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Ethnobotanical explorations of some anti-diabetic plants of District Solan, Himachal Pradesh, India

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Abstract

Ethnobotany investigates the intricate relationship of regional plants and their practical uses through the traditional knowledge of local communities. The present study documents and analyze the ethnobotanical knowledge of medicinal flora for the treatment of Diabetes mellitus (DM) in district Solan, Himachal Pradesh. A semi-structured survey was created to collect data about traditionally used antidiabetic plants. The collected data was evaluated through quantitative indices like fidelity level (FL) and use value (UV). A group of 74 native respondents (44 males and 30 females) were questioned about 42 plant species belonging to 34 families. Leaves (35%) were used predominantly for medicine, followed by fruits (23%), flowers (14%), whole plant (11%), root (7%), stem (4%) and seeds (2%) respectively. The maximum diversity of medicinal plants were recorded from the family Fabaceae (4 species), followed by Cucurbitaceae, Euphorbiaceae (3 species) and Rutaceae (2 species). The highest Fidelity level was reported for *Cichorium intybus, Luffa aegyptiaca and Trigonella foenum-graecun*. Similarly, the highest UV was found for *Tinospora cordifolia* (UV=0.87), *Ocimum tenuiflorum* (0.82) and *Withnia somnifera* (0.81). This investigation elucidates the ethnopharmacological knowledge and therapeutic application of antidiabetic flora traditionally employed by the indigenous communities, highlighting the need for their preservation and further pharmacological validation.

Key words : Ethnobotany, Antidiabetic Plants, Traditional Medicine, Quantitative Indices, Indigenous Communities.

Plants have served as vital natural resources in the preventive and therapeutic care of humans since antiquity[1]. Ethnobotany investigates the intricate relationship of regional plants and their practical uses through the traditional knowledge of local communities[2]. Ethnobotanical research is pivotal to bioprospecting novel pharmacophores from natural medicinal flora. For rural communities, ethnomedicinal plants serve as a viable healthcare alternative[3]. According to the WHO, nearly 80% of the global populace relies on phytotherapeutic traditions for primary healthcare. These medicinal plants are often cited for their pharmacological safety, cost-effectiveness and ecological accessibility within local surrounding[4]. India, renowned for its rich and uninterrupted legacy of indigenous medicine, harbors approximately 7,500 plant species used in traditional and modern medicinal systems[5]. The country has a long history of employing medicinal plants in the management of various ailments[6]. Among such ailments, Diabetes mellitus (DM) has emerged as a transnational metabolic pandemic, impacting populations of all age groups, geographic regions and economic systems worldwide.

Diabetes mellitus (DM) has emerged as a transnational metabolic pandemic, affecting nations, populations of all ages and economic systems worldwide. It is a chronic metabolic disorder affecting over 536 million individuals globally and ranking among the top causes of mortality, posing significant challenges for public health systems[7]. As per the International Diabetes Federation (2021), an estimated 425 million individuals worldwide had diabetes, a number projected to surge to 629 million by 2045[8]. India has the highest number of diabetics in the world with more than 31.7 million followed by 20.8 million in China and 17.7 million in US as per WHO, 2008. Conventional diabetes treatment rely on insulin and oral drugs, yet entails key limitations such as side effects, high cost, limited access, reduced efficacy and frequent treatment failure[9]. However, the traditional plant medicines offer low cost or low-risk treatments and aid in identifying bioactive compounds, especially in the developing countries, where 80% of the populations still rely on plant resources for health care needs[10].

The Indian Himalayan region, notably Himachal Pradesh, constitutes a phytodiversity hotspot harboring over 9,000 taxa, approximately 33% of which are endemic[11]. The state, encompassing 55,673 km², is administratively divided into 12 districts and 169 tehsils/sub-tehsils, with elevation ranging from 300 to 7,000 m[12]. Significant studies have scrutinized the distribution and therapeutic use of ethnomedicinal plants used against diabetes across the state[13-17].

Solan, nestled between the Shivaliks and mid-Himalayas, is phytogeographically rich for its ecological and ethnomedicinal diversity. Despite the abundance of ancestral wisdom, systematic documentation and scientific validation of such practices remain sparse. This investigation endeavors to systematically elucidate and archive the ethnobotanical knowledge pertaining to antidiabetic plant species traditionally utilized by local denizens. By employing comprehensive ethnobotanical surveys and participatory community engagements, the study seeks to safeguard traditional therapeutic wisdom, delineate flora with putative antidiabetic potential for subsequent pharmacological validation and advance the sustainable management of regional phytobiodiversity.

Study area :

The present survey was conducted in district Solan, situated in the south-central region of Himachal Pradesh, between latitudes 30°452 N to 31°102 N and longitudes 76°422 E to 77°202 E, covering an area of approximately

1,936 km² (Fig. 1, 2). It is a hub of biodiversity, is widely recognized as the "Mushroom capital of India" with diverse topography spanning rural and urban areas. The terrain is primarily mountainous, forming part of the Shivalik and lower Himalayan ranges. Summers are generally warm, with temperatures ranging between 25°C to 35°C, while winters are cool to cold. Further, the months of July and August mark the monsoon season with average rainfall ranging between 550 mm to 750 mm. Moreover the climate varies from sub-tropical in the lower areas to temperate in the higher altitudes. The flora of Solan district is dominated by various plant species such as *Ocimum sanctum*, *Aegle marmelos*, *Tinospora cordifolia*, *Withania somnifera*, *Terminalia chebula* and *Azadirachta indica* etc.

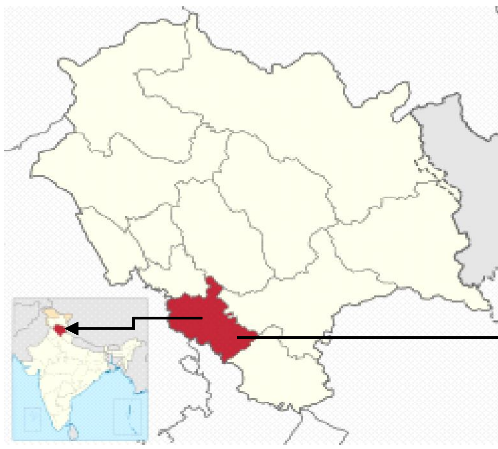

Figure 1. Location of Himachal Pradesh in India.

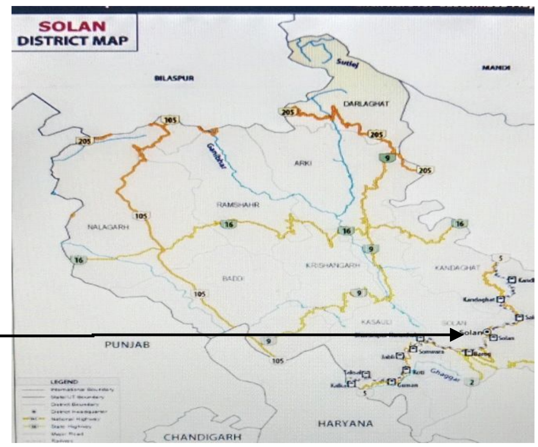

Figure 2. Map showing District Solan with Tehsils and an enlarged view of Himachal Pradesh

Data collection and field survey :

Comprehensive ethnobotanical study was carried out between July 2024 to February 2025. Structured questionnaires were employed to document data in tabulated form, including botanical name, local name, family, plant part(s) used, mode of preparation and method of administration. Field tours to this area was made as per the procedure delineated by[18-19,20]. Demographic distribution (age, education, gender and address) of the participant was also recorded (Table-1). During the survey, a total of 74 respondents were interviewed including 44 males and 30 females from different age groups ranging from 25-70. Ethnobotanical information was gathered from all categories of people such as the local healers or vaids, village leader, elderly persons and the person having a thorough knowledge of medical practices. Botanical identification of the selected species was first done with the help of regional floras[21-25]. Plant specimens were collected, dried and mounted using standard herbarium methods as per[26]. Whereas, the nomenclature of selected plant species was confirmed from online resources such as "The World Flora Online" http://www.worldfloraonline.org/ and "Plants of the World Online" https://powo.science.kew.org.

Quantitative Ethnobotanical Data :

The gathered data was analyzed using a number of quantitative ethnobotanical indices, such as Fidelity Level (FL) and Use Value (UV).

Fidelity Level :

The Fidelity Level (FL) quantifies a species' preferential use for treating a specific ailment and was determined using the following formula :

$$FL = \frac{\text{Np}}{\text{N} \times 100}$$

Whereas, Np is the number of informants that reported a use of a plant species to treat a particular disease and N is the number of informants that used the plants as a medicine to treat any given disease. High FL indicates a strong preference for a specific plant for a particular ailment, suggesting a high level of agreement among informants regarding its use[27].

Use Value :

The relative importance of plants was determined by using the formula below to calculate the use value[28].

$$UV = \Sigma U/n$$

Where, U is the number of use reports for a plant species and n is the total number of informants interviewed. A high UV indicates greater plant significance, while values near zero suggest limited use reports[29].

Socio-demographics of the informants :

Demographic characteristics of the informants were assessed through a questionnaire focusing on age, gender and educational background. A total of 74 informants (44 males and 30 females), aged between 25 and 75 years, were interviewed using a questionnaire. All recorded species, along with their family, vernacular name, habitat, dosage, and mode of administration, are detailed in Table 5. The informants were divided into 4 groups on the basis of their age (Table-1). Interviews revealed that individuals aged 30-60 held the most descriptive knowledge of medicinal plants. Overall, traditional knowledge holders were predominantly middle-aged and had varying levels of formal education, with limited literacy in the elderly.

Table-1. Demography and literacy profile of the informants.

Age Groups	No. of Informants			
25-30	5			
31-50	22			
51-60	27			
61-70	20			
Education and literacy	**Age groups**			
	25-30	**36-50**	**51-60**	**61-75**
Never attended school	0	0	0	7
Attended school for 1-5 classes (Primary level)	0	0	3	8
Attended school for 6-8 classes (Middle level)	0	3	13	4
Attended school for 9-10 classes (Metric level)	3	12	11	1
Attended school for 11-12 classes	2	7	0	0

Table-2. Plants Used for Curing Diabetes by the Rural Peoples of District Solan (H.P.)

Sr. No.	Botanical Names	Family	Local Name	Part/s Used	FL (%)	UV	Dosage and Mode of administration
1	*Abutilon indicum* (L.) Sweet	Malvaceae	Atibala	R	65.2	0.33	Root powder (5 g) with 1 tsp Amla powder, taken with lukewarm cow's milk daily for one month
2	*Achyranthes aspera* L.	Amarant-haceae	Puthh-kanda	WP	17.7	0.56	Fresh juice of whole plant (10 mL) consumed daily in the morning for 2–3 months
3	*Aegle marmelos* (L.) Correa	Rutaceae	Belpatr	L	39.1	0.47	Decoction (half glass) of leaves taken daily
4	*Allium sativum* L.	Alliaceae	Lahsun	B	68.7	0.60	2–3 buds eaten raw daily in the morning
5	*Annona squamosa* L.	Annon-aceae	Sharifa, Sitaphl	Fl	32.0	0.22	Flowers taken as vegetable
6	*Asparagus racemosus* Willd.	Aspara-gaceae	Sanspai, Kliyunti	R	21.7	0.75	Root powder (10 g), saunf (10 g) and rock sugar (5 g), taken daily in the morning
7	*Azadirachta indica* A. Juss.	Meliaceae	Neem	L	21.7	075	Fresh leaf juice (50 mL), taken twice daily
8	*Bacopa monnieri* (L.) Penell.	Scrophula-riaceae	Bhrami	L	40.6	0.16	Fresh leaf juice (4–5 mL), consumed daily in early morning
9	*Bauhinia variegata* L.	Fabaceae	Karyal, Kachnar	Fr, Bk	40.0	0.29	Fruits consumed as vegetable; bark decoction (25 mL) taken twice daily for 20 days
10	*Berberis lyceum* Royle	Berberida-ceae	Kashmal	R	37.5	0.25	Root juice (10 mL) taken thrice daily for one month
11	*Boerhavia diffusa* L.	Nyctagin-aceae	Bishkhapra, Punrnava	WP	45.4	0.54	Whole plant powder (2/ g) with lukewarm water taken twice daily on an empty stomach for 21 days
12	*Carica papaya* L.	Caricaceae	Papaya	Fr	76.1	0.29	Ripe fruits consumed daily
13	*Catharanthus roseus* (L.) G. Don	Apocyn-aceae	Sadabahar	L & Fl	70.9	0.27	Leaf and flower juice (5 mL) taken daily
14	*Chenopodium album* L.	Chenop-odiaceae	Bathua	L	20.0	0.20	Leaf juice (25 mL) consumed twice daily for one month

15	*Cichorium intybus* L.	Asteraceae	Chakora	WP	90.0	0.16	Whole plant powder (1 tsp) with water taken twice daily for one month
16	*Coccinia grandis* (L.) Voigt	Cucur-bitaceae	Banakdu	Fr	75.0	0.25	Fruits consumed both raw and cooked
17	*Diplazium esculentum* (Retz.) Sw.	Athyria-ceae	Lingdu	L	45.6	0.33	Leaves eaten as a vegetable or prepared as soup
18	*Enicostemma axillare* (Poir *ex* Lam.) A. Royal	Gentian-aceae	Nai, Pathriddi	L	56.0	0.29	Leaf juice (10 mL) with 5 g jaggery taken thrice daily
19	*Euphorbia hirta* L.	Euphor-biaceae	Dudhlu	L	33.3	0.59	Leaf juice (3 tsp) taken twice daily for 25 days
20	*Ficus palmata* Forssk.	Moraceae	Fegra	Fr	65.6	0.27	5-10 ripe fruits eaten daily
21	*Hordeum vulgare* L.	Poaceae	Jau	S	53.3	0.70	Seeds consumed in powdered form ('*sattu*') or as chapattis
22	*Jasminum grandiflorum* L.	Oleaceae	Chameli, Sunhi	L	13.0	0.14	5-6 leaves chewed daily in early morning
23	*Luffa aegyptiaca* Mill.	Cucurbi-taceae	Torai, Gangeri	Fr	88.5	0.40	Fruits consumed as a vegetable or in juice form
24	*Momordica charantia* L.	Cucurbi-taceae	Karela	Fr & L	56.3	0.56	Fruit and leaf juice (2 tsp) taken in the early morning
25	*Moringa oleifera* Lam.	Moring-aceae	Moranga	Fl & L	62.6	0.52	Flowers and leaves (5–10 g) boiled in cow's milk with jaggery, consumed daily for 15 days
26	*Murraya koenigii* (L.) Spreng.	Rutaceae	Gandhela	L	60.0	0.78	2-3 fresh leaves chewed in the morning
27	*Musa paradisiaca* L.	Musaceae	Kela	St	28.5	0.17	Stem decoction (15 mL) taken daily for 30 days
28	*Ocimum tenuiflorum* L.	Lamiaceae	Tulsi	L	17.3	0.82	Leaf powder (1-2 tsp) taken with a glass of lukewarm water
29	*Opuntia stricta* Haw.	Cactaceae	Shroltu	Fr	22.2	0.22	Fruits eaten raw
30	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	Khajoor	Fr	76.9	0.17	Ripened fruits (5–10 g) eaten daily with a glass of cow's milk
31	*Phyllanthus amarus* Schum. & Thonn.	Euphor-baceae	Bhuiamla	WP	22.7	0.47	Whole plant juice (10 mL) taken thrice daily for one month
32	*Phyllanthus emblica* L.	Euphor-biaceae	Amla	Fr	33.3	0.83	Dry fruit powder (1tsp) taken with one cup of milk

							twice daily
33	*Rhododendron arboreum* Sm.	Ericaceae	Buransh	Fl	16.6	0.14	Flower juice or squash consumed daily
34	*Rubia cordifolia* L.	Rubiaceae	Manjisht	WP	44.0	0.50	Whole plant decoction (15 mL) with 5 g of rock sugar taken twice daily for 15 days
35	*Senna alata* (L.) Roxb.	Fabaceae	Dadru	L	20.0	0.29	Leaf powder (5 g) with 1 tsp honey taken in early morning
36	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	Fr	60.0	0.62	10-15 ripened fruit consumed daily
37	*Tamarindus indica* L.	Fabaceae	Imli	Fr	15.0	0.44	Fruit mixture (5 g) with two garlic buds administered daily for one month
38	*Thuja orientalis* L.	Cupres-saceae	Sharu, Morpankhi	Fr	9.0	0.06	5-6 crushed fruits mixed with 2 tsp amla juice taken with half a glass of lukewarm water
39	*Tinospora cordifolia* (Willd.) Miers.	Menisper-maceae	Giloye, Gulje	St	48.0	0.87	Stem powder (10 g) taken with lukewarm water in early morning
40	*Trigonella foenum-graecun* L.	Fabaceae	Methi	Sd	80.0	0.66	Soaked seeds water consumed (half a glass) in early morning
41	*Urtica dioica* L.	Urticaceae	Bicchubuti	L	48.0	0.41	Decoction of leaves taken daily for a month
42	*Withania somnifera* (L.) Dunal	Solanaceae	Ashaga-ndha	Fr	16.0	0.81	Fruit powder (5 g) with 5 g *saunf* taken thrice daily for one month

Abbreviations: L.-Leaf; R.-Root; St.- Stem; Fl.- Flower; W.P.- Whole Plant; Fr.- Fruit; Sd.- Seed.

Plant Attributes :

A total of 42 plant species of medicinal importance belonging to 34 families 41 genera were documented from the study area. Of these, 35 species are dicots, 5 monocots, and one each from gymnosperms and pteridophytes (Fig. 3). Herbs are the most commonly used plants for treating diabetes in the area, followed by trees, shrubs and climbers. Leaves are the most frequently used plant part for diabetes treatment (35%), followed by fruits (23%), flowers (14%), whole plants (11%), roots (7%), stems (4%), and seeds (2%) (Fig. 5). Fabaceae(4 species), represented the most dominant dicotyledonous family in terms of species used for diabetes remedies, followed by cucurbitaceae and Euphorbiaceae (3

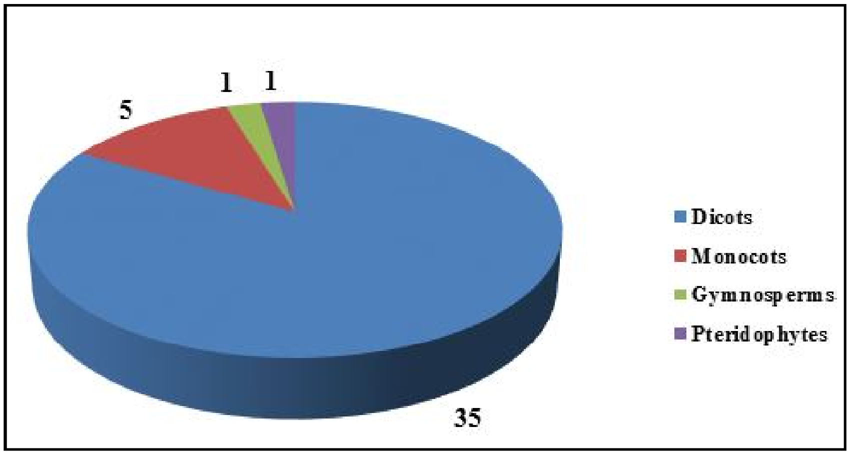

Fig. 3. Plant Divisions for curing Diabetes in District Solan

species each), Rutaceae (2 species) and other 30 families with one species each, while four monocotyledonous families (Alliaceae, Arecaceae, Asparagaceae, Musaceae and Poaceae) with one species each (Fig. 4). Notably, *Phyllanthus* was the only commonly used genus with more than one species, while the remaining 40 genera were represented by just a single species each. The juice (13) and raw/vegetable forms (12) dominate as the key methods of preparing anti-diabetic plant remedies, followed by powder (10), while decoction (4) was least preferred (Fig. 6).

Quantitative Ethnobotanical Data :

Fidelity Level :

Fidelity Level (FL) analysis elucidates the degree of informant consensus regarding the specific use of plant species in diabetes management. *Cichorium intybus* exhibited the highest FL (90.0%), signifying a strong collective agreement on its exclusive therapeutic application. Substantially high FL were also observed for *Luffa aegyptiaca* (88.5%), *Trigonella foenum-graecum* (80.0%), *Phoenix sylvestris* (76.9%), *Carica papaya* (76.1%) and *Coccinia grandis* (75.0%). Such elevated FL values underscore the consistent ethnomedicinal preference and perceived pharmacological efficacy of these taxa in the treatment of diabetes within traditional healthcare frameworks.

Use Value :

The Use Value (UV) analysis highlights the relative cultural significance of the recorded plant species based on informant consensus. *Tinospora cordifolia* exhibited the highest UV (0.87), indicating its frequent and diverse usage among local communities for managing diabetes followed by *Phyllanthus emblica* (0.83), *Ocimum tenuiflorum* (0.82), *Withania somnifera* (0.81) and *Trigonella foenum-graecum* (0.66), all of which were repeatedly cited for their effectiveness and accessibility. The high UVs reflect the frequent use and strong community reliance on these plants.

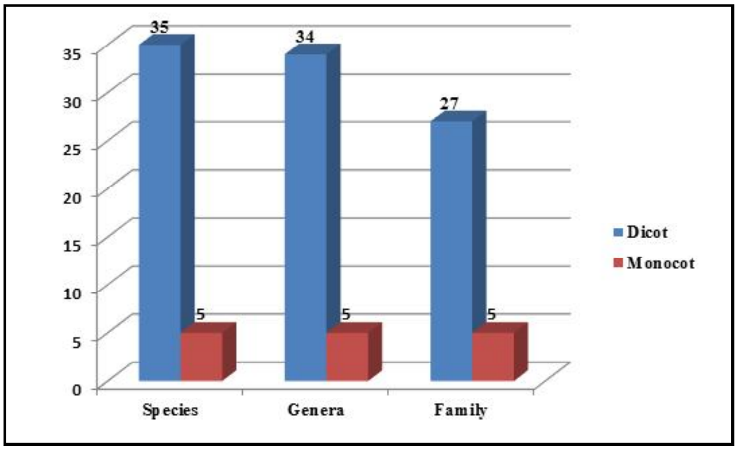

Fig. 4. Number of Families, Generas and Species for Curing Diabetes.

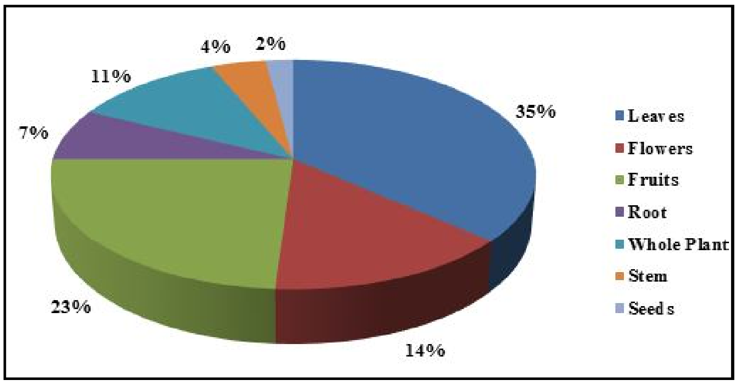

Fig. 5. Percentage of Various Plant Part/s Used for Curing Diabetes.

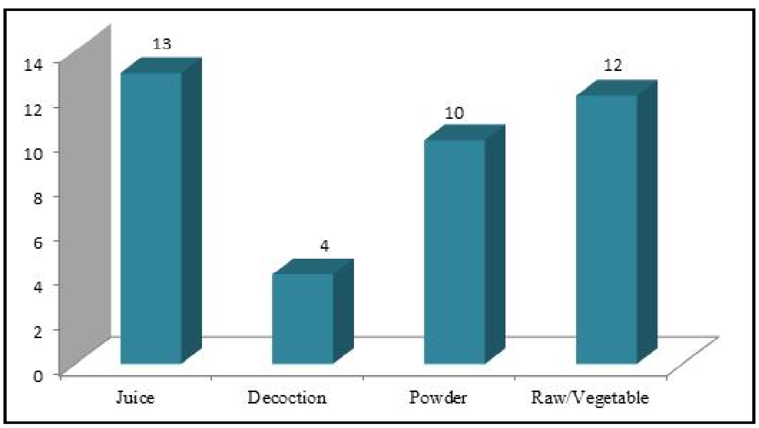

Fig. 6. Modes of Administration for Curing Diabetes in District Solan.

The ethnobotanical survey conducted in Solan District, Himachal Pradesh, documented 42 plant species traditionally used in the treatment of diabetes by local communities. These species, belonging to 31 families, reflect a rich indigenous knowledge system that is still actively practiced and passed down orally through generations. The plants documented not only demonstrate diversity in taxonomy but also in usage patterns, preparation methods and ethnomedicinal significance.

Among the documented plants, *Cichorium intybus* (FL = 90.0%) showed the highest fidelity level, indicating strong consensus among informants about its use in managing diabetes. This is followed by *Luffa aegyptica* (FL = 88.5%), *Phoenix sylvestris* (FL = 76.9%), *Carica papaya* (FL = 76.1%) and *Coccinia grandis* (FL = 75.0%). High FL values suggest strong cultural preference and established efficacy within the community, making these species potential candidates for further pharmacological studies.

The use value (UV) ranged from 0.06 (*Thuja orientalis*) to 0.87 (*Tinospora cordifolia*), highlighting varying degrees of importance attributed to individual species. *Tinospora cordifolia*, *Ocimum tenuiflorum* (UV = 0.82) and *Withania somnifera* (UV = 0.81) emerged as highly valued multipurpose plants. Such high UV scores suggest frequent citation and reliance on these species across different informants, likely due to their accessibility, perceived effectiveness and multifaceted therapeutic roles.

The plant parts used varied significantly, with leaves being the most frequently employed (n=17), followed by fruits (n=14), whole plants (n=6), roots (n=5), stems (n=3), flowers (n=3), seeds (n=2), barks (n=1) and stems (n=1). Leaves are often preferred due to their availability, ease of collection and high concentration of active phytochemicals such as flavonoids, phenolics, and alkaloids known for hypoglycaemic properties. The predominance of fresh juice and powder-based preparations reflects the practical and accessible nature of these remedies.

Modes of administration ranged from direct consumption (raw fruits, juices, powders) to decoctions and milk-based preparations, showing a balance between empirical knowledge and intuitive pharmacology. Notably, preparations involving *Aegle marmelos*, *Bauhinia variegata*, *Berberis lyceum* and *Rubia cordifolia* reflect a careful blend of plant parts and additives such as rock sugar, jaggery and milk, which may enhance taste, bioavailability, or synergistic effects.

Culturally, many of the cited plants such as *Azadirachta indica*, *Catharanthus roseus*, *Syzygium cumini*, and *Murraya koenigii* are well integrated into daily life and diets, potentially facilitating long-term management of chronic conditions like diabetes. Furthermore, several species like *Momordica charantia*, *Trigonella foenum-graecum* and *Ficus palmata* are already documented in Ayurvedic and Unani systems of medicine, reaffirming the reliability of local knowledge systems. While some plants such as *Thuja orientalis* (FL = 9.0%) and *Jasminum grandiflorum* (FL = 13.0%) were less cited, their inclusion indicates niche or household-level practices that may hold unexplored phytotherapeutic potential. Such lesser-known species deserve further phytochemical screening to evaluate their efficacy and safety.

The findings support the hypothesis that the Solan District hosts a wealth of ethnomedicinal knowledge with relevance to diabetes management. The strong agreement among informants for certain plants and the widespread use of local resources underscore the value of ethnobotanical surveys in informing natural product drug discovery and community-based healthcare interventions.

The present investigation elucidates the intricate ethnobotanical acumen and nuanced therapeutic paradigms associated with antidiabetic phytotherapeutics traditionally harnessed by indigenous populations, thereby underscoring the imperative for their bio-cultural conservation and rigorous pharmacological substantiation. The foregoing reveals the indigenous populace of Solan holds profound traditional knowledge. However, this intergenerationally transmitted traditional knowledge is undergoing rapid attrition, hastened by the invasion of modern lifestyles. The attrition in traditional knowledge and cultivation practices, along with wild plant harvesting, has led to reduced medicinal flora. Traditional medicine transcends its role as a mere therapeutic practice among indigenous populations, functioning as a vital symbol of cultural identity and ancestral continuity. Hence, it is imperative to initiate concerted, transdisciplinary interventions aimed at the systematic documentation, revitalization and integration of this invaluable ethnobotanical corpus into culturally consonant healthcare frameworks and biodiversity conservation paradigms, thereby ensuring its perpetuation across generational thresholds.

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