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Ethnomedicinal Survey of Medicinal Plants Used in the Management of Diabetes in Ibadan North East and South East, Oyo State, Nigeria

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Abstract

Diabetes mellitus, a lifestyle disease, affects 8.3% of the world's adult population. It is one of the most frequent non-communicable diseases in the modern period with enormous burden due to changes in lifestyle, eating habits, the aging population, and urbanization. This work aimed to document the ethnomedicinal plants used in the management of diabetes among Traditional Medical Practitioners (TMPs), herb dealers, and persons with claims of medicinal plant knowledge in two regions of Ibadan. Data was collected from 100 respondents using a semi-structured questionnaire. Data was examined using descriptive statistics and quantitative ethnobotanical indices. Majority of responders (94%) were females with little or no formal schooling (60%). Sixty plant species belonging to 35 families, and 57 genera were found to be used as antidiabetics in the study areas. The most prominent, being *Hunteria umbellata*, with the highest Use of Mention Index (UMI-0.56). Plants from the Fabaceae family were most mentioned (23%). The most regularly used plant part is the leaves (25%). Oral route was the main means of administration, with decoction being the most preferred method of preparation. The southwestern Nigeria is rich in unknown plants effective in diabetes control, however, more research is needed to extract, chemically clarify, and describe bioactive components that could be used as lead for the development of new antidiabetic medicines with favorable efficacy and safety profiles.

Keywords: *Diabetes, Ethnobotanical survey, Medicinal plants, Non-communicable, Quantitative ethnobotany*

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1. Introduction

Herbal medications continue to play a key role in diabetes care and given as an alternative to conventional therapeutics, particularly in underdeveloped countries where most people are resource-constrained and

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have little or no access to modern treatment (Acharya and Shrivastava, 2008; Ajaiyeoba *et al.*, 2005; Jung *et al.*, 2006). Due to the critical role that plant-derived compounds have played in drug discovery and development for the treatment of several diseases (Abubakar *et al.*, 2017; Mukherjee *et al.*, 2010), the isolation of new bioactive compounds from medicinal plants based on ethnomedicinal data appears to be a very promising approach (Abubakar *et al.*, 2017).

Prior to economic exploitation and dramatic domestication, ethnobotany is described as the science of identifying valuable plants that contain bioactive compounds (Erinoso and Aworinde, 2012). It is based on indigenous societies' traditional knowledge of surrounding plant diversity and how different people use indigenous plants in their communities (Igoli *et al.*, 2005). Ethnobotany has been shown in studies to be an excellent technique for analyzing the socio-cultural and economic elements that impact health and illness decisions in a community. It also assists in obtaining accurate information on the type of diseases and health problems that are prevalent among the inhabitants of a certain area; for example, it has aided in the provision of basic healthcare services required to address the health challenges faced by the rural population (Erinoso and Aworinde, 2012; Lawal *et al.*, 2010).

Information on medicinal plants is gleaned through the rich experiences of countless healers over millennia, acquired from ancestors, passed down from healer to healer, or created over time via personal experience or apprenticeship under those knowledgeable in the field. This data is gathered by a variety of methods, including questionnaires, interviews, voice recordings, and so on.

One of the most reliable approaches to drug discovery has been found to be ethnobotanical surveys of medicinal plants (Ekpo *et al.*, 2008; Fabricant and Farnsworth, 2001). Traditional medicine practitioners and herb vendors who are knowledgeable about medicinal plants and their applications use these plants either alone or in combination with mainstream treatments.

Diabetes Mellitus (DM) is a group of metabolic disorders characterized by a chronic hyperglycemic condition resulting from an absolute or relative deficiency in either the secretion, or action of insulin, or both (Wenjun, 2017). It can also be said that diabetes is either due to autoimmune antibody-induced destruction of insulin-secreting b-cells of pancreatic islets of Langerhans or from resistance to insulin release from b-cells as well as desensitization of peripheral tissue to insulin and down regulation of insulin receptors (Sarkar *et al.*, 2013). It is accompanied by greater or lesser impairment in the metabolism of carbohydrates, lipids, and proteins (Osadebe *et al.*, 2014). Currently, available therapy for diabetes include insulin and various oral hypoglycaemic agents such as sulfonylureas, biguanides, thiazolidinediones, glinides, and a-glucosidase inhibitors. These are known to produce prominent adverse effects and they have failed to significantly alter or amend diabetes complications in long term (Bahmani *et al.*, 2014; Kumar *et al.*, 2006; Mohammady *et al.*, 2012). According to the World Health Organization (WHO), diabetes affects about 3% of the world's population, with the prevalence anticipated to double to 6.3% by 2025 (Andrade-Cetto and Heinrich, 2005). Diabetes is expected to be the seventh largest cause of death by 2030, according to the WHO (Mathers and Loncar, 2006; Trivedi *et al.*, 2004).

In Africa, 19 million persons aged 20 to 79 years were anticipated to have diabetes in 2019, with that number expected to rise to 47 million by 2045 (Saeedi *et al.*, 2019). Africa has the greatest rate of undiagnosed people of any of the International Diabetes Federation (IDF) regions, with over 60% of adults living with diabetes unaware of it. According to reports, the disease is on the rise, with more than 80% of deaths occurring in low- and middle-income nations (Roglic *et al.*, 2005; WHO, 2014a, 2014b).

In Nigeria, one-third of all diabetes cases are said to occur in rural areas, with the balance occurring in metropolitan areas. In 2013, Nigeria has the largest burden in Africa (Ogbera and Ekpebegh, 2014), with 2.6 million cases, followed by South Africa with 1.9 million, and Tanzania with 1.7 million (Chiwanga *et al.*, 2016; IDF diabetes atlas, 2013). According to another survey, roughly 4.7 million Nigerians aged 20 to 79 had type 2 diabetes (Adeloye *et al.*, 2017).

The current prevalence of diabetes in persons aged 20 to 69 years is 1.7% (Uloko *et al.*, 2018). Patients and their families may experience considerable psychosocial dysfunction as a result of the emotional and social effects of diabetes mellitus and demand therapy. Poorly treated diabetes increases the risk of microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular (ischaemic heart disease, stroke, and

peripheral vascular disease) damage, resulting in a shorter lifespan and lower quality of life (Alhassan *et al.*, 2017; Malviya *et al.*, 2010). The growth in prevalence rate is due to population aging, increasing urbanization, westernization, and accompanying lifestyle changes, nutritional status, high family aggregation, increased life expectancy at birth, physical inactivity, and obesity, as well as possibly a hereditary susceptibility (Gutch *et al.*, 2014; Mbanya *et al.*, 2010; Wu *et al.*, 2014). However, because of environmental and behavioral risk factors, the incidence of type 2 diabetes mellitus varies significantly from one geographical region to the next (Zimmet *et al.*, 2001). Because there is no effective cure for diabetes mellitus, the majority of the population has become reliant on medicinal plants for their primary healthcare needs (Sofowora *et al.*, 2013; Wills *et al.*, 2000), as they have fewer side effects, are more effective, are more easily accessible, and are less expensive (Nasri and Shirzad, 2013). Furthermore, diabetes's enormous incidence, diverse pathophysiology, progressive process, and consequences all underscore the urgent need for improved therapies (Kooti *et al.*, 2016). As a result, the hunt for safe and effective traditional or alternative medicinal plants continues (Kunle *et al.*, 2012).

As a result, the WHO advises that effective alternative therapies for the treatment and management of diabetes mellitus be sought. This act promotes the advancement of scientific research into the hypoglycemic properties of various plant species (Dirks, 2004). As a result, bioactive molecules responsible for the therapeutic benefits seen must be isolated, identified, characterized, and screened in order to serve as leads in the development of anti-diabetic drugs.

A number of medicinal plant species that are used to treat diabetes mellitus around the world have been studied. *Allium cepa, Allium sativum, Aloe vera, Cinnamomum cassie, Coccinia indica, Momordica charantia, Catharanthus roseus, Ocimum sancum, Panax ginseng, Muurrayi komingii, Trigonella foemum-graecum, Pterocarpus marsupium*, and *Syzigum cumini* are among the plants (Gondwe *et al.*, 2008).

Polysaccharides, sterols, terpenoids, alkaloids, saponins, flavonoids, amino acids, and their derivatives are the most commonly encountered bioactive principles that displayed glycemic control in experimental animals, according to a review of various medicinal plant research findings (Afrisham *et al.*, 2015).

Despite the fact that Africa possesses a large number of medicinal plants, scientific validation of potency, purity, safety, and efficacy, as well as dosage standardization, is still absent for many of them. Residents of the research sites, on the other hand, are predisposed to the disease due to cultural and traditional practices relating to diet, lifestyle, and beliefs. As a result, this study was carried out in two local government districts of Ibadan metropolis to identify and document the species, parts used, methods and modes of preparation of the recipes used in the management of Diabetes.

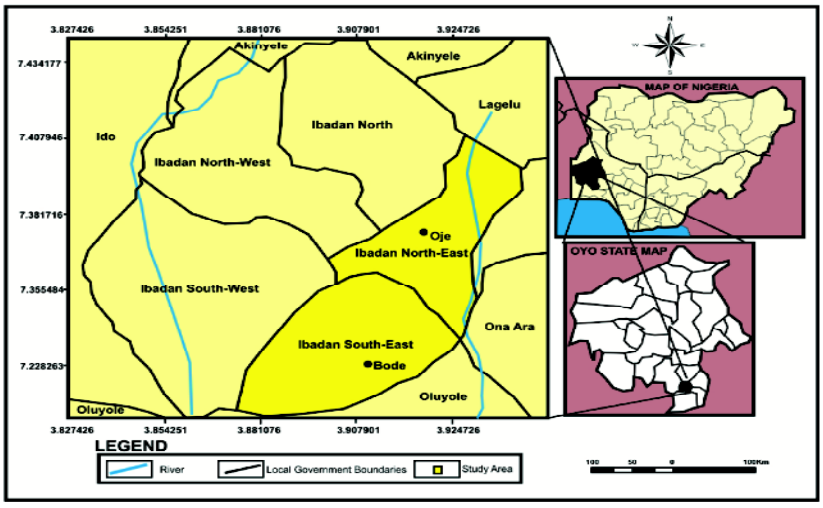

Figure 1: Map Showing the Areas of Study; Bode, Located in Ibadan South-East and Oje in Ibadan North-East

2. Materials and Methods

2.1. Study Area

The research was conducted in the markets of Bode and Oje in Ibadan, Oyo State, Nigeria, which are located in the south-east and north-east, respectively (Figure 1). Ibadan is located at 7.40° North latitude and 3.91° East longitude (Ojo and Awokola, 2012). The city rises from 160 m above sea level in the valleys to 275 m above sea level on the principal North-South ridge that runs through the heart of the city. The city is the largest in Nigeria, with a total area of 3,080 sq. km (1,190 square miles) (Areola, 1994). The Yoruba people, as well as diverse ethnicities from other regions of the country, make up the majority of the population of this attractive metropolis. In the Ibadan Metropolitan Area, there are eleven (11) local governments, with five (Adegebo, 2021) urban local governments in the metropolis and six semi-urban local governments in the smaller cities.

The city of Ibadan is naturally drained by four rivers, each with numerous tributaries: the Ona River in the north and west, the Ogbere River in the east, the Ogunpa River that runs through the city, and the Kudeti River in the center. The Ogunpa River is a third-order stream with a 12.76 km channel length and a 54.92 km catchment area. The city is bounded to the west by the Osun River and the Asejire Lake, while the city is bounded to the north by Lake Eleyele (Adeniran, 2018).

3. Data Collection

Between June and October 2018, an ethnobotanical survey was undertaken in Ibadan North-east and South-east, Oyo State, Nigeria, to document respondents' knowledge of medicinal plants and parts used in the management of diabetes. The information was gathered using an oral interview and a semi-structured questionnaire. Before the study and interview, each of the respondents gave their informed consent orally. Because the majority of the respondents were uneducated, an oral interview was used to collect the ethnobotanical data. The criteria proposed by Willcox for the conduct of a good ethnobotanical survey were observed (Willcox and Bodeker, 2004).

The targeted population for this study comprised mainly Traditional Medical Practitioners (TMPs), herb sellers, and few individuals with claims of medicinal plant knowledge as shown in Table 1. TMPs are persons recognized by the communities where they live, as competent to provide health care by using vegetable, animal and mineral substances and certain other methods serving as the nurse, pharmacist, and physician, dentist, mid-wife and dispenser (Elujoba *et al.*, 2005) while herb sellers sell herbs to the public. For clarity, the interviews were conducted in their original language (Yoruba); the data obtained included the local names of plants and components of the plants utilized, as well as the information gathered was sorted. A botanist photographed, collected, identified, and authenticated the plant specimens mentioned in the recipe using their local names. For all plants, voucher specimens were prepared and deposited at the Department of Pharmacognosy, University of Ibadan, Nigeria.

4. Ethical Issues

There are currently no regulations in place in Nigeria to guide the collection of data from informants about the use of plants in traditional medicine. However, after being informed about the research's goal, all of the informants in this study gave their oral informed consent. In other words, informants expressed a willingness to engage in the study and were given the option to stop at any moment.

5. Ethnobotanical Analysis

The data was examined with descriptive and quantitative statistics such as pie charts, tables, Frequency of Citation (FC), use mention index, and reported as a percentage depending on taxonomic diversity, habitat, and portions of the plant used to manage Diabetes. FC (Ocvirk *et al.*, 2013) was used to quantify indigenous antidiabetic plant species that received the most citations in comparison to other plant species cited. The FC is the result of multiplying the number of times a specific species was stated (N^sunit) by the total number of times all species were mentioned (T^stotal) by 100. Mathematically, FC = (N^sunit) / (T^stotal) *100; where "N^sunit" represents the number of times a particular species was mentioned and "T^stotal" is the total number of times that all species were mentioned. The 'Use Mention Index' (UMI) was also used to assess the questionnaire

data, which is defined as the number of mentions for one plant (UM) for diabetes treatment divided by the total number of informants questioned for antidiabetes phytomedicine (nu) (Attah *et al.*, 2012). This was used to compare survey results for all known anti-diabetic plants.

UMI = UM / nu; where "UM" represents the number of mentions for one plant while "nu" is the total number of informants

6. Results and Discussion

A total of 100 people, both men and women, between the ages of 21 and 60, who utilize medicinal herbs to treat their diabetes were questioned. Traditional remedies were utilized for self-medication and / or treatment of patients who willingly sought the advice of healers. Herb dealers (68%), Traditional Medical Practitioners (30%), and others (2%) who practice or live in the study region made up the informants. There were 90% more women than men (10%). A large percentage of the informants were between the ages of 21 and 40 (35%), with the middle-aged groups of 41-60 having the highest occurrence (50%). Only 15% of the respondents were beyond the age of 60.

Furthermore, the informants' work experience ranged from 5 to 15 years, with a small percentage (27%) being born into the profession and others having completed apprenticeship training in the medicinal plant sector (73%). The majority of the informants (60%) had little or no basic education, with those with at least elementary education accounting for 32%, secondary education for 7%, and university education accounting for only 1%. The majority of the informants in this study had a poor educational level, implying that enhanced or updated methods of traditional medical practices are still absent. In traditional medicine, education has been employed as one of several social and economic indices to determine the stage of development and level of advancement of the informants. It influenced higher ethnical behavior, such as refinement of taste, refinement of plant preparation and dose regimen, cultural awareness, patriotism, and social responsibility (Sun *et al.*, 2018). As a result, there is an immediate need for these healers to be sensitized in order to enhance their practices and protect the health of their patients. For ease of communication and clarity in acquiring suitable information, informants were interviewed in their native tongue; also, local names of medicinal plants used in the management of diabetes were provided and then authenticated. The adoption of local names supports Singh's claim that plants are universally recognized by their local names in all parts of the world (Singh, 2008). Although local names are not recommended for scientific accounts of plants due to their lack of uniformity and consistency (Singh, 2008), they can certainly be considered as a useful tool for obtaining useful information on plants, discovering new useful medicinal plants, and discovering new uses for already known plants (Erinoso and Aworinde, 2012). Local names are used by locals to refer to a certain location.

Based on the results of the surveys, a total of 60 medicinal plants from 57 genera and 35 families have been identified for use in the traditional care of diabetes (Table 2). The informants verified that different plant organs were occasionally mixed to treat diabetes. Fruits (22%), bark (13%), root (13%), leaves / root (8%), bulb (5%), stem (4%), seeds (3%), stem (3%), whole plant (3%), leaves / stem bark (2%) were the most common (Figure 2). Furthermore, the most common plant habits are trees (50%), shrubs (26%), climbers, and herbs (11% of the total population) (Figure 3).

The most cited family was Fabaceae, which ranked first (23%) with eight plant species, followed by Apocynaceae (17%) with six plant species, Annonaceae (11%) with four plant species, Cucurbitaceae (11%) with four plant species, and Liliaceae (8%) with three plant species, according to qualitative analysis of the data collected. *Hunteria umbellata* was the most mentioned plant species, with the highest frequency (F – 56), usage mention index (UMI – 0.56), and frequency of citation (FC – 23.53), indicating its popularity and possibly usefulness in diabetes control (Table 2). *Euphorbia lateriflora, Floscopa africana, Gongronema latifolium, Allium ascalonicum,* and *Adenopus breviflorus* had the lowest frequency (F - 1), Use Mention Index (UMI - 0.01), and frequency of citation (FC – 0.04), implying that they were the least popular among the informants for traditional diabetes treatment. The Apocynaceae and Fabaceae plant families had the highest frequency of citation and UMIs, reflecting the antidiabetic medicinal value of the 14 plant species mentioned under these two high-scoring plant families, according to quantitative analysis of survey data (Figure 4). The availability, accessibility, edibility, and low carbohydrate content of these plants may explain their use in traditional

medicine in the studied locations. For example, legumes, a Fabaceae subfamily, are well-known for being highly palatable, high in protein, low in carbohydrate, and, surprisingly, low in glycemic index (Ujinwal *et al.*, 2019). Legumes are well-domesticated in Nigeria, where they are grown for food and as a source of excellent anti-diabetic medicinal plants.

The most common dosage forms and techniques of preparation were decoction (34%), pulverization into powder (28%), juice extract (25%), cold maceration (8%), and infusion (5%) (Figure 5). Water, fizzy drinks, local gin (ethanol), lime, and aqueous extract from fermented maize are among the solvents used by informants to sufficiently extract the active part from reported plants. There was no standard volume of administration, but the herbal concoctions were given three times a day in glass cups or tumblers containing around 150 mL.

The study locations, the Bode and Oje communities, are dominated by aborigines from the old Ibadan metropolis, which was the largest city in Sub-Saharan Africa at the time of Nigeria's independence in 1960, with an estimated population of 3.5 million (Nwokocha and Olaniyan, 2020). The studied areas are among the oldest known marketplaces in Ibadan, Oyo State, Nigeria, with a history dating back over 100 years. They are centrally located in the core of the metropolitan metropolis. They have played an important role in providing alternative medicine to the region's rural residents, and they are well-liked. The abundant plant biodiversity of the surrounding forests has encouraged and strengthened their reliance on plants for their basic healthcare needs, including herbal diabetes therapy. *Allium sativum, Carica papaya,* and *Abrus precatorius* are some of the antidiabetic medicinal plants cited by the informants in this study, and have been recorded by other writers in ethnobotanical surveys undertaken in the country's south-western and south-eastern regions (Gbolade, 2009). In addition, medicinal plants such as *Allium ascolanicum, Alstonia boonei, Annona senegalensis, Citrullus*

Table 1: Demographic Characteristics of the Respondents

Variable	Number of Respondents
Age (years)	
< 20	2
21-40	33
41-60	50
60 and Above	15
Sex	
Female	96
Male	4
Educational Status	
Primary Education	32
Secondary Education	7
Tertiary Education	1
Other	60
Occupation	
Traditional Health Practitioner	30
Herb Seller	68
Others	2
Knowledge Acquisition	
From Birth	27
Apprenticeship	
Method of Treatment	Herbal only
Method of Administration	Oral
N = 100	

Table 2: Documented Plants used in the Management of Diabetes in Bode and Oje Communities of Ibadan, Nigeria

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
1.	*Abrus precatorius* Linn. Fabaceae	Oju-ologbo; Rosary pea, Crab's eye	1	0.01	0.42	DPHUI 1801	(Abo *et al.*, 2008; Ezuruike and Prieto, 2014; Gbolade, 2009; Moshi and Mbwambo, 2002; Soladoye *et al.*, 2012; Lawin *et al.*, 2015)
2	*Acacia nilotica* (Linn.) Wild ex. Del. Fabaceae	Booni, banni; Gum Arabic tree	2	0.02	0.84	DPHUI 1802	(Ezuruike and Prieto, 2014; Mukundi *et al.*, 2015)
3	*Adenopus breviflorus* Cucurbita-ceae	Tagiri; Pseudo colocynth	1	0.01	0.42	DPHUI 1803	(Soladoye *et al.*, 2012)
4	*Allium ascalonicum* Liliaceae	Alubosa elewe; Shallot, leafed onion (spring onion)	1	0.01	0.42	DPHUI 1804	(Ofuegbe and Adedapo, 2015; Soladoye *et al.*, 2012)
5	*Allium sativum* Liliaceae	Alubosa aayu; Garlic	1	0.01	0.42	DPHUI 1805	(Amuri *et al.*, 2018; Chikezie *et al.*, 2015; Eidi *et al.*, 2006; Ezuruike and Prieto, 2014; Gbolade, 2009; Izzo and Ernst, 2001; Ofuegbe and Adedapo, 2015; Soladoye *et al.*, 2012; Olorunnisola *et al.*, 2016)
6	*Aloe vera* (L.) Burm.f. Asphodela-ceae (Liliaceae)	Aloe Ahonerin; Aloe vera	1	0.01	0.42	DPHUI 1805	(Chikezie *et al.*, 2015; Ezuruike and Prieto, 2014; Gbolade, 2009)
7	*Aloe vera* (L.) Burm.f. Asphodela-ceae (Liliaceae)	*Alstonia boonei* De.Wild Apocynaceae	1	0.01	0.42	DPHUI 1807	(Abo *et al.*, 2008; Jouad *et al.*, 2001; Obute, 2005; Soladoye *et al.*, 2012; Subbulakshmi and Naik, 2001; Tahraoui *et al.*, 2007)

Table 2 (Cont.)

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
8	*Annona senegalensis* Pers	Epo; Wild custard apple	1	0.01	0.42	DPHUI 1808	(Ezuruike and Prieto, 2014; Lawin *et al.*, 2015; Soladoye *et al.*, 2012)
9	*Anthocleista djalonensis* A. Chew. Loganiaceae	Sapo; Cabbage tree	4	0.04	1.68	DPHUI 1809	(Ezuruike and Prieto, 2014; Gbolade, 2009; Olorunnisola *et al.*, 2016; Olubomehin *et al.*, 2013; Rosalie and Ekype, 2016; Soladoye *et al.*, 2012)
10	*Adenopus breviflorus* Cucurbitaceae	Akogun; Dutchman's pipe	22	0.22	9.24	DPHUI 1810	(Ezuruike and Prieto, 2014; Olorunnisola *et al.*, 2016; Sulyman *et al.*, 2016)
11	*Bombax buonopozense* P. Beauv Bombacaceaea	Ponpola; Silk cotton tree	1	0.01	0.42	DPHUI 1811	(Soladoye *et al.*, 2012)
12	*Bucholzia coriacea* Engl. Capparaceae	Wonderful kola; Musk tree	1	0.01	0.42	DPHUI 1812	(Oyedemi *et al.*, 2018)
13	*Calliandra haematocephala* Linn. Fabaceae	Tude; Snowflake acacia	4	0.04	1.68	DPHUI 1813	(Punnagai and Josephine, 2018)
14	*Carica papaya* Cariacaceae	Ibepe; Pawpaw	1	0.01	0.42	FHI 110088	(Abo *et al.*, 2008; Ezuruike and Prieto, 2014; Gbolade, 2009; Jouad *et al.*, 2001; Moshi and Mbwambo, 2002; Obute, 2005; Ofuegbe and Adedapo, 2015; Oke, 1998; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012; Subbulakshmi and Naik, 2001; Tahraoui *et al.*, 2007)

Table 2 (Cont.)

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
15	*Cassia fistula* Linn. Fabaceae	Aidan-toro; Golden shower	1	0.01	0.42	DPHUI 1814	(Akhila and Aleykutty, 2015; Olorunnisola *et al.*, 2016)
16	*Citrullus colocynthis* Cucurbita-ceae	Baara; Watermelon	10	0.10	4.20	DPHUI 1815	(Abdel-Hassan *et al.*, 2000; Abo *et al.*, 2008; Alarcon-Aguilara *et al.*, 1998; Ezuruike and Prieto, 2014; Jouad *et al.*, 2001; Lawin *et al.*, 2015; Obute, 2005; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012; Subbulakshmi and Naik, 2001; Tahraoui *et al.*, 2007)
17	*Citrus aurantifolia* (Christm.) Swingle.	Rutaceae Osan wewe; Lime	9	0.09	3.78	FHI 110086	(Abo *et al.*, 2008; Ezuruike and Prieto, 2014; Gbolade, 2009; Jaiyesimi *et al.*, 2000; Jouad *et al.*, 2001; Lawin *et al.*, 2015; Mahabir and Gulliford, 1997; Obute, 2005; Ofuegbe and Adedapo, 2015; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012; Subbulakshmi and Naik, 2001; Tahraoui *et al.*, 2007)
18	*Clausena anisata* (Wild) Hook.f.ex Benth. Rutaceae	Atari-obuko (egboagbasa); Clausena	1	0.01	0.42	DPHUI 1816	(Sagbo and Mbeng, 2018)
19	*Cocos nucifera* Arecaceae	Agbon; Coconut	33	0.33	13.87	DPHUI 1817	(Lawin *et al.*, 2015; Ofuegbe and Adedapo, 2015; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012)
20	*Cucumeropsis mannii* Naudin Cucurbita-ceae	OdidiItoo/ Egusi-itoo; White-seed melon	1	0.01	0.42	DPHUI 1818	(Ezuruike and Prieto, 2014; Soladoye *et al.*, 2012)

Table 2 (Cont.)

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
21	*Curculigo pilosa* (Schum& Thonn) Engl.	Hypoxidaceae Epakun	8	0.08	3.36	DPHUI 1819	(Ezuruike and Prieto, 2014; Ofuegbe and Adedapo, 2015; Soladoye *et al.*, 2012; Olorunnisola *et al.*, 2016)
22	*Euphorbia lateriflora* Schum. & Thonn. Euphorbi-aceae	Enu opiri; Little cactus	1	0.01	0.42	DPHUI 1820	
23	*Ficus exasperata* Vahl. Moraceae	Ipin; Sound paper leaf	3	0.03	1.26	FHI 111346	(Abo *et al.*, 2008; Ezuruike and Prieto, 2014; Moshi and Mbwambo, 2002; Ogunleye *et al.*, 2003; Soladoye *et al.*, 2012)
24	*Floscopa africana* (P.Beauv.) Commel-inaceae	Igba opolo; Lizard's tail	1	0.01	0.42	DPHUI 1821	
25	*Garcinia kola* Heckel Guttiferae (hyperica-ceae)	Orogbo; Bitter kola	2	0.02	0.84	FHI 108266	(Abo *et al.*, 2008; Ezuruike and Prieto, 2014; Gbolade, 2009; Iwu *et al.*, 1990; Lawin *et al.*, 2015; Soladoye *et al.*, 2012)
26	*Gladiolus dalenii* Van. Geel. Iridaceae	Baka; Dragon's – head lily	8	0.08	3.36	DPHUI 1822	(Lawin *et al.*, 2015)
27	*Gongronema latifolium* Benth et Hook. Asclepiad-aceae	Madunmaro (arokeke); Bush buck	1	0.01	0.42	DPHUI 1823	(Akah *et al.*, 2011; Chikezie *et al.*, 2015; Ezuruike and Prieto, 2014; Soladoye *et al.*, 2012; Ugochukwu *et al.*, 2005)
28	*Gossypium barbadense* Malvaceae	Owu akese; West Indian cotton leaves	1	0.01	0.42	DPHUI 1824	(Olorunnisola *et al.*, 2016)
29	*Hibiscus sabdariffa* Malvaceae	Isapa funfun; Bush rosette	1	0.01	0.42	DPHUI 1825	(Ndarubu *et al.*, 2019)

Table 2 (Cont.)

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
30	*Hunteria umbellata* (K.Schum) Haller. F. Apocynaceae	Abeere; Aarin	56	0.56	23.53	DPHUI 1826	(Ajibola *et al.*, 2018; Ezuruike and Prieto, 2014)
31	*Hyptis pectinata* (L.) Poit. Lamiaceae	Jobgo; Bushmints	1	0.01	0.42	DPHUI 1827	(Lawin *et al.*, 2015)
32	*Irvinga gabonensis* (Aubry-Lecomte ex O'Rorke) Baill. Irvingiaceae	Epon (epo); Bush Mango/ African mango	1	0.01	0.42	DPHUI 1828	(Ezuruike and Prieto, 2014)
33	*Khaya ivorensis* A. Chev. Meliaceae	Oganwo; African mahogamy	1	0.01	0.42	DPHUI 1829	(Ezuruike and Prieto, 2014; Gbolade, 2009; Soladoye *et al.*, 2012)
34	*Kigelia Africana* (lam.) Benth. Bignoniaceae	Pandoro / Amuyan; African Sausage tree	1	0.01	0.42	DPHUI 1830	(Amuri *et al.*, 2018; Lawin *et al.*, 2015; Soladoye *et al.*, 2012)
35	*Markhamia tomentosa* (Benth.) H. Schum. Bignoniaceae	Oruru; Bell bean tree	1	0.01	0.42	DPHUI 1831	(Soladoye *et al.*, 2012)
36	*Mondia whitei* (Hook.f.) Apocynaceae	Isigun; White's ginger	1	0.01	0.42	DPHUI 1832	(Ezuruike and Prieto, 2014)
37	*Morinda lucida* Benth Rubiaceae	Oruwo; Brimstone tree	3	0.03	1.26	DPHUI 1833	(Ezuruike and Prieto, 2014; Gbolade, 2009; Lawin *et al.*, 2015; Ofuegbe and Adedapo, 2015; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012)
38	*Moringa oleifera* Lam. Moringaceae	Ewe igbale; Moringa, miracle tree	2	0.02	0.84	FHI 110098	(Bamishaiye *et al.*, 2011; Ezuruike and Prieto, 2014; Gandji *et al.*, 2018; Lawin *et al.*, 2015; Leone *et al.*, 2015; Ofuegbe and Adedapo, 2015; Olorunnisola *et al.*, 2016; Popoola and Obembe, 2013; Soladoye *et al.*, 2012)

Table 2 (Cont.)

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
39	*Momordica charantia* Descourt. Cucurbitaceae	Ejinrin; Africa cucumber	5	0.05	2.10	DPHUI 1834	(Baldwa *et al.*, 1977; Ezuruike and Prieto, 2014; Gbolade, 2009; Jia *et al.*, 2017; Lawin *et al.*, 2015; Mahabir and Gulliford, 1997; Ofuegbe and Adedapo, 2015; Olorunnisola *et al.*, 2016; Saeed *et al.*, 2018; Sarkar *et al.*, 1996)
40	*Musa paradisiaca* Musaceae	Ogede agbaagba (dudu); Plantain	1	0.01	0.42	DPHUI 1835	(Ezuruike and Prieto, 2014; Ofuegbe and Adedapo, 2015; Soladoye *et al.*, 2012; Olorunnisola *et al.*, 2016)
41	*Nauclea latifolia* Rubiaceae	Egbesin; Nauclea	1	0.01	0.42	DPHUI 1836	(Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012)
42	*Ocimum gratissimum* Lamiaceae	Efinrin; Sweet basil	2	0.02	0.84	FHI 110087	(Abo *et al.*, 2008; Aguiyi *et al.*, 2000; Egesie *et al.*, 2006; Ezuruike and Prieto, 2014; Gbolade, 2009; Ofuegbe and Adedapo, 2015; Rosalie and Ekype, 2016; Soladoye *et al.*, 2012) (Lawin *et al.*, 2015; Olorunnisola *et al.*, 2016)
43	*Olax subscorpiodea* Oliv. Olacaceae	Ifon; Ifon	3	0.03	1.26	DPHUI 1837	(Lawin *et al.*, 2015; Soladoye *et al.*, 2012)
44	*Oxytenanthera abyssinica* (A.Rich.) Munro Poaceae	Paran pupa, funfun; Savannah Bamboo	1	0.01	0.42	DPHUI 1838	(Lawin *et al.*, 2015)
45	*Parkia biglobosa* Jacq Fabaceae	Igba; African Locust Bean	1	0.01	0.42	DPHUI 1839	(Abo *et al.*, 2008; Besancon *et al.*, 2005; Ezuruike and Prieto, 2014; Fred-Jaiyesimi *et al.*, 2009; Olorunnisola *et al.*, 2016)

Table 2 (Cont.)

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
46	*Parquetina nigrescens* (Afzel) Bullock. Periploca-ceae	Ogbo; African parquetina	1	0.01	0.42	DPHUI 1840	(Ofuegbe and Adedapo, 2015)
47	*Picralima nitida* (Stapf.) T. & H. Durand Apocyna-ceae	Erin; Picralima	1	0.01	0.42	DPHUI 1841	(Ezuruike and Prieto, 2014; Ofuegbe and Adedapo, 2015; Soladoye *et al.*, 2012; Lawin *et al.*, 2015; Olorunnisola *et al.*, 2016)
48	*Psidium guajava* Myrtaceae	Guava; Guava	1	0.01	0.42	FHI 112990	(Lawin *et al.*, 2015; Lufuluabo *et al.*, 2018; Olorunnisola *et al.*, 2016; Rosalie and Ekype, 2016)
49	*Rauwolfia vomitoria* Afzel. Apocyna-ceae	Asofeyeje; African rauwolfia	2	0.02	0.84	DPHUI 1842	(Amuri *et al.*, 2018; Ezuruike and Prieto, 2014; Gbolade, 2009; Lawin *et al.*, 2015; Soladoye *et al.*, 2012)
50	*Securidaca longepedu-nculata* Polygalaceae	Ipeta; Violet tree	1	0.01	0.42	FHI 109972	(Ezuruike and Prieto, 2014; Gbolade, 2009; Lawin *et al.*, 2015; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012)
51	*Senna alata* Fabaceae	Asunwon oyinbo; Candle bush	2	0.02	0.84	DPHUI 1843	(Ezuruike and Prieto, 2014; Ofuegbe and Adedapo, 2015; Soladoye *et al.*, 2012)
52	*Senna podocarpa* Guil. &Perr. Fabaceae	Asunwon ibile; Candle bush	2	0.02	0.84	DPHUI 1844	(Gbolade, 2009; Ofuegbe and Adedapo, 2015)
53	*Sphenoce-ntrum jollyanum* Pierre Menisper-maceae	Akerejupon; Sphenocentrum	4	0.04	1.68	FHI 111156	(Olorunnisola *et al.*, 2016)
54	*Strophanthus hispidus* DC Apocynaceae	Sagbere, sagere; Arrow poison plant	2	0.02	0.84	DPHUI 1845	(Soladoye *et al.*, 2012)

Table 2 (Cont.)

S.No.	Botanical Name and Family	Vernacular Name (Yoruba) and Common Name	Frequency	Use Mention Index (UMI)	Frequency of Citation (FC)	Voucher Specimen Number	Literature References
55	*Tetrapleura tetraptera* (Schun& Thonn) Taub. Fabaceae	Arindan, aidan; Aidan tree	1	0.01	0.42	DPHUI 1846	(Ezuruike and Prieto, 2014; Gbolade, 2009; Lawin *et al.*, 2015; Ojewole and Adewunmi, 2003; Soladoye *et al.*, 2012)
56	*Uvaria afzelii* Sc. Elliot Annona-ceae	Gbogbonise ; Monkey finger	4	0.04	1.68	DPHUI 1847	(Gbolade, 2009)
57	*Uvaria chamae* P. Beauv Annona-ceae	Eruju; Finger root	1	0.01	0.42	DPHUI 1848	(Gbolade, 2009; Lawin *et al.*, 2015; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012)
58	*Vernonia amygdalina* Asteraceae	Ewuro; Bitter leaf	10	0.1	4.20	DPHUI 1849	(Abo *et al.*, 2008; Ekpenyong *et al.*, 1999; Erasto *et al.*, 2005; Ezuruike and Prieto, 2014; Gbolade, 2009; Jouad *et al.*, 2001; Lawin *et al.*, 2015; Mohammed *et al.*, 2015; Ofuegbe and Adedapo, 2015; Olorunnisola *et al.*, 2016; Owolabi *et al.*, 2013; Soladoye *et al.*, 2012; Subbulakshmi and Naik, 2001; Tahraoui *et al.*, 2007)
59	*Xylopia aethiopica* (Dunal) A. Rich Annona-ceae	Eeru-lamo (Erualamo); African pepper	1	0.01	0.42	DPHUI 1850	(Ezuruike and Prieto, 2014; Lawin *et al.*, 2015; Mohammed *et al.*, 2015; Ofuegbe and Adedapo, 2015; Olorunnisola *et al.*, 2016; Soladoye *et al.*, 2012)
60	*Zea mays* Poaceae	Omi dun (omi ogi); Maize	1	0.01	0.42	DPHUI 1851	(Ezuruike and Prieto, 2014; Katiri *et al.*, 2017; Lawin *et al.*, 2015; Soladoye *et al.*, 2012; Suzuki *et al.*, 2005)

colocynthis, Ocimum gratissimum, Curculigo pilosa, Garcinia kola, Gladiolus psittacinus, and *Nauclea latifolia* have been reported to be used in the treatment of diabetes in a survey conducted in Nigeria's south-western region (Soladoye *et al.*, 2012). Another study found that *Carica papaya, Musa paradisiaca, Allium sativum, and Allium cepa* had anti-diabetic characteristics, while *Tetrapleura tetraptera, Nauclea latifolia, Vernonia amygdalina, Hibiscus sabdariffa,* and *Allium sativum* have antihypertensive properties (Ozougwu, 2017). This suggested that the respondent's information in this study was consistent with what has been published elsewhere for the treatment of diabetes.

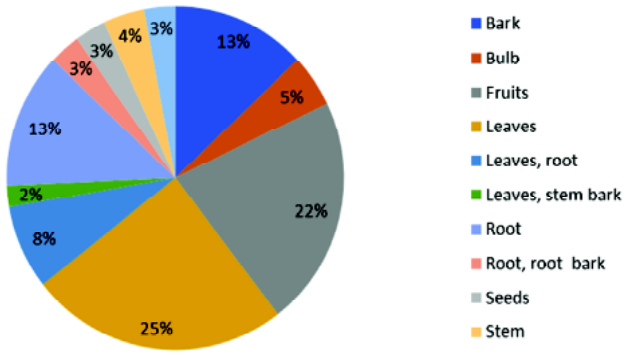

Figure 2: Percentage Distribution of Various Plant Part(s) Used in the Preparation of Anti-Diabetic Recipes

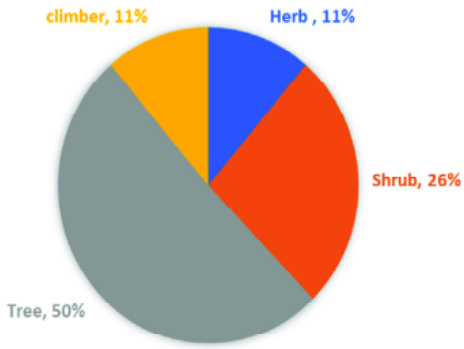

Figure 3: Percentage Occurrence of Plants Habit Used in the Management of Diabetes

A survey of the literature for all 60 antidiabetic medicinal plants described in this study revealed a substantial number of plants that have been claimed to have significant antidiabetic action in earlier studies. *Parkia biglobosa, Vernonia amygdalina* (Modu *et al.*, 2013), *Moringa oleifera* (Edoga *et al.*, 2013), *Allium cepa* and *Allium sativum* (Liu *et al.*, 2006), *Picralima nitida, Ocimum gratissimum* (Kazeem *et al.*, 2013), and *Carica papaya* are examples (Ezekwe *et al.*, 2014). The anti-diabetic properties of *Nauclea latifolia* and *Moringa oleifera* have been scientifically demonstrated (Ezekwesili *et al.*, 2018). Experimental evidence for the hypoglycemic action of numerous medicinal plants has been provided in this work using various diabetic experimental models (*in vitro* and *in vivo*). Mukundi *et al.* (2015), identified *Acacia nilotica*, *Psidium guajava* (Basha and Kumari, 2012), *Carica papaya* (Oke, 1998), *Colocynthis Citrullus* (Abdel-Hassan *et al.*, 2000), *Garcinia cola* (Iwu *et al.*, 1990), *Musa paradisiaca* (Ojewole and Adewunmi, 2003), *Ficus exasperate* (Ogunleye *et al.*, 2003), *Citrus aurantifolia* (Jaiyesimi *et al.*, 2000). The credibility of the conclusions from this study is increased by the supporting data from other

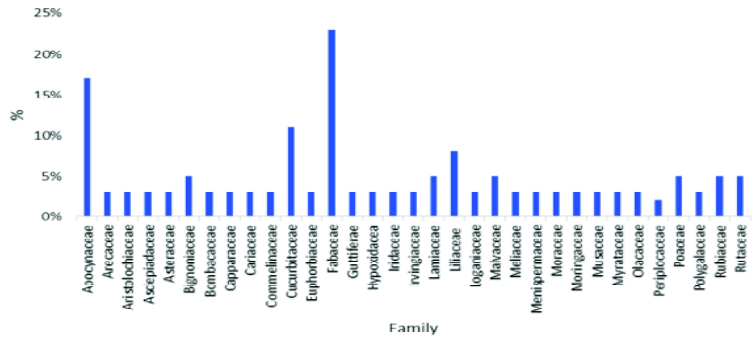

Figure 4: Percentage Distribution According to the Family of Plants Used in the Management of Diabetes

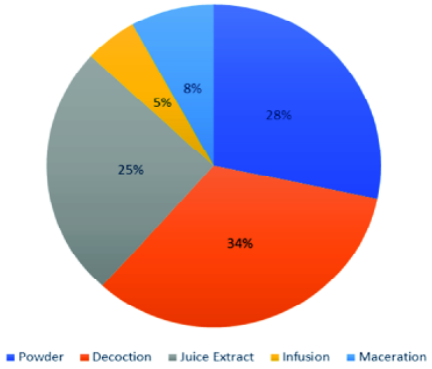

Figure 5: Mode of Preparation of Medicinal Plants Used in Management of Diabetes in Ibadan North-East and Ibadan South-East, Oyo State, Nigeria

studies, indicating the necessity for more research on suitable plants for an evidence-based application of medicinal plants.

The lack of dosage, the occurrence of toxic phytochemicals such as alkaloids and glycosides in high scoring plants (Apocynaceae) (Huang *et al.*, 2019), and increasing incidences of herbal contamination with deleterious heavy metals in the study region are all major drawbacks to antidiabetic ethnomedicine (Oyebanji *et al.*, 2019). Toxic adverse effects of local phytomedicines are rarely reported; instead, references to its safety are frequently made. However, the lack of standardized herbal medicines may lead to an increase in kidney failure and liver damage, which may be exacerbated by a lack of education among the administrators of these traditional phytomedicines (Mensah *et al.*, 2019), as shown in our study (Mensah *et al.*, 2019).

7. Conclusion

This is the first study of its kind on the anti-diabetic ethnomedicine of the Bode and Oje communities of Ibadan. In the Ibadan South-East and Ibadan North-East Local Government Areas, 60 plant species from 35 families have been documented for use in the control of diabetes. Decoction (34%), powder (28%), and juice extract were the three most popular methods of preparation (25%). Different solvents are typically utilized for extraction operations, ranging from water, carbonated drinks, local gin (ethanol), and lime to aqueous extract from fermented maize. There was no standard volume of administration, but the herbal concoctions were given three times a day in glass cups or tumblers containing around 150 mL. However, for the described herbal concoction, oral administration was the sole form of administration reported.

Traditional treatment practices and the use of medicinal plants have not vanished from the research areas, according to the findings. In this study, the value of documenting traditional ethnomedicinal knowledge was also highlighted. The most commonly mentioned plant families, Fabaceae and Apocynaceae, may provide valuable and novel bioresources for future research, notably phytochemical and pharmacological studies for the identification and development of anti-diabetic drugs.

8. Declaration of Competing Interest

The authors declare no competing interest.

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