Research Output Journal of Public Health and Medicine 5(2):99-106, 2025

ROJPHM

ISSN ONLINE: 1115-9715
ISSN PRINT: 1115-6147

https://rojournals.org/roj-public-health-and-medicine/

https://doi.org/10.59298/ROJPHM/2025/5299106

Understanding Patient-Centric Approaches to Medicinal Plant Use in Diabetes

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ABSTRACT

The use of medicinal plants for managing type 2 diabetes mellitus (T2DM) is widespread across many cultures, particularly in resource-limited settings such as Belize. This study investigates patient-centric approaches to the use of traditional medicinal plants in diabetes care, employing a multi-method community-based research design. Using both qualitative methods such as in-depth interviews, focus group discussions, and observational ethnobotany and quantitative methods like free listing, this research explores the beliefs, preferences, and behavioral patterns of individuals living with T2DM. Findings indicate that patients often use herbal remedies alongside or in place of pharmaceutical drugs due to perceived efficacy, affordability, accessibility, and cultural relevance. However, challenges such as inadequate doctor-patient communication, limited access to reliable health information, and fears of disclosure about plant use contribute to treatment inconsistencies and a fragmented care experience. The study highlights the importance of integrating traditional medicinal knowledge with modern healthcare systems to enhance culturally safe and effective diabetes management. This first phase lays a foundation for future research on the biomedical mechanisms of these plants and their therapeutic potential in diabetes care.

Keywords: Type 2 Diabetes Mellitus (T2DM), Medicinal Plants, Traditional Medicine, Ethnobotany, Patient-Centered Care, Belize, Diabetes Management.

INTRODUCTION

Considerable evidence suggests that patients use medicinal plants to manage diabetes, and many local plant species have scientific evidence for their anti-diabetic effects. There is therefore a need to understand patient-centric approaches to the use of medicinal plants in diabetes in the Belizean context. Following ethnobotanical guidelines, a community-based multi-method approach involving both qualitative and quantitative methods will be employed. Qualitative approaches such as focus group discussions, in-depth interviews, and observational ethnobotany will be applied to understand people's subjective beliefs, perceptions, attitudes, and experiences regarding the use of plants to manage diabetes. A quantitative approach involving free listing will also be applied to obtain a ranking of plants based on their salience. This is the first phase of a larger study that aims to understand the biomedical implications of plant medicines in diabetes care by studying their effects and interactions in preclinical, clinical, and pharmacy contexts. The knowledge gained will lay the foundation for a culturally safe and effective research agenda toward the larger goal and impact of increased community well-being. People living with T2DM face many barriers in accessing information about diabetes and its care. All participants reported privacy concerns in revealing their full TD2M and plant medicine use history to doctors. As a result, they would only share some part of their plant use history, if at all. Barriers in patient-doctor communication and other unmet information needs may lead to medication and therapy discordance. Additionally, the different cultures inform conflicting dietary practices. Some beliefs make it difficult for one group to adopt dietary practices that have been prescribed by doctors. Furthermore, barriers in the availability and

affordability of certain plant medicines may make it difficult for some people to use them. As a result of all these barriers, some people feel disillusioned and distrustful of the medical establishment [1, 2].

Overview of Diabetes

Diabetes is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. It is a chronic metabolic disease caused by insufficient insulin production by the pancreas (type 1 diabetes) or by peripheral insulin resistance, reduced insulin secretion, or both (type 2 diabetes). Insulin is a polypeptide hormone, secreted by the pancreatic β-cells in the islets of Langerhans, that plays a key role in fueling tissues by promoting the uptake of glucose, lipids, and amino acids. The hyperglycemia and abnormal glucose metabolism are associated with long-term damage, dysfunction, and failure of different organs, especially the eyes, kidneys, nerves, heart, and blood vessels. This results in the severe micro- and macrovascular complications of the disease. Diabetes management is aimed at maintaining near-normal levels of blood glucose to prevent the occurrences of those complications. Management includes lifestyle modifications and pharmacological interventions with anti-diabetic medications. Countries with a higher prevalence of diabetes have an accompanying burden of affordability of medications and management. Most medicines co-exist with naturally available plant products. Traditional herbal remedies are still used extensively worldwide. Many of the commonly used herbal medicines which are potent against diabetes comprise of a cocktail of bioactive compounds, including flavonoids, terpenoids, and saponins. These bioactive compounds exert anti-diabetic effects by modulation of multiple signaling pathways across different organs and tissue types. This review encapsulates the most significant medicinal plants and plant-derived bioactive compounds used in treatment of diabetes. In this review, emphasis is placed on novel and clinically tested plants and bioactive molecules along with a focus on their multi-targeting actions and a pharmacological reappraisal of the plants/composites with diabetes-protective actions. From the recent advancements made in plant-based anti-diabetic molecules, it is evident that plant-based therapies represent better and promising candidates for diabetes treatment and management [3, 4].

Medicinal Plants in Traditional Medicine

Medicinal plants have been crucial for human health for thousands of years, with traditional medicine (TM) often serving as the first treatment for various ailments. While TM practices differ culturally, they share universal principles regarding treatment and prevention. Practitioners often use plants, animal products, and minerals to address diabetes mellitus (DM) and its complications. TM, broadly encompassing alternative medicine founded on indigenous beliefs, typically excludes pharmacologically active substances. It includes medicinal plants in herbal formulations, particularly traditional herbal medicine (THM). A significant majority (72-96%) of participants reported using TM and medicinal plants for DM management. This knowledge illustrates cultural abilities to solve medical issues and strengthens the ethnobotanical knowledge economy. It also underpins indigenous peoples' understanding of their cultural and philosophical roots, along with their societal institutions. Knowledge of medicinal plants forms an extensive body of orally transmitted, non-codified wisdom. Traditional medicine practitioners safeguard this knowledge, available for emergencies at any hour. Written communication may appear in traditional medicine reference books, often in a formal, scientific style. To combat biopiracy, some ethnic groups seek international protection for their knowledge [5, 6].

Patient-Centric Approaches

Numerous plants assist in lowering blood glucose levels and alleviating T2DM symptoms like numbness, sluggish circulation, skin irritations, sleep disturbances, and fatigue. Participants were divided into three categories: exclusive plant users, those who combined plants with pharmaceuticals, and those who primarily used pharmaceuticals but complemented them with plants. Exclusive plant use was noted among participants, with one reporting improvement in blood glucose levels solely through herbal preparations. Another stopped pharmaceuticals due to side effects and opted for local plants, finding them effective. These participants took more control of their T2DM management while still interacting with their physicians. Most used plants alongside medications like metformin and other prescriptions for insulin or oral medications. Pharmaceuticals targeted blood glucose and insulin resistance, while plants acted systemically to prevent diabetes-related complications. Some began pharmaceutical treatments after experiencing T2DM-related health issues and often consulted physicians about plant and pharmaceutical use but remained decision-makers. The second approach focused on weight management education, addressing complications, and limited access to proper medications. Participants believed combining both methods was preferable to using no medication, as they did not see conflict due to differing mechanisms of

action or emphasized significant dietary changes. Nevertheless, there was hesitation to abandon pharmaceuticals, concerned about potential negative impacts on blood glucose or severe side effects from specific plants. Holistic health practitioners recommended continuing medications, asserting that non-vegetarian diets alone could lower blood glucose [7, 8].

Common Medicinal Plants Used for Diabetes

Medicinal plants and their preparation methods were investigated for managing diabetes in Tanzania, examining dosage forms, frequency, reasons for use, side effects, and sources. A qualitative approach involving in-depth interviews, focus group discussions, and unstructured observations was employed. The study identified twenty-two plant species across twenty-two families commonly used for diabetes management, predominantly prepared as concoctions and infusions (32%). Leaves were the most utilized part (6%), and participants favored medicinal plants as the primary dosage form. The most common usage frequency reported was twice daily, with effectiveness (66%), availability (58%), and affordability (55%) as the main reasons for their use. Side effects noted included food cravings and loss of sleep. Medicinal plants also serve as complementary therapies for various conditions, including asthma, obesity, cancer, and infections, highlighting their significance in modern healthcare. Traditional medicine in underdeveloped areas has led to a resurgence in plant-based remedies, countering synthetic pharmaceuticals' adverse effects. Key species like Azadirachta indica, Moringa oleifera, and others were noted for their anti-diabetic properties through various studies. With rising concerns regarding obesity, metabolic disorders, and diabetes, research on antidiabetic plant remedies has intensified, focusing on both cultivated and wild species for active resources [9, 10].

Mechanisms of Action

Many of the medicinal plants used by diabetes patients in this study (25 different plants) have been pharmacologically documented and proved to be hypoglycemiant, antidiabetic or nutraceutical. Moreover, some plant species not yet considered for these purposes are here presented with unaccounted indications and expected efficacy according to medical anthropology. The most representative plants are mostly from the well-known common fruit-bearing plant Ornamental plants; Asteraceae, a rank well supported by folklore, since seven herb species belong to this family: Achillea millefolium, Bellis perennis, Rumex acetosa, Taraxacum officinale, Tussilago farfara, Urtica dioica; Other rank were reviewed mainly for spices: Cinnamomum cassia, Cuminum cyminum, Hordeum vulgare. These results further support a strict correlation between plants species' use as medicine and their botanical classification. In particular, medicinal plants belonging to Compositae family are often used in folk medicine. Compositae also represents the most commonly used medicinal plant family in Mexico. The hypoglycemic activity of some phytocomplexes or pure compounds belonging to Aqueous extracts of leaves, fruits and seeds of extracts or fractions of Abutilon theophrasti; Antirrhinum majus; Moringa oleifera; natural phenolic acids; extract or fractions of Lippia citriodora seeds of Paullinia cupana and fruit extracts of Sesamum indicum and their components have been studied. Since uncontrolled information impedes reproducibility of work, inhibition of a particular target does not ensure a higher intelligence in drug design. Therefore, growing attention is focused on nutraceuticals for a valid and natural nutraceutical approach to diabetes. The most common hypoglycemic mechanisms of action include the inhibition of α-glucosidase and of AGE formation, the increase of GLUT-4 expression and of PPARs expression and the antioxidant activity. In this context, the use of herbal products often relies on the synergistic and multitarget effects of the plant phytocomplex [11, 12].

Bioactive Compounds

Bioactive compounds from medicinal plants have gained recognition in the pharmaceutical industry for their disease prevention and treatment properties, resulting from secondary metabolism in various plant species. Since Van Helmont recognized willow bark's medicinal properties in 1648, numerous studies on bioactive constituents have emerged. In developing countries, 80% of people rely on traditional medicines primarily derived from plants, which are often regarded as safe, effective, and affordable compared to modern pharmaceuticals. Recent investigations advocate for modern analytical methods to reassess traditional medicine for preventive or therapeutic effects. This has spurred significant research into the chemical and biological properties of medicinal plants. Diabetes mellitus, characterized by chronic hyperglycemia due to insufficient insulin or decreased sensitivity in insulin-dependent tissues, has led to antidiabetic medications that lower blood glucose levels. Currently, seven classes of antidiabetic drugs exist, but they can induce adverse effects like weight gain, gastrointestinal issues, and hypoglycemia. The discussion highlights that plant-based traditional medicine plays a vital role as an alternative for diabetes

treatment. Recent findings suggest that some bioactive compounds from plants exhibit stronger antidiabetic activities than conventional drugs [13, 14].

Impact on Blood Glucose Levels

In traditional medicine, diabetes is treated with medicinal plants, a practice that has existed for centuries. Proper screening protocols have typically been lacking in this field, so it's crucial for modern researchers to consider factors such as collection location, harvesting time, extraction techniques, and biological testing methods before evaluating plant materials. The utility of these plants in managing diabetes has ignited interest among pharmacologists and toxicologists, highlighting the need for pharmacotoxicological screening to identify bioactive agents behind the desired effects. Patients often seek these plants from various sources, including shops and herbalists, but this can lead to contamination risks associated with heavy metals and pesticides. Locally used medicinal plants are regarded as effective by patients, with claims they help regulate blood glucose and lipid levels, thus preventing complications like obesity and diabetic foot ulcers [15, 16, 17, 18]. The research on these plants should evolve to improve their applications in diabetes treatment, promoting better health outcomes globally. Furthermore, creating a manual on local botanicals backed by tissue culture efforts is essential for standardization and supplemental use. Optimizing extraction methods and establishing reliable reference materials should complement supportive government policies on herbal sales. There remains a need for detailed investigations into the taxonomic classification, nutritional properties, and mechanistic actions of various herbal species to enhance their scientific credibility [19, 20, 21, 22].

Patient Perspectives on Medicinal Plant Use

Individuals with type 2 diabetes mellitus (T2DM) in Belize create home remedies from local plants, with over a dozen identified for blood sugar management. Users report a long history of plant use despite limited formal education in medicinal practices, displaying significant knowledge about remedies. There is hesitance to discuss plant use with trusted physicians, and participants expressed a strong desire for more education from healthcare providers [23, 24, 25, 26]. The text discusses the rise of T2DM diagnoses, particularly in low- and middle-income countries like Belize, where about 8.3% of adults (440 million globally) live with diabetes, over 80% in these regions. Metabolic syndrome includes factors such as cholesterol-carrying lipoprotein particles, classified by apolipoproteins. T2DM patients often have small, dense low-density lipoprotein (LDL)-C particles, which penetrate the endothelium more easily and are less effectively cleared from the blood. Understanding the mechanisms that affect cholesterol particle size in T2DM patients is crucial for tailored treatment. The research gap emphasizes developing transparent detection methods for changes in LDL size in the plasma of T2DM patients [27, 28, 29, 30].

Integration of Medicinal Plants in Diabetes Care

Patients with diabetes accept medicinal plants therapeutically, and this was demonstrated. However, it is unknown when and how medicinal plants are integrated into diabetes treatment. This study explored the integration of medicinal plants into diabetes treatment through the actions and reflections of their patients. A longitudinal ethnographic field study at three locations in Ethiopia was conducted among 58 patients with type 2 diabetes, their caregivers, and herbal healers. Data collection techniques included semi-structured interviews and participant observation. Data analysis was based on stages of thematic analysis. The study's six themes reveal that people with diabetes consider lifestyle modification and medicinal plants as commonly acceptable interventions [31, 32, 33, 34]. They also consider herbal healers as an acceptable source of medicinal plants. Patients appreciate diabetes treatment sustained by medicinal plants and lifestyle modification. Medicinal plant use was viewed positively, despite some undesirable effects. People obtain diabetes care using medicinal plants. Patients also consult herbal healers at various times. Integration and isolation of medicinal plants in diabetes care are reported. The public already integrates medicinal plants into diabetes care according to its abilities and perceptions. Yet, awareness about the risk of delayed treatment is lacking [35, 36]. Greater awareness and evidence-based support are recommended for safer and more effective integration of medicinal plants. Medicinal plants are considered by patients as an acceptable option to get diabetes care. Patients also consider medicinal plants among the possible options to treat diabetes. Some patients find medicinal plants safer than modern drugs due to their perceived natural origin. Patients acquired knowledge about some plants from pharmacies. Patients do not equally value modern drugs and medicinal plants as an option to get diabetes care. Integrating medicinal plants into diabetes care can also enhance herbal healers' image and usage. Patients consider herbal healers a credible and acceptable source of medicinal plants. Herbal healers are respected

and assigned mental and moral capacity. Herbal healers are thought to have an understanding of human beings and nature. Disseminating knowledge about herbal healers might broaden their reach. Yet, abstaining from modern health professionals is not positively viewed [37, 38].

Safety and Efficacy Considerations

Traditional herbal medicines are vital in developing countries, where many patients depend on them for diabetes treatment and other health issues. An ethnobotanical study of 118 diabetes herbal solutions provided insights into usage and safety, emphasizing the importance of understanding these properties to mitigate health risks. Concerns about safety and drug interactions of local medicinal plants highlight public health threats. Various age groups utilize herbal products, which remain ingrained in diets and promote their therapeutic benefits. Their common availability through community networks supports their ongoing relevance. Indigenous societies have played a significant role in scientifically verifying the effectiveness of these plants. With Ghana's rich biodiversity of herbal resources, documenting these practices in local dialects is essential. Traditional herbal medicines form a crucial part of health care as patients utilize natural products from various sources. The ethnobotanical study revealed important safety issues and a necessity for awareness regarding plant interactions with prescribed drugs. Better public education on health impacts could enhance public health. In tackling disease burdens, many plant-derived agents are effective in diabetes treatment. This review assessed the safety and efficacy of natural products used for diabetes, analyzing 572 clinical trials. After evaluating 88 subset trials, the findings indicate strong evidence supporting the clinical use of these natural products for diabetes management [21, 22].

Case Studies

As diabetes is a common global disease, many patients turn to traditional medicine. This study evaluated the perspectives and practices of patients and herbalists regarding medicinal plants in diabetes management. Seventy-four patients and six herbalists were randomly sampled, with data collected through interviews and focus group discussions. The analysis utilized descriptive statistics and thematic analysis. Ethical clearance and consent were obtained. Most respondents (70/74, 94.59%) used medicinal plants in managing diabetes, either alone (47/74, 63.51%) or with conventional medicines (23/74, 31.08%). A majority (67/74, 90.54%) preferred plant-based traditional medicines of local origin. Reports included various preparations, methods, dosages, and pricing. Key reasons for using traditional medicines included accessibility (61/74, 82.43%), affordability (66/74, 89.2%), and beliefs about effectiveness (52/74, 70.27%). Most herbalists (5/6, 83.33%) relied on folklore for their knowledge and practiced with a patient-centered approach. However, their understanding of the physiological effects of the medicines was limited (5/6, 83.33%). This qualitative exploratory study aimed to understand medicinal plant usage among individuals with type 2 diabetes in Belize. Participants shared experiences transitioning from biomedical treatment to herbal remedies and expressed challenges in communication with healthcare providers. Overall, they wished for greater acknowledgment from physicians about the use of plant medicine, seeking a balance between herbal and conventional treatments for more culturally appropriate care [23, 24].

Future Directions in Research

Despite the important role that community and household medicinal plant use play in the management of diabetes in Kenya, as well as in many low-resource areas globally, research on this subject is polarised and limited. In low-resource areas, there is a substantial body of literature around the technology of medicinal plant use for diabetes management, primarily focusing on its efficacy, efficacy modelling, and empirical findings. However, research surrounding meanings, perceptions, experiences, and the broader social-political cultural matrix of medicinal plant use is scant. Future usage of the PEA into the analysis of the emerging data set generated by this study may robustly elucidate these areas, particularly for the neglected subject of community/civil certificate of health care systems in diabetes management. Beyond this, there is significant room for further exploration into patient-centric and non-commercial approaches to medicinal plant use in diabetes care in different regions of the world. Research into the perceived side effects of community and household medicinal plant use for diabetes reveals a strong empirical knowledge base of efficacy and efficacy zones. However, more research is needed in to education, economics and labour, religiosity, health and herbalism, and new governance arrangements, such as public-private partnerships. In policy circles generally, while diabetes tends to be seen in the aid accountability, socioeconomic development, and social protection spaces, more work could be done to raise awareness of

diabetes social movements amongst vulnerable groups living with untested, unregulated, and commercially exploited empirically effective household and community medicinal plants not understood by dominant biomedicine-based care systems [25, 29].

CONCLUSION

This study underscores the critical role of medicinal plants in the self-management of diabetes among Belizean patients, revealing a complex interplay between traditional knowledge, cultural practices, and modern healthcare approaches. Many patients utilize medicinal plants based on generational wisdom, perceived effectiveness, and holistic values, often integrating them with pharmaceutical treatments. However, communication gaps with healthcare providers and lack of systemic integration present major barriers to safe and coordinated care. Addressing these issues requires culturally responsive policies, enhanced patient-provider communication, and rigorous scientific validation of commonly used plants. By aligning traditional and modern systems, a more inclusive and effective model of diabetes care can emerge one that respects cultural heritage while improving patient outcomes.

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CITE AS: Otieno Karanja J. (2025). Understanding Patient-Centric Approaches to Medicinal Plant Use in Diabetes. Research Output Journal of Public Health and Medicine 5(2):99-106. https://doi.org/10.59298/ROJPHM/2025/5299106