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Original Research

Bio-efficacy of medicinal plants used for the management of diabetes mellitus in Gabon: An ethnopharmacological approach

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ABSTRACT

Background/Aim: People suffering of diabetes increased significantly worldwide. Population, in Sub-Saharan Africa and mainly in Gabon, rely on medicinal plants to manage diabetes, as well in rural as in urban areas. This study aimed to survey a wide range of Gabonese plants for their antidiabetic activity. **Materials and Methods:** This study focused on the identification of medicinal plants used in the local treatment of diabetes mellitus. Ethnobotanical investigations were carried out in rural and urban areas of three provinces of Gabon using a semi-structured interview. **Results:** About 50 plant species belonging to 31 families and 50 genera were recorded, a majority of which have been documented previously to have medicinal properties. Most have documented antidiabetic properties with characterized therapeutic chemical compounds. Of the plant parts used for treatment, stem barks were employed most frequently (50%), followed by leaves (26%); the remaining 24% comprised roots, fibers, fruit, bulbs, flowers, rhizom, skin, and stem. Regarding the mode of preparation, decoction was the most widely used (58%), followed by maceration (18%) and infusion (14%). Almost all the plant products were administered orally (98%). **Conclusions:** Taken in concert, this study highlights the possibility of exploiting traditional knowledge of specific medicinal plants for the inexpensive treatment and management of diabetes.

KEY WORDS: Medical plants, Bio-efficacy, diabetes mellitus, ethnopharmacology, Gabon

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. Studies were performed in villages and towns across three provinces in Gabon that represent different types of rainforest.

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].

Table 1: Demographic data of key informants

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

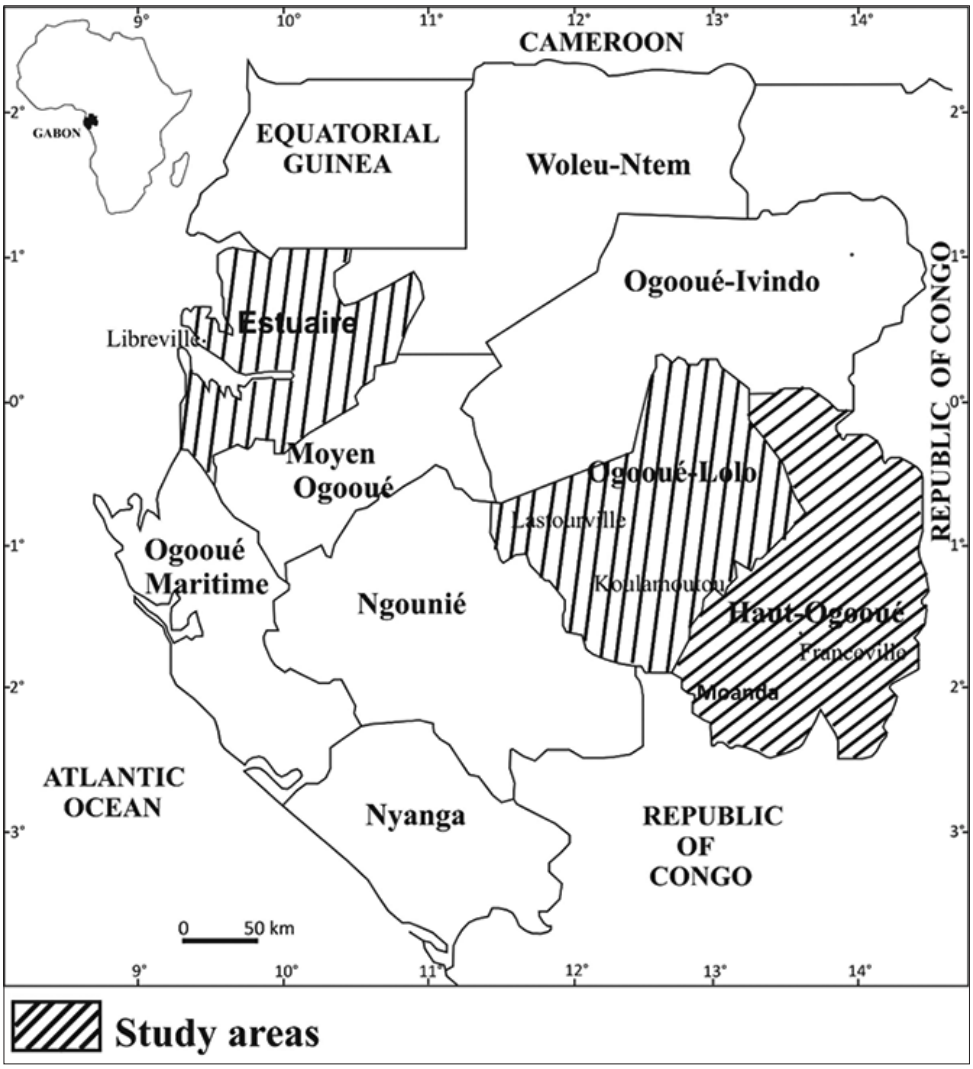

Figure 1: Map of study areas

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 informations; 14 were patients with physician-diagnosed a 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 approximatively 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. (*Caricaceae*), *Persea americana* Mill. (*Lauraceae*), *Allium sativum* L. (*Amaryllidaceae*), *A. muricata* (*Annonaceae*), *Ceiba pentandra* (L.) Gaertn. (*Malvaceae*), *Cocos nucifera* L. (*Arecaceae*), *Picralima 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*), *Eurypetalum 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, rhizom, 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.

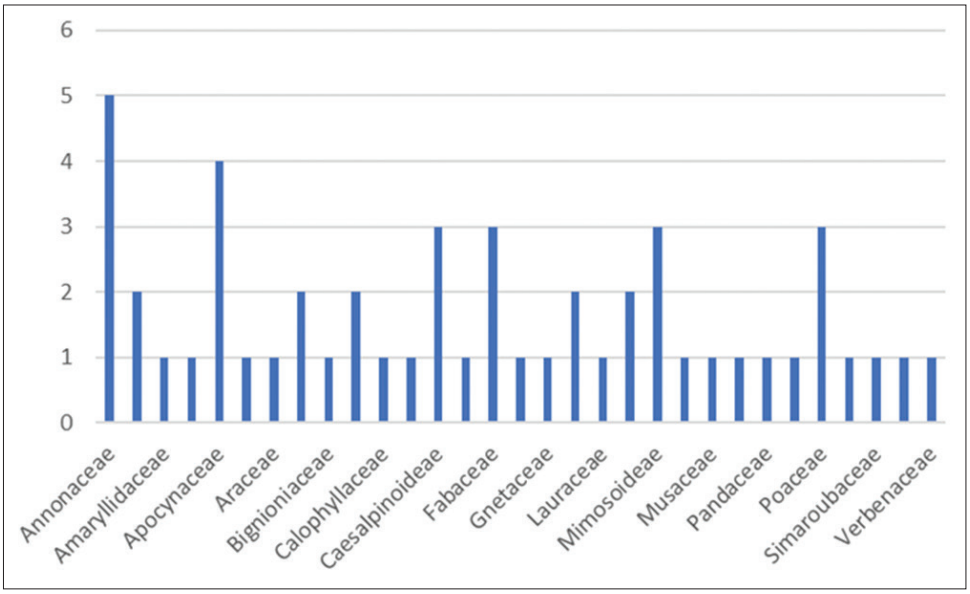

Figure 2: Repartition of plants families

Table 2: Data of medicinal plants traditionally used for the management diabetes mellitus

Botanicals 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 difformis (Blume) Engl.	Nkwe-ndôjgu (Galoa)	*Araceae*	Anchomanes	Rhizom	Maceration	Drink	1	1,428,571
Annickia chlorantha (Oliv.) Setten & Maas	Mwamba jaune	*Annonaceae*	Annickia	Stem barks	Decoction	Drink	1	1,428,571
Annona muricata L.	Soursop	*Annonaceae*	Annona	Stem barks	Decoction	Drink	3	4,285,714
Anonidium mannii (Oliv.) Engl. and Diels	Ebom	*Annonaceae*	Anonidium	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
Ceiba pentandra (L.) Gaertn.	Fromage	*Malvaceae*	Ceiba	Stem barks	Decoction	Drink	3	4,285,714
Celtis tessmannii Rendle	Diania	*Cannabaceae*	Celtis	Stem barks	Decoction	Drink	1	1,428,571
Cleistopholis glauca Pierre ex Engl. and Diels	Unknown	*Annonaceae*	Cleistopholis	Stem barks	Decoction	Drink	1	1,428,571
Cocos nucifera L.	Coconut	*Aracaceae*	Cocos	Fiber	Decoction	Drink	3	4,285,714
Combretum micranthum G. Don	Kinkêliba	*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 (DC.) Stapf	Lemongrass	*Poaceae*	Cymbopogon	Leaves	Infusion	Drink	1	1,428,571
Duboscia macrocarpa Bocq.	Akak	*Malvaceae*	Duboscia	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
Eurypetalum tessmannii Harms	Anzilim	*Caesalpinioideae*	Eurypetalum	Stem barks	Decoction	Drink	1	1,428,571
Gnetum africanum Welw.	Nkumu	*Gnetaceae*	Gnetum	Leaves	Cooking	Eat	1	1,428,571
Guibourtia tessmannii (Harms) J. Leonard	kévazigo	*Caesalpinioideae*	Guibuortia	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.	Lantanier	*Verbenaceae*	Lantana	Leaves	Infusion	Drink	1	1,428,571
Mammea africana Sabine	Oboto	*Calophyllaceae*	Mammea	Stem barks	Decoction	Drink	1	1,428,571
Microdesmis puberula Hook.f. ex Planch.	Inko	*Pandaceae*	Microdesmis	Stem barks	Infusion	Drink	1	1,428,571
Milicia excelsa (Welw.) C. C. Berg	Obiga (Akélé)	*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. Beauv.) Seem.	Ossomedzo (Ndoumu)	*Bignioniaceae*	Newbouldia	Stem barks	Decoction	Drink	1	1,428,571
Pennisetum purpureum Schumach.	Mikuku (bakota)	*Poaceae*	Pennisetum	Stem	Maceration	Drink	1	1,428,571
Peperomia pellucida (L.) Kunth	Pepper -elder	*Piperaceae*	Peperomia	Leaves	Infusion	Drink	1	1,428,571
Persea americana Mill.	Avocado	*Lauraceae*	Persea	Leaves	Maceration	Drink	3	4,285,714
Petroselinum crispum (Mill.) Fuss	Parsley	*Apiaceae*	Petroselinum	Leaves	Chewing	Eat	1	1,428,571
Phaseolus vulgaris L.	Bean	*Fabaceae*	Phaseolus	Fruit	Decoction	Drink	1	1,428,571
Picralima nitida (Stapf) T. Durand and H. Durand	Ebam	*Apocynaceae*	Picralima	Stem barks	Maceration	Drink	3	4,285,714
Piptadeniastrum africanum (Hook.f.) Brenan	Dabéma	*Mimosoideae*	Piptadeniastrum	Stem barks	Decoction	Drink	1	1,428,571
Pseudospondias longifolia Engl.	Ofoss	*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.	Mukèdji (Punu)	*Simaroubaceae*	Quassia	Stem barks	Maceration	Drink	1	1,428,571

(Contd...)

Table 2: *(Continued)*

Botanicals names	Local names/ venacular	Families	Genus	Parts used	Mode of preparation	Mode of administration	Numbers of citations	Frequencies of citations
Santiria trimera (Oliv.) Aubrév.	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 (Hemsl.) 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 Ontueles (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

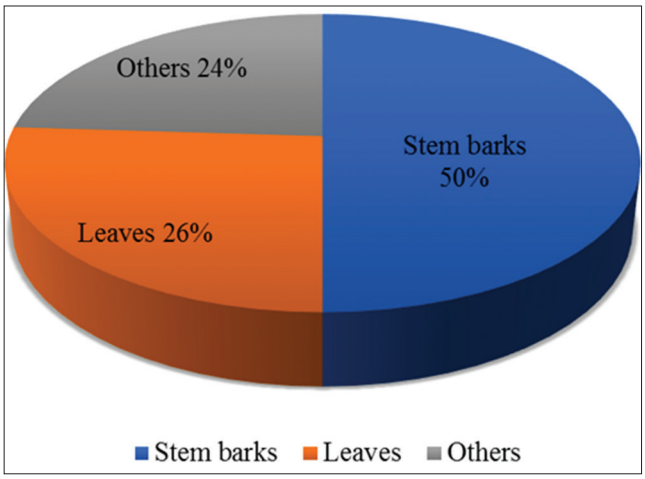

Figure 3: Plant parts cited for treating diabetes in the same areas of Gabon

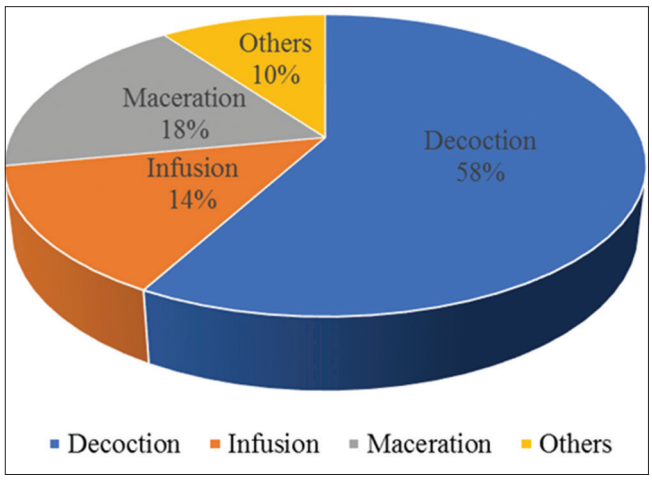

Figure 4: Pharmaceutical forms used to treat diabetes in some Gabonese regions

Respondents were dominated by aged people (>50 years). This experience is consistent with the study of Etuk *et al.* [147], in which showed 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 area as described earlier by Vashistha [149]. Indeed, in a rural area, endogenous knowledges 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 A. *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 observed 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

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. Tetrahydroxyflavanone, teracacidin, and trihydroxyflavanone, phenols, and tannins. Proanthocyanidins.	[17-20]
Allium sativum L.	Antioxidant activity. Antidiabetic and hypolipidaemic properties. Antihypertensive effect	Phenylpropanoids. Saponins, steroids, tannins, carbohydrates and cardiac glycosides. Propenyl cysteine and allyl cysteine	[21-24]
Alstonia boonei De Wild.	Diuretic activity. Hypoglycemic properties. Antioxidant	Saponins and indole alkaloids. Alkaloids, tannins, steroids, glycosides, flavonoids, and terpenoids. Triterpenes	[9,11,25,26]
Anchomanes difformis (Blume) Engl.	Antimicrobial activity. Anti-inflammation and anti-nociception activities	Cardiac glycosides, terpenoids, steroids, phlebotannins, and flavonoids.	[27,28]
Annickia chlorantha (Oliv.) Setten and Maas	Antibacterial activity. Noteworthy biological activity	Phenolics, flavonoids, alkaloids, glycosides, saponins. Isoquinoline, acetogenins, and sesquiterpenes	[29,30]
Annona muricata L.	Hypoglycemic effects. Antineoplastic potential. Antioxidant and anticancer agent	5-(3-hydroxybutyl) furanone, chloranthalactone E, dimethyl-6-hydroxycoumarin, triazole nucleosides, L-tryptophan, L-phenylalanine. Tannins, cardiac glycosides, terpenoids, and reducing sugars. Alkaloids, saponins, anthraquinones, phenols and phytosterols	[10,31-33]
Anonidium mannii (Oliv.) Engl. and Diels	Antibacterial activities. Cytotoxic agent	Alkaloids, phenols, polyphenols, saponins, tannins, sterols and triterpenes	[34,35]
Antrocaryon klaineanum Pierre	Antioxidant activity. Antiplasmodial	Phenolic, total flavonoids, total tannins total proanthocyanidins, coumarins, anthracenosids, saponosids, and triterpenoids. Antrocarine A-F. Ergostane-type antrocarine E	[36-38]
Aucoumea klaineana Pierre	Antioxidant activity. Antimicrobial activity	Monoterpenoids	[39,40]
Carica papaya L.	Antimicrobial activity, Antihyperglycemic and hypolipidemic activities. Antithrombocytopenic activity. Useful antioxidant. Antifungal agent	Saponins, cardiac glycoside, anthraquinone, flavonoids, steriods, tannins, and triterpenoids. Phenolics, carpaine. Benzylglucosinolate. Benzyl isothiocyanate	[41-45]
Ceiba pentandra L. Gaertn.	Hypoglycemic and antihyperglycemic effects. Antioxidant activity	Phenolic, flavonoid, alkaloid and tannins	[46,47]
Cleistopholis glauca Pierre ex Engl. and Diels	Antibacterial activity	Cleistriosides-2. Patchoulenone, cyperene and germacrene D	[48,49]
Cocos nucifera L.	Cytoprotective 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	Antihyperglycaemic activities. Antibacterial agent	Gallic acid, rutin trihydrate, (+)-catechin and benzoic acid. Alkaloids, saponins, tannins, anthraquinones, cardiac glycosides, flavonoids, and steroids	[52-54]
Cylicodiscus gabunensis Harms	Antiplasmodial activity. Antimicrobial activity. Antimalarial activity	Alkaloids and terpenes. Leucoanthocyanins, saponins, tannins, polyphenols, coumarins, cardiac glycosides, reducing sugars, steroids, flavonoids, sterols and or triterpenes. Gallic acid, oligosaccharides	[55-57]
Cymbopogon citratus (DC.) Stapf	Anti-inflammatory and sedative. Hypoglycemic and hypolipidemic effects. Antibacterial 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. Dubosciasides	[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]
Guibourtia tessmannii (Harms) J. Leonard	Hypotensive activity. Antioxidant activity. Hypoglycemic effect	Triterpenes, 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)*

Botanicals names	Biological properties	Phytochemicals compounds	References
Lantana camara L.	Hypoglycemic and wound healing properties. Antihyperglycaemic agent. Antimicrobial and cytotoxic activities	Carbohydrates, flavonoids, phytosterols, saponins. β-caryophyllene, ar-curcumene/zingiberene, γ-curcumen-15-al/ epi-β-bisabolol, (E)-nerolidol, davanone, eugenol/alloaromadendrene, and carvone	[74-76]
Mammea africana Sabine	Cytotoxic 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	keayanidines A, B, C and keayanine A. Saponins, cardiac glycosides, deoxysugars, alkaloids and terpenes	[80-82]
Milicia excelsa (Welw.) C. C. Berg	Wound healing and antibacterial effects. Used for the management of Type 2 diabetes	Tannins, alkaloids, flavonoids and saponins. Melicilamide A. 3,4-dimethoxybenzyl beta-D-xylopyranosyl -beta-D-glucopyranoside, lupeol acetate, ursolic acid, triacontyl (E)-ferulate, and 2-(3,5-dihydroxyphenyl) benzofuran-5,6-diol. Polyphenol, phenol, triterpenes and glycosides	[83-86]
Mimosa pudica L.	Antimicrobial activity. Hypolipidemic activity	C-glycosylflavones. Terpenoids, flavonoids, glycosides, alkaloids, quinines, phenols, tannins, saponins, and coumarins	[87-89]
Musa × *paradisiaca* L.	Antihyperglycemic activity. Anthelmintic activity. Antioxidant activity. Hypoglycemic activity	Tannins, eugenol, tyramine. Serotonin, levarterenol, norepinephrine and dopamine. Alkaloids, glycosides, steroids, saponins, flavanoids and terpenoids/steroids	[90-93]
Musanga cecropioides R.Br. ex Tedlie	Antihypertensive. Antioxidant activity	Cecropic acid methyl ester	[94-96]
Nauclea diderrichii (De Wild.) Merr.	Antitrypanosomal effects, Genotoxic activity	Alkaloids, flavonoids, terpenes and glycosides. Quinovic acid glycosides	[97,98]
Newbouldia laevis (P. Beauv.) Seem.	Antimicrobial activity. Hepatoprotective action. Antihyperglycemic activity	Chrysoeriol, newbouldiaquinone; 2-acetylfuro-1,4-naphthoquinone, 2-hydroxy-3-methoxy-9,10-dioxo-9,10-dihydroanthracene-1-carbaldehyde, lapachol, beta-sitosterol-3-O-beta-D-glucopyranoside, oleanolic acid, canthic acid, newbouldiamide and 2-(4-hydroxyphenyl)-ethyltrioctanoate	[99-101]
Pennisetum purpureum Schumach.	Antioxidant enzyme. Nutritional and antinutritional. Herbicidal activity	Ascorbic acid, rutin, epicatechin, anthocyanins, p-coumaric acid, quercetin, and catechin. Alkaloids, cyanogenic glycosides, flavonoids, oxalates, phytales, saponins, and tannins	[102-105]
Peperomia pellucida (L.) Kunth	Anticancer, antimicrobial, antioxidant properties. Antidiabetic, analgesic and anti-inflammatory activities	Phytol, 2-Naphthalenol, decahydro, hexadecanoic acid, methyl ester and 9,12-octadecadienoic acid (Z, Z)-, methyl ester. Alkaloids, tannins, resins, steroids, phenols and carbohydrate. Flavonoids, glycosides, saponins	[106-108]
Persea americana Mill.	Hypoglycemic and hypocholesterolemic activities	Tannins, saponins, steroids/triterpenoids and flavonoids. Estragole, α-farnesene, β-caryophyllene, germacrene D, α-cubebene, and eugenol	[109-111]
Petroselinum crispum (Mill.) Fuss	Antioxidant and antibacterial activities. Anti-vibrio activity. Antidiabetic effect	Phenolics compounds. 1,3,8-p-menthatriene, β-phellandrene, apiol, 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, myricetin, formononetin, 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 africanum (Hook.f.) Brenan	Antifungal activity. Gastroprotective and ulcer healing effects	Alkaloids, saponins, coumarins, flavonoids, carbohydrates, phenolic compounds, and tannins. Piptadenine and piptadenamide	[12,119,120]
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	Tannins, pentacyclic triterpenoids, guiajaverin, quercetin. Gallic acid, catechin, chlorogenic acid, caffeic acid, epicatechin, rutin, isoquercitrin, quercetin, kaempferol and luteolin, glycosylated campeferol, tocopherol, β-carotene and lycopene	[122,123]
Quassia africana (Baill.) Baill.	Antiamoebic activity. Antiviral activity. Larvicidal property	Tannins, alkaloids, saponins, steroids/terpens. Quassin and simalikalactone D	[124-126]
Santiria trimera (Oliv.) Aubrév.	Antimicrobial activity	Triterpenes. Alpha-pinene, beta-pinene. Alpha-humulene and beta-caryophyllene	[127-129]
Tabernanthe iboga Baill.	Insulinotropic effect	Ibogaine, tabernanthine, and voacangine	[130,131]
Tithonia diversifolia (Hemsl.) A. Gray	Antiamoebic activity. Antidiabetic effect. Antimicrobial activity	Flavonoids, tannins, saponins, steroids and terpens. Tannins and saponins. Sugars, sesquiterpenes lactones and phenolics	[124,132-134]
Vernonia amygdalina Delile	Antioxidant activity. Hypoglycemic and hypolipidemic agent	Flavonoids, terpenoids, saponins, tannins and reducing sugars, alkaloids, cardiac glycosides. Carbohydrates, sterols and balsams. Sesquiterpene lactone vernolide and vernodalol	[135-137]

(Contd...)

Table 3: *(Continued)*

Botanicals names	Biological properties	Phytochemicals compounds	References
Voacanga africana Stapf ex Scott-Elliot	Antioxidant activity. Antimicrobial activity	Anthranoids, anthraquinone, cardiac glycosides, phenols, phlobatanins, starch and tannins. Ibogamine, voacamine, vobasine, voacangine, voacristine, 19-epi-voacristine and 19-epi-heyneanine	[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]

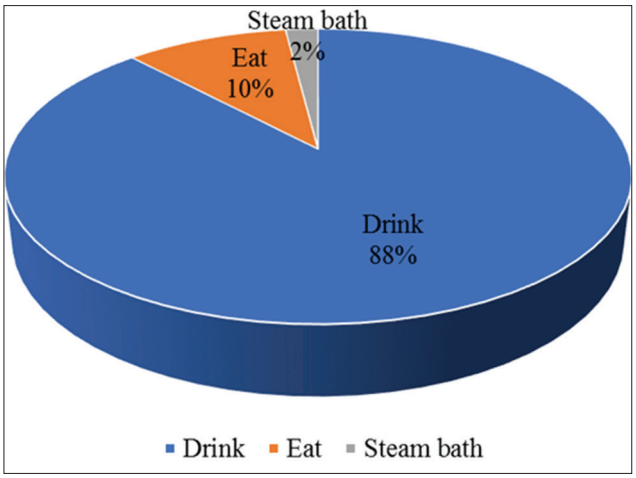

Figure 5: Mode of administration of recipes in the treatment of diabetes in some Gabonese regions

people from different regions for the management of diabetes. The literature also reports the use of some of these plants for diabetes treatment in others 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 antidiabetic 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]. *Guibourtia* 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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