Ethnobotanical study of medicinal plants used for treatment of Diabetes in Southern Punjab, Pakistan

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Research

Abstract

Background: Diabetics is a chronic metabolic disease and a leading cause of death worldwide. In rural areas of Pakistan like Mianwali, diabetes management relies on medicinal plants due to limited access to healthcare and the high cost of treatments. This study highlights the potential of Indigenous medicinal plants as safer, cost-effective alternatives and supports for further research to identify active compounds for diabetes treatment.

Methods: During October 2022 to December 2024 data was collected from 250 informants in Mianwali district through open interviews, semi-structured questionnaires and field surveys. Special focus was given to elderly respondents and traditional herbalists for their extensive knowledge of ethnomedicinal practices. The information was analyzed using the Use Value (UV), Family Importance Value (FIV), Relative Frequency Citation (RFC), and other quantitative indices.

Results: The study identified 44 plant species from 25 families as medicinally significant for diabetes management. Herbs accounted for 48.83% of the recorded species, followed by trees (30.23%), shrubs (18.60%), and climbers (2.32%). Key families included Fabaceae, Cucurbitaceae, and Solanaceae. Quantitative indices revealed *Moringa oleifera* with the highest Use Value (UV = 0.97) and *Rhazya stricta* with the highest Fidelity Level (FL = 92.86%).

Conclusions: This study highlights the rich ethnobotanical knowledge in the Mianwali district, documenting 44 plant species from 25 families used for diabetes management. Herbs were the most commonly utilized growth form (48.83%), reflecting their availability and versatility in treating various ailments.

Keywords: Ethnobotany; Asteraceae, Indigenous knowledge; Used value, Herbal medicine, Mianwali, Diabetes, Cucurbitaceae

Background

Diabetes ranking third among the world's leading causes of death (Onyango *et al.* 2018). Diabetes is a serious metabolic disorder. There are two forms of diabetes: Type 1 (which requires insulin) and Type 2 (which does not). Up to 90% of diabetes cases are type II diabetes, which is chronic. Type 1 diabetes, on the other hand, usually affects young adults and accounts for the remaining 5-10% of diabetes cases. It is projected that between 2000 and 2030, the prevalence of diabetes will rise by 151% in South Asian countries alone (Tariq *et al.* 2020). It is estimated that over 463 million people worldwide suffer from diabetes; by 2030 and 2045, that figure could rise to 578 and 700 million, respectively (Mohammad *et al.* 2023). The rural population of Pakistan relies mainly on their natural resources to produce medicines for the problems associated with diabetes because they cannot afford the high costs associated with treating the disease with allopathic drugs (Jayawardena *et al.* 2012). Finding an efficient treatment for diabetes with fewer side effects is crucial because it is a major financial burden on both the developed and developing worlds (Saini & Parkashyadav 2013). Allopathic medications cannot treat diabetes because they cannot return the body's natural glucose balance and have a wide range of unfavorable side effects. Alternative medications which are less expensive, more efficient, and have less side effects are desperately needed (Einstein *et al.* 2013). Plant-derived phytocompounds are the source of several pharmaceutical products used to treat diabetes. Compared to allopathic medications, traditional medicines are significantly less toxic and have potent therapeutic effects (Tariq *et al.* 2020). The current study was planned to study comprehensive ethno medical knowledge of the anti-diabetic plants of the district Mianwali and to analyze the phytochemical and pharmacological literature to lend some measurable credibility to the long-held traditional medical knowledge. When selecting the location, the following were the primary factors taken into account: A high incidence of diabetes patients, a rural setting, a rich diversity of medicinal plants, a low socioeconomic status, a lack of modern healthcare facilities, a long history of traditional knowledge, accessibility and ease of use are the other factors. could identify novel active ingredients beneficial for the management of diabetes.

Materials and Methods

Study area

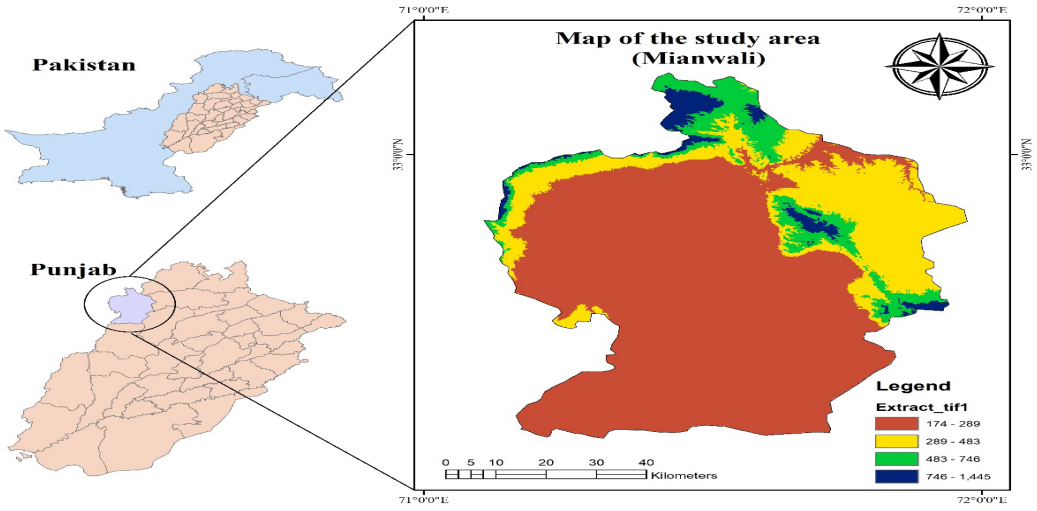

Figure 1. Map of District Mianwali, Punjab, Pakistan, showing the study area

The district of Mianwali is located northwest of Punjab. It shows the plains of the salt ranges near Sakesar hill in the western part. The eight district boundaries are as follows: the district of Attock is situated in the north; the districts of Kohat and Karak, Northwest; the district of D.I. Khan, South West; and the districts of Chakwal, North East, Bhakkar, South, Khushab, East, and West. With a total area of 5840 Km^2, District Mianwali is situated between 32° 30′ and 33° 14′ N. and 71° 7′ and 71° 44′ E. The Salt Range and Potohar Peak still stand for most of the region. The district has an extremely severe climate overall, with long, hot summers and cold, dry winters. June and July are the warmest months, with an average maximum temperature of 48^{0}C, and December and January are the coldest, with an average minimum temperature of 5^{0}C. The district experiences unpredictable and erratic rains. Rainfall in the district is highly variable and changeable, posturing significant challenges for agriculture and water resource management. Seasonal rainfall patterns related with the monsoonal rains during summer and irregular winter precipitation, which together shape the hydrological dynamics of the region. The vicinity to the Salt Range creates localized variations in rainfall distribution and concentration, further adding to the randomness.

These rainfall conditions play a crucial role in influencing the regions agricultural practices, water availability, and the nourishment of local ecosystems.

Fieldwork

An ethnobotanical study was done from October 2022 to December 2024 in order to knowledge about the indigenous people of the Mianwali district's use of medicinal plant species to treat diabetes. The information was gathered using a semi-structured interviews. Traditional data from 250 randomly chosen informants across various age groups. The age range of informants over 60 is 35 (14%), 45–60 is 97 (38.80%), and 35–45 is 76 (30.40%). Elderly respondents and traditional herbalists were given preference. Out of the total informants, 160 were men and 90 were women. During the study, it was also noted that women possess sufficient knowledge regarding the application and processing of medicinal plants. Informants were questioned regarding their understanding of the use of various medicinal plant species in the study area to treat various illnesses. In addition, we provided details about the plant parts, dosages, preparation techniques, and routes of administration for the various illnesses. All collected plant species were morphologically identified using the key of flora of Pakistan (http://www.efloras.org/flora_page.aspx?flora_id=5) and authenticated by comparing them with already preserved herbarium specimens (ISL). Additionally, voucher specimens were deposited at herbarium of Islamabad, for future reference.

Quantitative Ethnobotanical Data

The gathered data was analyzed using a number of quantitative ethnobotanical indices, such as Use Value (UV), Fidelity Level (FL), Relative Citation of Frequency (RFC) and Family Importance Value (FIV).

a) Relative Frequency of Citation (RFC)

By analyzing the quantitative relationship between local informants and plant species, we were able to calculate the RFC for a species' or family's folk importance. In order to perform relative frequency citation (RFC), the following formula was used (Mohammad *et al.* 2023).

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

FC is the number of local people who stated the use of the species and N indicate the number of local people participated in the study.

b) Use value (UV)

The relative significance of locally known plants is indicated by their use value. This formula was used to calculate it:

$$UV = \frac{\sum Ui}{N}$$

where N is the total number of informants and Ui is the number of uses for a specie that local informants have reported (Redouan *et al.* 2023).

c) FL, or Fidelity Level

The percentage of informants who say a plant can be used to treat a particular illness is what matters. The following formula determines the fidelity level:

$$FL\ (\%) = Np \times 100\ N$$

Where N is the total number of informants and Np is the number of informants who provide information about the use of a particular plant species for a particular disease (Zareef *et al.* 2023).

d) Family Importance value (FIV)

FIV values show the informant knowledge about the families of plant species used. FIV of plants is investigated by using formula as under (Rahim *et al.* 2023).

$$FIV = \frac{\text{No.of families cited by informants}}{\text{Total no of informants}} \times 100$$

The higher the FIV value greater the knowledge of plants among informants while smaller the FIV values, lesser the awareness about the use of family.

Results

Demographic Characteristics of Respondents

A total of the 250 participants surveyed for this study. During this survey, a total of 160 (64%) were men and 90 (36%) were women. In comparison to female respondents, male respondents were more common in the study area where the majority of respondents were men. Interviewers were unable to have a conversation with female respondents because of a clear cultural barrier. The age distribution of informants is as follows: those over 60 are 35 (14%), 45–60 is 97 (38.80%), and 35–45 is 76 (30.40%). Just 6% of the respondents had a university degree, while the majority of them (26.80%) were illiterate (Table 1).

Table 1. Demographic characteristics of the informants

Variation	Category	Number	Percentage %
Gender	**Male**	160	64.00
	Female	90	36.00
Age	25-35	42	16.80
	35-45	76	30.40
	45-60	97	38.80
	>60	35	14.00
Educational Background	Illiterate	67	26.80
	Primary	59	23.60
	Middle	44	17.60
	Secondary	39	15.60
	Undergraduate	26	10.40
	Graduate	15	6.00

Plants and growth form

The current survey found that 44 plant species across 25 families were used for medicinal purposes. The plant species that have been given scientific names, family names, local names, growth forms, parts used, modes of preparation, FIV, RFC, UV, and FL are listed in Table 2. Fabaceae (four species), Solanaceae (three species), Lamiaceae, Poaceae, and Asteraceae (two species each) were the next largest families, with Cucurbitaceae having five species. Herbs were the most prevalent growth form (48.83%), followed by trees (30.23%), shrubs (18.60%), and climbers (2.32%), as shown in (Figure 2). Because they are easily obtained and have the ability to treat a wide range of illnesses, herbs are frequently used.

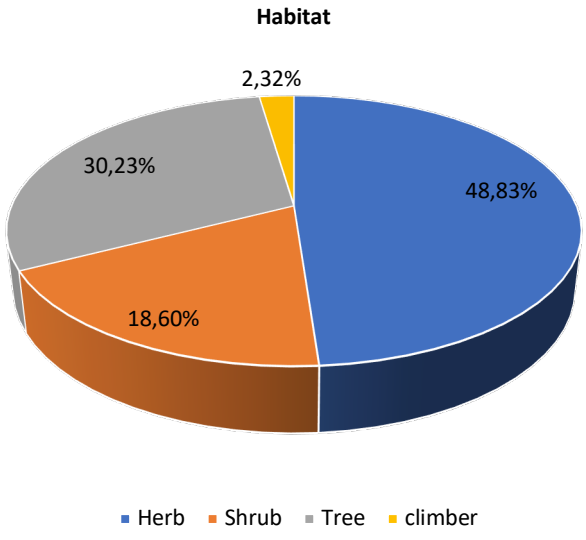

Figure 2. Growth forms of therapeutic plants at District Mianwali, Pakistan

Plant parts used and Mode of preparation

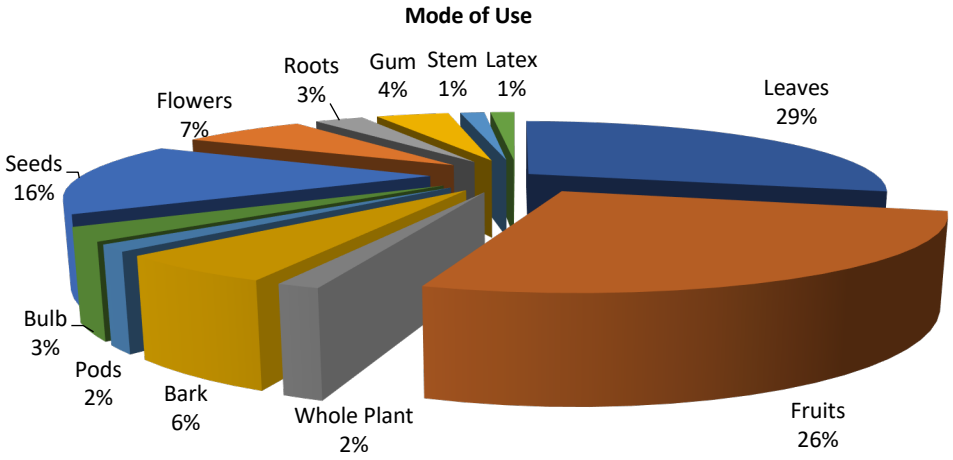

Figure 3. Plant parts used in remedies preparations in District Mianwali, Pakistan

As illustrated in (Figure 3), the majority of plant parts utilized in remedy preparations were leaves (29%), followed by fruits (26%), seeds (16%), flowers (7%) and barks (6%) each. The most popular method for preparing remedies was juice (25%), which was followed by paste (15%), decoction (20%), powder (23%), and infusion (17%) (Figure 4).

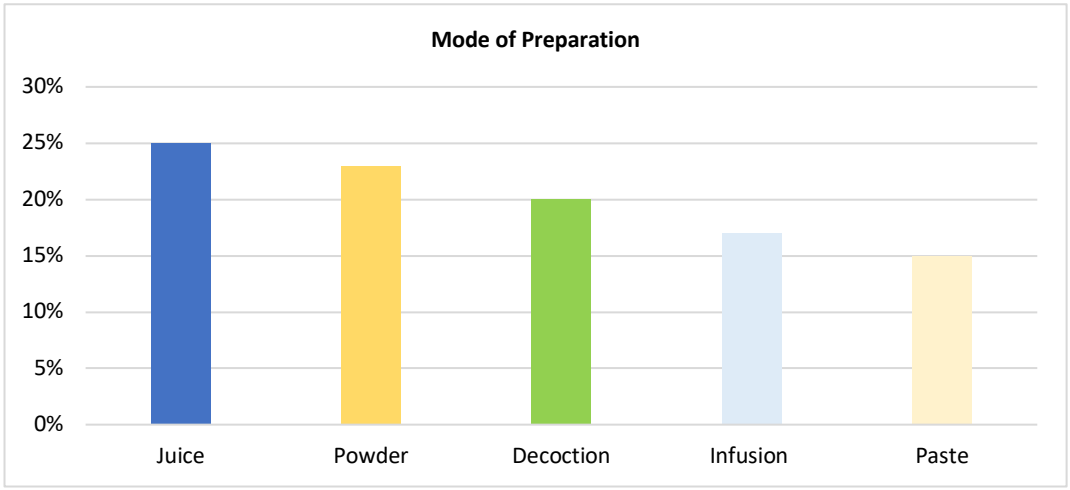

Figure 4. Mode of preparation at District Mianwali Pakistan

Quantitative data analysis

Relative Frequency of Citation

The medicinal plants that were recorded had RFC values ranging from 0.12 to 0.36. *Piper nigrum* had the highest RFC value (0.36), followed by *Momordica chrantia* (0.32), and *Rhapnus sativus* (0.12) had the lowest (Table 2).

Use Value

The documented medicinal plants' UV values ranged from 0.49 to 0.97. Moringa oleifera had the highest UV reading (0.97), followed by *Aloe vera* (0.91), *Piper nigrum* (0.91), *Cucurbita pepo* (0.90), and *Nigella sativa* (0.87), with *Raphanus sativus* having the lowest UV reading (0.49) (Table 2).

Fidelity Level (FL)

Ranged from 51.56 to 92.86% in the current investigation. With 92.86% fidelity levels, *Rhazya stricta* Decne., *Moringa oleifera* Lam, *Citrullus vulgaris* Schrad, *Nigella sativa* L., *Aloe vera* (L.), and *Cucurbita pepo* Wall were the most often used medicinal plants in the survey. According to Table 2, the FL recorded 92.78%, 90.56%, 90.80%, 89.01%, and 87.18%, respectively.

Family Importance Value (FIV)

Apocynaceae (FIV= 97.69%) was the most significant plant family in the study, followed by Cucurbitaceae (90.76%), Moringaceae (90.46%), and Alocaceae (88.46%). Ceaselpiniaceae (44.15%) had the lowest FIV value.

Table 2. Medicinal plants with scientific name, vernacular, family name, growth form, part

Plant Name	Family Name	Local Name	Growth forms	Part Used	Mode of Utilization	RFC	FIV	UV	FL	voucher specimens
Acacia nilotica L.	Fabaceae	Kikar	Tree	Gum, Pod, Bark/ Leaves	Powder, Infusion	0.26	75.38	0.73	71.43	HS-ISL-130
Albizia lebbeck L. (Benth.)		Kala Shareen	Tree	Seed/	Powder	0.19		0.68	65.23	HS-ISL-131
Acacia modesta (L.) Wall.		Phulai	Tree	Gum, Flower Bark, Seed/	Powder, Juice Decoction	0.15		0.53	51.56	HS-ISL-132
Azadirachta indica A. Juss		Neem	Tree	Seed, Bark, Fruit, Gum,	Decoction, Powder	0.36		0.91	90.00	HS-ISL-133
Allium sativum L.	Alliaceae	Lehsan	Herb	Leaves, Whole Plant,	Bulb Infusion, Paste Juice	0.26	66.15	0.70	69.43	HS-ISL-134
Allium cepa L.		Piaz	Herb	Leaves, Bulb/	Infusion, Juice	0.26		0.75	64.43	HS-ISL-135
Aloe vera (L.) Burm.f.	Alocaceae	Kwar gandal	Herb	Leaves	Infusion, Paste, Juice	0.32	88.46	0.91	89.90	HS-ISL-136
Bauhinia purpurea L.	Fabaceae	Kachnar	Tree	Flowers and leaves/	Decoction	0.19	75.38	0.64	61.31	HS-ISL-137
Cucumis sativus L.	Cucurbitaceae	Khira	Herb	Fruit	Juice	0.35	90.76	0.65	80.87	HS-ISL-138
Citrullus lanatus (Thunb.) Matsum. & Nakai		Tarbooz	Herb	Fruit	Paste	0.30		0.57	90.56	HS-ISL-139
Citrullus colocynthis (L.) Schrad.	Cucurbitaceae	Tumba	Herb	Seed, Fruit	Powder, Decoction, Infusion, Paste	0.31		0.83	81.47	HS-ISL-140
Cucurbita pepo Wall.		Kadu	Herb	Fruit	Paste	0.36		0.90	87.18	HS-ISL-141
Citrus medica L.	Rutaceae	Sangtra	Tree	Fruit	Juice	0.15		0.52	51.78	HS-ISL-142
Citrus limon (L.) Osbeck		Lemoo	Tree	Fruit	Juice	0.19		0.61	60.22	HS-ISL-143
Cassia fistula L.	Ceaselpiniaceae	Amaltas	Tree	Seeds	Juice	0.15	44.15	0.53	54.56	HS-ISL-144
Calotropis procera (Aiton) W.T.Aiton	Apocynaceae	Akk	Shrub	Flower	Decoction	0.25	97.69	0.74	73.64	HS-ISL-145
Elettaria cardomomum Maton	Zingiberaceae	Chotti elachi	Herb	Seed/	Powder	0.36		0.92	83.78	HS-ISL-146
Fagonia indica Burm. f.	Zygophyllaceae	Dhamana	Herb	Bark, Leaves, Shoot	Juice	0.19	51.46	0.61	60.22	HS-ISL-147
Ficus carica L.	Moraceae	Anjeer	Shrub	Leaves	Decoction	0.26	65.78	0.79	69.02	HS-ISL-148
Hordium vulgare L	Poaceae	Baajra	erb	Seed	Powder	0.29	80.42	0.83	80.74	HS-ISL-149
Justicia adhatoda L.	Acanthaceae	Bekkar	Herb	Leaves	Juice	0.15	45.22	0.53	51.56	HS-ISL-150

Momordica charantia L.	Cucurbitaceae	Karella	Climber	Fruit	Juice, Powder,	0.32		0.89	85.47	HS-ISL-151
Moringa oleifera Lam.	Moringaceae	Sawanjhna	Tree	Leaves, Seeds	Juice, Decoction	0.36	90.46	0.97	92.78	HS-ISL-152
Morus alba L.	Moraceae	Shatoot	Tree	Fruit, Root/	Paste, Decoction	0.19		0.61	55.22	HS-ISL-153
Mentha piper L.	Lamiaceae	Podina	Herb/	Leaves	Powder	0.24		0.81	83.78	HS-ISL-154
Nigella sativa L.	Ranunculaceae	Kalwanji	Herb	Leaves Seeds, Whole Plant	Decoction, Infusion, Powder	0.25	86.46	0.87	90.80	HS-ISL-155
Ocimum sanctum L	Lamiaceae	Tulsi	Herb	Leaves	Powder	0.26	78.46	0.71	71.43	HS-ISL-156
Olea europaea L.	Oleaceae	Zatoon	Tree	Fruit	Powder	0.30	86.42	0.81	83.27	HS-ISL-157
Olea ferruginea Wall		Kao	Shrub	Leaves, Fruit	Decoction	0.26		0.71	70.00	HS-ISL-158
Psidium guajava L.	Myrtaceae	Amrood	Tree	Fruit, Leaves	Paste, Juice, Infusion	0.30	81.46	0.83	81.47	HS-ISL-159
Piper nigrum L.	Piperaceae	Kaali Mirch	Vine	Seeds	Powder	0.36	88.46	0.91	89.01	HS-ISL-160
Papaver somniferum L.	Papaveraceae	Kashkash	Herb	Fruit, Seed, Latex	Juice, Decoction	0.15	51.46	0.57	56.62	HS-ISL-161
Parthenium hysterophorus L.	Asteraceae	Thandi booti	Herb	Fruit, Leaves, Flower	Powder	0.15	45.38	0.53	51.56	HS-ISL-162
Raphanus sativus L.	Brassicaceae	Mooli	Herb	Root	Decoction	0.12	51.43	0.49	53.57	HS-ISL-163
Rhazya stricta Decne.	Apocynaceae	Weinrran,	Shrub	Whole Plant, Leaves/	Decoction, Juice or Powder	0.36		0.94	92.86	HS-ISL-164
Syzygium cumini (L.) Skeels	Myrtaceae	Jamin	Tree	Seed	Powder, Paste, Decoction	0.28		0.81	78.47	HS-ISL-165
Solanum incanum Scheff	Solanaceae	Marongay	Shrub	Leaves	Infusion	0.19	56.15	0.63	60.22	HS-ISL-166
Solanum surattense L.	Solanaceae	Kandiari	Herb	Fruit	Decoction Powder,	0.15		0.54	53.56	HS-ISL-167
Taraxacum sect. Taraxacum F.H. Wigg.	Asteraceae	Hand	Herb	Root/	Decoction	0.19		0.62	59.22	HS-ISL-168
Ziziphus nummularia (Burm. f.) Wight & Arn.	Rhamnaceae	Bhair, Beera	Shrub	Gum, Leaves, Fruit/	Decoction, Infusion	0.15	55.46	0.51	50.65	HS-ISL-169
Ziziphus nummularia (Burn. f.) Wight & Arn.	Rhamnaceae	Beera	Shrub	Gum, Leaves, Fruit	Decoction, Infusion	0.19	66.15	0.63	61.22	HS-ISL-170

Legends: Specimen (Herbarium) voucher number: HS-Haleema Sadia; **ISL**-Abbreviation of Herbarium of Quaid-i-Azam University Islamabad, Pakistan; **QAU**-Quaid-i-Azam University, Islamabad, Pakistan.

Discussion

A recent study identified 44 medicinal plants from 25 plant families as potential treatments for diabetes. In earlier literature, medicinal plants have been reported in ethnomedical studies from nearby tribal areas by Mianwali Aziz et al. (2016). The use of medicinal plants from southwest Pakistan to treat diabetes was documented by Zain-ul-Abidin *et al.* (2018). The majority of plant species belong to family Rutaceae, Apocynaceae, Fabaceae and Cucurbitaceae reported similar outcomes in 2020 and 2022, respectively. When preparing herbal remedies, herbs were the most common growth form utilized (Faruque and Faruque *et al.* 2014, Hussain *et al.* 2018 & Rehman *et al.* 2022a) all reported similar findings. According to Abbasi *et al.* (2013), herbaceous plants possess bioactive compounds. All parts of plants were used by indigenous healers to prepare herbal remedies, but leaves were most commonly used. In earlier research, comparable findings were documented (Kidane *et al.* 2018). The reason leaves were used in remedy preparations was because they were simpler to gather and preserve. The highest relative frequency of the citation value provides an explanation for the majority of traditional healers are aware of the benefits of these medicinal plants (Bhutt *et al.* 2015 & Rehman *et al.* 2022b). According to (Rehman *et al.* 2022c), the high UV content of therapeutic plants in the study area is linked to their extensive distribution in the research area and the locals' familiarity with their medical applications. Furthermore, it is not right that therapeutic plants with low use values are less important; rather, they suggest that there may be less indigenous knowledge about these plant species or that a particular therapeutic plant is more difficult to find (Chaudhary *et al.* 2006). The UV shows the relative importance of using medicinal plant species in a given area, according to (Bhutt *et al.* 2015 & Rehman *et al.* (2022b). The highest RFC values show that the majority of informants were familiar with these therapeutic plants. The relative citation frequency indicates how familiar the locals are with the medicinal properties of particular plants. It is also easy to use, effective, and has fewer side effects (Kayani *et al.* 2015 & Vitalini *et al.* 2013). The respondents' preference for treating the particular ailment was indicated by the maximum FL value (Karakose, 2022). A plant's maximum FL value indicates how unique and potent it is in treating a specific disease (Sahil *et al.* 2014). The greatest FIV value, according to the data supplied by the respondents, explains why members of a particular plant family are frequently utilized to treat various illnesses.

Conclusion

This study is the first to explore the use of medicinal plants for diabetes treatment by the indigenous communities in Mianwali, Pakistan. It identified 44 plant species from 25 families, with Fabaceae and Cucurbitaceae being the most common, and herbs as the main growth form. Plants like *Moringa oleifera*, *Aloe vera*, and *Nigella sativa* were found to have high medicinal value, with leaves being the most frequently used part, often prepared as juices or powders. However, issues like overharvesting, deforestation, and lack of awareness about conservation put these plants at risk. The study emphasizes the need for more research to confirm their benefits and promote conservation efforts to protect this valuable traditional knowledge and resource.

Declarations

List of abbreviations: AS - Asifa Sameen; ISL - Herbarium of Quaid-i-Azam University Islamabad, Pakistan; QAU - Quaid-i-Azam University, Islamabad, Pakistan

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Consent for publication: Not applicable

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