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

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Abstract

Background: Diabetes mellitus, which is described to be a lifestyle disease, affects about 8.3% of the adult population of the world. Due to its alarming rate, it is one of the most common non-communicable diseases of current era. The burden of this disease is immense owing to transition in lifestyle and dietary habits, ageing of the population and urbanization in the setting of a genetically predisposed environment.

Methodology: The study was aimed at documenting the knowledge of Traditional Medical Practitioners (TMPs) in Ibadan on ethnomedicinal plants used in the management of diabetes. A semi-structured questionnaire was used to obtain data from 100 TMPs and herb sellers within the study area. Data obtained was analysed using both descriptive statistics as well as quantitative ethnobotany including Use Mention Index, Use Value index and Fidelity level.

Results:The total number of respondents from both study areas were 100, which were mainly females (94%) and most of them had no formal education. All respondents were Yoruba speaking. Results revealed 60 plants species belonging to 35 different families and 57 genera were cited by the respondents which they use in the management of diabetes. *Hunteria umbellata* is the most prominent plant species having the highest UMI reflecting it popularity and efficacy in the management of diabetes in both areas. Fabaceae (23%) has the highest number of plants species followed by Apocynaceae (17%), Annonaceae (11%), Curcurbitaceae (11%) and Liliaceae (8%). The leaves (25%) were the most commonly used plant parts for the management of diabetes followed by fruits (22%) and Bark (13%).in that order.

Conclusion: The Southwest part of Nigeria is rich with unexplored plants useful in management of Diabetes and these documented traditional uses require scientific exploration and exploitation for drug discovery in diabetes therapy. Further studies are therefore encouraged in order to isolate, chemically elucidate and characterize the hypoglycaemic bioactive component which could serve as chemical lead for the development of novel antidiabetic drugs with desirable efficacy and safety profiles.

Background

Ethno-botany has been defined as the study as well as the investigation of traditional knowledge of indigenous communities about surrounding plant diversity and how various people make use of indigenous plants found in their localities [1]. Studies have demonstrated ethnobotany to be an effective tool in understanding the social cultural and economic factors that influence decisions as regards health and illness within a community. It also aids in getting the right information on the types of diseases and health problems prevalent amongst the people of a particular locality.

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Ethnobotanical survey of plants traditionally used in the management of diabetes in different parts of Nigeria have been carried out by different authors [2, 3, 4, 5, 6, 7]. These medicinal plants are used either alone as a primary therapeutic choice, or in conjunction with conventional medicines.

Since plants are rich sources of medication, information about them are obtained based on the rich experiences of innumerable healers over centuries inherited from ancestors, healer-to-healer transfer or developed through personal experience over time or apprenticeship under those versatile with this knowledge. This information is obtained using different techniques such as the use of questionnaires, interview, voice recording, etc.

In ancient times, the primitive man observed and appreciated the great diversity of plants available to him. Herbs had been used by all cultures for the treatment and management of diabetes mellitus [8;9] which was an integral part of the development of modern civilization. Hence, herbal medicines continue to play significant role in diabetic therapy as well

as alternative to conventional therapy, most especially in the developing nations where most people are resource-poor and with little or no access to modern treatment [10].

Currently available therapy for diabetes includes insulin and various oral hypoglycaemic agents such as sulfonylureas, biguanides, thiazolinediones, glinides and α-glucosidase inhibitors [11]. These are known to produce serious adverse effects, are not easily affordable and are not readily available [12, 13] There is no effective cure for diabetes mellitus; this has resulted in the dependency on medicinal plants by majority of the populace for their primary health care needs [14, 15, 16], since they pose less side effect, are effective, readily accessible and affordable. Hence, the search for traditional or alternative medicinal plants which are safe and effective is ongoing [17]. The WHO (World Health Organization) recommended the search for medicinal plants that are effective and beneficial for the treatment of Diabetes Mellitus as well as their use in the management of diabetes mellitus. This act encourages the expansion of the frontiers of scientific evaluation of hypoglycaemic properties of diverse plant species [18]. Thus, there is the need to isolate, identify, characterize and screen these bioactive chemicals responsible for the therapeutic effects seen.

Several species of medicinal plants used for the management of Diabetes Mellitus worldwide have been evaluated. Some of the plants include: *Allium cepa, Allium sativum, Aloe vera, Cinnamomum cassie, Coccinia indica, Gymmema slyvestre, Momordica charantia, Catharanthus roseus, Ocimum sancum, Panax ginsend, Muurrayi komingii, Trigonella foemum-graecum, Pterocarpus marsupium and Syzigum cumini* (19–23). A survey of several medicinal plants research findings showed that polysaccharides, sterols, terpenoids, alkaloids, saponins, flavonoids, amino acids and their derivatives are the most encountered bioactive principles that exhibited glycemic control in experimental animals [20, 21, 24]

Diabetes Mellitus (DM) is a group of metabolic disorders characterized by a chronic hyperglycemic condition resulting from absolute or relative deficiency in secretion, insulin action or both. It can also be said that diabetes is due to autoimmune antibody induced destruction of insulin secreting β-cells of pancreatic islets of Langerhans or from resistance to insulin release from β-cells as well as desensitization of peripheral tissue to insulin and down regulation of insulin receptors [25–27] It is accompanied by greater or lesser impairment in the metabolism of carbohydrates, lipids and proteins. It could result in abnormal high amounts of glucagon and other counter regulatory hormones such as growth hormone, sympathomimetic amines and corticosteroids [28]

The World Health Organization projects, that diabetes will be the 7th leading cause of death by the year 2030 [29].

In USA, diabetes is now the leading cause of end stage renal disease (ESRD). Other complications such as cardiovascular disease including coronary heart disease (CHD), cerebrovascular disease (CVD) or stroke and peripheral vascular disease (PVD) are the common causes of morbidity and mortality among people with diabetes [30–34].

In Africa, 19.8 million dwellers suffered from diabetes in 2013 and this is expected to rise to 41.5 million by 2035 [35]. Reports have it that the disease is on the increasing trend with more than 80% cases of death coming from low and middle income countries.

In Nigeria, one third of all the cases of diabetes are known to occur in rural communities, while the rest are in the urban centres. Nigeria has the highest burden in Africa, followed by South Africa with 2.6 million cases, Ethiopia 1.9 million, and Tanzania 1.7 million in 2013. Another study, found that about 4.7 million Nigerians aged between 20 and 79 years had type 2 diabetes [36].

The emotional and social impact of Diabetes Mellitus and demand therapy may result in significant psychosocial dysfunction in patients and their families. Poorly controlled diabetes would aggravate the risk of diabetes

complications, particularly cardiovascular diseases. The clinical coups and prognosis for diabetic patients are influenced predominantly by the duration of the disease and degree of metabolic control exercised (37).

According to WHO, it was estimated that 3% of the world's population have diabetes and the prevalence is expected to double by the year 2025 to 6.3% [38, 39].

The rise in prevalence rate is as a result of aging of the population, rapid urbanization, westernization and their associated lifestyle changes, nutritional status, high family aggregation, increase in life expectancy at birth, physical inactivity and obesity and possibly a genetic predisposition [40–42]. The prevalence of diabetes mellitus in Nigeria increased from 2.2% in 1997 to 5.0% in 2013 [43]. The incidence of type 2 Diabetes Mellitus varies substantially from one geographical region to the other as a result of environmental and lifestyle risk factors [44].

Materials And Methods

Study area

The study was carried out in Bode and Oje markets in Ibadan, Oyo state, Nigeria; which are located in Ibadan South-East and Ibadan North-East respectively (Figure 1). Ibadan falls within latitude 7.40N and longitude 3.91E [45,46]. The city ranges in elevation from 160 m in the valley area, to 275 m above sea level on the major north-south ridge which crosses the central part of the city. The city covers a total area of 3,080 square kilometres (1,190 sq mi) in geographical size, the largest in Nigeria [47]. The Yoruba people are the main inhabitant of this popular city, as well as various communities from other parts of the country. There are eleven (11) Local Governments in Ibadan Metropolitan area consisting of five urban local governments in the city [48] and six semi-urban local governments in the fewer cities.

The city of Ibadan is naturally drained by four rivers with many tributaries: Ona River in the North and West; Ogbere River towards the East; Ogunpa River flowing through the city and Kudeti River in the Central part of the metropolis. Ogunpa River, a third-order stream with a channel length of 12.76 km and a catchment area of 54.92 km. Lake Eleyele is located at the northwestern part of the city, while the Osun River and the Asejire Lake bounds the city to the east [49,50].

Data collection

The ethnobotanical survey was conducted between June and October, 2018 to document the knowledge of respondents on medicinal plants and the parts used in the management of diabetes in Ibadan North-east and South-east, Oyo state, Nigeria. The data collection was based on oral interview with the aid of a semi-structured questionnaire. Ethical approval was obtained from the community leaders before the study and informed consent was also obtained orally from each of the respondent, before interview was made. Since most of the respondents were not educated, oral interview was adopted to obtain the relevant ethno-botanical data. The criteria proposed by Willcox for the conduct of a good ethnobotanical survey were observed [51].

The targeted population for this study comprises mainly Traditional Health practitioner, herb sellers, and few individuals with claims of medicinal plant knowledge. The interviews were done in their native language (Yoruba language) for clarity; while the information gathered was sorted, the data collected included the local names of plants and parts of the plants used. Plant specimens indicated in the recipe were photographed, collected, identified and authenticated using their local names by a botanist. Voucher specimens were prepared for all plants and deposited at the herbarium unit of the Department of Pharmacognosy, University of Ibadan, Nigeria.

Ethical Issues

In Nigeria, there are no existing regulations guiding the collection of data from informants on the use of plants in Traditional Medicine. However, all informants interviewed in this study gave oral informed consent following the description of the purpose of the research to them. In other words, informants showed voluntary willingness to participate in the study and they were allowed to discontinue the interviews at any time.

Ethnobotanical analysis

Data obtained were analyzed using both descriptive and quantitative statistics such as pie chart, tables, frequency of citation (FC), use mention index and expressed as a percentage based on taxonomic diversity, habitat and parts of the plant used to manage Diabetes. The frequency of citation, FC [52] was used to quantify indigenous antidiabetic plant species with the highest citation relative to other plant species cited. The FC is the value obtained from the number of times a particular species was mentioned (N^sunit) divided by the total number of times that all species were mentioned (T^stotal) multiplied 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 questionnaire data were also analyzed using the 'use-mention- index' (UMI) which has been defined as the number of mentions for one plant (UM) for diabetes treatment, divided by the total number of informants interviewed for antidiabetes phytomedicine (nu) [6]. This was applied to compare the survey data for all documented antidiabetic plants.

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

Results And Discussion

A total of 100 respondents within the age range of 21-40, 41-60 and > 60 years , both women and men, who use medicinal plants to manage diabetes, were interviewed. These Traditional Medicines were used for self-medication and/or to treat patients who willingly consult the healers. The informants were made up of herb sellers (68%), Traditional Medical Practitioners (30%) and the other category (2%) who practice or reside in the study area. There were more women (90%) than men (10%) . A good number of the informants were youngsters whose age fall within 21-40 (35%) while those of middle-aged groups of 41–60 having the highest occurrence of 50%. Only 15% of the informants were above 60 years. Most of the informants have little or no basic level of education with those having at least primary education making up 32%, secondary education 7% and tertiary education forming only 1%. Informants without a formal education make up 60% of total informants who participated in the interview. In addition, the work experience of the informants' ranges from5 years and above with few of them born into the trade while others have gone through apprenticeship training in medicinal plant trade.

Bode and Oje communities , the study areas are dominated by aborigines of the old Ibadan city, which at Nigeria's independence in 1960 was the largest city in Sub-Saharan Africa with an estimated population of 3.5 million [53]. The study areas are among the oldest known markets reputed to have

existed over 100 years and they are centrally situated in the heart of the metropolitan city, Ibadan, Oyo state, Nigeria. They have played significant roles in provision of alternative medicine for rural dwellers within the region and they are well patronized. The surrounding forests with their rich plant biodiversity has encouraged and strengthen their dependence on plants for their primary healthcare needs including the herbal treatment of diabetes. Some of the antidiabetic medicinal plants mentioned by the informants included *Allium sativum*, *Carica papaya*, *Abrus precatorius* which have been reported by other authors in ethnobotanical surveys conducted in South-western and South-eastern parts of the country as commonly used to treat diabetes (Abo *et al*., 2008; Gbolade, 2009). Also, it has been reported in a survey conducted in South-western region that the following *Allium ascolanicum, Alstonia boonei, Annona senegalensis, Citrullus colocynthis, Ocimum gratissimum, Curculigo pilosa, Garcinia kola, Gladiolus psittacinus, Nauclea latifloria* among others, are used in treating diabetes [5]. Another survey conducted identified the following medicinal plants has having antidiabetic properties which *are Carica papaya, Musa paradisiaca, Allium sativum, Allium cepa* while *Tetrapleura tetraptera, Nauclea latifolia, Vernonia amygdalina, Hibiscus sabdariffa, Allium sativum*, exhibit antihypertensive properties [54]. This indicated conformity of the information provided by respondent in this study with what has been reported elsewhere for the treatment of diabetes.

Educational level of informant interviewed in this study was predominantly low suggesting that the improved or advanced methods of Traditional Medical Practices are still lacking. Education has been used as one of the many social and economic indicators to ascertain the state of development and the level of advancement of the informants in traditional medicine. It inspired higher ethnical behavior; refine taste, refine the method of plants preparation and dosage regimen, cultural awareness, patriotic devotion and social responsibility [55]. There is therefore an urgent need for the sensitization of these healers in order to improve their practices and to ensure patient’s health is safeguarded.

During the survey, the informants were interviewed in their native dialect for ease of communication and to ensure clarity in obtaining appropriate information; in addition, local names of the medicinal plants used in the management of diabetes were provided and subsequently authenticated. The use of local names is in agreement with what was reported by Singh that plants are generally recognized by their local names in every part of the world [56]. Although local names are not recommended directly for scientific accounts of plants as they lack uniformity and consistency [56], yet they may certainly be considered as a useful tool for obtaining useful information on plants, discovering new useful medicinal plants as well as new uses of known plants [57]. Local names provide means of reference by local people in a particular area.

Diversity of plants used for diabetes treatment

In Table 1, the description of documented ethnomedicinal have been presented. A total of 60 medicinal plants belonging to 57 genera, from 35 families have been documented for use in the traditional management of diabetes**.** The most cited family is Fabaceae ranked highest (23%) with 8 plant species, followed by Apocynaceae (17%) with 6 plant Species, Annonaceae (11%) with 4 plant species, Cucurbitaceae (11%) with 4 plant species and Liliaceae (8%) with 3 plant species. *Hunteria umbellata*, was the most cited plant species with the highest frequency (F - 56), use mention index (UMI - 0.56) and frequency of citation (FC – 23.53) reflecting its popularity and perhaps efficacy in the management of diabetes (Table 2). *Euphorbia lateriflora, Floscopa Africana, Gongronema latifolium, Allium ascalonicum, Adenopus breviflorus,* had the least frequency (F - 1), use mention index (UMI - 0.01) and frequency of citation (FC – 0.04) suggesting their least popularity of use by the informants for the traditional treatment of diabetes. The plant habits include trees having the highest frequency of50%, followed by shrub (26%), climbers and herbs make up 11% (Table 1). Informants equally reported specific organs of plants frequently used part for the management of diabetes. Of these, 25% were leaves, followed by fruits (22%), Bark (13%), Root (13%), Leaves/root (8%), Bulb (5%), Stem (4%), Seeds (3%), Stem (3%), Whole Plant (3%), Leaves/Stem bark (2%) (Figure 2). Leaves appear to be the plant part most commonly used plant organ during the management of diabetes in the traditional medicine of Bode and Oje communities of Oyo state, Nigeria. In addition, informants confirmed that different organs of the plants were sometimes combined to treat diabetes.

Modes of preparation and administration

. The mode of preparation preferred were decoction, juice extract, cold maceration, drying and pulverization into powder. Informants use different solvents to adequately extract the active portion from documented plants including water, carbonated drinks, local gin (ethanol), lime and aqueous extract from fermented maize. There was generally no standardized volume of administration but the herbal recipes were administered using glass cups or tumblers with approximately 150 mLs three times daily. Plant parts commonly used by informants include the leaves, fruits, bark and roots which are preferably used when fresh (Figure 2). The most reported mode of administration of documented herbal preparation is oral while the methods of preparation include decoction, infusion, soaking, drying and pulverization into fine powder

Table 1: Documented plants used in the management of diabetes in Bode and Oje communities of Ibadan, Nigeria.

S/N	Botanical name	Family	Vernacular name (Yoruba)	Common name	Plant part used	Habit
1	*Abrus precatorius* Linn.	Fabaceae	Oju-ologbo	Rosary pea, Crab's eye	Leaves, root	Herb
2	*Acacia nilotica* (Linn.) Wild ex. Del.	Fabaceae	Booni, banni	Gum Arabic tree	Leaves	Tree
3	*Adenopus breviflorus*	Cucurbitaceae	Tagiri	Pseudo colocynth	Fruit	Creeper
4	*Allium ascalonicum*	Liliaceae	Alubosa elewe	Shallot, leafed onion (spring onion)	Bulb	Herb
5	*Allium sativum*	Liliaceae	Alubosa aayu	Garlic	Bulb	Herb
6	*Aloe vera (L.)* Burm.f.	Asphodelaceae (Liliaceae)	Aloe Ahonerin	Aloe vera	Whole plant	Herb
7	*Alstonia boonei* De.Wild	Apocynaceae	Awun	Stool wood	Bark	Tree
8	*Annona senegalensis* Pers.	Annonaceae	Epo	Wild custard apple	Leaves, stem bark	Shrub
9	*Anthocleista djalonensis* A. Chew.	Loganiaceae	Sapo	Cabbage tree	Bark	Tree
10	*Aristolochia ringens* Vahl	Aristolochiaceae	Akogun	Dutchman's pipe	Root, bark	Creeper

11	*Bombax buonopozense* P. Beauv	Bombacaceaea	Ponpola	Silk cotton tree	Leaves	Tree
12	*Bucholzia coriacea* Engl.	Capparaceae	Wonderful kola	Musk tree	Fruits	Shrub
13	*Calliandra haematocephala* Linn.	Fabaceae	Tude	Snowflake acacia	Leaf, Root	Shrub
14	*Carica papaya*	Cariacaceae	Ibepe	Pawpaw	Fruit	Tree
15	*Cassia fistula* Linn.	Fabaceae	Aidan-toro	Golden shower	Leaves	Tree
16	*Citrullus colocynthis*	Cucurbitaceae	Baara	Water melon	Fruit	Creeper
17	*Citrus aurantifolia* (Christm.) Swingle.	Rutaceae	Osan wewe	Lime	Fruits, juice	Tree
18	*Clausena anisate*	Rutaceae	Atari-obuko (egboagbasa)	Clausena	Roots,bark	Tree
19	*Cocos nucifera*	Arecaceae	Agbon	Coconut	Coconut water	Tree
20	*Cucumeropsis mannii* Naudin	Cucurbitaceae	OdidiItoo/ Egusi-itoo	White-seed melon	Fruits , seeds	Climber
21	*Curculigo pilosa* (Schum& Thonn) Engl.	Hypoxidaceae	Epakun	Golden eye grass	Fruits, root	Tree
22	*Euphorbia lateriflora* Schum. & Thonn.	Euphorbiaceae	Enu opiri	Little cactus	Stem	Shrub
23	*Ficus exasperata* Vahl.	Moraceae	Ipin	Sound paper leaf	Leaves	Tree
24	*Floscopa*	Commelinaceae	Igba opolo	Lizard’s tail	Leaves	Herb

	Africana (P.Beauv.)					
25	*Garcinia kola* Heckel	Guttiferae (hypericaceae)	Orogbo	Bitter kola	Fruit	Tree
26	*Gladiolus dalenii* Van. Geel.	Iridaceae	Baka	Dragon's –head lily	Bulb	Shrub
27	*Gongronema latifolium* Benth et Hook.	Asclepiadaceae	Madunmaro (arokeke)	Bush buck	Leaves	Shrub
28	*Gossypium barbadense*	Malvaceae	Owu akese	West Indian cotton leaves	Leaves	Tree
29	*Hibiscus sabdariffa*	Malvaceae	Isapa funfun	Bush rosette	Fruit	Herb
30	*Hunteria umbellata* (K. Schum) Haller. F.	Apocynaceae	Abeere	Aarin	Fruit, seeds,	Tree
31	*Hyptis pectinata* (L.) Poit.	Lamiaceae	Jobgo	Bushmints	Leaves	Shrub
32	*Irvinga gabonensis (Aubry-Lecomte ex O'Rorke) Baill.*	Irvingiaceae	Epon (epo)	Bush Mango/ African mango	Seeds	Tree
33	*Khaya ivorensis* A. Chev.	Meliaceae	Oganwo	African mahogamy	Bark	Tree
34	*Kigelia Africana (lam.)* Benth.	Bignoniaceae	Pandoro/Amuyan	African Sausage tree	Fruits	Tree
35	*Markhamia tomentosa (Benth.) H. Schum.*	Bignoniaceae	Oruru	Bell bean tree	Bark	Tree

36	*Mondia whitei* (Hook.f.)	Apocynaceae	Isigun	White's ginger	Root, root bark	Creeper
37	*Morinda lucida* Benth	Rubiaceae	Oruwo	Brimstone tree	Leaves	Tree
38	*Moringa oleifera* Lam.	Moringaceae	Ewe igbale	Moringa, miracle tree	Whole plant	Tree
39	*Mormodica charantia* Descourt.	Cucurbitaceae	Ejinrin	Africa cucumber	Leaves	Creeper
40	*Musa paradisiaca*	Musaceae	*Ogede agbaagba* (dudu)	Plantain	Stems	Tree
41	*Nauclea latifolia*	Rubiaceae	Egbesin	Nauclea	Leaves, root	Tree
42	*Ocimum gratissimum*	Lamiaceae	Efinrin	Sweet basil	Leaf	Herb
43	*Olax subscorpiodea* Oliv.	Olacaceae	Ifon	Ifon	Leaves, root	Tree
44	*Oxytenanthera abyssinica* (A.Rich.) Munro	Poaceae	Paran pupa, funfun	Savannah Bamboo	Leaves	Herb
45	*Parkia biglobosa* Jacq	Fabaceae	Igba	African Locust Bean	Seeds, leaves	Tree
46	*Parquetina nigrescens* (Afzel) Bullock.	Periplocaceae	Ogbo	African parquetina	Leaves	Creeper
47	*Picralima nitida*	Apocynaceae	Erin	Picralima	Bark	Tree
48	*Psidium guajava*	Myrtaceae	Guava	Guava	Fruits, Leaves	Tree
49	*Rauwolfia vomitoria* Afzel.	Apocynaceae	Asofeyeje	African rauwolfia	Stem bark, Leaves	Shrub

50	*Securidaca longepedunculata*	Polygalaceae	Ipeta	Violet tree	Root, bark, Stem	Tree
51	*Senna alata*	Fabaceae	Asunwon oyinbo	Candle bush	Leaf	Shrub
52	*Senna podocarpa* Guil. &Perr.	Fabaceae	Asunwon ibile	Candle bush	Leaves	Shrub
53	*Sphenocentrum jollyanum Pierre*	Menispermaceae	Akerejupon	Sphenocentrum	Leaves, root, Seed	Tree
54	*Strophanthus hispidus* D.C	Apocynaceae	Sagbere, sagere	Arrow poison plant	Root	Shrub
55	*Tetrapleura tetraptera* (Schun&Thonn) Taub.	Fabaceae	Arindan, aidan	Aidan tree	Roots	Tree
56	*Uvaria afzelii* Sc. Elliot	Annonaceae	Gbogbonise	Monkey finger	Leaves, root	Shrub
57	*Uvaria chamae P. Beauv*	Annonaceae	Eruju	Finger root	Root	Shrub
58	*Vernonia amygdalina*	Asteraceae	Ewuro	Bitter leaf	Leaf	Shrub
59	*Xylopia aethiopica* (Dunal) A. Rich	Annonaceae	Eeru-lamo (Erualamo)	African pepper	Fruit	Tree
60	*Zea mays*	Poaceae	Omi dun (omi ogi)	Maize	Juice	Shrub

Table 2: Quantitative analysis of antidiabetic plants used in Bode and Oje communities of Ibadan city, Nigeria

S/N	Botanical name	Mode of preparation	Frequency	Use mention index (UMI)	Frequency of Citation (FC)
1	*Abrus precatorius* Linn.	Infusion Decoction	1	0.01	0.42
2	*Acacia nilotica* (Linn.) Wild ex. Del.	Powder	2	0.02	0.84
3	*Adenopus breviflorus*	Powder Infusion	1	0.01	0.42
4	*Allium ascalonicum*	Powder	1	0.01	0.42
5	*Allium sativum*	Powder	1	0.01	0.42
6	*Aloe vera (L.)* Burm.f.	Maceration	1	0.01	0.42
7	*Alstonia boonei* De.Wild	Decoction Infusion	1	0.01	0.42
8	*Annona senegalensis* Pers.	Infusion	1	0.01	0.42
9	*Anthocleista djalonensis* A. Chew.	Decoction Infusion Maceration	4	0.04	1.68
10	*Aristolochia ringens* Vahl	Powder Decoction Maceration Infusion	22	0.22	9.24

11	*Bombax buonopozense* P. Beauv	Decoction	1	0.01	0.42
12	*Bucholzia coriacea* Engl.	Maceration	1	0.01	0.42
13	*Calliandra haematocephala* Linn.	Decoction	4	0.04	1.68
14	*Carica papaya*	Maceration	1	0.01	0.42
15	*Cassia fistula* Linn.	Decoction	1	0.01	0.42
16	*Citrullus colocynthis*	Decoction Infusion	10	0.10	4.20
17	*Citrus aurantifolia* (Christm.) Swingle.	Juice extract	9	0.09	3.78
18	*Clausena anisate*	Decoction	1	0.01	0.42
19	*Cocos nucifera*	Juice extract	33	0.33	13.87
20	*Cucumeropsis mannii* Naudin	Juice extract	1	0.01	0.42
21	*Curculigo pilosa* (Schum& Thonn) Engl.	Powder Decoction	8	0.08	3.36
22	*Euphorbia lateriflora* Schum. & Thonn.	Maceration	1	0.01	0.42
23	*Ficus exasperate* Vahl.	Juice extract	3	0.03	1.26
24	*Floscopa Africana* (P.Beauv.)	Juice extract	1	0.01	0.42
25	*Garcinia kola* Heckel	Powder	2	0.02	0.84
26	*Gladiolus dalenii* Van. Geel.	Powder	8	0.08	3.36

		Maceration			
27	*Gongronema latifolium* Benth et Hook.	Decoction	1	0.01	0.42
28	*Gossypium barbadense*	Juice extract	1	0.01	0.42
29	*Hibiscus sabdariffa*	Powder	1	0.01	0.42
30	*Hunteria umbellata* (K. Schum) Haller. F.	Powder Decoction Maceration	56	0.56	23.53
31	*Hyptis pectinata* (L.) Poit.	Juice extract	1	0.01	0.42
32	*Irvinga gabonensis (Aubry-Lecomte ex O'Rorke) Baill.*	Powder	1	0.01	0.42
33	*Khaya ivorensis* A. Chev.	Decoction	1	0.01	0.42
34	*Kigelia Africana (lam.)* Benth.	Powder	1	0.01	0.42
35	*Markhamia tomentosa (Benth.) H. Schum.*	Decoction	1	0.01	0.42
36	*Mondia whitei* (Hook.f.)	Decoction Maceration	1	0.01	0.42
37	*Morinda lucida* Benth	Juice extract	3	0.03	1.26
38	*Moringa oleifera* Lam.	Juice extract Infusion Decoction	2	0.02	0.84
39	*Mormodica charantia* Descourt.	Juice extract	5	0.05	2.10
40	*Musa paradisiaca*	Powder	1	0.01	0.42
41	*Nauclea latifolia*	Decoction	1	0.01	0.42

		Infusion Juice extract			
42	*Ocimum gratissimum*	Juice extract	2	0.02	0.84
43	*Olax subscorpiodea* Oliv.	Decoction	3	0.03	1.26
44	*Oxytenanthera abyssinica* (A.Rich.) Munro	Juice extract Infusion	1	0.01	0.42
45	*Parkia biglobosa* Jacq	Powder	1	0.01	0.42
46	*Parquetina nigrescens* (Afzel) Bullock.	Juice extraction Infusion	1	0.01	0.42
47	*Picralima nitida*	Powder	1	0.01	0.42
48	*Psidium guajava*	Infusion	1	0.01	0.42
49	*Rauwolfia vomitoria* Afzel.	Powder (pulverization)	2	0.02	0.84
50	*Securidaca longepedunculata*	Decoction Infusion	1	0.01	0.42
51	*Senna alata*	Decoction	2	0.02	0.84
52	*Senna podocarpa* Guil. &Perr.	Decoction Maceration	2	0.02	0.84
53	*Sphenocentrum jollyanum Pierre*	Powder	4	0.04	1.68
54	*Strophanthus hispidus* D.C	Decoction Maceration	2	0.02	0.84
55	*Tetrapleura tetraptera* (Schun&Thonn) Taub.	Decoction	1	0.01	0.42
56	*Uvaria afzelii* Sc. Elliot	Decoction	4	0.04	1.68

57	*Uvaria chamae P. Beauv*	Decoction	1	0.01	0.42
58	*Vernonia amygdalina*	Juice extract Maceration Decoction	10	0.1	4.20
59	*Xylopia aethiopica* (Dunal) A. Rich	Maceration	1	0.01	0.42
60	*Zea mays*	Juice extract	1	0.01	0.42

Literature analysis of all the 60 antidiabetic medicinal plants reported in this study revealed that large number of these plants have been reported in other climes to have significant antidiabetic activity during various laboratory experiments among which are plants like *Parkia biglobosa* , *Vernonia amygdalina* [58-61], *Moringa oleifera* [62], *Allium cepa* and *Allium sativum* [63-65, *Picralima nitida*, *Ocimum gratissimum* [66-68], Aloe vera, *Anthocleista djalonensis* [69] and *Carica papaya* [70-72].

The antidiabetic activity of *Nauclea latifloria* and *Moringa oleifera* have been validated scientifically [73-76]. There have been experimental evidences for the hypoglycemic activity of these medicinal plants, in experimental model of diabetes [58].

Quantitative analysis of survey data showed that the Fabaceae and Apocynaceae families have the highest Frequency of citation and Use mention indices which reflects the antidiabetic medicinal value of the 14-plant species mentioned under these two high scoring plant families. Their application in the traditional medicine of the study areas may be related to their availability, accessibility, their edibility and low carbohydrate content. For instance, legumes, a sub-family of Fabaceae are largely known to be very edible, high in protein, low in carbohydrate and interestingly have a low glycemic index [77]. In Nigeria, legumes are well domesticated and are cultivated both for food and as source of effective antidiabetic medicinal plants.

Conclusion

Our study has reported for the first time the antidiabetic ethnomedicine of the Bode and Oje communities of Ibadan metropolitan city. Sixty plant species belonging to 35 families have been reported for use in the management of

diabetes in both Ibadan South-East and Ibadan North-East Local Government areas. This study showed that traditional treatment systems and the use of medicinal plants has not disappeared from the study areas. The importance of documentation of traditional ethnomedicinal knowledge has also been demonstrated in this work. The present study documents several new antidiabetic ethnomedicinal species with their specific and detail method of extraction and mode of administration. The most mentioned plant families of Fabaceae and Apocynaceae may represent important and new bioresources for further studies particularly phytochemical and pharmacological studies for antidiabetic drug discovery and development.

Declarations

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Authors'contributions
TOA and GOT planned and performed the study and field survey, TOA and AFA wrote the draft manuscript, and analyzed the data, and AFA revised the manuscript and data analysis. All authors read and approved the final manuscript.

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None

Availability of data and materials

The authors already included all data in the manuscript collected during the field surveys. The documented medicinal plant species were deposited at the herbarium unit of the Department of Pharmacognosy, University of Ibadan, Nigeria.

Ethics approval and consent to participate;

Prior consent of the informants was taken before the field work to see to it that conducting these studies to comply with the ethical standards of community participation in scientific research.

Consent for publication;

Not applicable.

Competing interests;

The authors declare no competing interest

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Figures

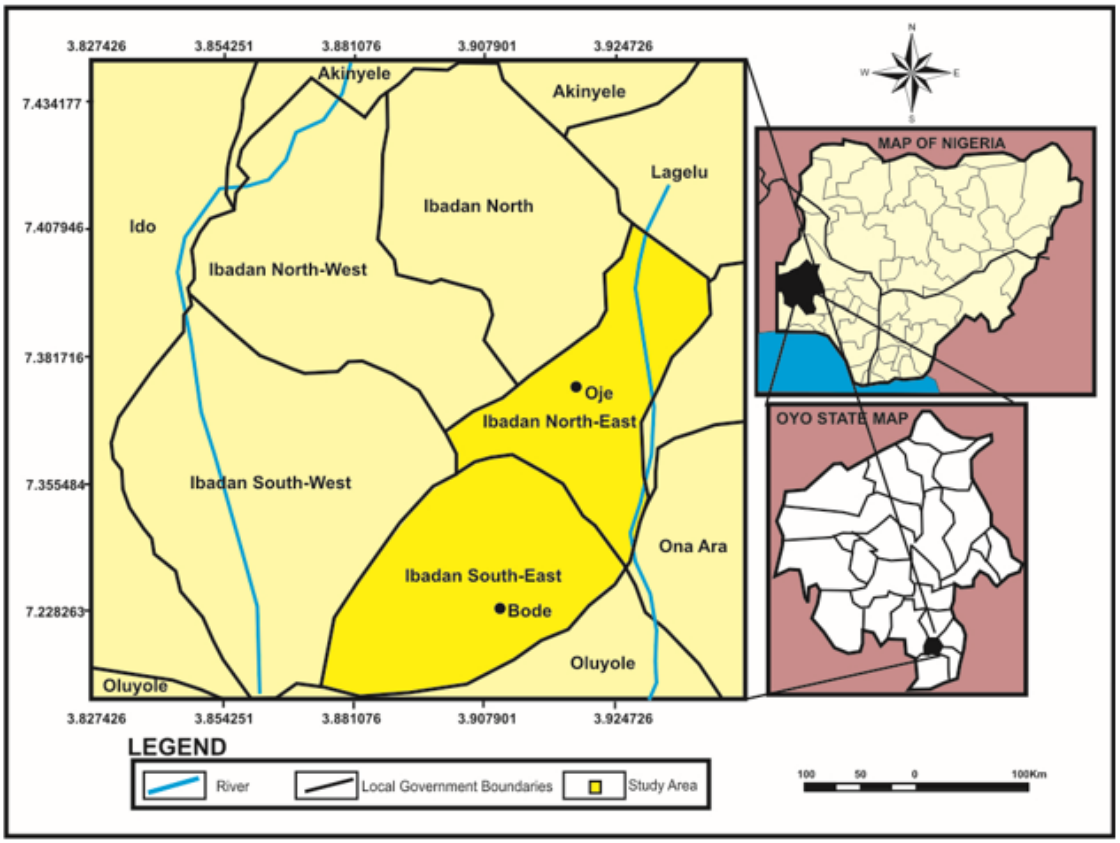

Figure 1

Map showing the areas of study; Bode, located in Ibadan South-East and Oje in Ibadan North-East

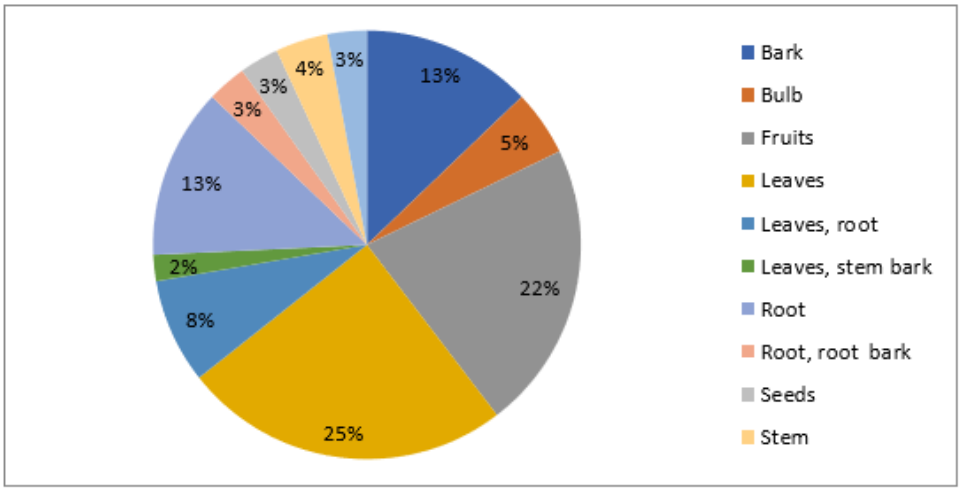

Figure 2

Percentage distributionn of various plant part(s) used in preparation of anti-diabetic recipes.

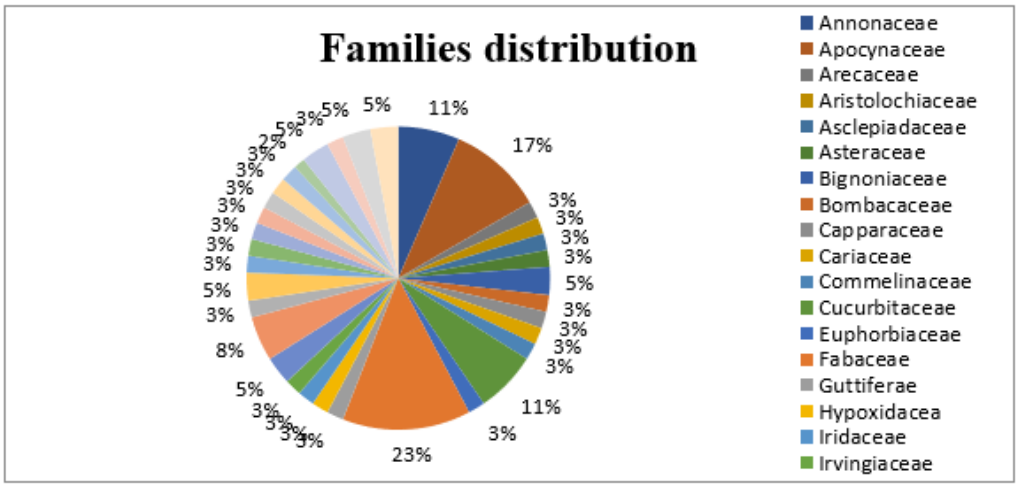

Figure 3

Percentage distribution according to family of plants used in the management of diabetes