INTRODUCTION

Diabetes mellitus is a metabolic disorder characterized by disruption of carbohydrate, fat, and protein metabolism. The disorder is associated with severe complications, including retinopathy, microangiopathy, and peripheral neuropathy [1]. Diabetes causes major economic losses worldwide and impedes country development [2,3].

The number of persons affected by diabetes is expected to reach 438.4 million worldwide in 2030 [4]. Only a fraction (49.3%) of the population in Africa has been tested for the disease [5] but, in sub-Saharan Africa alone, an estimated 10.4 million people lived with diabetes in 2007 [6]. In the central African country of Gabon, which has a population of ~1.7 million people [7], 10.71% of the population has been diagnosed with this disease [8]. Since, pharmaceutical products used for the management of diabetes are expensive for rural populations and may induce serious side effects [9], medicinal plants are used predominately to treat this disease. According to George et al. [10], medicinal plants contain biologically active compounds with diverse therapeutic applications. For example, saponins and alkaloids in Alstonia boonei De Wild. have a diuretic effect and are utilized in the treatment of urinary edema and hypertension [11]. The fungicidal action of saponins in (Piptadeniastrum africanum Hoof. f.) Brenan provides another example [12] used in traditional medicine. In Gabon, 78.2% of the species of plants in forests are used medicinally by pygmies [13], which exemplifies this country’s botanical medicinal heritage. It is important to improve understanding of plants used by local people in the treatment of diabetes in Gabon and which may have beneficial applications for the world at large. The aim of this study is to survey a wide range of Gabonese plants for their antidiabetic activity.

MATERIALS AND METHODS

Study Area

Gabon is a small francophone country located in Central Africa bordering the Atlantic Ocean at the Equator between the Republic of the Congo and Equatorial Guinea. The climate
is always hot and humid. Gabon houses some of Africa’s most biodiverse rainforests, which comprise approximately 80% of the country and stretch to the coast. Research in the Northwest and South Central/East of Gabon was done in the following three provinces: Estuaire (N.W. coastal region), Ogooué-Lolo (south-central forest region), and Haut-Ogooué (southeast mosaic of forest-savanna) [Figure 1]. The sampling was conducted in both rural areas and urban regions, including is even towns and six departments of the three provinces [Table 1].

Investigation Method

The ethnobotanical survey was conducted between October 2014 and March 2015, which spans periods of sparse but heavy rainfall (October-November), a short dry season (December-January), and part of the long wet season with heavy rainfall (February-April). The investigation was carried out using a semi-structured questionnaire in French or in the native language of the informant. Interviewees included diabetic patients, traditional healers, traditional health practitioners, herbalists, and other knowledgeable people. The recorded parameters were locality, sociodemographic data (age and gender), vernacular or local plant names, plant parts used, method of preparation, method of administration, quantity consumed, and type of material, samples collected for botanical identification were dried, preserved and identified by an expert botanist, ISSEMBE Yves, at National Herbarium of Libreville, Gabon. The Latino names of some plant species have been updated using the plant list database [14].

Data Analysis

The frequency of citation (FC) of a plant species was evaluated using the following formula: FC = (Number of times a particular species was mentioned/Total number of times that all species were mentioned) × 100 [15,16].

| Informants group           | Number of persons (urban/rural) | Age (years) | Professional experience (years) |
|---------------------------|---------------------------------|-------------|-------------------------------|
| Diabetic patients         | 8/6                             | 50-65       | -                             |
| Traditional healers       | 0/29                            | 27-69       | 10-30                         |
| Traditional health practitioners | 10/0                  | 40-65       | 10-30                         |
| Herbalists                 | 15/0                            | 25-45       | 3-10                          |

Figure 1: Map of study areas
RESULTS

Demographic Characteristics

A total of 80 people were investigated, of which 68 informants had a rich knowledge of herbal medicine [Table 2]. The balance did not report knowledge of medicinal plants and was excluded from further study. Of those that reported information, 14 were patients with physician-diagnosed diabetes mellitus or people were relatives of people suffering from diabetes, 29 were traditional healers, 10 were traditional health practitioners, and 15 were herbalists. More than half (65%) of the interviewees were male, and the average age of both sexes was approximately 53 years with informants ranging in age until 70 years. More than half of all respondents (51.5%) were from rural areas, traditional healers who were the most numerous informants were mainly represented areas rural while herbalists and traditional health practitioners were only recorded that in urban areas.

Ethnobotanical Characteristics and Associated Knowledge

The species cited by respondents in this study were listed in alphabetical order by scientific name, local or vernacular name, family, genus, plants parts used, mode of preparation, mode of administration, and FC [Table 2]. 50 species belonging to 31 families and 50 genus were used for the treatment of diabetes. The Annonaceae was the most commonly represented of all families [Figure 2], with particular use of soursop Annona muricata L. Nine plant species were most cited by interviewers as a remedy for diabetes, of which Guibourtia tessmannii (Harms) J. Leonard (Caesalpinioideae) was the most frequent (7.14%) followed by A. boonei (Apocyanceae), Carica papaya L. (Carciceae), Persea americana Mill. (Lauraceae), Allium sativum L. (Amaryllidaceae), A. muricata (Annonaceae), Ceiba pentandra (L.) Gaertn. (Malvaceae), Cocos nucifera L. (Areaceae), Pieralima nitida (Stapf) T. Durand and H. Durand (Apocynaceae) (4.29%). The others species were least cited, it is the case of Annickia chlorantha (Oliv.) Setten and Maas (Annonaceae), Cymbopogon citratus (DC.) Stapf (Poaceae), Eugenialum tessmannii Harms (Caesalpinioideae), Lantana camara L. (Verbenaceae), Musa × paradisiaca L. (Musaceae), Psidium guajava L. (Myrtaceae), Vernonia amygdalina Delile (Asteraceae), Xylopia aethiopica (Dunal) A. Rich. (Annonaceae), and the gymnosperm Gnetum africanum Welw. (Gnetaceae) [Table 2]. Bibliographic research showed that about 94% of plants were well-documented in literature [Table 3]. All 50 plants are used to prepare medicinal drugs individually or in various combinations.

The result shows that the most frequently used plant parts were stem barks (50%) followed by leaves (26%) and other plant parts (24%), including roots (6%), fibers (4%), bulbs, fruit, flower, rhizome, skin, and stem (2% each) [Figure 3]. Most components were prepared by decoction (58%). Maceration (18%) and infusion (14%) were other modes of preparation and use, as was chewing (4%), burning and cooking (2%) [Figure 4]. Three modes of administration were used. Herbal products were primarily administered orally (98% of cases), mostly in liquid form (88%). Administration by mastication was also recorded (10% of cases) as was treatment by vapor bath (2% of cases) [Figure 5].

DISCUSSION

The results of demographic data showed that most knowledgeable interviewees were male (65%) of average age >50 years. A previous study found that women (69%) frequently used more medicinal plants than men (31%) [145]. Uniyal et al. [146] also found that men knew comparatively more about plant-based medicines than females because women were occupied by household working pressure. In Gabon, women tender house gardens and are more ready than men to bring out the first health care.

Figure 2: Repartition of plants families
| Botanical names                  | Local names/venacular                  | Families       | Genus       | Parts used | Mode of preparation | Mode of administration | Numbers of citations | Frequencies of citations |
|---------------------------------|---------------------------------------|----------------|-------------|------------|---------------------|------------------------|-----------------------|--------------------------|
| Acacia auriculiformis Benth.    | Akasmani                              | Fabaceae       | Acacia      | Leaves     | Infusion            | Steam bath             | 1                      | 1,428,571                |
| Allium sativum L.               | Garlic                                | Amaryllidaceae | Allium      | Bulb       | Decoction           | Drink                  | 3                      | 4,285,714                |
| Alstonia boonei De Wild.        | Emien                                 | Apocynaceae    | Alstonia    | Stem barks  | Maceration          | Drink                  | 3                      | 4,285,714                |
| Anchomanes dillmonti (Blume)    | Nkwe-n'dóju (Galoa)                   | Araceae        | Anchomanes  | Rhizom     | Maceration          | Drink                  | 1                      | 1,428,571                |
| Annickia chlorantha (Oliv.)      | Mwamba jaune                          | Annonaceae     | Annickia    | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Setten & Maas                    |                                       |                |             |            |                     |                        |                        |                          |
| Annona muricata L.              | Soursop                              | Annonaceae     | Annona      | Stem barks  | Decoction           | Drink                  | 3                      | 4,285,714                |
| Annonidium mannii (Oliv.) Engl.  | Ebom                                  | Annonaceae     | Annonidium  | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Antrocaryon klaineanum Pierre   | Onzabili                              | Anacardiaceae  | Antrocaryon | Stem barks  | Infusion            | Drink                  | 1                      | 1,428,571                |
| Aucoumea klaineana Pierre       | Okoumé                                | Burseraceae    | Aucoumea    | Stem barks  | Maceration          | Drink                  | 1                      | 1,428,571                |
| Carica papaya L.                | Papaya                                | Caricaceae     | Carica      | Root       | Decoction           | Drink                  | 3                      | 4,285,714                |
| Celtis tessmannii (L.) Gaertn.   | Fromage                               | Malvaceae      | Celtis      | Stem barks  | Decoction           | Drink                  | 3                      | 4,285,714                |
| Celtis tessmannii Rendle         | Diania                                | Cannabaceae    | Cannabaceae | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Cleistopholis glauca Pierre ex  | Unknown                               | Annonaceae     | Cleistopholis | Stem barks | Decoction          | Drink                  | 1                      | 1,428,571                |
| Engl. and Diels                  |                                       |                |             |            |                     |                        |                        |                          |
| Cocos nucifera L.               | Coconut                               | Aracaceae      | Cocos       | Fiber      | Decoction           | Drink                  | 3                      | 4,285,714                |
| Combretum micranthum G. Don      | Kinkéliba                             | Combretaceae   | Combretum   | Leaves     | Infusion            | Drink                  | 1                      | 1,428,571                |
| Copaifera mildbraedii Harms     | Murei (Punu)                          | Caesalpinioideae | Copaifera   | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Cylicodiscus gabunensis Harms    | Okan                                  | Mimosoideae    | Cylicodiscus | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Cymbopogon citratus (D.C.) Stapf | Lemongrass                            | Poaceae        | Cymbopogon  | Leaves     | Infusion            | Drink                  | 1                      | 1,428,571                |
| Dubia macrocarpa Bocq.          | Akak                                  | Malvaceae      | Dubiosa     | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Entada gigas (L.) Fawcett and Rendle | Cœur de mer                             | Mimosoideae | Entada     | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Euryetapetum tessmannii Harms   | Anzilim                               | Caesalpinioideae | Euryetapetum | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Gnetum africanum Welw.           | Nkumu                                 | Gnetaceae      | Gnetum      | Leaves     | Cooking            | Eat                    | 1                      | 1,428,571                |
| Guibourtia tessmannii (Hamars) J. Leonard | kévazigo                             | Caesalpinioideae | Guibourtia | Stem barks  | Decoction           | Drink                  | 5                      | 7,142,857                |
| Harungana madagascariensis Lam. ex Poir. | Atsui                                 | Hyperaceae     | Harungana   | Leaves     | Chewing           | Eat                    | 1                      | 1,428,571                |
| Lantana camara L.               | Lantanière                            | Verbenaceae    | Lantana     | Leaves     | Infusion            | Drink                  | 1                      | 1,428,571                |
| Mammeea africana Sabine Microdesmis puberula Hook.f. ex Planch. | Oboto                                | Calophyllaceae | Mamea     | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Milicia excelsa (Welw.) C. C. Berg | Obiga (Akléé)                             | Moraceae       | Milicia     | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Mimosa pudica L.                | Bodji (Punu)                          | Fabaceae       | Mimosa      | Leaves     | Decoction           | Drink                  | 1                      | 1,428,571                |
| Musa × paradisiaca L.           | Plantain                              | Musaceae       | Musa        | Skin       | Burning            | Eat                    | 1                      | 1,428,571                |
| Musanga cecropioides R.Br. ex Tedlie | Parassolier                             | Urticaceae    | Musanga     | Leaves     | Decoction           | Drink                  | 1                      | 1,428,571                |
| Nauclea diderrichii (De Wild.) MERR. | Bilinga                                 | Rubiaceae      | Nauclea     | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Newbouldia laevis (P. Beaup.) Seem. | Ossomendo (Ndoumu)                        | Bignoniaceae  | Newbouldia  | Stem barks  | Decoction           | Drink                  | 1                      | 1,428,571                |
| Pennisetum purpureum Schumach.   | Mikuku (bakota)                         | Poaceae        | Pennisetum  | Stem       | Maceration          | Drink                  | 1                      | 1,428,571                |
| Pereromia lucellia (L.) Kunth Pepper - elder | Piperaceae                              | Piperaceae     | Pereromia   | Leaves     | Infusion            | Drink                  | 1                      | 1,428,571                |
| Persea americana Mill.          | Avocado                               | Lauraceae      | Persea      | Leaves     | Infusion            | Drink                  | 3                      | 4,285,714                |
| Petroselinum crispum (Mill.) Fuss | Parsley                              | Apiaceae       | Petroselinum | Leaves     | Chewing            | Eat                    | 1                      | 1,428,571                |
| Phaseolus vulgaris L. P. Picralima nitida (Stapf) | Bean                                | Fabaceae       | Phaseolus  | Fruit      | Decoction           | Drink                  | 1                      | 1,428,571                |
| T. Durand and H. Durand Piptadeniastrum africana (Hook.f.) Brenan | Dabéma                                 | Mimosoideae    | Piptadeniastrum | Stem barks | Decoction           | Drink                  | 1                      | 1,428,571                |
| Pseudospondias longifolia Engl. | Ofof                                  | Anacardiaceae  | Pseudospondias | Stem barks | Decoction           | Drink                  | 1                      | 1,428,571                |
| Psidium guajava L.              | Guava                                 | Myrtaceae      | Psidium     | Leaves     | Decoction           | Drink                  | 1                      | 1,428,571                |
| Quassia africana (Baill.) Baill. | Mukédi (Punu)                         | Simaroubaceae  | Quassia     | Stem barks  | Maceration          | Drink                  | 1                      | 1,428,571                |

(Contd...)
Respondents were dominated by aged people (>50 years). This experience is consistent with the study of Etuk et al. [147], in which the estimated age range of respondents was 40-70 years. Others have documented a profound and growing knowledge gap regarding medicinal plants between old and young people [148]. According to Uniyal et al. [146], the younger generations are ignorant of the vast medicinal resources available in their surroundings and are occupied in the search for money through market resources. Transmission of traditional medicinal knowledge from one generation to the next is thereby under threat [13,16].

It was also found that plant-based medicinal knowledge was more prevalent among people living in rural rather than urban areas as described earlier by Vashistha [149]. Indeed, in a rural area, endogenous knowledge being more preserved [150], people resort, culturally, to the use of traditional medicine and herbal drugs are socioeconomically acceptable [151,152].

50 medicinal plants were exploited by both rural and urban people for the treatment of diabetes. Annonaceae was the most represented family. Members of the Annonaceae contain natural products with varied therapeutic properties, such as the anti-flavonol taxifolin [153], which is known to possess antidiabetic, antitumor, and anti-inflammatory properties [154]. In addition, Annonaceae acetogenins are potent mitochondrial toxins with anticancer and anti-HIV activities [154]. However, excessive use of Annona muricata has been associated with atypical parkinsonism on the island of Guadeloupe [155].

Among plant components used for medicinal purposes, stem barks were most often used followed by leaves in accord with the findings of other investigators [13,16,147]. Bark is easily collected and contains concentrated bioactive [58,60]. However, leaves which also accumulate pharmacologically active principles reportedly are often used to manage diabetes [15,156]. Whereas the collection of leaves does not induce plant damage, collection of bark, roots or the whole plant is destructive and may lead to species depletion [157]. Some respondents recognized and addressed this problem with a traditional ritual in which a coin was placed at the base of the tree and while the injured part was wiped with dead leaves. This practice reportedly was undertaken to facilitate a rapid regeneration of the excised part of the plant.

Herbal drugs were most commonly used as oral decoctions. This observation was in accordance with the work of Madingou et al., [68] who observed that healing plants are generally boiled in medicinal recipes and then taken orally by many healers in Gabon and also many other reports worldwide [158-160].

Evaluating the bio-efficacy of the medicinal plants recorded, it was observed that each plant was mentioned at least twice by

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**Table 2: (Continued)**

| Botanical names | Local names/venacular | Families | Genus | Parts used | Mode of preparation | Mode of administration | Numbers of citations | Frequencies of citations |
|-----------------|------------------------|----------|-------|------------|--------------------|------------------------|-----------------------|--------------------------|
| Santiria trimera (Oliv.) Aubrèv. | Ebo | Burseraceae | Santiria | Root | Decoction | Drink | 1 | 1,428,571 |
| Tabernanthe iboga Baill. | Iboga | Apocynaceae | Tabernanthe | Stem barks | Maceration | Drink | 1 | 1,428,571 |
| Tithonia diversifolia (Hems.) A. Gray | Daisy | Asteraceae | Tithonia | Flowers | Decoction | Drink | 1 | 1,428,571 |
| Vernonia amygdalina Delile | Ndolé | Asteraceae | Vernonia | Leaves | Chewing | Eat | 1 | 1,428,571 |
| Voacanga africana Stapf ex Scott-Elliot | Ondou or Ontuless (Téké) | Apocynaceae | Voacanga | Root | Maceration | Drink | 1 | 1,428,571 |
| Xylopia aethiopica (Dunal) A. Rich. | Mugana (Punu) | Annonaceae | Xylopia | Fruit | Decoction | Drink | 1 | 1,428,571 |
| Zea mays L. | Maize | Poaceae | Zea | Fiber | Decoction | Drink | 1 | 1,428,571 |

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**Figure 3:** Plant parts cited for treating diabetes in the same areas of Gabon

**Figure 4:** Pharmaceutical forms used to treat diabetes in some Gabonese regions
Table 3: Phytochemical and pharmacological properties of plants

| Botanicals names | Biological properties | Phytochemicals compounds | References |
|------------------|-----------------------|--------------------------|------------|
| Acacia auriculiformis Benth. | Antifilarial effect. Antioxidant activity | Triterpenoid saponins. Proacaciaside and acacia mini. Tetrahydroxylavonane, teracacidin, and trihydroxyflvanone, phenols, and tannins. Proanthocyanidins. | [17-20] |
| Allium sativum L. | Antioxidant activity. Anti-diabetic and hypolipidemiac properties. Antihypertensive effect | Phenylpropanoids. Saponins, steroids, tannins, carbohydrates and cardiac glycosides. Propenyl cisteine and allyl cisteine | [21-24] |
| Alstonia boonei De Wild. | Diuretic activity. Hypoglycemic properties. Antioxidant activity | Saponins and indole alkaloids. Alkaloids, tannins, steroids, glycosides, flavonoids, and terpenoids. Tripterpenes | [9,11,25,26] |
| Anchormanites diffimmers (Blume) Engl. | Antimicrobial activity. Anti-inflammation and anti-noiception activities | Cardiac glycosides, terpenoids, steroids, phlebotannins, and flavonoids. | [27,28] |
| Annicka chlorantha (Oliv.) Setten and Maas | Antioxidant activity. Noteworthy biological activity | Phenolics, flavonoids, alkaloids, glycosides, saponins. Isoquinoline, acetonenins, and sesquiterpenes | [29,30] |
| Annonidium manni (Oliv.) Engl. and Diels | Antitubercular activity. Cytotoxic agent. Antioxidant activity and anticanancer agent | Alkaloids, phenols, polyphenols, saponins, tannins, steroids and triterpenes | [34,35] |
| Annonidium manni (Oliv.) Engl. and Diels | Antimicrobial activity. | Phoenolic, total flavonoids, total tannins total proanthocyanidins, coumarins, anthracones, saponins, and triterpenoids. Antrocarine A-F. Ergostane-type antrocarine E | [36-38] |
| Aucoumea klaireana Pierre | Antioxidant activity. Antimicrobial activity | Monoterpenoids | [39,40] |
| Annonidium manni (Oliv.) Engl. and Diels | Antimicrobial activity. Antihyperglycemic and hypolipidemic activities. Antithrombocytopenic activity. Useful antioxidant. Antifungal agent | Saponins, cardiac glycoside, anthraquinone, flavonoids, steroids, and tannins. Phenolics, cARPaine. Benzylicosinolate. Benzyl isothiocyanate | [41-45] |
| Ceiba pentandra L. Gaernt. | Hypoglycemic and antihyperglycemic effects. Antioxidant activity | Phenolic, flavonoid, alkaloid and tannins | [46,47] |
| Cleistophilus glauca Pierre ex Engl. and Diels | Antimicrobial activity. | Cleistriosides-2. Patchoulenone, cypere and germacrene D | [48,49] |
| Cocos nucifera L. | Cytotoxic and antihyperglycemic properties. Antimalarial activity | Phenolic compounds, flavonoids, resins, alkaloids, carbohydrate, proteins, and fibers. Tannins, saponins, glycosides, steroids and anthraquinones | [50,51] |
| Combretum micranthum G. Don | Antihyperglycemic activities. | Gallic acid, rutin trihydrate, (+)-catechin and benzoic acid. Alkaloids, saponins, tannins, anthraquinones, cardiac glycosides, flavonoids, and steroids | [52,54] |
| Cylcodiscus gabunensis Harms | Antiplasmodial activity. Antimicrobial activity. Antimalarial activity | Alkaloids and terpenes. Leucoanthocyanins, saponins, tannins, polyphenols, coumarins, cardiac glycosides, reducing sugars, steroids, flavonoids, steroids and or triterpenes. Gallic acid, oligosaccharides | [55,57] |
| Cymbopogon citratus (DC.) Stapf | Anti-inflammatory and sedative. Hypoglycemic and hypolipidemic effects. Antitubercular activity. Anti-inflammatory activity. | Citral and terpenes. Alkaloids, saponins, tannins, anthraquinones, steroids, phenols. Carlinoside, isoorientin, cynaroside, luteolin 7-O-neohesperidoside, kurilesin A and cassiaoccidentalin B | [58-61] |
| Duboscia macrocarpa Bocq. | | Dubosane. Dubosides | [62,63] |
| Entada gigas (L.) Fawcett and Rendle | Used for diarrhea. Microbial infection | Alkaloids, phenols, and tannins | [64,65] |
| Gnetum africanum Welw. | Potential chemopreventive agents. Antimicrobial activity | Phenolic compounds, flavonoids, phytosterols, alkaloids, tannins, saponins, chlorophyll, and glycosides. β-caryophyllene, (E)-phytol and trimethyl-2-pentadecanone | [66,67] |
| Guilbouertia tessmannii (Harms) J. Leonard | Hypotensive activity. Antioxidant activity. Hypoglycemic effect | Tripterpenes, sterols, alkaloids, tannins, polyphenols, sugars and saponosides | [68,70] |
| Harungana madagascariensis Lam. ex Poir. | Anti-inflammatory, antioxidant and antidiabetic activities | Polyphenols, tannins, and triterpenes. Alkaloids, saponins, and flavonoids | [71,73] |

(Contd...)
### Table 3: (Continued)

| Botanical names | Biological properties | Phytochemicals compounds | References |
|-----------------|-----------------------|--------------------------|------------|
| **Lantana camara** L. | Hypoglycemic and wound healing properties. Antihyperglycaemic effect. Antimicrobial and cytotoxic activities. | Carbohydrates, flavonoids, phytosterols, saponins, β-caryophyllene, ar-curcumene/zingiberene, γ-curcumene-15-al/epi-β-bisabolol, (E)-nerolidol, davanone, euugenol/alooaromadendrene, and carvone | [74-76] |
| **Mammee africana** Sabine | Cytoprotective and antimicrobial activities. Hypoglycemic effect. Hepatoprotective activity. | 4-phenylcoumarins, 4-n-propylcoumarins, one 4-n-pentylcoumarin, 1,5-dihydroxyxanthone and 1-methoxy-5-hydroxyxanthone | [77-79] |
| **Microdesmis puberula**Hook.f. ex Planch. | Analgesic and anti-stress agent. | keayandines A, B, C and keayanine A. Saponins, cardiac glycosides, deoxysugars, alkaloids, and terpenes | [80-82] |
| **Milicia excelsa** (Welw.) C. Berg | Wound healing and antibacterial effects. Used for the management of Type 2 diabetes | Tannins, alkaloids, flavonoids and saponins. Melicamidine A. 3,4-dimethoxybenzyl beta-D-xypophorosyl -beta-D-glucopyranoside, lupeol acetate, ursolic acid, triacetylt (E)-ferulate, and 2-(3,5-dihydroxiphenyl) benzofuran-5,6-diol. Polyphenol, phenol, triterpenes and glicosides | [83-86] |
| **Mimosa pudica** L. | Antimicrobial activity. Hypolipidemic activity. Antihyperglycemic activity. Anthelmintic activity. Antioxidant activity. | C-glycosylflavones. Terpenoids, flavonoids, glycosides, alkaloids, quinines, phenols, tannins, saponins, and coumarins | [87-89] |
| **Musa × paradisiaca** L. | Antitryptansomal effects. Genotoxic activity. | Alkaloids, flavonoids, terpenoids, saponins, tannins, and reducing sugars, alkaloids, and cardenolides. | [90-93] |
| **Musanga cecropioides**R.Br. ex Tedlie | Antihypertensive. Antioxidant activity. | Cercropic acid methyl ester | [94-96] |
| **Nauclea diderrichii** (De Wild.) Merr. | Antitryptansosomal effects. | Alkaloids, flavonoids, terpenoids, saponins, tannins, and reducing sugars, alkaloids, and cardenolides. | [97,98] |
| **Newbouldia javaeis** (P. Beaux.) Seem. | Antimicrobial activity. | C-glycosylflavones. Terpenoids, flavonoids, glycosides, alkaloids, quinines, phenols, tannins, saponins, and coumarins | [99-101] |
| **Pennisetum purpureum** Schumach. | Antioxidant enzyme. Nutritional and antinutritional. Heribical activity. | Ascorbic acid, rutin, epicatechin, anthocyanins, p-coumaric acid, caffeine, and terpinene. | [102-105] |
| **Peperomia pellucida** (L.) Kunth | Anticancer, antimicrobial, antidiabetic properties. | Phytochemicals compounds. 3,3,8-p-menhthatriene, β-phellandrene, apiole, myristicin, and terpinolene. | [106-108] |
| **Persea americana** Mill. | Hypoglycemic and hypolipidemic activities. Antihyperglycemic activity. | Alkaloids, flavonoids, terpenoids, saponins, tannins, resins, steroids, phenols and carbohydrate. Flavonoids, glycosides, saponins, and terpenoids. | [109-111] |
| **Petroselinum crispum** (Mill.) Fuss | Antioxidant and antibacterial activities. Anti-virico activity. Antidiabetic effect. | Phenolics compounds. 3,3,8-p-menhthatriene, β-phellandrene, apiole, myristicin, and terpinolene. | [112-114] |
| **Phaseolus vulgaris** L. | Antihyperglycemic activity. Antioxidant and antiproliferative effects. | Alkaloids, flavonoids, proteins, tannins, terpenoids, saponins, quercetin, anthocyanin and catechin. Gallic acid, chlorogenic acid, epicatechin, myricitin, fumonisin, caffeic acid, and kaempferol. | [115,116] |
| **Picralima nitida** (Stapf) T. Durand and H. Durand | Hypoglycemic activity. Antioxidant and antidiabetic activities. | Flavonoids, terpenes, sterols, saponins, alkaloids and polyphenols. | [117,118] |
| **Piptadeniastrum africanaum** (Hook.f.) Brenan | Antifungal activity. Gastroprotective and ulcer healing effects. | Alkaloids, saponins, coumarins, flavonoids, carbohydrates, phenolic compounds, and tannins. Piptadenine and piptadenamide | [119,120] |
| **Pseudospondias longifolia** Engl. | Antioxidant and antimicrobial properties. | Total phenols, gallic acid, flavonoids, quercetin, tannins, tannic acid and proanthocyanidins procyanidin. | [121] |
| **Psidium guajava** L. | Hypoglycemic and hypotensive properties. Antioxidant activity. | Total phenols, gallic acid, flavonoids, quercetin, tannins, tannic acid and proanthocyanidins procyanidin. | [122,123] |
| **Quassia africana** (Baill.) Baill. | Antiamoebic activity. Antiviral activity. Larvicidal property. | Alkaloids, saponins, carboxylates, phenolic compounds, and tannins. Psiddin and pseuderine | [124-126] |
| **Saintiria trimera** (Oliv.) Aubrèv. | Antimicrobial activity. | Tannins, alkaloids, flavonoids, saponins, terpenes. Quassin and sinalkalactone D | [127-129] |
| **Tabernanthe iboga** Baill. | Insulinotropic effect. Antiinflammatory activity. | Iboigaine, tabernanthine, and voacangin | [130,131] |
| **Tithonia diversifolia** (Hemsl.) A. Gray | Antihyperglycemic activity. | Flavonoids, tannins, saponins, sterols and terpenes. Tannins and saponins. Sugars, sesquiterpene lactones and phenolics. | [124,132-134] |
| **Vernonia amygdalina** Delile | Hypoglycemic and hypolipidemic activity. | Flavonoids, terpenoids, saponins, tannins and reducing sugars, alkaloids, cardic glycosides. Carbohydrates, sterols and balsams. Sesquiterpene lactone vernolide and vernolial | [135-137] |
people from different regions for the management of diabetes. The literature also reports the use of some of these plants for diabetes treatment in other countries such as A. boonei has been studied in Nigeria [9]; P. americana, studied in Nigeria and Brazil [109,110]; P. nitida in Nigeria and Cameroon [117,118].

Moreover, the literature reports anti-diabetic properties of many of these plants. 15 of them would have hypoglycemic, hypolipemia the case of P. americana, P. guajava, C. citratus, C. pentandra, C. papaya, L. camara, A. muricata, and A. sativum [22,109,110]. C. pentandra would have both antihyperglycemic and hypoglycemic effects [46]. Gaubouria would have antioxidant and hypoglycemic [69,70]. Since, the frequency of plant use citations by both traditional healers and literature is an indication of the pharmacological relevance of the plant and thus, of curative properties [156], one may argue the therapeutic properties of some of the investigated medicinal plants which were evidenced by their studied pharmacological properties.

CONCLUSION

The study highlights the drug discovery great potential of the Congo Basin Forest. Nowadays, the management of diabetes is not the only fact of modern medicine, many medicinal based plants recipes are proposed by healers worldwide and deserve to be valued and rationalize.

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Table 3: (Continued)

| Botanical names | Biological properties | Phytochemicals compounds | References |
|-----------------|-----------------------|--------------------------|------------|
| Voacanga africana Stapf ex Scott-Elliot | Antioxidant activity. Antimicrobial activity | Anthranoids, anthraquinone, cardiac glycosides, phenols, phlobatannins, starch and tannins. Ibogamine, voacamine, vobasine, voacangine, voacristine, 19-epi-voacristine and 19-epi-heynanine | [124,138,139] |
| Xylopia aethiopica (Dunal) A. Rich. | Hypoglycemic effects. Antihyperglycemic and antioxidant potentials | Alkaloids and polyphenols | [140,141] |
| Zea mays L. | Preventive effect of the diabetic nephropathy. Antioxidant activity. Therapeutic and antioxidative agents | Anthocyanins and phenolics compounds. Flavonoids, saponins, tannins, phlobatannins, alkaloids, cardiac glycosides, and terpenoids | [142-144] |
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