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# Medicinal Plants used in Four Local Government Areas of South-Western Nigeria for the Management of Diabetes and its Comorbidities: An Ethnopharmacological Survey.

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**Abstract**

Introduction: Diabetes mellitus (DM) continues to pose a major global health threat with serious economic burden in sub-Saharan Africa, especially Nigeria. This condition is often worsened as most diabetic patients have other accompanying comorbidities such as hypertension, stroke, heart disease and obesity, further putting a strain on their wellbeing. In spite of the several orthodox medicines for the treatment of diabetes and its comorbidities, complication arising from the use of such agents have limited therapeutic success. It is therefore imperative to search for safer alternative and affordable treatment options from plants.

This study aimed at accessing and documenting the medicinal plants used in four local government areas of South-Western Nigeria for the management of diabetes and its comorbidities. Semi-structured questionnaires were used to obtain information from traditional medical practitioners, village elders and herb sellers. The data obtained were analyzed and discussed in relation to previously published literature. Fifty-three respondents mostly males (77.4%) provided information on medicinal plants useful for the management of diabetes and its comorbidities. A total of 77 medicinal plants used concomitantly belonging to 44 plant families were mentioned by the respondents. 53 medicinal plants are being used for managing diabetes, 35 for hypertension, 28 for stroke, 17 for heart diseases and 25 for obesity. The frequently used plant species were *Vernonia amygdalina* Delile with use-mention-index (UMi) of 0.208, *Citrus aurantifolia* (Christm.) Swingle (UMi 0.170), *Viscum album* L. (UMi 0.151), *Carica papaya* L. (UMi 0.151) and *Allium sativum* L. (UMi 0.132). *Citrus aurantifolia* was the only plant mentioned for the management of the five ailments. Most diabetic patients often have one or more accompanying comorbidities. A safe and efficacious single herbal preparation that can manage both diabetes and its comorbidities may provide scientific breakthrough and relief from the side effects associated with the use of different synthetic drugs that is often experienced by sufferers of DM with accompanying comorbidities.

**Keywords:** Diabetes, Comorbidities, Medicinal plants, Therapies, Nigeria.

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## Introduction

Medicinal plants have been used for several centuries for the treatment of various ailments and almost seventy thousand species of plant in the world have been screened for their pharmacological activities (1).

The WHO stated that 80% of the world citizens utilize medicinal plants for the management of their health (2). The importance of the tropical rain forest as a source of raw materials for modern drug development cannot be over-emphasized, as about 11% of the 252 drugs

considered to be essential drugs are exclusively of plant origin with several others synthesized using natural products template (3, 4). Although orthodox medicine has bettered the lot of many people worldwide, its use is being complemented by traditional practices in some countries like China and India (5).

In Nigeria, medicinal plants play prominent role in healthcare delivery as many of her residents, especially those dwelling in the rural areas, rely greatly on medicinal plants and visit traditional medical practitioners (TMPs) for their health care need(6). An earlier study reported that the ratio of TMPs to the population was 1:110, while the ratio of medical doctors to the population was 1:16,400; inferring that TMPs are more accessible to the populace (7). Therefore, herbal medicines continue to play vital role in healthcare delivery, especially in third world nations, where most people have great financial constraints with little or no access to orthodox therapies(6).

Diabetes mellitus (DM), a leading metabolic disorder characterised by improper management of carbohydrate and lipid metabolism by insulin, affects approximately 8.3% of the adult world population and the number of suffers is expected to rise from 382 million in 2013 to 592 million in 2035 (8,9). There has been an increasing incidence of DM worldwide and this ailment has been shown to pose major health threats and socioeconomic burdens (10). Of the DM sufferers, 22 million reside in sub-Saharan Africa, with Nigeria, the most populous black nation in the world, accounting for a fifth of all diabetes cases in the region (11). It is worrisome that of the approximately 4 million DM sufferers in the country, 70%-80% remain undiagnosed and/or untreated. The mortality of DM in Nigeria were estimated as 105,091 in 2013 and the number is expected to rise to approximately 125,000 by 2020 (11, 12). The prevalence of DM varies across the different regions of Nigeria with the ailment prevalent in less than 2% of the rural population, whereas the values ranges from 5% to 10% amongst urban dwellers. The adoption of western lifestyle, particularly western foods and sedentary practices, by the residents of the urban areas is often seen to be responsible for the corresponding high prevalence of DM (13, 14). Comorbidity, defined as a situation where one or more chronic ailments occur in an individual with an index-disease is a common phenomenon amongst DM sufferers (15). In fact, DM has been reported to be a major predisposing factor to the formation of myocardial infarction, cerebrovascular accident and peripheral vascular diseases (16). Common diabetic related comorbidities include hypertension, obesity, chronic kidney diseases, cardiovascular diseases, hyperlipidemia, retinopathy, nephropathy and diabetic foot ulcers (17,18). A recent study conducted in the US between July 2014 and June 2015 revealed that approximately 98% of DM patients had at least one comorbid condition, while about 89% had at least two (19). More precisely, the commonest comorbidities recorded from the study included hypertension (82.1%), obesity

(78.2%), hyperlipidemia (77.2%), chronic kidney diseases (24.1%) and cardiovascular diseases (21.6%) (19). The debilitating impact of DM comorbidities on patients' health status cannot be underestimated. Comorbidities can drain the financial resources of DM sufferers thereby increasing their out-of-pocket cost for medical care which eventually hinders the ability of the patient to manage their ailments (20,21). In addition, most health care facilities, especially in developing nations, are poorly designed to support effective DM and comorbidity management. This condition has frustrated several diabetes care providers who are often faced with inability to meet patient's multiple treatment demands (22). Although there are several medications currently in use for the management of DM and its comorbidities, the success of these drugs is often limited by noxious effects such as weight gain, hypoglycaemia, dropsy, abdominal pain, flatulence and renal toxicity (23). In view of this, there is a need to explore safer alternative means, such as natural sources especially medicinal plants, to discover natural therapies and develop novel bioactive molecules which may help tackle the menace caused by DM and its related comorbidities.

Ethnobotany is the study of how indigenous people living in a particular community utilise plants for medicinal, ornamental, cultural and economic purposes (24). Since indigenous knowledge (IK) is largely undocumented, the nondisclosure of such knowledge before the demise of the individual that possess them may lead to the extinction of the knowledge (25). The documentation of indigenous knowledge has helped in identifying marketable medicinal plants; this can greatly contribute to the economies of local communities. The IK of traditional healers is an asset in the discovery of medicinal plants with therapeutic potentials. Several ethnobotanical studies on plants used in the management of diabetes have been reported in various parts of the world such as Bangladesh (26), Morocco (27), Togo (28), and Turkey (29). In Nigeria, similar researches have been carried out in the North-Western (30), North-central (31), South-Western (32) and South-Eastern (33) regions. However, only few researches have investigated the usage of medicinal plants in the treatment of other co-morbidities of DM. Therefore, this study was carried out to document the various medicinal plants and herbal recipes used in the treatment of DM and its comorbidities and to establish existing relationships between the different recipes for the various diseases.

## Materials and methods

### *Study area*

The study was carried out in four local government areas (LGAs) namely: Ibadan (urban; Ibadan North LGA), Ago-Are (rural; Atisbo LGA), Ikare-Akoko (urban; Akoko North-East LGA) and Oba-Akoko (rural; Akoko South-East LGA). The study areas lie in Oyo and Ondo states of South- Western Nigeria (Figure 1). Oyo state lies between latitude 8°.12' N and longitude 3° 42' E and covers an area of approximately 28,454 km$^2$

with a population of 110,792 (34), while Ondo state lies between latitude 6° 90' N and longitude 4° 89' E with a land mass of 15,500 km$^2$ and a population of 3, 440,000 as at the 2006 national census (34). The inhabitants of the urban settlers in the study areas were mainly educated and involved in high skill jobs, while the rural dwellers were predominately farmers and local traders. The common language spoken by the residents of the study area is Yoruba. The study areas have a tropical climate characterized by two distinct weather conditions; rainy season which begins in April and ends in September and the dry season which runs from October to March. The area experiences a relatively high rainfall and humidity for most parts of the year with an average temperature of 32 °C.

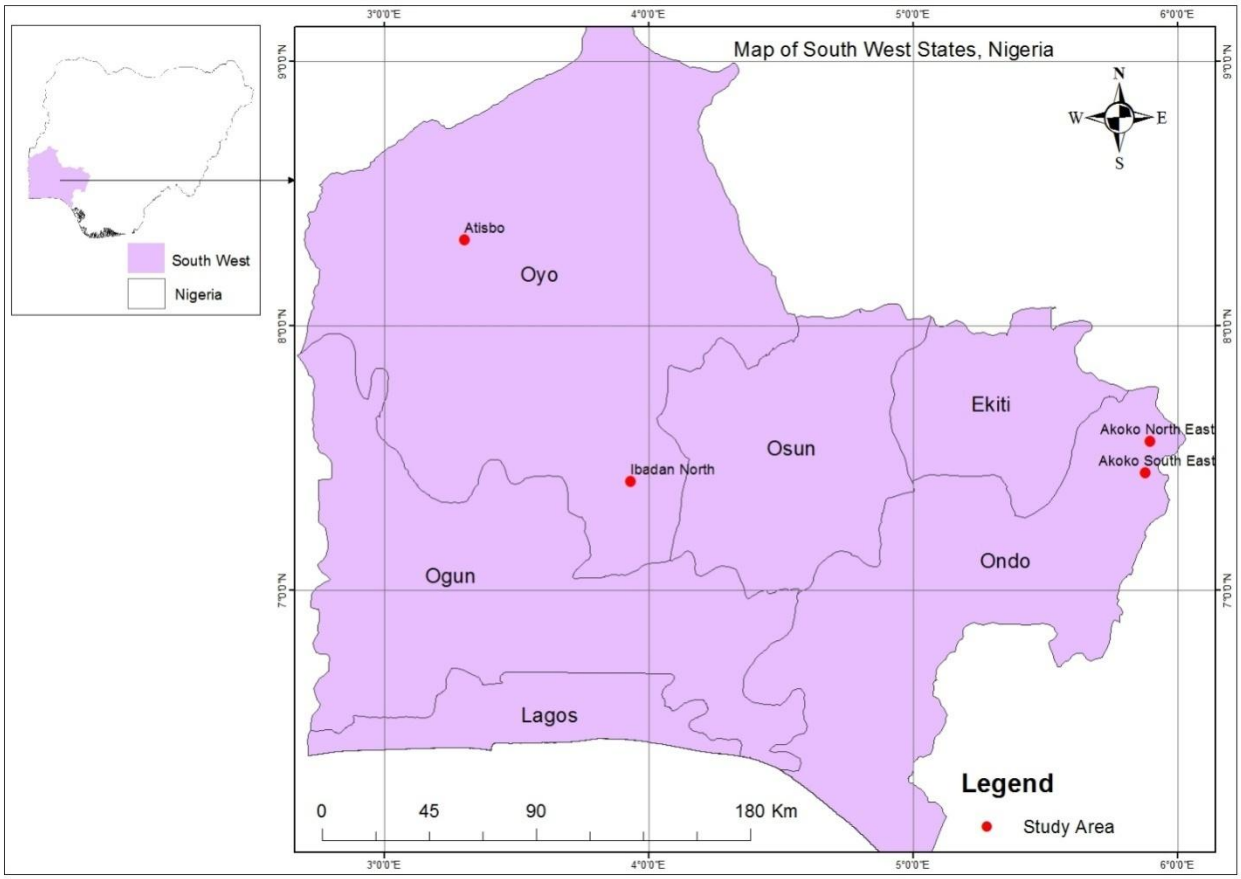


**Figure 1.** Map of South-Western Nigeria showing the study areas

*Informed consent*

At the start of the interview, the objective of the study was clearly explained to the intending participants and informed consent to publish the research was sought orally. When the respondents granted consent, the questions contained in the questionnaire were asked and when consent was not given, the individuals were asked no further question.

*Data collection*

The study was carried out from May to October, 2013. The ethnomedicinal information of plants used for the management of DM and its comorbidities such as

hypertension, obesity, stroke and heart disease were obtained by consulting TMPs, herb sellers and elders in the communities listed above. The use of semi-structured questionnaire via oral interview in the local dialect of the respondents was adopted to obtain the relevant data. Since the interviewer understood the local dialect of the respondents, no interpreter was used in this survey. The questionnaire was divided into three sections. Section 1 deals with demographic information such as age, sex, religion, local tribe, duration of practice, nationality and level of education. Section 2 captures plants used in the treatment of DM and its comorbidities and consisted questions such as frequency of treatment, accompanying side effects and duration of treatment. Section 3 centered on plant parts used, plant availability, local names of diseases, preparation of the recipe and mode of administration of the herbal recipe used in the treatment of diabetes and its comorbidities. Each plant sample was collected at the time of the survey. The botanical names and families of each collected plant samples were authenticated at the Forest Herbarium Ibadan (FHI), Nigeria. The botanical name of the plants was verified on the plant list database (35).

*Data analysis*

The Microsoft Office Excel spreadsheet software was used to conduct descriptive statistical analysis on the socio-demographic data of the respondents, plant part used and plant families. The use-mentions index (UMi) was also calculated and was taken as the frequency of usage of a particular plant for the treatment of diseases divided by the total number of respondents interviewed.

**Results**

*Demographic data*

Seventy individuals, including TMPs, herb sellers and village elders, who possess indigenous knowledge (IK) on the ethnomedicinal use of plants and/or had utilised them for DM and/or its comorbidities in the study area were identified and interviewed. However, only 53 respondents agreed to provide their valuable IK.

**Table 1. Demographic data of respondents (n=53)**

| Parameter | Frequency | Percentage (%) |
|---|---|---|
| Specialty | | |
| Traditional medical practitioner | 16 | 30.19 |
| Herb seller | 14 | 26.42 |
| Herbalist | 23 | 43.39 |
| Sex | | |
| Male | 41 | 77.36 |
| Female | 12 | 22.64 |

| | | |
|---|---|---|
| Age (years) | | |
| 31-50 | 19 | 35.85 |
| 51-60 | 27 | 50.94 |
| >60 | 7 | 13.21 |
| Educational level | | |
| None | 4 | 7.55 |
| Primary | 30 | 66.04 |
| Secondary | 13 | 24.53 |
| Tertiary | 1 | 1.89 |
| Religion | | |
| Christianity | 14 | 26.42 |
| Islam | 37 | 69.81 |
| Traditionalist | 2 | 3.77 |
| Source of knowledge acquisition | | |
| Ancestral (Inherited) | 29 | 54.72 |
| Training | 8 | 15.09 |
| Ancestral and Training | 16 | 30.19 |

**Table 2: List of plants used concomitantly for the management of diabetes and its co-morbidities in the study are**

| S/N | Family | Plant Name (Voucher specimen no) | Common Name | Local Name (Y) | Part Used | Therapeutic Use | | | | | UMi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | D | HTN | S | HD | O | |
| 1. | Acanthaceae | *Acanthus montanus* (Nees) T. Anderson (FHI 106492) | Mountain thistle | Ahon-ekun | l | | | X | | | 0.019 |
| 2. | Amaryllidaceae | *Allium cepa* L. (FHI 107561) | Onion | Alubosa | bu, l | | X | | X | X | 0.075 |
| 3. | Amaryllidaceae | *Allium sativum* L. (FHI 107576) | Garlic | Ayuu | bu | X | X | | X | X | 0.132 |
| 4. | Anacardiaceae | *Anacardium occidentale* L. (FHI 109858) | Cashew | Kaju | s | X | | | | | 0.038 |
| 5. | Anacardiaceae | *Mangifera indica* L. (FHI 109451) | Mango tree | Mangoro | l, s | X | | | | X | 0.038 |
| 6. | Anacardiaceae | *Spondias mombin* L. (FHI 106132) | Hog plum | Iyeye | s | X | | | | | 0.019 |
| 7. | Annonaceae | *Uvaria afzelii* G.F. Scott-Elliot (FHI 107332) | Monkey finger | Gbogbonise | s | | | | | X | 0.019 |
| 8. | Annonaceae | *Xylopia aethiopica* (Dunal) A. Rich. (FHI 10897) | Ethiopian pepper | Eru | s, f | X | X | | X | X | 0.113 |
| 9. | Apocynaceae | *Alstonia boonei* De Wild. (FHI 107254) | Cheese wood | Ahun | s, f | | | | X | X | 0.038 |
| 10 | Apocynaceae | *Holarrhena floribunda* (G.Don) T. Durand & Schinz (FHI 110053) | False rubber tree | Dagba | l | | X | | | | 0.019 |
| 11 | Apocynaceae | *Picralima nitida* (Stapf) T .Durand & H .Durand (FHI 108794) | Akaumma plant | Abere | s | X | X | | X | | 0.019 |
| 12 | Apocynaceae | *Rauvolfia vomitoria* Afzel. (FHI 108987) | Swizzle stick | Asofeyeje | s, r | X | X | | | X | 0.094 |
| 13 | Apocynaceae | *Parquetina nigrescens* (Afzel.) Bullock (FHI 110044) | African Parquentina | Ogbo | l | X | X | | | | 0.075 |
| 14 | Araceae | *Anchomanes difformis* (Blume) Engl. (FHI 109585) | | Aburushoko | l, t | X | X | | | | 0.057 |
| 15 | Bignoniaceae | *Kigelia Africana* (Lam.) Benth. (FHI 107654) | Sausage tree | Pandoro | f | X | X | X | | X | 0.094 |
| 16 | Bignoniaceae | *Newbouldia laevis* (P. Beauv.) Seem. (FHI 107753) | Fertility tree | Akoko | l, s, r | X | | X | | X | 0.094 |
| 17 | Bombacaceae | *Adansonia digitata* L. (FHI 109806) | Baobab | Ose | f | | X | X | | | 0.038 |
| 18 | Boraginaceae | *Heliotropium indicum* L. (FHI 110156) | Indian heloitrope | Apari Igun | ae | X | X | X | | | 0.057 |
| 19 | Bromeliaceae | *Ananas comosus* (L.) Merr. (FHI 107515) | Pineapple | Ope oyinbo | f | X | X | | | | 0.057 |
| 20 | Caricaceae | *Carica papaya* L. (FHI 109462) | Pawpaw | Ibepe | l, r | X | X | X | | X | 0.151 |
| 21 | Combretaceae | *Anogeissus leiocarpa* (DC.) Guill. & Perr. (FHI 107122) | Axle wood tree | Ayin | r | | | X | | X | 0.038 |
| 22 | Compositae | *Acanthospermum hispidum* DC. (FHI 110050) | Goat's head | Dagunro gogoro | ae | X | X | | | | 0.038 |
| 23 | Compositae | *Ageratum conyzoides* (L.) L. (FHI 109634) | Goat's weed | Imi-esu | l | X | X | | | | 0.057 |
| 24 | Compositae | *Tithonia diversifolia* (Hemsl.) A.Gray (FHI 108055) | Mexican sunflower | Sepeleba | l | X | | X | | | 0.038 |
| 25 | Compositae | *Vernonia amygdalina* Delile (FHI 109061) | Bitter leaf | Ewuro | l | X | X | X | | X | 0.208 |
| 26 | Convolvulaceae | *Ipomoea asarifolia* (Desr.) Roem. & Schult. (FHI 110052) | Morning glory | Gboroayaba | l | | X | | | X | 0.057 |
| 27 | Crassulaceae | *Bryophyllum pinnatum* (Lam.) Oken (FHI 107762) | Wonder plant | Odundun | l | X | X | | | | 0.113 |
| 28 | Cucurbitaceae | *Lagenaria breviflora* (Benth.) Roberty (FHI 109040) | Bottle gourd | Tagiri | s | | | | | X | 0.057 |
| 29 | Cucurbitaceae | *Momordica charantia* L. (FHI 109638) | African cucumber | Ejinrin | l, s | X | | | X | | 0.075 |
| 30 | Euphorbiaceae | *Alchornea laxiflora* (Benth.) Pax & K.Hoffm. (FHI 110155) | Lowved bead-string | Pepe | l | | X | X | | | 0.038 |
| 31 | Euphorbiaceae | *Bridelia ferruginea* Benth. (FHI 109985) | Bridelia plant | Irasa | l, s | X | | | | | 0.038 |
| 32 | Euphorbiaceae | *Croton gratissimus* Burch. (FHI 109041) | Lavender croton | Ajeobale | r | | X | | X | | 0.038 |
| 33 | Euphorbiaceae | *Euphorbia poissonii* Pax (FHI 109035) | Cactus | Oro Adete | s | | | X | | X | 0.057 |
| 34 | Euphorbiaceae | *Jatropha curcas* L. (FHI 109020) | Nettlespurge | Lapalapa | l | X | | X | | | 0.057 |
| 35 | Euphorbiaceae | *Macaranga barter i*Müll. Arg. (FHI 107230) | Macaranga plant | Agbasa | r | X | | | | | 0.019 |
| 36 | Gentianaceae | *Anthocleista djalonensis* A. Chev. (FHI 109007) | Cabbage tree | Sapo | r, s | X | | | | X | 0.075 |
| 37 | Hypoxidaceae | *Curculigo pilosa* (Schumach. & Thonn.) Engl. (FHI 109047) | English African Crocus | Epakun | rhi | | | | | X | 0.094 |
| 38 | Lamiaceae | *Ocimum gratissimum* L. (FHI 108057) | Tea bush | Efinrin | l | X | | X | | | 0.113 |
| 39 | Lamiaceae | *Solenostemon monostachyus* (P. Beauv.) Briq. (FHI 108913) | Painted nettle | Olojonguru | ae | | | | X | | 0.038 |
| 40 | Lauraceae | *Persea americana* Mill. (FHI 109444) | Avocado tree | Igba | l | | X | X | | | 0.094 |
| 41 | Fabaceae | *Abrus precatorius* L. (FHI 107452) | Cat's eye | Ominsinmisi | l | X | | | X | | 0.057 |
| 42 | Fabaceae | *Acacia nilotica* (L.) Delile (FHI 108425) | Prickly acacia | Boonii | s | X | X | | | | 0.057 |
| 43 | Fabaceae | *Baphia nitida* Lodd. (FHI 106544) | Camwood | Irosun | l | | X | | | | 0.019 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | Fabaceae | *Cassia fistula* L. (FHI 110261) | Purging cassia | Aidantoro | s | | | X | | X | 0.057 |
| 45 | Fabaceae | *Dialium guineense* Willd. (FHI 109509) | Velvet tamarind | Irede | s, l | | | X | | | 0.038 |
| 46 | Fabaceae | *Parkia biglobosa* (Jacq.) G. Don (FHI 107939) | African locust beans | Igi iru | s | X | X | | | | 0.094 |
| 47 | Fabaceae | *Piliostigma thonningii* (Schum.) Milne-Redh. (FHI 107815) | Camel's foot | Abafe | l | | | X | | | 0.019 |
| 48 | Fabaceae | *Senna alata* (L.) Roxb. (FHI 108062) | Candle bush | Asunwon | l | X | | | | | 0.038 |
| 49 | Fabaceae | *Tetrapleura tetraptera* (Schum. & Thonn.) Taub. (FHI 110141) | Aidan tree | Aidan | f | | X | | X | | 0.095 |
| 50 | Malvaceae | *Gossypium barbadense* L. (FHI 107327) | Cotton plant | Owu | l, s | X | | | | X | 0.038 |
| 51 | Malvaceae | *Hibiscus sabdariffa* L. (FHI 107622) | Roselle | Isapa | f | X | | | | X | 0.075 |
| 52 | Meliaceae | *Azadirachta indica* L. (FHI 109461) | Neem tree | Dongoyaro | l | X | | | | | 0.038 |
| 53 | Mimosaceae | *Mimosa pudica* L. (FHI 100332) | Sensitive plant | Patanmo | l | X | | | | | 0.038 |
| 54 | Moraceae | *Artocarpus altilis*(Parkinson ex F.A.Zorn) Fosberg (FHI 110483) | Breadfruit | Gberebuutu/Epa Oyinbo | l | X | | X | | | 0.038 |
| 55 | Moraceae | *Ficus exasperata* Vahl (FHI 109453) | Fig tree | Epin | l | | X | | X | | 0.057 |
| 56 | Musaceae | *Musa paradisiaca* L. (FHI 110122) | Banana | Ogede agbagba | f | X | | X | | | 0.095 |
| 57 | Myrtaceae | *Psidium guajava* L. (FHI 109454) | Guava tree | Gurofa | s, l | X | X | | | | |
| 58 | Olacaceae | *Olax subscorpioides* Oliv. (FHI 109065) | Stink ant forest | Ifon | l, s | X | | | | X | 0.057 |
| 59 | Orchidaceae | *Calyptrochilum christyanum* (Rchb. f.) Summerh. (FHI 110054) | Calyptrochilum plant | Ela | l | X | | | | | 0.038 |
| 60 | Phyllanthaceae | *Phyllanthus amarus* Schumach. & Thonn. (FHI 109059) | Black catnip | Eyin olobe | l, t | X | X | | | | 0.057 |
| 61 | Piperaceae | *Piper guineense* Schumach. & Thonn. (FHI 110051) | West African pepper | Iyere | f | | | X | X | | 0.057 |
| 62 | Poaceae | *Bambusa vulgaris* Schrad. (FHI 109052) | Bamboo | Oparun | l | X | | X | | | 0.038 |
| 63 | Poaceae | *Zea mays* L. (FHI 109082) | Maize | Agbado | l | | | | X | | 0.038 |
| 64 | Polygalaceae | *Securidaca longipedunculata* Fresen. (FHI 109972) | Violet tree | Ipeta | s, r | X | X | | | | 0.057 |
| 65 | Rubiaceae | *Morinda lucida* Benth. (FHI 106992) | Brime stone tree | Oruwo | l | X | | | | | 0.075 |
| 66 | Rubiaceae | *Nauclea diderrichii* (De Wild.) Merr. (FHI 110049) | Leichhardt tree | Egbesi | s | X | | X | | | 0.113 |
| 67 | Rutaceae | *Citrus aurantifolia* (Christm.) Swingle (FHI 110009) | Lime | Osanwewe | f | X | X | X | X | X | 0.170 |
| 68 | Santalaceae | *Viscum album* L. (FHI 108411) | Mistletoe | Afomo | l | X | X | | | X | 0.151 |
| 69 | Sapindaceae | *Lecaniodiscus cupanioides* Planch. ex Benth. (FHI 110081) | Lecaniodiscus | Akika | s | X | | X | | | 0.038 |
| 70 | Sapotaceae | *Vitellaria paradoxa* C.F. Gaertn. (FHI 107924) | Shea butter | Ori | s | | | | X | X | 0.057 |
| 71 | Solanaceae | *Datura metel* L. (FHI 106922) | Thorn apple | Gegemu | l | X | | X | | | 0.075 |
| 72 | Solanaceae | *Solanum erianthum* D. Don (FHI 106923) | Potato tree | Asimau | l, r | X | | X | X | | 0.095 |
| 73 | Talinaceae | *Talinum triangular* (Jacq.) Willd. (FHI 109932) | Water leaf | Egbure | ae | X | X | | | | 0.057 |
| 74 | Ulmaceae | *Trema orientalis* (L.) Blume (FHI 107813) | Pigeon wood | Afefe | l, s | X | | X | | | 0.057 |
| 75 | Xanthorrhoeaceae | *Aloe vera* (L.) Burm.f. (FHI 108024) | Aloe | Ahon-erin | l | X | X | | | | 0.113 |
| 76 | Zingiberaceae | *Aframomum melegueta*K.Schum. (FHI 109986) | Alligator pepper | Atare | f | X | | X | | | 0.075 |
| 77 | Zingiberaceae | *Zingiber officinale* Roscoe (FHI 107935) | Ginger | Atale | rhi | X | X | | X | X | 0.113 |

Keys: ae = aerial part; bu = bulb, f = fruits; l = leaves; rhi = rhizome; r = root; s = stem bark; t = tuber. D=diabetes, HTN= hypertension, S=stroke, HD=heart disease, O=obesity

**Table 3: Herbal recipes for the management of diabetes and its co-morbidities in the study area**

| Disease | Recipe combination and dosage regimen | Solvent used | Type of preparation |
|---|---|---|---|
| Diabetes | The roots of *Carica papaya, Vernonia amygdalina* and *Newbouldia laevis* are boiled together in water. One glass cup of the decoction is taken twice daily. | Water | Decoction |
| | The fresh leaves of *Ocimum gratissimum* and *Morinda lucida* are washed in water and squeezed until the juice comes out. One glass cup is taken twice daily. | - | Juice |
| | The leaves of *Vernonia amygdalina, Morinda lucida* and *Momordica charantia* are dried and ground into powder. One tablespoonful of the powder is taken with hot pap twice daily for two weeks. | Pap | Powder |
| | The fresh leaves of *Momordica charantia* and *Ocimum gratissimum* are soaked in pap water for one day and squeezed until the juice comes out. Two tablespoonfuls is taken twice daily. | Pap water | Juice |
| | The young and tender leaves of *Carica papaya* is squeezed until the juice comes out. One tablespoonful of the juice is mixed a table spoonful of fresh honey and taken thrice daily. | Honey | Juice |
| | The leaves of *Carica papaya* and *Vernonia amygdalina;* the fruits of *Xylopia aethiopica* and *Capsicum frutescens;* the bulbs of *Allium sativum* and *Allium cepa;* the stem bark of *Anacardium occidentalis* and *Zingiber officinale* rhizomes are boiled together in tap water. One glass cup of the decoction is taken twice daily. | Water | Decoction |
| | The stem barks of *Nauclea diderrichii* and *Newbouldia laevis* are boiled together in water for few hours. Two glass cups of the resulting decoction are taken twice daily. | Water | Decoction |
| | The leaves of *Tithonia diversifolia* are squeezed until the juice comes out. One glass cup is taken twice daily. | - | Juice |
| | The unripe fruits of *Carica papaya* and the leaves of *Heliotropium indicum* and *Bridelia ferruginea* are boiled together in water. Two glass cups of the decoction are taken twice daily. | Water | Decoction |
| | The stem barks of *Securidaca longipedunculata* and *Olax subscorpioides,* the unripe fruits of *Ananas comosus* and the seeds of *Aframomum melegueta* and *Picralima nitida* are boiled together in tap water. Two glass cups of the decoction are taken three times daily. | Water | Decoction |
| | The leaves *of Azadirachta indica*, *Vernonia amygdalina*, *Ocimum gratissimum*, *Aloe vera* and *Momordica charantia* are soaked in pap water for one day and squeezed until the juice comes out. One table spoonful is taken twice daily. | Pap water | Juice |
| | The stem bark of *Anacardium occidentalis* and the leaves of *Ocimum gratissimum* and *Psidium guajava* are boiled together in tap water. Two glass cups of the decoction are taken twice daily. | Water | Decoction |
| | The leaves of *Vernonia amygdalina* and *Mangiferaindica* are dried and ground into powder. Two table spoonful are taken with hot pap twice daily. | Hot pap | Powder |
| | The stem barks of *Parkia biglobosa* together with the roots of *Anthocleista djalonensis* and *Rauvolfia vomitoria* are boiled together in pap water. Two glass cups of the decoction are taken thrice daily for one | Pap water | Decoction |

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| | month and then once daily in the second month. | | |
| | Seeds of *Spondias mombin* and *Gossypium barbadense* are dried and milled. The powder is mixed with palm kernel (*Elaeis guineensis*) oil and to form a paste. A tablespoonful of the paste is to be taken orally twice daily. | Palm kernel oil | Paste |
| | The fresh leaves of *Senna alata* and the whole plant of *Phyllanthus amarus* are washed and boiled in pap water. It is allowed to cool and a glass cup is to be taken twice daily. | Pap water | Decoction |
| | The leaves of *Parquentina nigrescens* and *Vernonia amygdalina* are soaked in pap water for one day and squeezed until the juice comes out. One tea cup of the extract is taken twice daily. | Pap water | Juice |
| | The fresh leaves of *Musa paradisiaca* and *Vernonia amygdalina* are soaked in local dry gin for 3 – 4 days. The supernatant is decanted and a glassful of the fresh preparation is taken three times daily. | Local gin | Infusion |
| | Seeds of *Acacia nilotica* and *Xylopia aethiopica* are milled and soaked in local dry gin for 2 days. The extract obtained is to be taken twice daily; a teacupful. | Local gin | Infusion |
| | The leaves of *Momordica charantia, Vernonia amygdalina* and *Morinda lucida* are washed in water and squeezed until the juice comes out. One glass cup is taken twice daily. | - | Juice |
| | The unripe powdered fruit of *Musa paradisiaca* is soaked in *Citrus aurantifolia* juice. The infusion obtained is taken morning and night; one glass cup. | Water | Infusion |
| | The dried fruit of *Kigelia africana* and the roots of *Jatropha curcas* are ground and soaked in local gin for one day. A glass cup of the extract is to be taken twice daily. | Local gin | Infusion |
| | The whole plant of *Calyptrochilum christyanum* is boiled with water. One glass cup is taken every morning and night. | Water | Decoction |
| Hypertension | The leaves of *Holarrhena floribunda* are boiled in water. Pure honey is added to the decoction and one glass cup of is taken twice daily. | Water | Decoction |
| | The aerial parts of *Talinum triangulare* and *Solenostemon monostachyus* are squeezed until juice comes out. Half glass cup is taken twice daily. | Water | Infusion |
| | Leaves of *Ficus exasperata* are washed and squeezed until the juice that emanates is mixed with honey. One tablespoonful is taken morning and night. | Honey | Juice |
| | The calyx of *Hibiscus sabdariffa* and the bulbs of *Allium sativa* and *Allium cepa* are boiled in water, one glass cup is to be taken twice daily. | Water | Decoction |
| | The unripe fruit of *Carica papaya* is sliced and soaked in water for 24 hours. One glass cup is taken twice daily. | Water | Infusion |
| | The fruits and stem bark of *Tetrapleura tetraptera* and the aerial part of *Heliotropium indicum* are milled together and the mixture cooked into soup using palm oil *(Elaeis guineensis)*. A small bowl of soup is taken twice daily. | Palm oil | Decoction |
| | The leaves of *Ficus exasperata,Vernonia amygdalina,* and *Persea americana* are squeezed until the juice | - | Juice |

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| | comes out. The juice is mixed with *Citrus aurantium* juice and the three tea spoonfuls of the combined juice taken thrice daily. | | |
| | The fruits of *Adansonia digitata,* the calyx of *Hibiscus sabdariffa,* the bulbs of *Allium sativum* and the rhizomes of *Zingiber officinale* are boiled together in water. One glass cup of the decoction is taken twice daily. | Water | Decoction |
| | The leaves of *Bambusa vulgaris, Persea americana, Psidium guajava*, the rhizomes of *Zingiber officinale* and the bulb of *Allium sativum* are washed and boiled together in water. One glass cup to be taken morning and night. | Water | Decoction |
| | The leaves and stem barks of *Rauwolfia vomitoria,* tuber of *Anchomanes difformis* and the leaves of *Parquetina nigrescens* are boiled together in water. One glass cup is taken twice daily. | Water | Decoction |
| | The leaves of *Ageratum conyzoides* are squeezed until juice comes out. Two tablespoonfuls are taken three times daily. | - | Juice |
| | The latex of *Aloe vera* is mixed with honey and a tablespoonful of the mixture is taken orally twice daily. | - | Juice |
| | The leaves of *Persea americana* and *Viscum album* are boiled together in water and two glass cups of the extract are taken thrice daily. | Water | Decoction |
| | The roots and stem barks of *Rauwolfia vomitoria* and the young fruits of *Kigelia africana* are ground and boiled together in water. A glass cup is taken twice daily. | Water | Decoction |
| | The stem barks of *Parkia biglobosa* and *Rauwolfia vomitoria* and the bulbs of *Allium cepa* and *Allium sativum* are boiled together in water. One glass cup is to be taken once daily. | Water | Decoction |
| | The aerial part of *Aloe vera,* leaves of *Bryophyllum pinnatum* and the bulb of *Allium cepa* are ground and soaked in water for 24 h. The supernatant is decanted; one glass cup taken with pure honey twice daily. | Water/Honey | Infusion |
| | The stem barks and roots of *Securidaca longipedunculata* and the seeds of *Xylopia aethiopica* are milled and soaked in water for 48 h. The supernatant is decanted and one glass cup taken twice daily. | Water | Infusion |
| | The aerial parts of *Phyllanthus amarus* and *Acanthospermum hispidum* and the calyx of *Hibiscus sabdariffa* are boiled together in pap water. One glass cup is taken thrice daily. | Pap water | Decoction |
| | The leaves and stem bark of *Baphia nitida* are soaked in water overnight. One glass cup is taken twice daily. | Water | Infusion |
| Stroke | The leaves of *Vernonia amygdalina* and *Heliotropium indicum*are squeezed until juice comes out. A tablespoonful of the juice is taken twice daily. | - | Juice |
| | The leaves and stem barks of *Trema orientalis* are boiled together in water. A glass cup is taken twice daily. | Water | Decoction |
| | The roots of *Jatropha curcas, Anogeissus leiocarpa* and *Vernonia amygdalina* are ground and boiled together in water. A glass cup of the decoction is taken thrice daily. | Water | Decoction |
| | The leaves of *Carica papaya* are dried and milled into powder. This is then mixed with palm kernel (*Elaeis guineensis*) oil to form a paste. Incisions are made on the affected body part and the paste is applied through the incisions. | Palm kernel oil | Paste |

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| | The seeds of *Aframomum melegueta,Kigelia africana* and *Citrus aurantifolia* are ground into powder. The powder is divided int two portion. To the first portion, palm kernel (*Elaeis guineensis*) is mixed and a tablespoonful is taken twice daily. The second portion is mixed with black soap and used to bath the affected part morning and night. | Palm kernel oil / black soap | Paste |
| | The stem barks and leaves of *Newbouldia laevis* are dried and ground into powder. Two tablespoonfuls of the powder is taken twice daily with hot pap. | Hop pap | Powder |
| | The fresh leaves of *Carica papaya* and *Persea americana* are boiled together in water. One glass cup is to be taken twice daily and the decoction is also used to bath the affected part of the body morning and night. | Water | Decoction |
| | The seeds of *Aframomum melegueta* are dried and milled into powder. This is then mixed with palm kernel (*Elaeis guineensis*) oil to form a paste. Incisions are made on the affected body part and the paste is applied through the incisions. | Palm kernel oil | Paste |
| | The leaves of *Acanthus montanus* are squeezed without adding water until the juice comes out. One glass cup of fresh daily preparation is taken twice daily. | - | Juice |
| | The aerial parts of *Solanum erianthum* are boiled in water. One glass cup of the decoction is taken twice daily. In addition, the leaf is used as sponge to bath the affected part with black soap every morning. | Water | Decoction |
| Heart disease | The bulbs of *Allium sativum* and *Allium cepa* are dried and ground powder. The mixture is taken with pure honey; a tablespoonful twice daily. | Honey | Powder |
| | The leaves of *Abrus precatorius* and the stem barks of *Vitellaria paradoxa* are boiled together in water. One glass cup is taken three times daily. | Water | Decoction |
| | The fruits of *Tetrapleura tetraptera, Alstonia boonei*and *Xylopia aethiopica* are dried and ground into powder. Two tablespoonfuls of the powder is taken with hot pap twice daily. | Hot pap | Powder |
| | The rhizomes of *Zingiber officinale,* the bulbs of *Allium sativum* and the fruits of *Piper guineense* and *Tetrapleura tetraptera* are soaked in lime juice (*Citrus aurantifolia*) overnight. Two table spoonfuls are taken twice daily. | Lime juice | Infusion |
| | The roots of *Croton gratissimus* are ground and boiled in water. One glass cup is to be taken twice daily. | Water | Decoction |
| | The leaves of *Solenostemon monostachyus* are squeezed until juice comes out. Two table spoonfuls of the fresh preparation is taken twice daily. | - | Juice |
| | The aerial part of *solanum erianthum* is boiled in pap water. The decoction is taken twice daily; one glass cup. | Pap water | Decoction |
| Obesity | The juice of *Citrus aurantifolia* fruits is squeezed out and a glass cup is taken once daily. | - | Juice |
| | The leaves of *Vernonia amygdalina* and *Ocimum gratissimum* are soaked in pap water overnight. One glass cup of the infusion is taken twice daily. | Pap water | Infusion |
| | The stem barks of *Dialium guineense* and the seeds of *Xylopia aethiopica* are boiled together in water. One glass cup is to be taken three times daily. | Water | Decoction |

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| The stem barks *Vitellaria paradoxa* and *Mangifera indica* boiled together in pap water. One glass cup of the decoction is taken twice daily. | Pap water | Decoction |
| The rhizomes of *Curculigo pilosa* and the fruits of *Kigelia africana* are cut into pieces and soaked in water overnight. One glass cup of the infusion is taken twice daily. | Water | Infusion |
| The roots of *Anogeissus leiocarpa* are boiled in water and a glass cup of the decoction is taken twice daily. | Water | Decoction |
| The roots of *Anthocleista djalonensis* and *Senna alata* are soaked in local gin. One glass cup of the infusion is taken once daily. | Local gin | Infusion |
| The stem barks of *Anthocleista djalonensis*and *Uvaria afzelii* are dried and ground into powder. One teaspoonful of the powder is taken with hot pap twice daily. | Hot pap | Powder |
| The stem barks of *Alstonia boonei, Rauvolfia vomitoria* and the seeds of *Xylopia aethiopica* are boiled in water. One glass cup is taken twice daily. | Water | Decoction |
| The leaves of *Ipomoea asarifolia* are squeezed until juice comes out. Two table spoonfuls of the juice are taken twice daily. | - | Juice |
| The fruits of *Lagenaria breviflora* and the rhizome of *Curculigo pilosa* are cut into small pieces and soaked in water overnight. One glass cup is taken twice daily. | Water | Infusion |

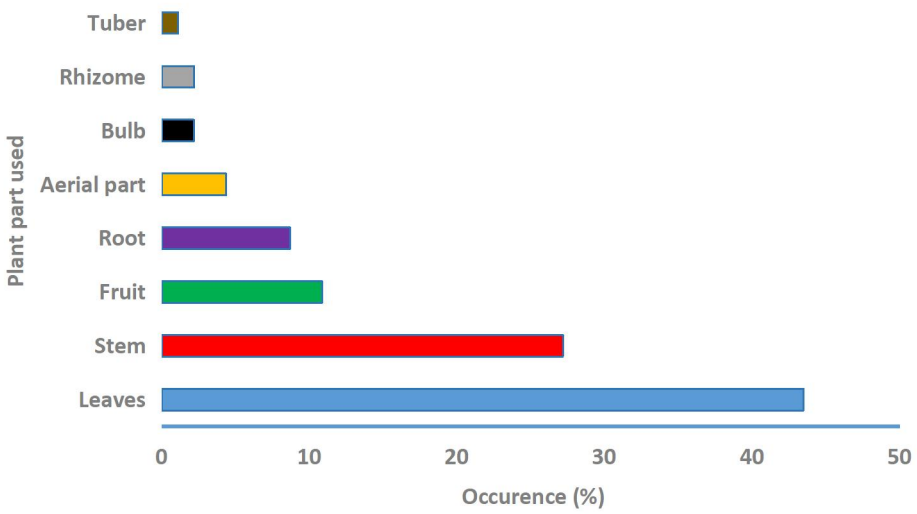


**Figure 2: Percentage occurrence of various plant parts mentioned**

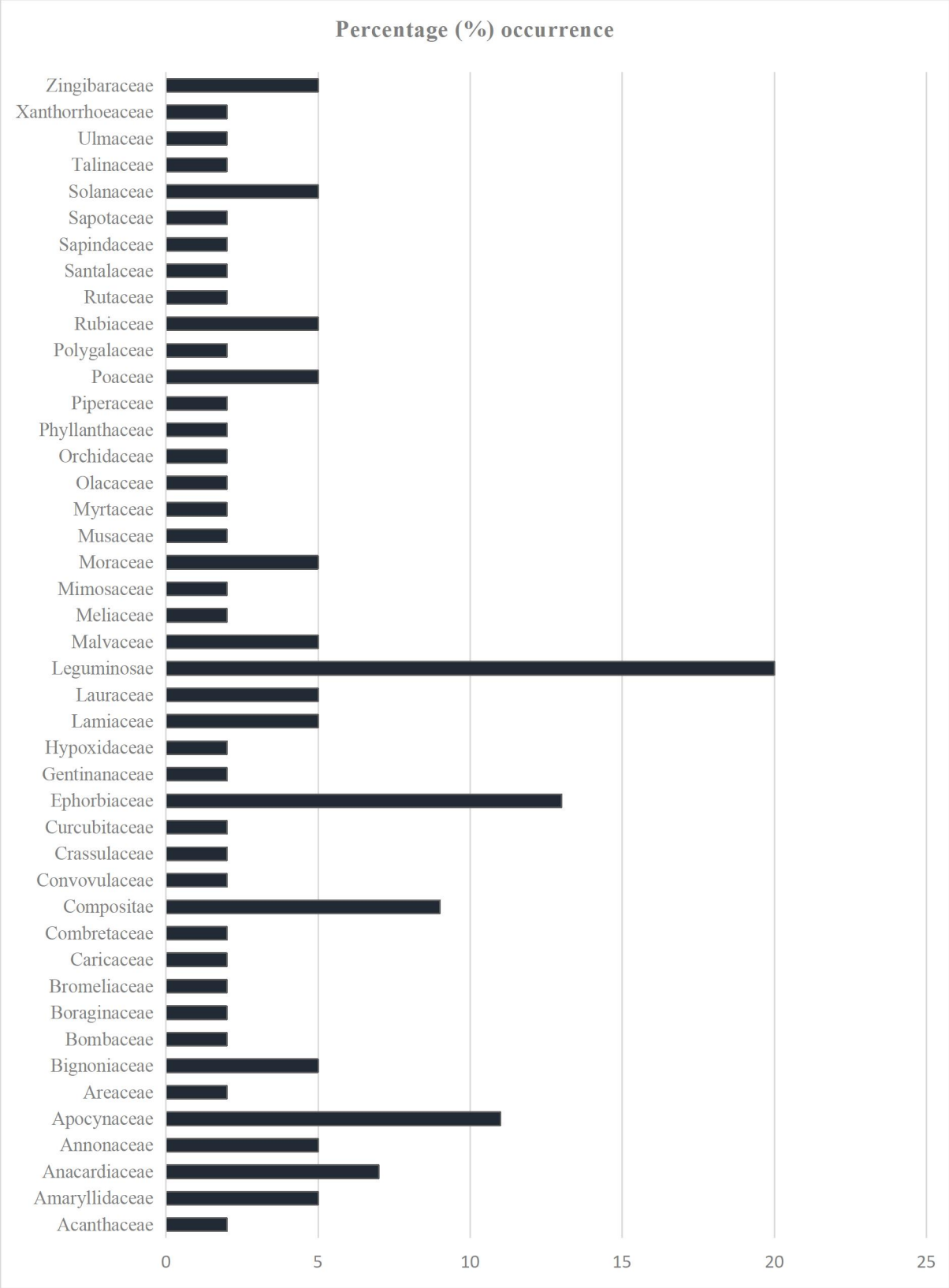


**Figure 3: Percentage occurrence of overall plant families**

**Discussion**

Medicinal plants have been frequently used in the prevention and treatment of human degenerative ailments such as diabetes and its comorbidities. There has been report of successful treatment of various diseases conditions with herbal therapy, and it is usually opted for as a result of its cost effectiveness, easy access and potency (36,37,38).

The plants mentioned in this survey were readily available as they were easily obtained from the forest, around homes and in the market places. Of the plant species encountered in the study for the treatment of various ailments, trees constituted 45% of the plant population, while shrubs, herbs and climbers contributed 33%, 18% and 4%, respectively. Similar occurrences were recorded in previous ethnobotanical studies in several parts of Nigeria (6,33,39,40,41) although this did not resonate with the findings of some other studies (42,43).

The herbal recipes obtained from the respondents were found to be poly-herbals as they believe it is a more holistic method of managing the illness and they claimed it is more potent than the use of individual plant species. Previous studies have revealed that the combination of several plant species in traditional medicine offers synergistic approach to the management of the ailment as each plant will contribute different quota to the therapeutic efficacy of the recipes (44,45). In this study, twenty-three (23), nineteen (19), eleven (11), ten (10) and seven (7) herbal remedies were mentioned for the treatment of diabetes, hypertension, stroke, heart diseases and obesity respectively (Table 3).Various methods employed for the preparation of the herbal recipes were encountered in this study including decoction, juice, infusion, powder and paste. The plant parts used in this study revealed that the dominant plant part was leaves (43%), followed by stem (27%) and fruit (10%) (Figure 2). This could be connected to the relative availability of leaves for most part of the year and its collection posing the least threat to biodiversity conservation.

Data obtained from this study revealed that *Vernonia amygdalina* was the most frequently used plant with a use mention index (UMi) of 0.208. Other commonly used medicinal plants included *Citrus aurantifolia* (UMi 0.170), *Viscum album*. (UMi 0.151), *Carica papaya* (UMi 0.151), *Allium sativum*. (UMi 0.132), *Bryophyllum pinnatum* (UMi 0.113), *Xylopia aethiopica* (UMi 0.113), *Ocimum gratissimum* (UMi 0.113), *Nauclea diderrichii*(UMi 0.113), *Aloe vera* (UMi 0.113) and *Zingiber officinale* (UMi 0.113). Amongst the plant species, *Citrus aurantifolia* was the only plant mentioned by several respondents for the management of the five ailments. *Allium sativum,Xylopia aethiopica* and *Zingiber officinale* were used for the treatment of all the ailments with the exception of stroke, while *Carica papaya*, *Vernonia amygdalina* and *Kigelia Africana* Benth were used for the management of DM, hypertension, stroke and obesity (Table 2). With the exception of *Anacardium occidentale*, *Spondias mombin*, *Bridelia*

*ferrugineaMacaranga barteriSenna alata Calyptrochilum christyanum* and *Morinda lucida* all the plant species that were mentioned for the treatment of DM were also used in the treatment of one or more of its co-morbidities.

Previous ethnobotanical surveys in several communities in Nigeria and other countries cited the use of most of the plant species obtained in our study for the management of DM and other ailments associated with it. A study conducted in five districts in Lagos, a southwestern state of Nigeria, documented the use of*Vernonia amygdalina, Carica papaya,Ocimum gratissimum, Morinda lucida*, *Allium sativum*, *Aloe vera*, *Azadirachta indica*, *Momordica charantia*, *Phyllanthus amarus*,*Mangifera indica* and *Psidium guajava* in the management of DM. Similar to our findings, *Citrus aurantifolia*, *Vernonia amygdalina, Carica papaya* were mentioned in the survey as the predominant plant species for the management of DM(33). Another recent study conducted in the southwestern part of Nigeria documented the use of *Kigelia africana, Allium cepa* and *Persea americana* in the management of hypertension (46). In agreement with our findings, *Aframomum melegueta,Allium sativum, Carica papaya,Persea americana, Rauvolfia vomitoria, Viscum album* and *Zingiber officinale* were the frequently cited plant species for the management of hypertension by the traditional medical practitioners in Edo, South-Eastern Nigeria (47). A recent study revealed that *Allium sativum, Carica papaya, Citrus aurantifolia, Vernonia amygdalina* and *Heliotropium indicum* were used for the concurrent management of hypertension and DM in Kwara state, North-Central Nigeria (48). A study conducted in the Akwa Ibom state, southeastern Nigeria, documented *Persea americana, Mangifera indica*, *Carica papaya, Allium sativum* and *Zingiber officinale* as prominent plants in the management of DM and hypertension (49). *Momordica charantia, Anacardium occidentale* and *Parkia biglobosa* that were identified in this study for the management of DM and hypertension were also documented as used traditionally in the central region of Togo (28). A recent ethnobotanical study conducted in Burkina Faso revealed that *Citrus aurantifolia* and *Hibiscus sabdariffa* were predominately used for the management of obesity (38). Five of the plant species namely *Allium sativum, Olax subscorpioides, Kigelia africana*and *Xylopia aethiopica* which were cited in this report for the management of obesity were also frequently mentioned by traditional healers for the management of obesity in Lagos, southwestern Nigeria (50). Our results agreed with the findings of Olorunnisola *et. al.*,(46) who had earlier reported the use of *Cassia fistula, Aframomum melegueta* and *Allium sativum* in the management of several cardiovascular diseases including stroke and heart attack.

**Conclusion**

Despite considerable progress in treatment of diabetes and it co-morbidity by synthetic drugs, search for newer drugs continues because the existing synthetic drugs have several

limitations. Thus, drugs from natural products especially plants have retained functional strength compared to synthetic drugs because of its minimal side effect and easy accessibility among others. The report from this study provide inventory of medicinal plants in four local government areas of South-Western Nigeria used for the management of diabetes and its comorbidities. This documentation will serve a great deal in preserving the indigenous traditional knowledge of the local communities. This study has also presented an interactive inventory details showing the plants, parts of plant used, method of preparation and administration, thus making it easy for interested researchers to easily identify and further research on plants of interest. In particular, it may be needful to subject the herbal preparations prepared by the TMPs to rigorous human studies before a reasonable conclusion can be drawn as regards their potency and safety. Positive outcome from the efficacy and safety evaluation of these herbal recipes may enable development of less expensive therapies and this may break dependence on orthodox drugs, most of which are embedded with side effects. Bearing in mind that most diabetic patients often have one or more accompanying comorbidities. A safe and efficacious single herbal preparation that can manage both diabetes and its comorbidities may provide scientific breakthrough and relief from the side effects associated with the use of different synthetic drugs that is often experienced by sufferers of DM with accompanying comorbidities.

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