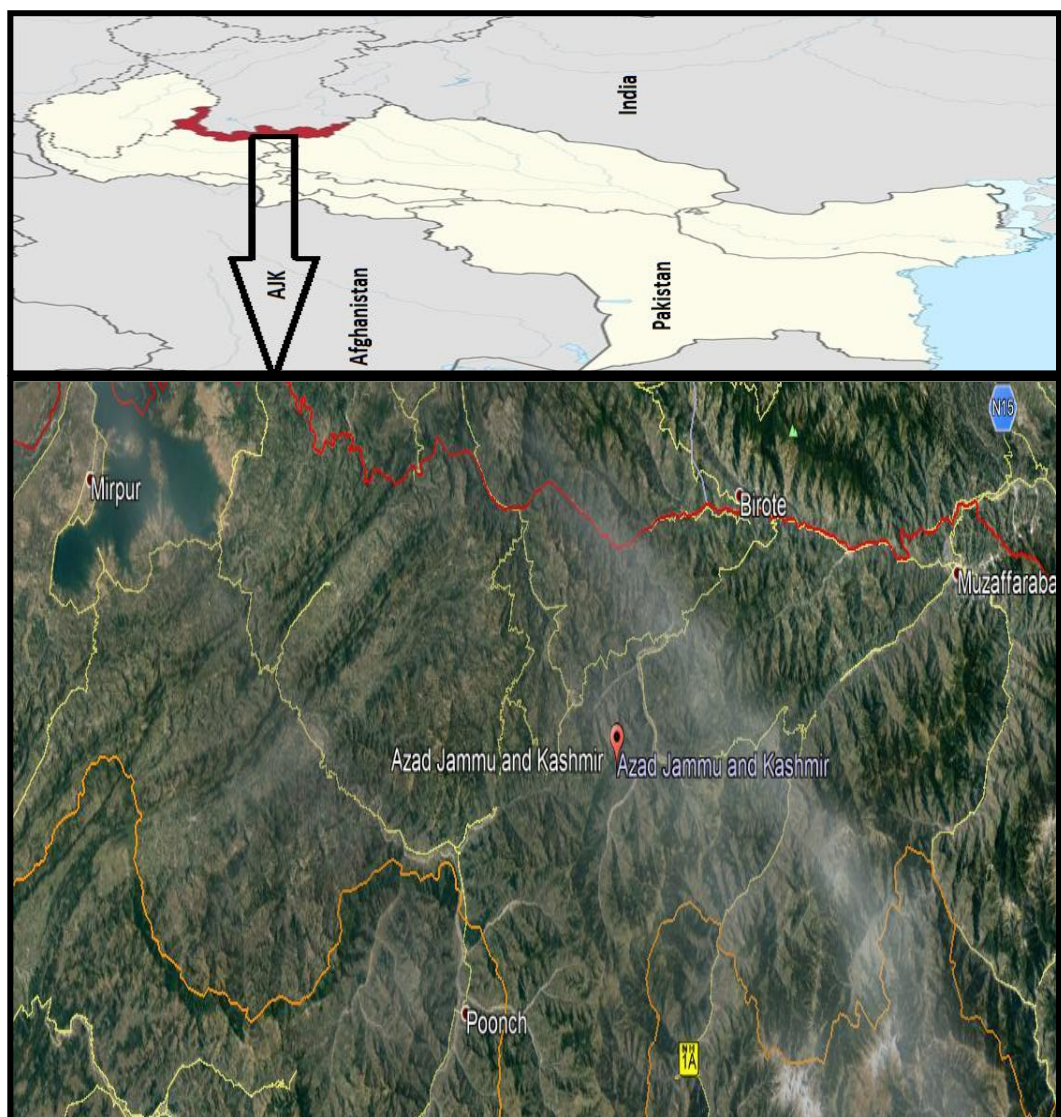

Figure 1. Map of the study area (AJK)

Data collection

Data was collected from people of different age groups belonging to different professions (formers, shopkeepers, teachers, herbal practitioners, wood sellers, students etc.) by using semi structured questionnaire (see *Appendix*), developed by using the

method of Edwards et al. (2005). The collected data comprised of local names of the plants, the parts of plant, recipe and usage method, quantity of dose and duration of treatment.

Relative frequency of citation

The frequency of citation was calculated to assess the incidence of one particular plant species used for the treatment of diabetes in relation to the overall citations for all plants. The relative frequency of citation for a plant species was calculated as *Equation 1* (Tardio and Pardo-de-Santayana, 2008).

$$RFC = \frac{FC}{N} \ (0 < RFC < 1) \tag{Eq.1}$$

Where FC is the number of informants who mentioned the use of plant and N is the total number of informants.

Family importance value

The consensus between informants and indigenous use of family was evaluated by formula in *Equation 2* (Molares and Ladio, 2009)

$$FIV = FC_{Family} / N \times 100 \tag{Eq.2}$$

Where FC = Number of informants mentioned indigenous use of family for particular disease and N= total number of informants mentioning all family for particular disease.

Jaccard index

JI was used to find the resemblance in indigenous data among various ethnic groups and geographical areas by comparing present study with published works from the neighboring areas as in *Equation 3* (Gonza et al., 2008).

$$JI = \frac{c \times 100}{(a + b) - c} \tag{Eq. 3}$$

where a is the species present in our area only, b is the species present in neighboring area only and c is the species found in both areas.

Data analysis

Measuring the importance of plants and vegetation to people is a central concern in quantitative ethnobotany. Quantitative indices help to obtain quality information on medicinal plant usage which in turn contributes conservation of natural resources. Furthermore, such indices helped to establish consensus on which species are effective to cure diabetes, as well as the species' relative importance and enabled us to understand the extent of the potential utilization of each species. In this study, data ethnobotanical data was tested using quantitative indices namely: RFC, FIV, and JI. Multivariate cluster analysis was done on RFC and FIV.

Results

Demographic profile

The present study was conducted in rural areas of Azad Jammu and Kashmir, Pakistan. A total of 340 informants have been interviewed (*Table 1*). The demographic profile of the area showed that there were 51% male and 49% female respondents. All the informants were classified into 3 age groups viz. Below 30 years (20%), 30 to 50 years (27%) and above 50 years (56%). It was observed that indigenous knowledge was more confined to older people.

Table 1. *Demographic data of the informants*

Variable	Categories	Total	%
Gender	Male	175	51
	Female	165	49
Age groups	Below 30	69	20
	30-50	91	27
	Above 50	190	56

Documentation of plants

The ethnobotanical data showed that inhabitants of Azad Jammu and Kashmir use 42 plant species belonging to 41 genera and 30 families for the treatment of diabetes. Most of them were angiosperms while gymnosperms and pteridophytes are represented by only one species each. All the recorded plant species are arranged in alphabetical order with their families, voucher specimen, local name, part used and recipes (*Table 2*).

Table 2. *Documentation of medicinal plants used for the treatment of diabetes mellitus in Azad Jammu and Kashmir, Pakistan with scientific names, local names, parts used, recipe, FC and RFC*

S. No.	Taxon	Local name	Part used	Recipe	FC	RFC
1	*Acacia arabica* Willd. **(Fabaceae)**	Keeker	Pods, leaves, gum	Decoction	13	0.03
2	*Aconitum heterophyllum* Wall. **(Ranunculaceae)**	Patrees	Underground stem and roots	Decoction, powder	21	0.06
3	*Ajuga bracteosa* Wall. **(Lamiaceae)**	Kori booti	Whole plant	Decoction	113	0.33
4	*Ajuga parviflora* L. **(Lamiaceae)**	Adamjan	Whole plant	Decoction	70	0.20
5	*Aloe barbadensis* Mill **(Liliaceae)**.	Kanwar gandal	Fresh leaves	Leaf juice	57	0.16
6	*Anethum graveolens* L. **(Apiaceae)**	Saunf	Leaves, stem, fruit	Juice of all fresh parts	103	0.30

7	*Avena sativa* L. **(Poaceae)**	Jei	Seeds, roots	Extracts of straws and roots, seeds as powder	12	0.03
8	*Bauhinia variegata* L. **(Fabaceae)**	Kachnar	Leaves, flower, bark	Decoction	80	0.23
9	*Berberis lycium* L. **(Berberidaceae)**	Simloo	Root bark	Dried root, bark powder and Juice	257	0.75
10	*Beta vulgaris* L. **(Chenopodiaceae)**	Chuqander	Tap root, leaves, seeds	Juice and decoction	136	0.40
11	*Caltha palustris* L. **(Ranunculaceae)**	Marsh marigold	Aerial parts	Decoction	45	0.13
12	*Catharanthus roseus* L.**(Apocynaceae)**	Madaguscar	Leaves, roots	Decoction and extract	33	0.09
13	*Cedrus deodara* Roxb. **(Pinaceae)**	Deodar	Leaves extract, heart wood oil	Heart wood and dried leaves decoction	88	0.25
14	*Chenopodium album* L **(Chenopodiaceae)**.	Bathuwa	Leaves, seeds	Leaves as vegetable and dry seeds orally with water	29	0.08
15	*Coriandrum sativum* L. **(Apiaceae)**	Dhaniyan	Leaves, fruit	Leaves as salad and fruits are taken with water	139	0.40
16	*Cuscuta reflexa* Roxb.**(Convolvulaceae)**	Neeladhari	Whole plant	Decoction of dry and fresh plant	32	0.09
17	*Equisetum hyemale* L. **(Equistaceae)**	Commen horsetail	Whole plant	Decoction of dried plant	10	0.02
18	*Eriobotrya japonica* Thumb. **(Rosaceae)**	Loquat	Leaves, flower, fruit	Dry leaves extracts and decoction	10	0.02
19	*Fragaria vesca* L. **(Rosaceae)**	Kanachi	Roots, leave	Decoction of dried and fresh roots and leaves	18	0.05
20	*Hedra helix* L. **(Araliaceae)**	Herbambel	Leaves	Powder and decoction of shade dried leaves	136	0.40
21	*Juglans regia* L. **(Juglandaceae)**	Akhore	Leaves, bark, fruit	Decoction of dried leaves and bark, fruit oil	32	0.09
22	*Lycium barbarum* L. **(Solanaceae)**	Kankoli	Ripe fruit	Ripe fruit	111	0.32
23	*Marrubiam vulgare* L. **(Lamiaceae)**	White horehound	Leaves, roots	Extracts of dry leaves and roots	63	0.18
24	*Mentha arvensis* L. **(Lamiaceae)**	Podina	Aerial parts	Decoction and sauce of fresh or dry leaves	87	0.25

25	*Momordica charantia* L. **(Cucurbitaceae)**	Karela	Fruit, seeds, leaves	Seed oil and leaves decoction	277	0.81
26	*Nasturtium officinale* L. **(Brassicaceae)**	Chow	Aerial parts	Used as vegetable	123	0.36
27	*Olea europaea* L. **(Oleaceae)**	Zeytoon	Leaves, seeds	Decoction of dried leaves and seeds	153	0.45
28	*Oxalis corniculata* L. **(Oxalidaceae)**	Khatkoira	Whole plant	Juice and decoction of fresh leaves and roots	189	0.55
29	*Phaseulus vulgaris* L. **(Fabaceae)**	Lobia	Beans	Pods and bean sauce vegetable	113	0.33
30	*Plantago lanceolata* L. **(Plantaginaceae)**	Chamch-e-Pattar	Whole plant, seeds	Seeds decoction, leaves as vegetable	151	0.44
31	*Polygonum aviculare* L.**(Polygonaceae)**	Masloon	Whole plant	Decoction of fresh or dried plant	109	0.32
32	*Psidium guajava* L. **(Myrtaceae)**	Amrood	Fruit, leaves, roots	Fresh leaves juice and dry leaves extract	91	0.26
33	*Quercus dilatata* Thumb. **(Fagaceae)**	Burri	Bark	Bark decoction	10	0.02
34	*Rehmannia glutinosa* Gaertn. **(Scrophulariaceae)**	Chandal booty	Roots	Decoction	49	0.14
35	*Solanum nigrum* L. **(Solanaceae)**	Kach Maach	Whole plant, fruit	Decoction and extract	29	0.08
36	*Syzygium cumini* L. **(Myrtaceae)**	Jaman	Leaves, seeds, fruit	Powder orally with water	201	0.59
37	*Taraxacum officinale* L. **(Asteraceae)**	Hund	Whole plant	Leaves as vegetable, decoction of dried plant	139	0.40
38	*Trigonella foenum-gracum* L. **(Fabaceae)**	Methi	Leaves and seeds	Leaves fresh as vegetable and seed decoction or extract	80	0.23
39	*Urtica dioica* L. **(Urticaceae)**	Bichhu booty	Roots	Hot water extracts of dried roots	17	0.05
40	*Woodfordia fruticosa* L. **(Lythraceae)**	Bela, Davi	Flowers	Dried flower extract	10	0.02
41	*Zanthoxylum alatum* Roxb. **(Rutaceae)**	Timber	Bark, fruits and leaves	Extracts of all dried parts	38	0.11
42	*Zizpiphus mauritiana* Lam. **(Rhamnaceae)**	Beri.	Fruits and leaves	Mixture of dried fruit and leaves extracts	76	0.22

Family participation

It was found that most dominant families with respect to species number were Fabaceae and Lamiaceae with 4 species each followed by Apiaceae, Chenopodiaceae, Ranunculaceae, Rosaceae and Solanaceae with 2 species each (*Fig. 2*). All other families were represented with one species. The dominance of the families is corresponded to the fact that these are well known among the people and easy to access.
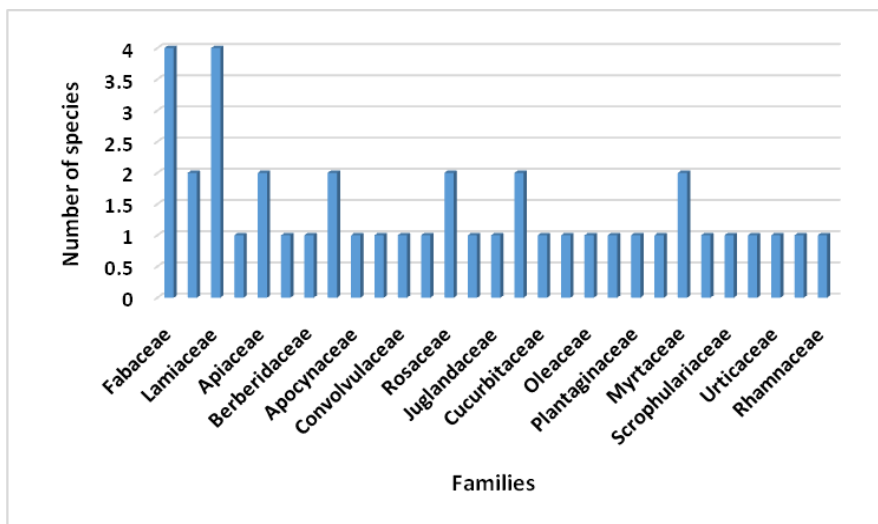

Figure 2. *Number of species per family*

Parts used and methods of administration

Most frequently used plant parts were the leaves (28%) and fruits (16%) followed by whole plant (13%), seeds (12%), roots (10%), bark (7%), flowers (4%) and aerial parts (3%) as shown in *Figure 3*. Herbal medicines were prepared by using different preparation methods, i.e. decoction, powder, juice, extract and vegetable (*Fig. 4*). Most frequent used method was decoction (48%) followed by extract (21%), juice and vegetable (11% each) and powder (9%) as presented in *Figure 4*.
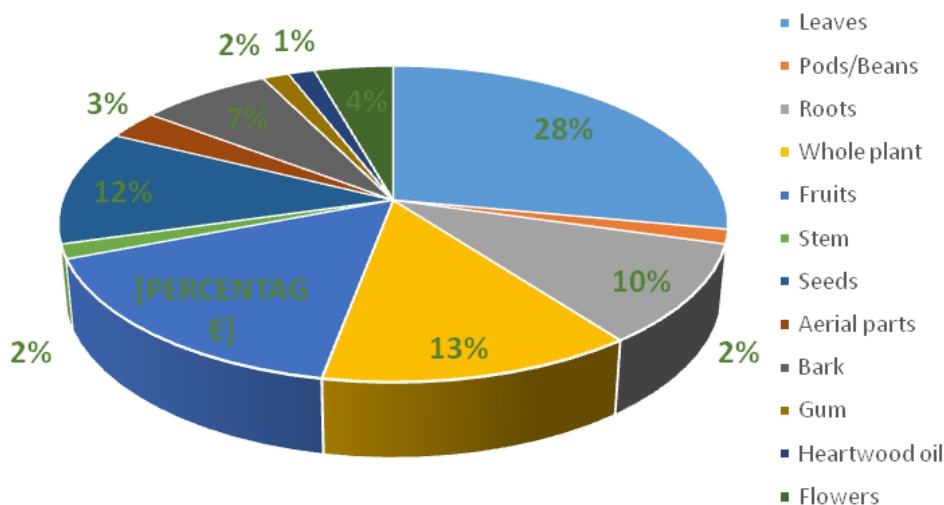

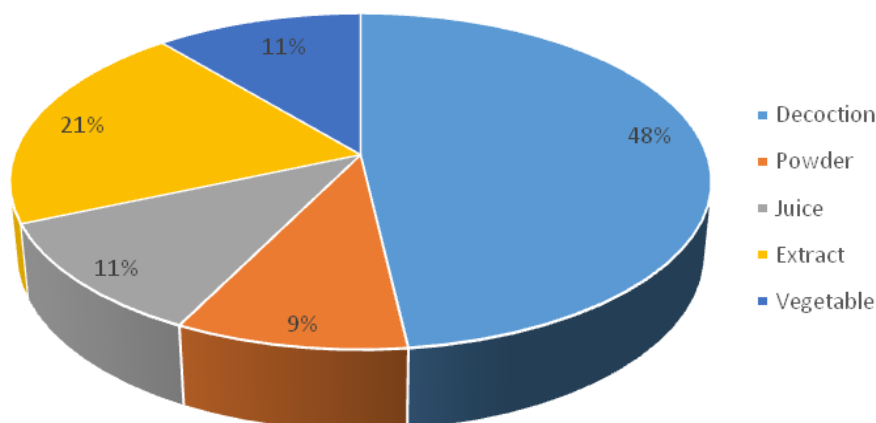***Figure 3.*** *Plant parts used to treat diabetes*

Figure 4. *Methods of herbal drug preparation*

Relative frequency of citation

Most common plants used to treat diabetes as mention by informants were determined by calculating RFC. The RFC values were shown in *Table 2,* which ranged from 0.09 to 0.95. The highest RFC was found for *Berberis lycium* (0.95) followed by *Momordica charantia* (0.91) and *Beta vulgaris* (0.80).

Family importance value

The results of FIV are shown in *Table 3*. The highest consensus between informants and indigenous uses of family was shown by Lamiaceae with 97.44 FIV followed by Fabaceae (87.05), Myrtaceae (85.88), Cucurbitaceae (81.47), Berberidaceae (75.58) and Apiaceae (71.17).

Table 3. *Family importance value*

Family	FC	FIV
Equitaceae	10	2.94
Lythraceae	10	2.94
Polygonaceae	109	32.05
Poaceae	12	3.52
Brassicaceae	123	36.17
Araliaceae	136	40
Asteraceae	139	40.88
Solanaceae	140	41.17
Plantaginaceae	151	44.41
Oleaceae	153	45.00
Chenopodiaceae	165	48.52
Urticaceae	17	50.00
oxalidaceae	189	55.58
Apiaceae	242	71.17
Berberidaceae	257	75.58

Cucurbitaceae	277	81.47
Rosaceae	28	8.23
Myrtaceae	292	85.88
Fabaceae	296	87.05
Convolvulaceae	32	9.41
Juglandaceae	32	9.41
Apocynaceae	33	9.70
Lamiaceae	333	97.94
Rutaceae	38	11.17
Scrophulariaceae	49	14.41
Liliaceae	57	16.76
Ranunculaceae	66	19.41
Rhamnaceae	76	22.35
Pinaceae	88	25.88

Jaccard index

It was used to compare the indigenous knowledge use to treat diabetes among different communities as the ethnobotanical knowledge greatly vary among the communities because of different origins, geography, culture and social behavior. This comparison of knowledge may result in discovery of many new drugs (Leonti, 2011). The present study was compared with 9 other studies from Pakistan, India, Bangladesh, Iran (*Table 4*). The maximum degree of parallel index was found with studies by Bahmani et al., (Bahmoni et al., 2014) from Uramia, Northwest Iran, Ahmad et al. (2009) Attock Pakistan and Kumari et al. (2011) Uttarakhand, India.

Table 4. *Jaccard index comparing present study with previous studies*

Area	Study year	Number of recorded plant species	Total species common in both area	Species enlisted only in aligned areas	Species enlisted only in study area	JI	Citation
Attock, Pakistan	2009	37	5	32	37	7.81	Ahmad et al., 2009
Tamil Nadu, India	2017	65	5	60	37	5.43	Aadhan and Anand, 2017
Uttarakhand, India	2011	16	3	13	39	6.12	Kumari et al., 2011
Dhaka, Bangladesh	2013	37	3	34	39	4.29	Ocvirk et al., 2013
Madhya Pradesh, India	2012	28	1	27	41	1.49	Yadav et al., 2012
Taroudant Province, Morocco	2017	39	4	35	38	5.80	Katiri et al., 2017
Tamilnadu, Southern India	2012	16	2	14	40	3.85	Elavarasi and Saravanan, 2012
Urmia, Northwest Iran	2014	30	5	25	37	8.77	Bahmani et al., 2014

Novelty and future impact

The novelty index was determined by comparing present study with previous studies conducted in Pakistan, India, Bangladesh and Iran as shown in *Table 3*. In Azad Jammu and Kashmir, no previous study was found on anti-diabetes uses of medicinal plants. In Pakistan only few studies were found. There was very little resemblance with previous studies in uses of plants to treat diabetes. Some of the newly documented medicinal plants used to treat diabetes were *Berberis lycium*, *Beta vulgaris*, *Coriandrum sativum*, *Oxalis corniculata*, *Phaseulus vulgaris*, *Psidium guajava*, *Zizpiphus mauritiana*, *Mentha arvensis*, *Hedra helix*, *Bauhinia variegata*, *Taraxacum officinale* and *Zanthoxylum alatum*.

Multivariate cluster analysis

Based upon RFC values, multivariate cluster analysis results reveal significant relationship among plant species. There were two main clusters (*Fig. 5*).
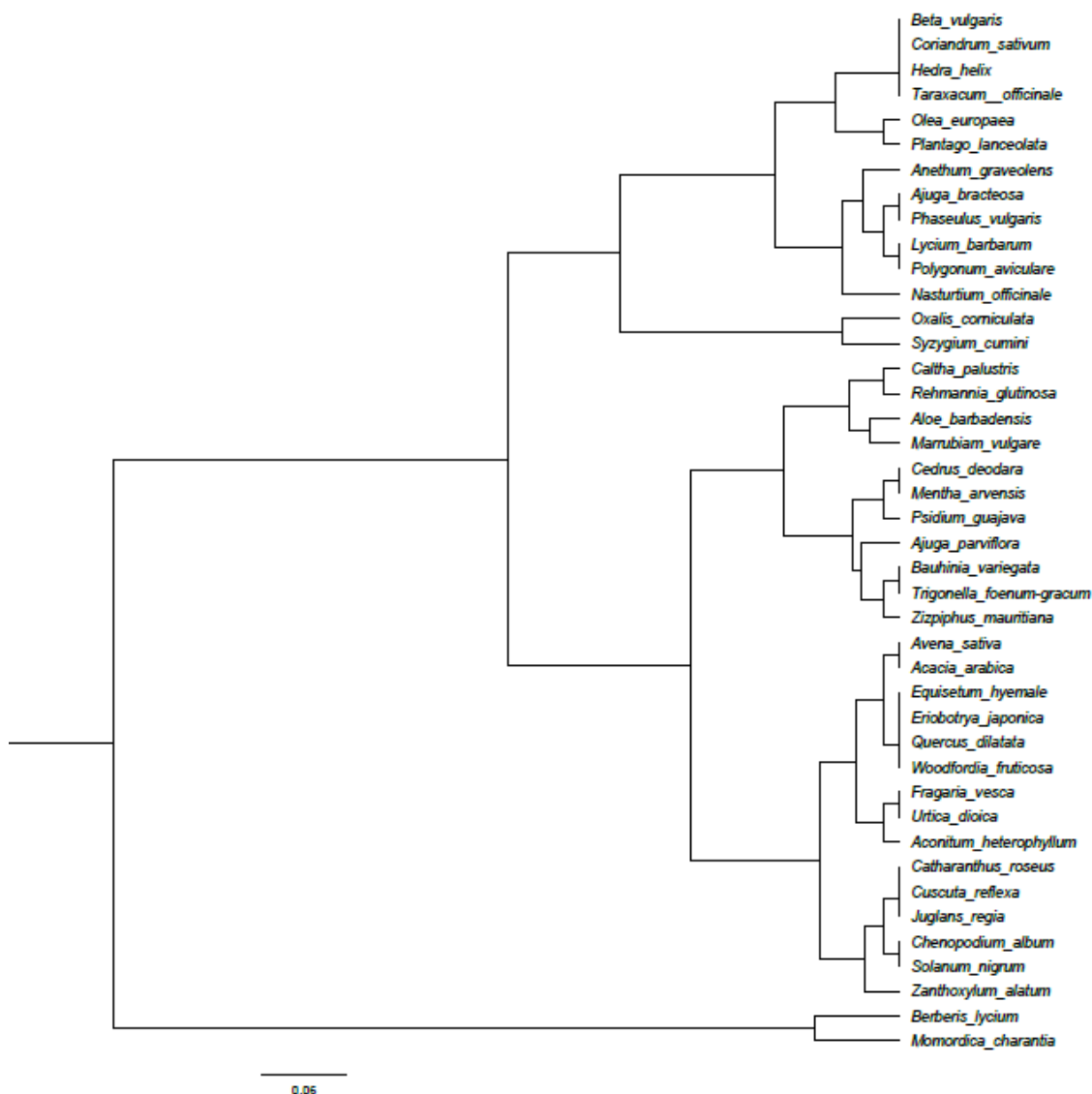

***Figure 5.** Cluster analysis based on RIF values of plants*

Cluster one comprised of *Berberis lycium* and *momordica charantia*. Both species showed close relationship based upon RFC. Cluster two received 41 species, it was the largest group. Cluster two was further divided into 4 sub clades. *Beta vulgaris*, *Coriandrum sativum*, *Hedra helix* and *Taraxacum officinale* showed closed RFC values. *Olea europea* and *Plantago lanceolata* were sister species, showing close association. *Anethum graveolens* and *Nasturtium officinale* showed weak association with rest of the species in the clade, i.e. *Ajuga bracteosa*, *Lycium barbarum* and *Polygonum aviculare*. *Oxalis corniculata* and *S. cumini* were closely associated based on RFC values. *C. palustris* was closely related to *R. glutinosa*. *F. vesca*, *A. dioca* and *A. hydrophyllum* were closely related species. In the next cluster, *C. reflexa*, *J. regia*, *C. album* and *S. nigrum* were more closely related plant species. In the cluster, *B. variegata* was more closely related *T. foenum-gracum* and *Z. mauritiana* than *A. parviflora*. Whereas *C. deodara* was more closely related to *M. arvensis* than *S. guajava*.

Multivariate cluster analysis, on the basis of FIV, suggested a close relationship among the families. It is divided into two main clusters (*Fig. 6*). Cluster 1 showed the association of Rosaceae, Equitaceae, Lythraceae and Poaceae. Cluster 2 is further divided into 3 sub clusters. Brassicaceae was most closely related to Polygonaceae. Chenopodiaceae was closed to Urticaceae than Oxalidaceae. Apiaceae and Berberidaceae were more close to each other on the basis of FIV.
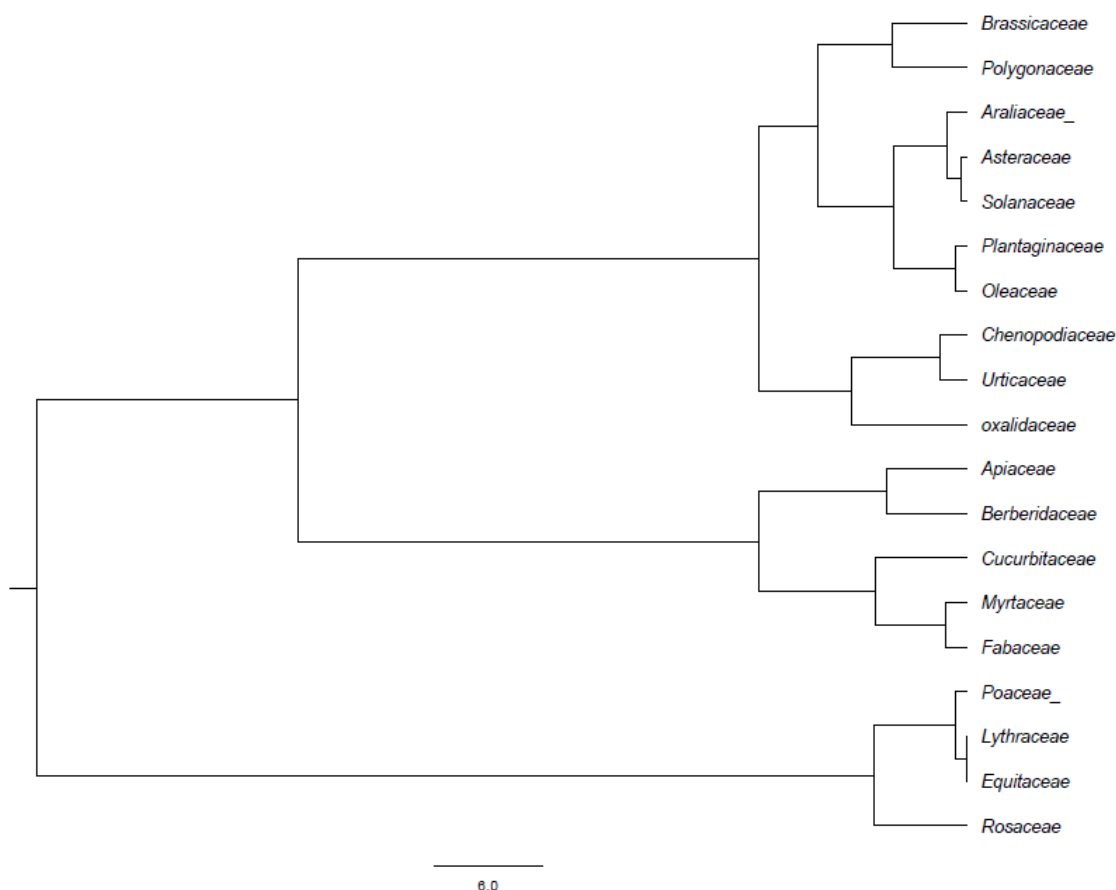

Figure 6. *Cluster analysis of families based on FIV*

Discussion

The present investigation was confined in rural areas of Azad Jammu and Kashmir, Pakistan. The objective was to document the medicinal flora of the area traditionally used for the treatment of diabetes and to explore the constituents of these medicinal plants. To collect the ethnobotanical information, 340 informants were interviewed. There had been tendency of increasing ethnobotanical knowledge with the age of informants. The ethnobotanical data showed that 42 plant species belonging to 41 genera and 30 families were used for the treatment of Diabetes. The reason is that older people are more familiar with the use of medicinal plants and are involving in ethnomedicinal practicing and traditional knowledge. However younger people have less interest in older traditional knowledge regarding the use of plants for treatment of diseases. Previous studies also show that elder people have more ethnomedicinal knowledge (Kpodar et al., 2015; Abouri et al., 2012).

Fabaceae and Lamiaceae were the dominant families in the study area with 4 species each followed by Apiaceae, Chenopodiaceae, Ranunculaceae, Rosaceae and Solanaceae with 2 species each. The dominance of the families is corresponded to the fact that these are well known among the people and easy to access. Furthermore, locals have more knowledge about these families and used these plants for generations to generations. Frequent use of these families also suggests that important secondary metabolites are present in the member of these families. In previous study, it was found that members of Fabaceae and Lamiaceae are used for the treatment of diabetes (Aadhan and Anand, 2017).

Most frequent used plant parts were the leaves, followed by fruits, whole plant, seeds, roots, bark, flowers and aerial parts Leaves are mostly used parts because of the fact that leaves are the main photosynthetic organs and they are the part of the plants which is most easily reachable and accessible throughout the year (Fezon et al., 2008). Leaves are also valuable in phytotherapy because they contain more effortlessly extractable phyto-compounds, crude drugs and several additional mixtures (Bano et al., 2014a, b). Moreover, leaves are easy to collect and process and their collection does not harm the plant considerably in contrast to collection of bark, roots and whole plant (Telefo et al., 2011; Zheng and Xing, 2009). Leaves are most frequent plant parts used as ethnopharmacology as reported in previous studies (Amjad et al., 2017; Khan et al., 2015).

Most frequent used method was decoction followed by extract, juice, vegetable and powder. In ethnobotanical practices, the major forms of herbal drug preparation are the decoction (mixing plant part with water, tea or soup (Amjad et al., 2017). The other reason of the use of decoction is that it is prepared by heating which may hasten the biological reactions resultant in the increased accessibility of many bioactive compounds (Han et al., 2007; Zhang et al., 2005).

The RFC values were from 0.09 to 0.95. The highest RFC was found for *Berberis lycium* and *Momordica charantia* reflected that these species were very famous and familiar among the local inhabitants of the study area and these species could be further investigated for their pharmacological and phytochemical properties (Mukherjee and Wahile, 2006). Number of studies suggests that *Momordica charantia* has higher potential as antidiabetic (Chaturvedi, 2012; Nama et al., 2011; Shibib et al., 1993; Ali et al., 1993).

Jaccard index results showed ethnobotanical knowledge varied greatly among the communities because of different origins, geography, culture and social behavior. This

comparison of knowledge may result in discovery of many new drugs (Leonti, 2011). The maximum degree of parallel index was found with studies by Bahmani et al. (2014) from Uramia, Northwest Iran, Ahmad et al. (2009) Attock Pakistan and Kumari et al. (2011) Uttarakhand, India. The highest similarity index corresponds to same type of vegetation and geographical conditions or same ethnic values. Most common species were the *Momordica charantia*, *Trigonella foenum-gracum* and *Syzygium cumini*. These species are found in almost all compared areas, which demonstrate their importance for the treatment of diabetes. The lowest JI was found for the study of Yadav et al. (2012) from Madhya Pradesh, India. This difference is might be due to geographical barriers and different type of vegetation and habitat (Leonti, 2011). Strong positive correlation between UV and RFC showed that increase in number of informants also increases the knowledge of the uses of species (Ishtiaq et al., 2007; Ahmed et al., 2017). This suggested that this study is a significant contribution towards the documentation of plants used for the treatment of diabetes.

Conclusions

This ethnobotanical study documented the ethnophytotherapeutic management of diabetes mellitus and support of traditional healers in Azad Jammu and Kashmir. The indigenous population still relies to a great extent on traditional healers and medicinal plants to meet their healthcare needs because of the perceived effectiveness, presumed safety with minimal side effects and affordability. In conclusion, this article presented a list of anti-diabetic plants used in the treatment of diabetes mellitus. Medicinal plants are good alternative to synthetic drugs due to biocompatibility, cost effective and less or no side effects. Further studies are needed to be carried out to explore the exact mechanism of these medicinal plants' antidiabetic activity. The documented plants should also be further screening for their phyctochemical constituents, pharmacognostic characters and biochemical assays for their sustainable and effective uses.

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APPENDIX

Questionnaire for collecting ethnomedicinal data during Ethnobotanical Study

Questionnaire:

Informants' consent for the participation in the study:

I.. (name of informant) hereby give my full consent and conscious to participate in this study and declare that to the best of my knowledge the information that I have provided are true, accurate and complete.

Date.......................................   (Signature/Thumb impression of Informant)

Informants' details:
Name..
Gender..
Age...
Occupation..
Education..
Location/Residence..
Data about medicinal plant and its use:
Plant (Local name)..
Habit (Tree/Herb/Shrub/Climber/…...)
Plant part used...
Cultivated/Wild..
If cultivated, cultivated for……………………………….................
If wild, availability in natural resources (easy/difficulty/very difficult)
Conservation needs...
Conservation efforts made by Government and local residents…….……
Method of collection and storage………………………....................
Name of disease(s) treated…………………………….....................
Method of crude drug preparation...
Mode of administration...
Dosage...
Other uses (if any)…………………………..……...........................

Remarks:
Plant identified as …………………………………………… (Botanical name and family)

Information provided by informants will be used for research purposes only

Signature of Researcher