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Ethno-pharmacological and *in-vitro* anti-diabetic study of some medicinal plants commonly used in Ogbomoso, South Western Nigeria.

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ABSTRACT

Objective: to document the knowledge of the anti-diabetic plants used by traditional healers in Ogbomoso, Oyo state Nigeria and to validate their antidiabetic property using *in vitro* approach.

Methodology and Results: An ethnobotanical survey on plants commonly used for treatment of type-2 diabetes mellitus was conducted and 5 of the plants chosen at random were investigated *in-vitro* for anti-diabetic property. A semi-structured questionnaire was given to 132 traditional healers and medicinal herb dealers who claimed to have treated type 2 diabetes mellitus or have knowledge on how to treat the disease in the five local government areas in Ogbomoso. *In-vitro*-anti-diabetic activities of *Uvaria chamae* (finger root or bush banana) (P.BAEUV), *Peperomia pellucida* (pepper elder) (L.KUNTN), *Argimones Mexican (*mexican poppy) (Papaveracea), *Anchomanes difformis* (kabaka-kachulu) (Araceae) and Cassia fistula (golden rain tree) (LINN) were assessed using *α-amylase* inhibition assay. Data were analyzed qualitatively and quantitatively.**:** A total of 71 plants species from 44 families were reported from 132 respondents out of whom 53 % were males and 47 % females. From the list of plants, the most cited families are Malvaceae and Euphorbiaceae (9.9%) while *Vernonia amygdalina* (RFC = 0.159) was the most cited species. The part of plants mostly used is the leaf or in a mix with other parts. The ethanolic leave extracts of *Uvaria chamae* demonstrated the highest dose dependent alpha amylase inhibitory (59.81 %) activity with an IC50 value of 385 µg/ml when compared with the other plant extracts. However, the plant showed a weaker alpha amylase inhibitory property when compared with the standard drug Acarbose (IC50 value of 46.2 µg/ml).

Conclusion and application of results: The *in vitro* anti-diabetic property of the chosen plants showed that there is need for proper documentation and preservation of indigenous knowledge on the treatment of diabetes mellitus.

INTRODUCTION

Diabetes mellitus is one of the major causes of morbidity and mortality in the world. According to Durmuşkahya and Öztürk (2013), there are 285 million (6.6% of population aged 20-79 years) diabetic patients across the globe and it account for more than 1.1 million deaths worldwide. By 2030, it is estimated that the number of diabetes patients will reach 450 million with 97% showing type 2 diabetes mellitus (Israili, 2010, 2011). In Africa, approximately 13.6 million people are reported to be suffering from diabetic mellitus and 7 million of this population resides in sub-Saharan Africa (). Nigeria has the highest number of people with diabetic (approximately 1.2 millions) and impaired glucose tolerance estimated at 3.85 million. Consumption of energy-rich diet and obesity, increase in sedentary lifestyle has been attributed to the rise in the number of diabetic cases (Mustafa *et al*., 2014). Based on aetiology and clinical presentation, diabetes mellitus is classified into two namely type 1 and type 2. Type 1, commonly referred to as insulin dependent diabetes mellitus (IDDM) is caused by immunological destruction of pancreatic β cells resulting in insulin deficiency (Notkins,2002) while, Type 2, also known as non-insulin –dependent diabetes mellitus (NIDDM) is characterized by both impaired insulin secretion and insulin resistance which is often associated with obesity and hereditary disposition (Zimmet,1990). Although, there are many conventional therapies such as stimulation of endogenous insulin secretions, enhancement of the action of insulin at the target tissues, use of oral hypoglycaemic agents (biguanids and sulfonylureas) and the inhibition of degradation of dietary starch by glycosidases (α-amylase and α glucosidase) (Sudha et.al., 2011), over 80 % of rural dwellers in developing countries still depend on medicinal herbs (van Wyk *et al*., 2002). They believe that plants and plant materials are cheap, easily accessible and have fewer or no side effects. Therefore, they rely on it as a better alternative to the synthetic drugs (Rajans and Kumarasamys, 2012). In Ogbomosho, south west Nigeria , 80% of people still rely on traditional medicine and Traditional Health Practitioners(THPs) as the primary source of health care (WHO,2002) due to accessibility and cultural acceptance. Information and documentation on herbs commonly employed in the treatment and management of diabetes mellitus in Ogbomoso is scanty in the literature. Hence, the present survey was undertaken to document the knowledge of the anti-diabetic plants used by traditional healers in the study area and to validate the antidiabetic property of few of them using *in vitro* approach.

MATERIALS AND METHODS

Briefly, the survey was carried out in five local areas (Kinnira, Arowomole, Surulere, Orire and Ogo-Oluwa) which cover the whole of Ogbomoso North and a substantial part of Ogbomoso South. Ogbomoso lies between latitude 8' 08' 00" and longitude 4 16' 00". It is densely populated majorly by the "Yoruba's" and was estimated to cover 27.5 square kilometres, the second largest city after Ibadan in Oyo State Nigeria (Olorunnisola *et al*., 2013). This study was carried out between January and April 2014 to gathered phyto-therapeutic information about indigenous plants used in the treatment of diabetes.

Data collection: A total of one hundred and thirty two (132) respondent mostly traditional healers and medicinal herb dealers who are rural dwellers and are aware of the disease (DM) were interviewed. A guided questionnaire was given to the respondents. Each respondent was then interviewed alone to maintain confidentiality among them. The interviews deduced information on the socio-demographic data like age, education, occupation, the causes and diagnosis of type 2 diabetes mellitus, medicinal plants, vernacular names, parts used, source of the plant materials, methods of preparation, and routes of administration, duration of treatment and contraindications or likely side effect in traditional treatment of the disease. Professor JA Ogunkunle, a botanist in the Department of Pure and Applied Biology, Ladoke Akintola University of Science and technology, Ogbomoso, identified the medicinal plants mentioned by the interviewees. Voucher specimens of each plant species reported

were collected for confirmation and are deposited at the University's Herbarium.

Intellectual property agreement: The respondents who contributed to the wealth of information here reported were financially rewarded and assured that the information supplied will not be used for commercial purposes but to serve as enlightenment information to the community and to conserve the wealth of knowledge of plants used for the treatment of type 2 diabetes mellitus in Ogbomoso, Oyo State.

Data analysis: The data obtained in this study was analysed using relative frequency of citation, which was used to access whether synthetic index could assist to quantify the distribution and diversity of information supplied by each respondent on a particular plant species. Relative frequency of citation (RFC) is used to determine the probability between number of people who give citation to each species and number of all respondents. The result of RFC obtained described the local importance of each species of the plants collected. The RFC was therefore calculated according to Tardìo and Pardo-De-Santayana (2008):

RFC = FC/N

Where FC is the number of informants who mentioned the use of the plants and N is the total number of respondents. Descriptive statistics such as frequency distribution, pie chart and percentages were used in the analysis of the data

RESULTS

Age, Demographic and Educational data of Respondents: Information obtained from 132 respondents interviewed revealed that 53 % were males healers compared to 47 % females. The ages of the respondents were between 40-70 years. Thirty-seven of the respondents were between 40 – 50 years, Forty-three of them were between the ages of 51 – 60 years old, while the remaining 52 of the respondents were between the ages of 61 – 70 years of age. All of the respondents claim to have inherited the knowledge from their parents and that it has become the normal practice in the lineage (Table 1). About 31.06 % of the respondents claimed to have between 26 and 30 years of experience in the treatment of type 2 diabetes mellitus (Table 1). We observed that 38.64 % of the total respondents had secondary education, 25.76% had the primary school education, 18. 94 % had vocational education/training while 16.67% of had no formal education. However, with little or no formal education, the respondents were able to diagnose diabetes based on sugar in the urine, frequent urination and loss of body weight. Majority of the respondents therefore believed their patients were cured once there is disappearance of sugar in the urine and reduced frequency in urination.

Table 1: showing demographical data of the respondents

Age (years)	**Frequency**	**Percentage**
< 40	0	0
40 – 50	37	28.03
51 – 60	43	32.58
61 – 70	52	39.39
>70	0	0
Total	132	100
Gender		
Male	70	53
Female	62	47
Total	132	100
MAI		
Ancestral	132	100
Others	0	0
Total	132	100
YEDT		
1 – 5	3	2.27
6 – 10	15	11.36
11 – 15	36	27.27

16 – 20	11	8.33
21 – 25	26	19.70
26 – 30	41	31.06
>30	0	0
Total	132	100
LE		
No education	22	16.67
Primary school	34	25.76
Secondary education	51	38.64
Vocational education	25	18.94
Graduate	0	0
Total	132	100

MAI-Represents Mode of acquiring information; YEDT-Represents Years of experience in diabetes treatment; LE-Represents level of education

Anti-diabetic medicinal plant species: In the present study, 71 species belonging to 44 plant families were reported by the traditional healers to possess anti-diabetic properties (Table 2). Malvaceae and Euphorbiaceae have the highest number of species (4 species) and were the most frequently mentioned (9.9 %) by the traditional healers in the preparation of their recipes. Other plant families commonly mentioned include Annonaceae, Cucurbitaceae and Fabaceae with 6.82 % each. The results of RFC (Table 3) showed that *Vernonia amygdalina,* is the most important plant with (RFC = 0.159) 21 citations from 16 % of the respondents, followed by *Morinda lucida* (RFC = 0.136) with 18 citations. About 45 % of the total plants were cited once by the respondents therefore has least local importance as indicated by their least RFC. The ethnobotanical index and ranking of the plants as mentioned by the respondents were also presented in table 3.

Table 2: Showing distribution of plant family and the percentage of occurrence

Family	Distribution	Percentage species
Malvaceae	4	9.09
Euphorbiaceae	4	9.09
Annonaceae	3	6.82
Cucurbitaceae	3	6.82
Fabaceae (Leguminosae)	3	6.82
Arecaceae	2	4.55
Asteraceae	2	4.55
Bignoniaceae	2	4.55
Poaceae	2	4.55
Rubiaceae	2	4.55
Rutaceae	2	4.55
Sapotaceae	2	4.55
Solanaceae	2	4.55
Zingiberaceae	2	4.55
Phyllanthaceae	1	2.27
Acanthaceae	1	2.27
Amaryllidaceae	1	2.27
Anacardiaceae	1	2.27
Apocynaceae	1	2.27
Araceae	1	2.27
Aristolochiaceae	1	2.27

Boraginaceae	1	2.27
Bromeliaceae	1	2.27
Caesalpiniaceae	1	2.27
Caricaceae	1	2.27
Clusiaceae	1	2.27

Table 3: showing Results of analysis used by RFC

S/N	Species	FC	Ethnobotanical index	Ranking of RFC
1.	*Vernonia amygdalina* (Del)	21	0.159	1
2.	*Morinda lucida* (Benth)	18	0.136	2
3.	*Picralina nitida*(Staphf)	16	0.121	3
4.	*Citrusllus colocynthis*(Schrad)	12	0.091	4
5.	*Cocos nucifera L.*	12	0.091	4
6.	*Carica papaya* (L)	11	0.083	5
7.	*Ocinum gratissium*(Linn)	10	0.076	6
8.	*Momordica charantia*(L)	8	0.061	7
9.	*Allium cepa* (L)	7	0.053	8
10.	*Allium sativum (Linn)*	7	0.053	8
11.	*Anthocleista djalonensis*(A. Chev.)	7	0.053	8
12.	*Aristolochia ringens (Vahl.)*	6	0.045	9
13.	*Curculigo pilosa (schum & Thonn.)*	6	0.045	9
14.	*Azadirachta indica (Juss.)*	5	0.038	10
15.	*Citrus aurantium(L.)*	5	0.038	10
16.	*Psidium guajava*(L)	5	0.038	10
17.	*Viscum album (Linn.)*	5	0.038	10
18.	*Aframomum melegueta* (K. Schum)	4	0.030	11
19.	*Ageratum conyzoides* (L)	4	0.030	11
20.	*Phyllanthus niruri* (L)	4	0.030	11
21.	*Citrus aurantifolia* (Christm)	4	0.030	11
22.	*Ficus asperifolia* (Miq)	4	0.030	11
23.	*Tithonia diversifolia* (Hemsl.)	4	0.030	11
24.	*Hibiscus acetosella* (Welw.)	3	0.023	12
25.	*Jatropha gossypiifolia Linn.*	3	0.023	12
26.	*Kigelia africana* (Lam.) Benth.	3	0.023	12
27.	*Mangifera indica(L)*	3	0.023	12
28.	*Saccharum officinarum*(L)	3	0.023	12
29.	*Anchomanes difformis* (Blume) Engl	2	0.015	13
30.	*Butyrospermum paradoxum* (Don)	2	0.015	13
31.	*Chlorophora excelsa* (Withs Bath.)	2	0.015	13
32.	*Chrysophyllum delevoyi* (De Wild)	2	0.015	13
33.	*Cymbopoqon citrates* (DC)	2	0.015	13
34.	*Distemonanthus benthamianus* (Bail.)	2	0.015	13

35.	*Gossypium barbadense* (L)	2	0.015	13
36.	*Hymenocardia acida* (Tul.)	2	0.015	13
37.	*Juglans regia* (L)	2	0.015	13
38.	*Musa paradisiaca* (Linn.)	2	0.015	13
39.	*Pergularia daemia (Forsk) Chiov*	2	0.015	13
40.	*Acanthus montanus* (T. Anderson)	1	0.008	14
41.	*Allanblackia floribunda* (Oliv.)	1	0.008	14
42.	*Aloe barbadensis* (L)	1	0.008	14
43.	*Aloe barbadensis* (L)	1	0.008	14
44.	*Ananas sativus* (Schult)	1	0.008	14
45.	*Anogeissus leiocarpus (DC) Guill & Perr*	1	0.008	14
46.	*Cola acuminate* (Schott & Endl.)	1	0.008	14
47.	*Croton zambesicus* (Muell. Arg.)	1	0.008	14
48.	*Curcuma longa* (L)	1	0.008	14
49.	*Eugenia aromatica* (Linn.)	1	0.008	14
50.	*Gliricidia sepium* (Jacq)	1	0.008	14
51.	*Harungana madagascariensis* (Lam.)	1	0.008	14
52.	*Heliotropium indicum* (L.)	1	0.008	14
53.	*Hura Crepitans* (L.)	1	0.008	14
54.	*Luffa cylindricum* (*L.)*	1	0.008	14
55.	*Monodora myristica* (Gaertn)	1	0.008	14
56.	*Moringa oleifera* (Lam.)	1	0.008	14
57.	*Nauclea latifolia* (L.)	1	0.008	14
58.	*Newbouldia laevis* (P. Beauv.)	1	0.008	14
59.	*Nyctaginaceae boerhavia diffusa* (Linn)	1	0.008	14
60.	*Parkia biglobosa* (Jacq)	1	0.008	14
61.	*Peperomia pellucida* (Kunth)	1	0.008	14
62.	*Piliostigma reticulatum* (DC.)	1	0.008	14
63.	*Securidaca longipedunculata* (Fresen)	1	0.008	14
64.	*Senna fistula* (Linn)	1	0.008	14
65.	*Solanum aethiopicum* (L.)	1	0.008	14
66.	*Solanum Hispidum*(Pers.)	1	0.008	14
67.	*Sphenocentrum jollyanum* (Pierre)	1	0.008	14
68.	*Thumanmato-coccus* (Dannelli)	1	0.008	14
69.	*Uvaria chamae* (P. Beauv.)	1	0.008	14
70.	*Xanthosoma sagittifolium* (L. Schot)	1	0.008	14
71.	*Xylopia aethiopica* (Dun.)	1	0.008	14

Other relevant information about the plants used: According to the respondents different parts of the plants were mention for the therapeutic usage of these plants such as leaves, stem, bark, roots, fruits, seeds and whole plants (Fig. 1). Different parts of the same plant were also mentioned by the respondents or sometimes combination of parts. The leaves were the most frequently used parts with 57.75 % followed by

the combination of leaf, bark, root with 12.68 %, this is followed by the fruits with 11.27 %. The least frequently used are seed, bulb and stem with 1.41 %. These plant parts are majorly prepared in water or schinapps. These result of this study revealed that different parts of the plants were used for treatments (Table 4) and also most of the respondents rarely use a single plant species for the treatment but rather prepare two or more plants as concoctions with different methods of preparations (table 5). The patients are required to take specific dosage at intervals based on the experience of the respondent.

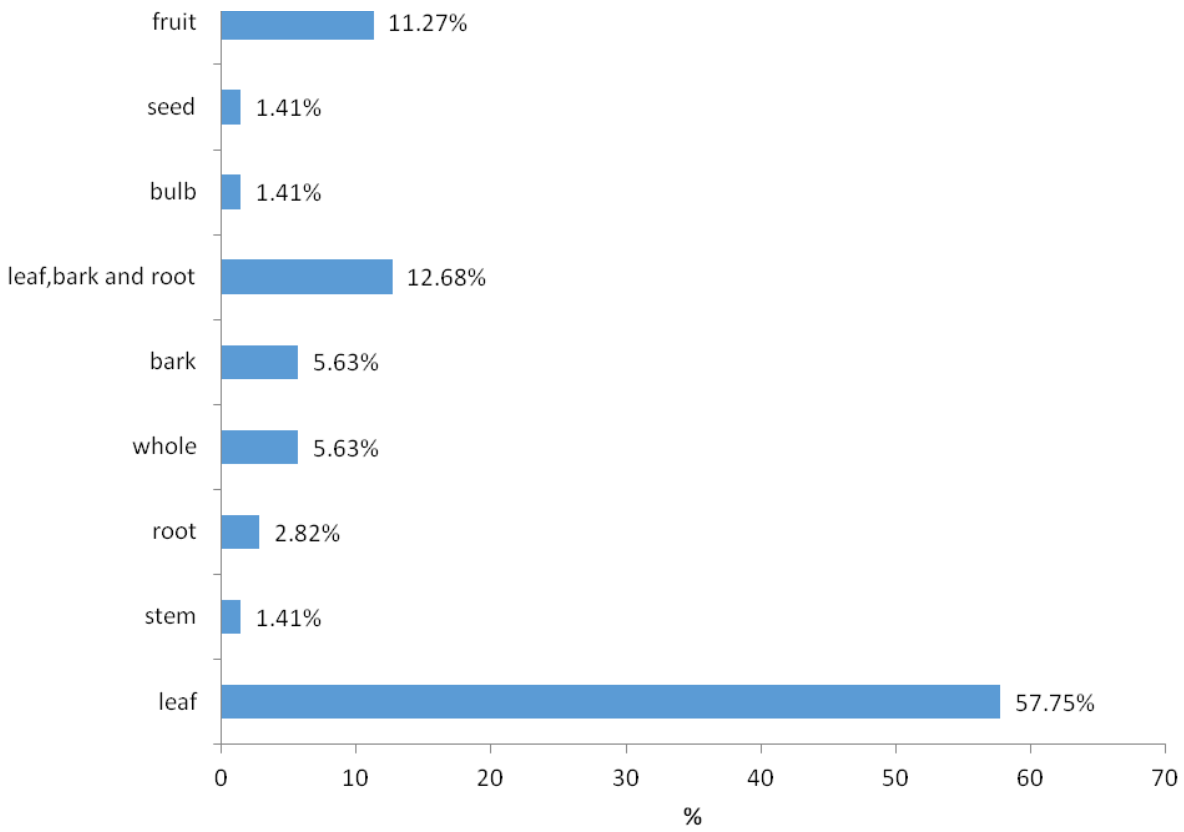

Figure 1: showing the variations in the plant parts used in the treatment of diabetes

Table 4: Species used for the treatment of diabetes

S/N	Species	Local name	Family	Number of occurrences	Parts used	Pictures
1	*Acanthus montanus*	Ahon-ekun	Acanthaceae	1	Leaf	N/A
2	*Aframomum melegueta*	Ataare	Zingiberaceae	4	Leaf, fruit	
3	*Ageratum conyzoides*	Imi-esu	Asteraceae	4	Leaf	
4	*Allanblackia floribunda*	Orogbo	Clusiaceae	1	Fruit	
5	*Allium cepa*	Onion	Amaryllidaceae	7	Bulb	N/A
6	*Allium sativum Linn*	Ayu	Lilaceae	7	Fruit	
7	*Aloe barbadensis*	Allovera/eti erin	Xanthorrhoeaceae	1	Leaf	
8	*Aloe barbadensis*	Eti-erin	Xanthorrhoeaceae	1	Leaf	N/A
9	*Ananas sativus*	Ope oyinbo	Bromeliaceae	1	Leaf	N/A
10	*Anchomanes difformis*	Ogirisako	Araceae	2	Leaf	N/A
11	*Anogeissus leiocarpus (DC) Guill & Perr*	Ogo ayin	Combretaceae	1	Bark	N/A

12	*Anthocleista djalonensis*	shapo	Loganiaceae (APG: Gentianaceae)	7	Leaf	
13	*Aristolochia ringens Vahl.*	Akogun	Aristolochiaceae	6	Leaf, Root	
14	*Azadirachta indica Juss.*	Dongoyaro	Meliaceae	5	Leaf	
15	*Butyrospermum paradoxum*	Emi	Sapotaceae	2	Leaf	
16	*Carica papaya*	Ibepe dudu	Caricaceae	11	Leaf	N/A
17	*Phyllanthus niruri*	Eyin olobe	*Euphorbiaceae*	4	Leaf	
18	*Chlorophora excelsa (Weths) Bth.*	Iroko	Moraceae	1	Leaf	N/A
19	*Chrysophyllum delevoyi*	Baka	Sapotaceae	2	Fruit	
20	*Citrus aurantifolia*	Lime	Rutaceae	4		N/A

21	*Citrus aurantium L.*	Oronbo	Rutaceae	5	Juice	
22	*Citrusllus colocynthis*	Bara egunsi	Cucurbitaceae	2	Leaf, pod	 
23	*cocos nucifera L.*	Omi agbon	Arecaceae	12	Water	N/A
24	*Cola acuminata*	Obi olojumeta	Malvaceae	1	Nut/fruit	N/A
25	*croton zambesicus*	Ajeobale	Euphorbiaceae	1	Leaf	N/A
26	*Curculigo pilosa (schum & Thonn.)*	Epa ikun	Hypoxidaceae	6	Fruit	
27	*Curcuma longa*	Laali pupa	Zingiberaceae	1	Leaf	
28	*Cymbopoqon citratus*	Tea	Poaceae	2	Leaf	
29	*Distemonanthus benthamianus Bail.*	Igi Ayan	Leguminosae	2	Bark	N/A
30	*Eugenia aromatica Linn.*	Kanna furu	Myrtaceae	1	Leaf	N/A
31	*Ficus asperifolia*	Ipin	Moraceae	1	Leaf	

32	*Gliricidia sepium (Jacq)*	Agunmaniye	*Fabaceae (Leguminosae)*	4	Whole	
33	*Gossypium barbadense*	Ewe Owu	Malvaceae	1	Leaf	
34	*Harungana madagascariensis*	Ewe amuje	Hypericaceae	1	Leaf	
35	*Heliotropium indicum L.*	Ogbe akuko	Boraginaceae	2	Leaf	
36	*Hibiscus acetosella*	Owuakese	Malvaceae	1	Leaf	N/A
37	*Hura Crepitans*	kerebuje	Euphorbiaceae	1	Leaf	
38	*Hymenocardia acida*	Orupa omunu	Phyllanthaceae	3	Leaf	N/A
39	*Jatropha gossypiifolia Linn.*	Lapalapa pupa	Euphorbiaceae	1	Leaf	
40	*Juglans regia L*	Walnut (Awusa)	Juglandaceae	2	Fruit	N/A
41	*Kigelia Africana*	Pandoro	Bignoniaceae	3	Leaf	N/A

42	*Luffa cylindricum l H(c)*	Erun	Cucurbitaceae	2	Leaf,root	
43	*magnifera indica*	Mangoro	Anacardiaceae	3	Leaf	N/A
44	*Momordica charantia*	Ejinrin	Cucurbitaceae	1	Leaf	
45	*Monodora myristica (Geatn)*	Sasangbaku	Annonaceae	3	Whole	N/A
46	*Morinda lucida*	Oruwo	Rubiaceae	8	leaf, Bark and root	N/A
47	*Moringa oleifera*	Igbale	Moringaceae	1	Leaf	N/A
48	*Musa paradisiaca Linn.*	Ogede agbagba	Musaceae	18	Fruit	N/A
49	*Nauclea latifolia*	Egbeesi	Rubiaceae	1	Leaf	
50	*Newbouldia laevis*	Akoko	Bignoniaceae	2	Leaf	
51	*Nyctaginaceae boerhavia diffusa Linn*	etipon ola	Fabaceae	1	Root	N/A
52	*Ocinum gratissium*	Efirin	Lamiaceae	1	Leaf	
53	*Parkia biglobosa Jacq*	Igba	Fabaceae	1	Bark	N/A

54	*Peperomia pellucida*	Rinrin	Piperaceae	10	Leaf	N/A
55	*Pergularia daemia (Forsk) Chiov*	Koleorogba	Apocynaceae		Leaf	N/A
56	*Picralina nitida*	Abeere	Apocynaceae	1	Seed	
57	*Piliostigma reticulatum*	Abefe	Caesalpiniaceae	1	Leaf	
58	*Psidium guajava*	Guava	Myrtaceae	2	Leaf	N/A
59	*Saccharum officinarum*	sugar cane	Poaceae	1	Juice	N/A
60	*Securidaca longipedunculata*	Egbo ipeta	polygalaceae	1	Root	
61	*Senna fistula Linn*	Aidan tooro	Fabaceae/Leguminosae	5	Whole	
62	*Solanum aethiopicum L.*	Efo gbagba	Solanaceae	3	Leaf	N/A
63	*Solanum Hispidum*	Mafowokan omo	Solanaceae	1	Leaf	N/A
64	*Sphenocentrum jollyanum Pierre*	Akerejupon	Menispermaceae	1	Stem	

65	*Theobroma cacao L .*	Ewe cocoa	Malvaceae	1	Leaf, pod	
66	*Thumanmato-coccus dannelli (Benn.) Benth*	Ewe Iran, miracle berry	Marantaceae	1	Leaf	N/A
67	*Tithonia diversifolia*	Jogbo	Asteraceae	2	Leaf	N/A
68	*Uvaria chamae*	eruju	Annonaceae	1	Leaf,root	
69	*Vernonia amygdalina*	Ewuro	Asteraceae	2	Leaf	
70	*Viscum album Linn.*	Afomo	Viscaceae; Loranthaceae	1	Whole	N/A
71	*Xanthosoma sagittifolium L. Schot*	isu koko coco yam	Araceae	1	Bark	N/A
72	*Xylopia aethiopica*	Eeru	Annonaceae	4	Leaf	N/A

Table 5: List of some recipes for the treatment of diabetes

S/N	RECIPE	Mode of preparation	Mode of administration	Possible side effect
1	*Ficus asperifolia*	The plant is crushed and soaked in water. shake before use	A full glass cup is taken orally once per day	Not reported
2	*Carica papaya*, kan bilala	Squeeze the leaf of carica papaya and add small amount of kan bilala	A full glass cup taken orally in the morning and night	Too much can cause stomach ache
3	*Pricanina nitida* and coconut water	The leaf Squeezed thoroughly, then mixed with coconut water	A small cup is taken per day	Not reported
4	*Gossypium barbadense, Jatropha gossypiifolia, Kolanut (oloju meta)*	The root of *Jatropha gossypiifolia* and kolanut were grounded together, mixed with the fluid from *Gossypium barbadense* and kept in shinnapp bottle	Small cup taken orally 3 times per day	Not reported
5	*Vernonia amygdalina, Morinda lucida,*coconut water	The leaves are washed thoroughly then squeezed. Coconut water is then added. This is kept in a 5 litre bottle	A cup is taken twice daily	Not reported
6	*Picralina nitida, Aristolochia ringens, Citrus aurantifolia*	*Picralina nitida* and *Aristolochia ringens* were grounded together, sieved and mixed with liquid from *Citrus aurantifolia.* This is kept in a clean bottle	A cup 3 times daily	Not reported
7	*Morinda lucida, ocinum gratissium, Citrus aurantifolia*	Squeeze the leaves of *Morinda lucida* and *Ocinum gratissium* then sieve to get the liquid in a different container. Then squeeze the liquid from *Citrus aurantifolia*	Orally 4 times a day	Not reported
8	*Citrusllus colocynthis,* palm wine, kaun bilala	Palm wine is added to sliced *Citrusllus colocynthis in a bottle* and kaun bilala added. This is stored for 3 days before usage.	A cup taken daily	Not reported
9	*kigelia africana*	Soak peeled and sliced plant with water or fermented water from sohgum	Taken orally, a cup once per day	Can terminate pregnancy at early stage
10	*Picralina nitida*	Lime water is added to grounded plant and mix for 10 minutes	2 tea spoons morning and night	Not reported
11	*Anchomanes difformis*	The slice root of *Anchomanes difformis* is	A cup taken orally every morning	Body itching

		soaked in water in a clay pot and cooked thoroughly		
12	*Vernonia amygdalina,* natural honey, lime, *Jatropha gossypiifolia Linn.*	The *vernonia amygdalina* is crushed and water extracted is added to crushed *Jatropha gossypiifolia* before adding lime and honey.	A cup taken orally once a day	Not reported
13	*Agaratum conyzoids L,* gin, sugar	Agaratum conyzoids is soaked in gin with a little quantity of sugar	Half a cup taken morning and evening	Not reported
14	*Kigelia Africana, Aframomum melegueta*	Slight burning of both plants.	The powder is taken with ogi (cooked sohgum)	Not reported
15	*Anchomanes difformis,* palm oil	The plant is sliced and grounded, the liquid is collected and added to palm oil	A cup is taken orally every morning	The plant causes itching
16	*Nyctaginaceae boerhavia diffusa Linn.*	boil root of the plant, lime stone with water in a pot.	Take orally a cup 3 times daily	Not reported
17	*Vernonia amygdalina*	Squeeze the leaf thoroughly in a big bowl, the leaf is cooked as soup while the liquid is kept in a bottle	Liquid taken orally 3 times daily, while the soup is eaten as many ties as possible	Not reported
18	*Momordica charantia,* bitter gourd	*Momordica charantia* is sqeezed into a bottle and bitter gourd is added	A cup taken twice a day	Not reported
19	*Vernonia amygdalina, Ocinum gratissium, allium satium*	The leaves sqeezed in to a bowl, then alliu satium and potash added and also lime juice	A glass cup three times daily	Not reported
20	*Gossypium barbadense*	The leaves are dried and grounded. Then soaked in water	One cup of the liquid twice daily	Not reported
21	*Momordica charantia*	The leaves are squeezed into a bowl	1 cup taken twice a day	Not reported
22	*Psidium guajava*	The leaves are cooked in a clean pot with water. Or the leaves are oven dried then grinded. The powder is kept in a bottle and taken with pap	A spoon	Not reported
23	*Aristolochia ringens*	The seeds are cooked in a clean pot. The cooked seeds are then soaked with water in a bottle for 2 hrs.	1 cup of liquid taken orally twice a day.	Not reported
	Aristolochia ringens, with *aframoum melegueta*	The leaves grinded with *aframoum melegueta*	Add two tea spoons with pap morning and night	Dizziness, vomit
24	*Chanca piedra,lime*	Squeeze the leaves and add lime and water	1 cup taken twice per day	Not reported

25	*Anthocleista djalonensis, Allum cepa,Tithonia diversifolia*	The leaves of *Anthocleista djalonensis, Allum cepa* and *Tithonia diversifolia* are crushed together before coconut water is added	1 tea spoon in the morning and night	Not reported
26	*Citrulus colocynthis,Curculigo pilosa, Allum cepa, Allium sativum, Picralina nitida, Piper guineensis*	The bark of *Citrulus colocynthis* grinded with *Curculigo pilosa,*	1 cup in the morning and night	Stomach pain, irregular menstrual cycle and excessive cases of diarrhoea
27	*Carica papaya*	The leaves are squeezed in warm water	A glass cup taken daily	Constipation, ulcer, convulsion
28	*Picralina nitida,* coconut water	grinded seeds are mixed with coconut water	½ tea spoon for females and 1 tea spoon for males	Headache
29	*Chanca piedra, Picralina nitida, lime*	*Chanca piedra* is boiled with seeds of *Picralina nitida.* Lime is added as preservatives	1 cup twice daily	Dizziness
30	*Moringa lucida,* Palm wine	Grind the whole plant of *Moringa lucida* in a calabash. Palm wine is then added to the liquid in a bottle.	1 cup daily	Dizziness
31	*Momordica charantia, Ocinum gratissium*	The leaves of both plants are squeezed in water.	A glass cup, 3 times a day	Headaches and dizziness
32	*Viscum album*	An handful of fresh or dried *Viscum album* is soaked in water overnight. The following day, a cup of hot water is added.	1 cup morning and night	Miscarriage
33	*Azadirachta indica*	The leaves are squeezed into water	1 spoon daily	Headache
34	*Allium sativum*	3 bulbs of *Allium sativum* are mashed and soaked in a bottle of hot water overnight	A glass full three times daily	Hypertension
35	*Musa acuminata*	The roots are cut into pieces and pounded in a mortal. The juice is extracted and chaff discarded. Then add half bottle of honey	2 spoons three times daily	Stomach complications if overused.
36	*magnifera indica*	The leaves are soaked in warm water then filtered in the morning	Regularly	Dizziness
37	*Carica papaya, Xylopia aethiopica*	Boil the dried leaves of *Carica papaya* with *Xylopia aethiopica* with one tea spoon of salt and allowed	½ cup every morning	Not reported

		to settle		
38	*Anthocleista djalonensis*	Soak the root/stick in lime water for 5-7 days	1 glass cup once daily	Not reported
39	*Xylopia aethiopica*	Cut the part into pieces, rinse and soak in a bottle for 12 hrs.	1 glass cup morning and evening	Not reported
40	*Ocinum gratissium, Azadirachta indica*, potash, onion	Squeezed *Ocinum gratissium* and *Azadirachta indica* are soaked in water. Blended onion and potash are then added.	3 spoons taken orally 3 times daily	Not reported

α-Amylase inhibitory activities of the selected plants: Figure 2 below show that *Uvaria chamae* (P.BAEUV), *Peperomia pellucida* (L.KUNTN), *Argimones Mexican* (Papaveracea), *Anchomanes difformis* (Araceae) and *Cassia fistula* (LINN) demonstrated significant ($p<0.05$) ∞-amylase inhibitory activities. The result showed that *Uvaria chamea* (UV) has the highest percentage α-amylase inhibition activity and its activity is concentration dependent. Uvaria Chamea (UV) > Anchomanes difformis (AD) > *Cassia fistula* (CF) > Peperomia pellucida (PP) > *Argimones Mexican* (AM). The alpha amylase activity of the most potent plant i.e *Uvaria chamea* is significantly lower than that of the standard (AC). Table 5 revealed that *Uvaria chamea* demonstrated the lowest IC50 when compared with other plant extracts. However, its IC50 is significantly ($p>0.05$) higher than the standard Acarbose.

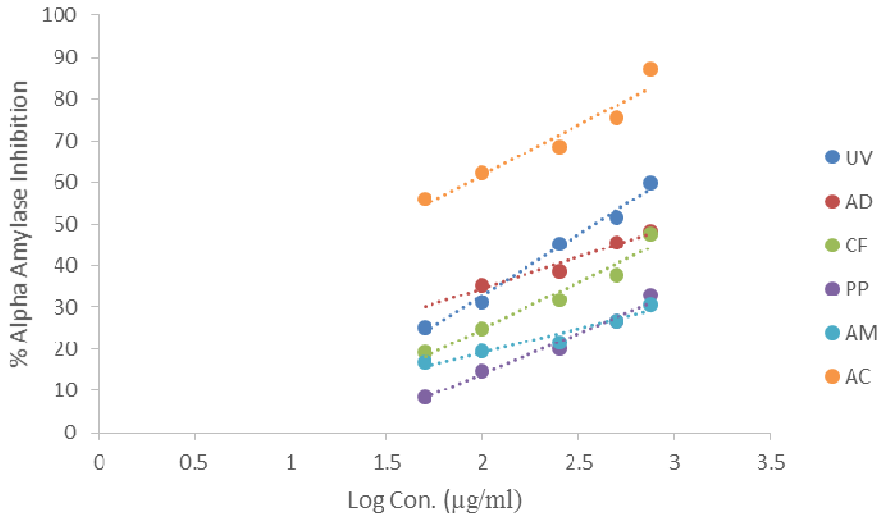

Fig 2: Inhibitory effect of selected plant extracts and standard drug on ∞-amylase

Table 5: IC50 values of alpha amylase inhibition of the selected plants.

Plant	***Uvaria chamae***	***Anchomanes difformis***	***Cassia fistula***	***Peperomia pellucida***	***Argimones Mexican***	**Acarbose**
IC50 µg/ml amylase inhibition	385.0	873.8	1343.4	6950.0	55446.1	46.5

DISCUSSION

Medicinal plants have been used by man for the treatment of various diseases since prehistoric time (Solecki and Shanidar, 1975) and these plant materials have been found to be potent, safe, reliable and cheaper compare to the synthetic drugs (Vliathan, 1998). From these results, it was important to note the higher percentage of the male respondents to the female, which may be associated with boldness and ability to command respect. This may also be because of the believed that the male child will retain the indigenous knowledge with the family unlike the females that will leave by marriage. The age of the respondents also correlates with the years of experience indicating the dependence of people of Ogbomoso on herbal treatment. The two families of plants Malvaceae and Euphorbiaceae frequently mentioned here reported indicate a trend of compounds with antidiabetic activity. Plant species with the most frequency of citation need to be analyzed further to discover potential new antidiabetic drugs. Pharmacological studies of these plants may be required to actually justify the use of these plants scientifically and to identify the therapeutic agents responsible for the hypoglycaemic activity. Studies may also be needed to determine the mechanisms of actions of these therapeutic agents. All the respondents mentioned leaf part of the plants for treatment or with a mix with other parts; this indicates the importance of leaves to plants. This is similar to the reports of other studies (Kadir *et al*., 2012; Gonzalez *et al*., 2010). The leaves are important for photosynthesis and storage of secondary metabolites of medicinal value and another reason may be the ease of collection of the leaves to other plant parts (Kadir *et al*., 2012). Some of the plants cited by the respondents in this study (Table 4) have been reportedly demonstrated in the in vivo and in vitro diabetic models. *Azadirachta indica* has been reported for its antidiabetic property by Dixit *et al*. (1986) and Khosla *et al*. (2000). *Ocimum gratissimum* has been reported for its anti-diabetic activities by Aguiyi *et al*. (2000) and Egsie *et al*. (2006). *Citrus aurantifolia* and *Citrus sinensis* has been reported by Jaiyesimi *et al*. (2000), *Colocynthis citrullus* has been reported for antidiabetic activities by Abdel-Hassan *et al*. (2000), *Cola acuminata* has been reported by Ogunleye *et al*. (2003), *Carica papaya* has been reported by Oke (1998), *Momordica charantia* has been reported by Bailey *et al*. (1985) while *Ficus exasperata* has been reported by Ogunleye *et al*. (2003).

Based on these findings, it is anticipated that these medicinal plants documented are required to ameliorate hyperglycaemia by either inhibiting carbohydrate hydrolysing enzymes, increase beta cells proliferation thereby increase insulin secretion or inhibit glucose output by the liver (Malviya *et al.,* 2010). Although further investigation is still required to determine the mechanism of action of active biomolecules in these plants, they may also work by blocking the active sites of enzymes involved in glucose metabolism. Most of these plants have been reported to contain alkaloids, flavonoids, saponins, glycosides etc, which have been implicated with anti-diabetic properties (Malviya *et al*., 2010; Negri, 2005; Oke 1998).

CONCLUSION

This study was undertaken to investigate the herbs used by the people in Ogbomoso, western Nigeria, as regard the treatment and management of diabetes. The medicinal plants documented here therefore reflect a rich ethno-medicinal knowledge and belief that herbal remedies are cheap and readily accessible. 71 plants belonging to 44 families were mentioned by the respondents for the treatment of diabetes. The most commonly mentioned plants being *Vernonia amygdalina, Morinda lucida, Picralina nitida, Citrusllus colocynthis, Cocos nucifera L., Carica papaya, Ocinum gratissium* and *Momordica charantia*. This information documented indicates the importance of natural flora, how to maximize their usage, preserve the indigenous knowledge and help to develop novel antidiabetic drugs for global usage. The report of the alpha amylase inhibitory effect of the selected plants (*Uvaria chamae (P.BAEUV), Peperomia pellucida (L.KUNTN), Argimones Mexican (Papaveracea), Anchomanes difformis (Araceae) and Cassia fistula (LINN*) justifies the anti-diabetic potentialities of these plants. These findings suggest that the anti-hyperglycaemic effects of these five plants could be exerted at least partly by their inhibitory effects on digestive enzymes.

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