Ethnomedicinal knowledge of plants used in non-conventional medicine in the management of diabetes mellitus in Kinshasa (Democratic Republic of Congo)

Abstract

Background: People with diabetes, herbalists, and traditional medicine practitioners (TMP) from Kinshasa use plants to treat diabetes, but no study has inventoried the plants used by these populations. The present study was conducted to identify the plants used in Kinshasa to treat diabetes mellitus. *Methods*: The survey conducted in the form of a semi-structured interview between March 2005 and August 2006 made it possible to collect ethnobotanical information from people with diabetes (n=126), herbalists (n=80), and TMPs (n=120). *Results*: The 326 subjects consulted (sex ratio M / F = 0.6, age 51 ± 7 years, experience: 17 ± 5 years) provided information on 71 plants, most of which are trees (35%), belonging to 38 families dominated by Fabaceae (19.7%) and indicated in 51 other cases of consultation dominated by malaria (12%). From these 71 plants derived, 86 antidiabetic recipes were administered orally, where the leaf is the most used part (>50%) and the decoction (>46%), the most common mode of preparation. This study reports for the first time the antidiabetic ethnobotanical use of 11 species, among which *Tephrosia vogelii*[X] (0.08), *Chromolaena corymbosa*[X] (0.06), *Baphia capparidifolia*[X] (0.06) present the highest consensus indices (CI) high and *Marsdenia latifolia*[W] (UVp = 0.08) and *Rauvolfia mannii* [X] (UVp = 0.06) the highest UVs. *Conclusion*: The results show that Kinshasa people treat diabete use several plants. Some are specific to the ecological environment; others are used in other regions. Pharmacological studies are underway to assess the therapeutic efficacy of these plants.

Keywords: *Tephrosia vogelii*, *Chromolaena corymbosa*, *Baphia capparidifolia*, Herbalists, Traditional Medicine Practitioners.

1. Introduction

Diabetes mellitus (DM) is a set of metabolic disorders indicated by abnormal insulin production and its action. The disease begins when the patient has plasma glucose values ≥ 7.0 mmol/L (126 mg/dl), 2 h post-load blood glucose ≥ 11.1 mmol/L (200 mg/dl) (5) , HbA1c ≥ 6.5% (48 mmol/mol); or random blood glucose ≥ 11.1 mmol/L (200 mg/dl) in the presence of signs and symptoms of hyperglycemia [2 This insulin deficiency leads to elevated blood glucose levels and decreased carbohydrate and protein metabolism [1].

Worldwide, 537 million adults (20-79 years old) live with diabetes. This number is expected to rise to 643 million by 2030 and 783 million by 2045. More than 3 out of 4 adults with diabetes live in low-income countries like DR Congo, and diabetes has been responsible for 6.7 million death in 2021, i.e., one death every 5 seconds [1]. In the absence of appropriate treatment, cardiac, vascular, neurological, and renal damage and neuropathy may occur. Treatment includes diet, exercise, and medication [2]. Given that most cases occur in low-income countries, where a significant fraction of the population resorts to traditional medicine, which essentially uses plant resources, medicinal plants constitute a credible alternative in the fight against diabetes mellitus.

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Medicinal plants have vast potential in treating various ailments due to the presence of therapeutically significant phytochemicals that constitute them. Certain plants are rich sources of compounds reputed to be antidiabetic such as flavonoids, alkaloids, phenolic compounds, and tannins, improving pancreatic tissues' efficiency by increasing insulin secretion or decreasing intestinal glucose absorption [3]. The literature suggests about 410 plants with experimentally proven antidiabetic properties whose complete mechanism has only been studied for 109 plants [4].

In Democratic Republic of Congo, a country which shares the same reality as other developing countries, not only in terms of the increasing prevalence of diabetes but also and above all about the rate of recourse to medicinal plants in the treatment burden of diabetes, data on the plants used against this condition are not sufficiently available. Some studies, although less systematic, have reported presumed antidiabetic plants in Kinshasa [5,6].

This study completes the data reported in these studies while highlighting plants used by TMPs and diabetics, and herbalists in Kinshasa.

2. Methods

*2.1. Experimental framework.*The city-province of Kinshasa is located between 4° 18' and 4° 25' South latitude and between 15° 18' and 15° 22' East longitude. It is bounded to the north and east by the province of Kwilu, to the south by the province of Congo Central, and the west by the Republic of Congo, with an average altitude of 300 m above the sea. Kinshasa city's climate is tropical. It is characterized by a long rainy season lasting 8 months (October – July), discontinuous between January and February, August and September in favor of the short dry season. The vegetation of Kinshasa consists of degraded primitive forests, savannahs, and aquatic and semi-aquatic formations in the valleys and Malebo pool. It belongs to the Guinean-Congolese region, the Congolese basin domain, and the Congolese-Zambezian transition sector [7].

*2.2 Ethnobotanical Data Collection.*This cross-sectional descriptive ethnobotanical study was conducted between March 2005 and August 2006 through semi-structured interviews based on a questionnaire. The interview focused on knowledge about plants used to manage diabetes mellitus. Three groups of subjects were consulted: people with diabetes, herbalists, and TMPs from Kinshasa.
People with diabetes were met in 4 health zones of the city of Kinshasa: Bumbu, Kalamu I, Limete,and Makala, covering the biomedical centers for the care of people with diabetes in Kinshasa supervised by BDOM (diocesan office of biomedical works). The reference health centers (RHC) Libundi, Bondeko, Saint Clément, 2e Rue, the Bondeko clinic, and the Saint Joseph general reference hospital were concerned.
The herbalists consulted during this study were met in 5 popular markets in Kinshasa, the central market, the Selembao market, the Matadi Kibala market, the Mariano market, and the UPN market.
The TMPs were met in 4 communes of Kinshasa (Bumbu, Kalamu, Limeté, and Makala). These municipalities are covered by the health zones selected during the survey of people with diabetes. The TMPs were reached by snowballing from the TMPs provided by the population in each area concerned and the investigations were carried out in Lingala. The plant species listed were collected with the help of the subjects interviewed and then compared to the reference herbaria of Kisantu, the National Institute of Agronomic Studies, and Research of Kinshasa to produce the first scientific names. These were then formatted according to the Plants of the world online database: POWO de

Kew (https://powo.science.kew.org/) or African Plant Database (https://africanplantdatabase.ch/) or The World Flora Online (http://www.worldfloraonline.org/).

2.3. Data analysis. Three ethnobotanical indexes were calculated to assess the significant species: the usual value (UV), the fidelity index (FI), and the consensus index (CI). The formula determined the usual value (VU): VU = (∑Ui)/Ni where Ui is the number of uses mentioned by an informant for a plant (organ), Ni = number of informants who said the plant. The consensus index on the plant (organ) (IC) was calculated by the formula: IC= Np/N where Np is the number of people who cited the plant (organ) and N is the number of people consulted in the study. The fidelity index of the recipe was calculated by the formula FI= nr/Np where nr = number of people who cited the recipe and Np the number of people who cited the plant. Apart from the 3 ethnobotanical indexes mentioned above, the relative citation frequency (RCF) was also determined. It was calculated by the formula F_{CR} = nx100/N with n, the number of occurrences of the factor examined and N= total number of the population concerned. This factor was used to quantify various factors analyzed in this study except for the factors that were concerned by the ethnobotanical indexes.
In this study, UV: makes it possible to evaluate the medicinal importance of a plant in the environment; IC: makes it possible to identify the level of consensus of the population on the use of a species in the management of diabetes mellitus; IF: makes it possible to establish the level of loyalty that emerges among informants on an antidiabetic recipe.

3. Results

3.1. Ethnobotanical profile of inventoried plants. Seventy-one plants were inventoried during this study. These plants were informed by 3 types of informants, herbalists (class Y), diabetics (class X), and TMPs (class W). The coexistence of these 3 types of informants gave rise to two other classes, the class of plants common to the 3 sources (class Z) and plants familiar to herbalists and TMPs (Class V). Because of the previous, the results show that 16 plants are from diabetics, 7 plants are from herbalists, 22 from TMP, 6 from both herbalists and TMP, and 20 from concomitantly TMPs, herbalists and diabetics (Table 1). It should be noted, however, that the TMP class provided the largest,most significant number of species, i.e., 31% (Figure 3c-d).
Each of these plants is named in one of the 15 Congolese ethnic groups reported in this study, of which Kikongo (50.7%) and Lingala (11.3%) occupy the first two places (Figure 1). These plants belong to 38 families dominated by the Fabaceae (19.7%), followed respectively by Rubiaceae Juss (7.0%), Apocynaceae Juss (5.6%), Asteraceae Bercht & J. Presl (5.6%) and Phyllanthaceae Martinov with 5.6% (Figure 2). These plant taxa are mostly trees (35%) or perennial herbs (31%) endemic to tropical Africa (Figure 3a-b). Among the 71 inventoried species, only *Persea americana* Mill (30.67%), *Senna alata* (L.) Roxb (30.67%), *Garcinia kola* Heckel (18.40%), *Piliostigma reticulatum* (DC.) Hochst (17.79%) and *Vachellia karroo* (Hayne) Banfi & Galasso (17.79%) showed a relative citation frequency > 15% (Table 1).
Eighty-five percent of plants inventoried during this study are reported in previous studies either as plants for ethnomedical use against diabetes (13%) or as plants having demonstrated an antihyperglycemic effect during an ethnopharmacological research (72%). Nevertheless, this study highlights 11 plant species never reported before as antidiabetic plants, among which *Tephrosia vogelii*^{X} ($\mathbf{F_{CR}}$ = 7.98), *Chromolaena corymbosa*^{X} ($\mathbf{F_{CR}}$ = 6.44), and *Baphia capparidifolia*^{X} ($\mathbf{F_{CR}}$ = 5.52) are the most cited (Table 1).

Table 1: Botanical characteristics and previous knowledge of the plants inventoried

Taxon	F_{CR} (n=326)	Family	Appellation	Ethnicity	U_D	A_D
Abelmoschus esculentus (L.) Moench [X]	0.61	Malvaceae	Dongodongo	Lingala	Fr	*In vivo*-Rat: 100-200 mg/Kg [8]
Acalypha paniculata Miq. [W]	1.23	Euphorbiaceae	Kabobo	Bemba	NR	NR
Aframomum melegueta K.Schum. [W]	2.15	Zingiberaceae	Mundongo	Lingala	Tb	*In vivo*-Rat: 200-400 mg/kg [9]
					F	*In vivo*-Rat: 200-400 mg/kg [10]
Albizia adianthifolia (Schumach.) W.Wight[W]	1.23	Fabaceae	Mulu	Kongo	F	*In vivo*-Ginea pig: 500 mg/kg [11]
Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg. [Y]	0.92	Euphorbiaceae	Mambunzila	Kongo	F	*In vivo*-Rat: 200-600 mg/kg [12]
Aloe succotrina Weston [V]	1.53	Asphodelaceae	Langa	Ngwaka	F [13]	NR
Anacardium occidentale L. [X]	0.92	Anacardiaceae	Nkasu	Kongo	R	*In vitro*: 12,5 µg/mL [14]
					F	*In vivo*-Rat : 100 mg/kg [15]
					ET	In vivo-Rat: 200 mg/kg [16]
Annona senegalensis Pers. [W]	3.07	Annonaceae	Kilolo	Kongo	F	*In vivo*-Rat: 100-200 mg/kg [17]
Antidesma venosum E. Mey. ex Tul. [Y]	1 ;53	Phyllanthaceae	Misengo	Kongo	ET [18]	NR
Artemisia afra Jacq. ex Willd. [X]	1.53	Asteraceae	Lengana	Bemba	PA	*In vivo*-Rat: 500-1000 mg/kg [19]
Asparagus racemosus Willd. [Y]	1.23	Asparagaceae	Lutwa	Mbala	PE	*In vitro*-amylase model[20]
Azadirachta indica A.Juss. [V]	0,61	Meliaceae	Marumaru	Shi	Gr	*In vivo*-Rat: 500 mg/kg[21]
					R	*In vivo*-Rat:100-800 mg/kg [22]
Baphia capparidifolia Baker[X]	5.52	Fabaceae	Mumbwo	Ngbandi	NR	NR
Bidens pilosa L.[Z]	5.52	Asteraceae	Kokoyalimo	Lokele	PE	*In vivo* - Rat: 250 mg/Kg [23]
Boerhavia diffusa L. [Y]	2.45	Nyctaginaceae	Ndemba	Ngwaka	F	*In vivo* - Rat: 500 mg/kg [24]
					R	*In vivo*-Rat: 50-300 mg/Kg [25]
Brassica juncea (L.) Czern. [W]	3.68	Brassicaceae	Nkofi	Kongo	Gr	*In vivo*-Rat: 250-450 mg/kg (Thirumalai et al., 2011)
					F	*In vitro&vivo*-Rat:500 mg/kg [26]

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Taxon	F_{CR} (n=326)	Family	Appellation	Ethnicity	U_D	A_D
Bridelia ferruginea Benth. [Z]	3.37	Phyllanthaceae	Kimwindu kinseke	Kongo	ER	*In vivo*- Rat: 50 mg/kg [27]
					F	*In vivo*- Rat: 200-800 mg/kg [28]
Brillantaisia owariensis P.Beauv. [Y]	1.23	Acanthaceae	Lembalemba	Lingala	NR	NR
Cajanus cajan (L.) Huth [Z]	5.52	Fabaceae	Ngoliolio	Ngwaka	F	*In vivo*-Rat: 400-600 mg/kg [29]
Catharanthus roseus (L.) G.Don [V]	1.23	Apocynaceae	Fulele	Ngwaka	T	*In vivo*-Rat: 37.5-150 mg/kg [30]
Chromolaena corymbosa (Aubl.) R.M.King & H.Rob.[X]	6.44	Asteraceae	Mpala kasakula	Kongo	NR	NR
Citrus × *aurantium* L. [W]	1.84	Rutaceae	Nlala	Kongo	Fr	*In vivo*-Rat: 200-300 mg/kg [31]
Costus lucanusianus J.Braun & K.Schum. [Y]	3.37	Costaceae	Ngo nkini	Kongo	F	In vivo-Rat: 100,200 mg/kg [32]
Costus phyllocephalus K. Schum. [Z]	1.23	Costaceae	Mafulungu	Kongo	F [33]	NR
Crinum ornatum (Aiton) Herb. [Z]	1.84	Amaryllidaceae	Munselebende	Kongo	NR	NR
Crossopteryx febrifuga (Afzel. ex G.Don) Benth. [W]	4.91	Rubiaceae	Mvala	Kongo	ET	*In vivo*-Rat: 500-1500 mg/kg [34]
Crotalaria medicaginea Lam. [Z]	1.84	Fabaceae	Nkeka zango	Yanzi	NR	NR
Cymbopogon citratus (DC.) Stapf [W]	4.60	Poaceae	Sinda	Lingala	PE:	*In vivo*-Rat: 2500-5000 mg/kg [35]
Dioscorea dumetorum (Kunth) Pax [X]	5.83	Dioscoreaceae	Ngamba	Kongo	B	*In vivo* -Rat: 100 mg/Kg [36]
Diospyros heudelotii Hiern [W]	3.68	Ebenaceae	Lufwa lundomba	Kongo	R [33]	NR
Dysphania ambrosioides (L.)[x]	9.51	Amaranthaceae	Kulamoka	Yaka	F	*In vivo* -Rat: 100-400 mg/kg [37]
Erythrina abyssinica Lam.[w]	1.23	Fabaceae	Kikumbu	Kongo	ER	*In vivo* - Ginea pig: 500 mg/kg [18]
Ficus benghalensis L.[Y]	1.53	Moraceae	Nsanda	Suku	ET	*In vitro*: AC_{50} = 84.44 ± 1.65 µg/mL [38]
Ficus exasperata Vahl[Y]	1.23	Moraceae	Kikuya	Kongo	F	*In vivo* - Rat: 150 mg/kg [39]
Garcinia kola Heckel[V]	18.40	Clusiaceae.	Ngadiadia	Kongo	Gr	*In vivo*-Rat: 200-800 mg/kg [40]
Gladiolus gregarius Welw. ex Baker[W]	0.61	Iridaceae	Litungulu ya Zamba	Lingala	Bb [18]	NR
Gymnanthemum amygdalinum (Delile) Sch.Bip.[V]	3.07	Asteraceae	Mukari kari	Kongo	F	*In vitro*-α-glucosidase : IC_{50} 47.29 ± 1.12 µg/mL [41]
Harungana madagascariensis Lam. ex Poir.[Y]	2.45	Hypericaceae	Ntumu	Mbala	F	*In vivo* - Rat: 500 mg/Kg [42]
Heinsia crinita (Wennberg) G.Taylor[Z]	2.76	Rubiaceae Juss.	Iyaku	Mongo	F	*In vivo*-Rat: 400 mg/kg [43]

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Taxon	F_{CR} (n=326)	Family	Appellation	Ethnicity	U_D	A_D
Hymenocardia acida Tul.[X]	4.29	Phyllanthaceae	Kigeti	Kongo	F	F: *In vivo*-rat: 250-1000 mg/kg [44]
Lantana camara L.[W]	0.61	Verbenaceae	Ngbanyamando	Ngwaka	F	*In vivo*-Rat: 200-400 mg/kg[45]
					Fr	*In vivo*-Rat: 50-2000 mg/kg [46]
Lippia multiflora Moldenke [Y]	1.23	Verbenaceae	Bulukutu	Kongo	F [47]	NR
Marsdenia latifolia (Benth.) K.Schum.[W]	0.92	Apocynaceae	Lolango	Kongo	NR	NR
Millettia drastica Welw. ex Baker[W]	0.92	Fabaceae	Mwengzti	Kongo	R [33]	NR
Mitragyna stipulosa (DC.) Kuntze[W]	1.23	Rubiaceae	Liluku	Lingala	NR	NR
Monodora myristica (Gaertn.) Dunal[Y]	2.45	Annonaceae	Mpei	Kongo	Gr	*In vivo*-Rat: 50-200 mg/Kg [48]
Morinda lucida Benth.[Y]	1.23	Rubiaceae	Nkisi	Kongo	F	*In vitro*- α-glucosidase: [49]
					ET	*In vivo*-Rat: 125-500 mg/kg [50]
Musanga cecropioides R.Br. ex Tedlie[W]	1.23	Urticaceae	Nsanga	Kongo	F	*In vivo*-Rat: 10-40 mg/kg [51]
					ET	*In vitro* α- glucosidase [52]
Nauclea latifolia Sm.[Y]	1.53	Rubiaceae	Kilolo	Kongo	F	*In vivo*-Rat: 100-200 mg/Kg [53]
Ocimum gratissimum L.[Y]	1.23	Lamiaceae	Dinsusu-nsusu	Kongo	F	*In vitro* α- glucosidase [52]
Palisota schweinfurthii C.B.Clarke [X]	8.28	Commelinaceae Mirb.	Mabongubongu	Yanzi	F [33]	NR
					PE [33]	NR
Pentaclethra macrophylla Benth.[X]	1.84	Fabaceae	Mutunzama	Kongo	ET	*In vivo*-Rat: 200-400 mg/kg [54]
Persea americana Mill.[X]	30.67	Lauraceae	Savoka	Yanzi	F	*In vivo*-rat: 100 mg/kg [55]
					Fr	In vitro α- glucosidase [56]
Phaseolus vulgaris L.[W]	1.53	Fabaceae	Madesu	Lingala	Gr	*In vivo*-Rat : 1-5 mg/kg [57]
Phyllanthus niruri L.[Y]	2.45	Phyllanthaceae	Kahungahunga	Luba-kas	R	*In vivo*-Rat: 200-400 mg/kg [58]
					PA	*In vitr* α- glucosidase:[59]
Piliostigma reticulatum (DC.) Hochst.[X]	17.79	Fabaceae	Falabuta	Suku	F	*In vivo*-rat: 250-1000 mg/kg [60]
Piliostigma thonningii (Schumach.)[Y]	1.53	Fabaceae	Tshifumbe	Luba-kas	ET	*In vivo*-Rat: 500 mg/Kg [61]
Piper guineense Schumach. & Thonn.[W]	0.61	Piperaceae	Kapinde	Kongo	F	*In vivo*-Rat: 40-100 mg/kg [62]
Platymitra arborea (Blanco)	2.45	Annonaceae	Mpei	Kongo	NR	NR

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Taxon	F_{CR} (n=326)	Family	Appellation	Ethnicity	U_D	A_D
P.J.A.Kessler[Y]						
Psidium guajava L.[W]	0.61	Myrtaceae	Mapela	Lingala		*In vivo*-Rat: 40-100 mg/kg [62]
Quassia amara L.[X]	0.61	Simaroubaceae	Mupesipesi	Luba-kat	F,T,R	*In vivo*-Rat: 200 – 500 mg/kg [63]
Rauvolfia mannii Stapf[X]	0.92	Apocynaceae	Kilungu	Kongo	NR	NR
Schwenckia americana L.[Y]	2.45	Solanaceae	Lunzilanzila	Kongo	PE	*In vivo*-Rat: 600 mg/Kg [64]
Senna alata (L.) Roxb.[X]	30.67	Fabaceae	Mbwabwa	Kongo	F Flr [66]	*In vivo*-Rat: 500-500 mg/kg [65] Flr : In vivo: 250-500 mg/kg [67]
Senna occidentalis (L.) Link [V]	2.15	Fabaceae	Ntsambi ntsambi	Kongo	F R	*In vivo*-Rat: 200 mg/kg [68] *In vivo*-Rat: 200 mg/kg [32]
Syzygium cordatum Hochst. ex Krauss [Y]	1.53	Myrtaceae	Mugorhe	Shi	F	*In vivo*-Rat:3-50 mg/Kg [69]
Tephrosia vogelii Hook.f.[X]	7.98	Fabaceae	Uleku	Kongo	NR	NR
Terminalia mollis M.A.Lawson [Y]	2.45	Combretaceae	Mboumbou	Luba-kas	F [18] R [18]	NR NR
Vachellia karroo (Hayne) Banfi & Galasso[X]	17.79	Fabaceae	Munga	Luba-kat	F	*In vitro* α- glucosidase: 25 µg/mL [70]
Voacanga africana Stapf [W]	0.61	Apocynaceae	Kondiankondia	Yaka		*In silico*[71]
Ziziphus mucronata Willd.[W]	1.23	Rhamnaceae	Sula	Hemba	F ET R	*In vitro* α- glucosidase: 1mg/mL , A: 70 % [72] *In vitro* α- glucosidase: 62,5 µg/mL, A: 20 % [73] -Rat:150-300 mg/kg [74]

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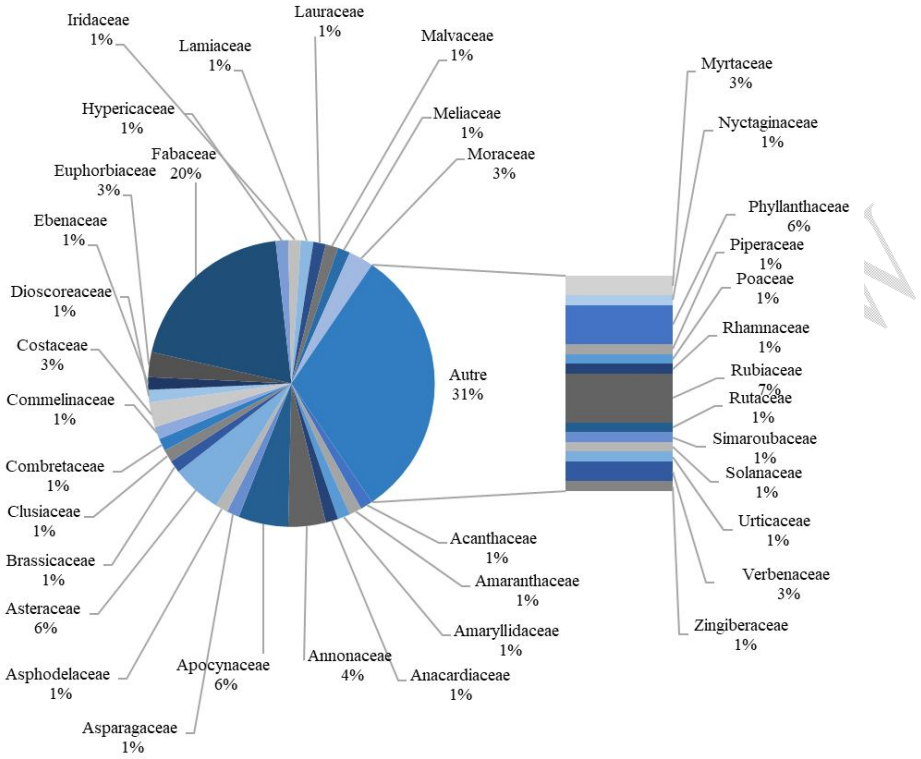
Legend - UD: antidiabetic use; A_D: Previous antidiabetic activity; F_{RC}: relative frequency of citation in percentage; B: Bulb; ER: Root bark; ET: Stem bark; F: Leaves; Fr: Fruits; Gr: Seeds; PA: Aerial.

Comment [WBMD9]: Autre = others ? Should be translated to english



parts,

Figure 1: Botanical family of listed plant species

Legend -PE: Whole plants; R: Roots and Tb: Tubers; NR: Nothing to Report.

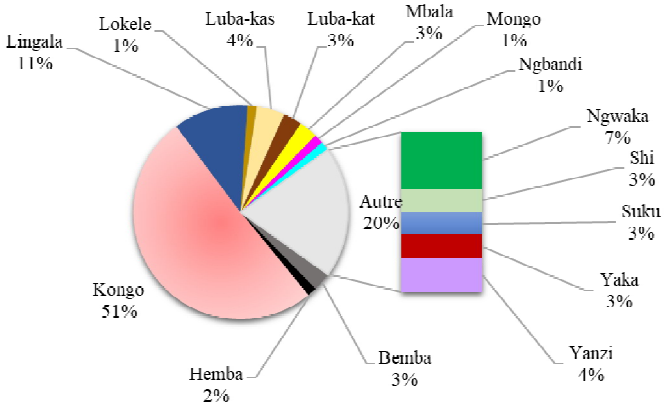


Figure 2:Languages of names of inventoried plants.

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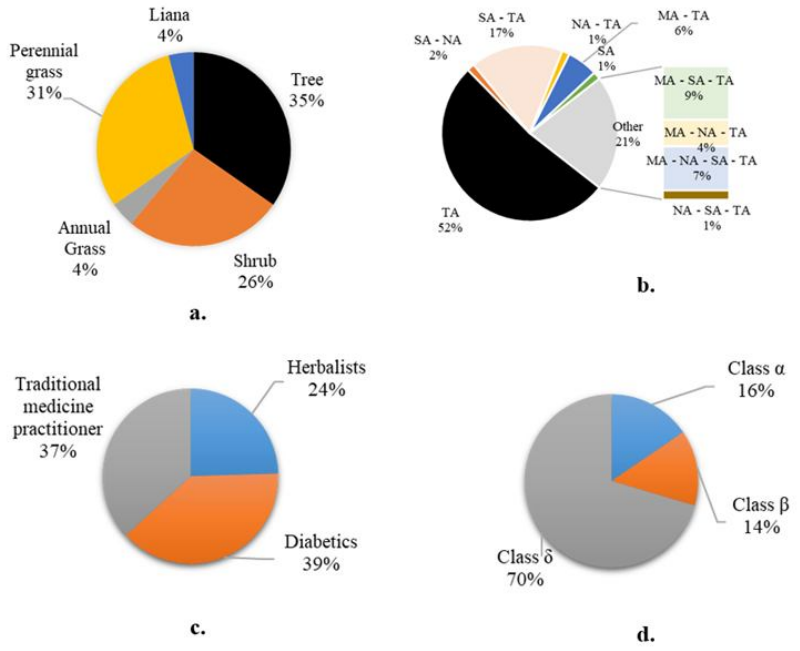

Figure 3: Morphological (a) and geographical (b) type of plants, category of informants (c), and situation of the plant with the literature.

Legend: NA: North Africa; CA: Central Africa; TA: tropical Africa; SA: southern Africa; MA: Madagascar; Plants with pharmacological study concerning diabetes: Class α; Plants without ethnobotanical or pharmacological study related to diabetes: Class β; Plants for ethnobotanical use but without pharmacological research concerning diabetes: Class δ.

3.2. Ethnomedical profile of inventoried plants. The 71 plants inventoried during this study are used in 86 antidiabetic recipes, of which 80 recipes use one plant and 6 combine two plants (Table 2). In the two types of recipes, the administration is essentially done orally, the leaf is the most used organ (50 and 58.3%), and decoction is the most predominant mode of preparation with 46.3 and 66.7% (Figure 4).

Comment [WBMD11]: Maybe better to use traditional formulations ?

Table 2: Antidiabetic recipes in monophytotherapy and other indications

Plant species	R_{EC}	P_U	Preparation	E_R	E_{esp}	IC_R	IC_p	IF_R	VU_O	VU_P	Other indications
Abelmoschus esculentus[X]	R1	F	Maceration	2	2	0.01	0.01	1.0	0.04	0.04	Constipation
Acalypha paniculata[W]	R2	ER	Decoction	4	4	0.01	0.01	1.0	0.04	0.04	Amoeba
Aframomum melegueta[W]	R3	Gr	Infusion	7	7	0.02	0.02	1.0	0.04	0.04	Gastroesophageal reflux

Plant species	R_{EC}	P_U	Preparation	E_R	E_{esp}	IC_R	IC_p	IF_R	VU_O	VU_P	Other indications
Albizia adianthifolia[W]	R4	F	Maceration	4	4	0.01	0.01	1.0	0.06	0.06	Sexual weakness and sores
Alchornea cordifolia[Y]	R5	R	Decoction	3	3	0.01	0.01	1.0	0.06	0.06	Malaria, stomach aches
Aloe succotrina[V]	R6	F	Infusion	5	5	0.02	0.02	1.0	0.08	0.08	Acne, Malaria, and Wounds
Anacardium occidentale[X]	R7	F	Maceration	3	3	0.01	0.01	1.0	0.04	0.04	Warts
Annona senegalensis[W]	R8	ET	Decoction	8	10	0.02	0.03	0.8	0.10	0.12	Sexual weakness, hepatitis, malaria, and sores.
	R9	R	Decoction	2		0.01		0.2	0.04		Urogenital infections
Antidesma venosum[Y]	R10	R	Decoction	5	5	0.02	0.02	1.0	0.08	0.08	Chest pain, pneumonia, and cough
Artemisia afra[X]	R11	F	Maceration	5	5	0.02	0.02	1.0	0.04	0.04	Malaria
Asparagus racemosus[Y]	R12	PE	Decoction	4	4	0.01	0.01	1.0	0.04	0.04	Joint stiffness
Azadirachta indica[V]	R13	F	Maceration	2	2	0.01	0.01	1.0	0.04	0.04	Diarrhea, malaria, and stomachaches.
Baphia capparidifolia[X]	R14	F	Infusion	18	18	0.06	0.06	1.0	0.04	0.04	Inflammation
Bidens pilosa[Z]	R15	R	Infusion	14	18	0.04	0.06	0.8	0.04	0.08	Cataract
	R16	Flr	Decoction	2		0.01		0.1	0.04		Glaucoma
	R17	F	Maceration	2		0.01		0.1	0.04		Pyomyositis
Boerhavia diffusa[Y]	R18	F	Maceration	8	8	0.02	0.02	1.0	0.04	0.04	Angina
Brassica juncea[W]	R19	F	Infusion	12	12	0.04	0.04	1.0	0.04	0.04	Eczema
Bridelia ferruginea[Z]	R20	ER	Decoction	11	11	0.03	0.03	1.0	0.04	0.04	Dislocation
Brillantaisia owariensis[Y]	R21	ER	Decoction	4	4	0.01	0.01	1.0	0.04	0.04	Epilepsy
Cajanus cajan[Z]	R22	F	Maceration	18	18	0.06	0.06	1.0	0.04	0.04	Malaria
Catharanthus roseus[V]	R23	F	Infusion	4	4	0.01	0.01	1.0	0.04	0.04	High blood pressure
Chromolaena corymbosa[X]	R24	F	Maceration	21	21	0.06	0.06	1.0	0.04	0.04	Tuberculosis
Citrus × aurantium[W]	R25	F	Infusion	6	6	0.02	0.02	1.0	0.04	0.04	Colic
Costus lucanusianus[Z]	R26	F	Maceration	11	11	0.03	0.03	1.0	0.04	0.04	Peptic ulcer disease
Costus phyllocephalus[Y]	R27	F	Decoction	4	4	0.01	0.01	1.0	0.04	0.04	Cough
Crinum ornatum[Z]	R28	F	Maceration	6	6	0.02	0.02	1.0	0.04	0.04	Conjunctivitis
Crossopteryx febrifuga[W]	R29	R	Decoction	14	16	0.04	0.05	0.9	0.06	0.06	Diarrhea and malaria
	R30	F	Decoction	2		0.01		0.1	0.06		Diarrhea and malaria
Crotalaria medicaginea[Z]	R31	PE	Infusion	4	4	0.01	0.01	1.0	0.04	0.04	Cough
Cymbopogon citratusW	R32	F	Maceration	15	15	0.05	0.05	1.0	0.04	0.04	Malaria and cough

Plant species	R_{EC}	P_U	Preparation	E_R	E_{esp}	IC_R	IC_p	IF_R	VU_O	VU_P	Other indications
Dioscorea dumetorum[X]	R33	Tb	Decoction	19	19	0.06	0.06	1.0	0.06	0.06	Diarrhea and wound
Diospyros heudelotii[W]	R34	R	Decoction	12	12	0.04	0.04	1.0	0.04	0.04	Contusion
Dysphania ambrosioides[X]	R35	PE	Decoction	31	31	0.10	0.10	1.0	0.06	0.06	Intestinal bruising and worms
Erythrina abyssinica[W]	R36	ER	Decoction	2	4	0.01	0.01	0.5	0.06	0.12	Sexual weakness and malaria
	R37	F	Decoction	2		0.01		0.5	0.08		Cancer, cough, and tuberculosis
Ficus benghalensis[Y]	R38	ET	Decoction	5	5	0.02	0.02	1.0	0.06	0.06	Eczema and vomiting
Ficus exasperata[Y]	R39	F	Infusion	4	4	0.01	0.01	1.0	0.06	0.06	Convulsions and peptic ulcer disease
Garcinia kola[V]	R40	Gr	Infusion	60	60	0.18	0.18	1.0	0.04	0.04	Glaucoma
Gladiolus gregarius[W]	R41	B	Infusion	2	2	0.01	0.01	1.0	0.06	0.06	Angina and amoeba
Gymnanthemum amygdalinum[V]	R42	F	Decoction	10	10	0.03	0.03	1.0	0.10	0.10	High blood pressure, STI, Malaria, and cough
Harungana madagascariensis[Y]	R43	ER	Decoction	8	8	0.02	0.02	1.0	0.06	0.06	Sickle cell disease and malaria
Heinsia crinita[Z]	R44	F	Decoction	9	9	0.03	0.03	1.0	0.06	0.06	Cough and HIV
Hymenocardia acida[X]	R45	R	Decoction	14	14	0.04	0.04	1.0	0.04	0.04	Sickle cell disease
Lantana camara[W]	R46	Fr	Decoction	12	12	0.04	0.04	1.0	0.06	0.06	Malaria and cough
Lippia multiflora[Y]	R47	F	Maceration	4	4	0.01	0.01	1.0	0.08	0.08	Angina, asthma, and sexual weakness
Marsdenia latifolia[W]	R48	R	Decoction	3	3	0.01	0.01	1.0	0.08	0.08	Constipation, cough, and intestinal worms
Millettia drastica[W]	R49	R	Decoction	3	3	0.01	0.01	1.0	0.04	0.04	Sickle cell disease
Mitragyna stipulosa[W]	R50	ER	Decoction	4	4	0.01	0.01	1.0	0.04	0.04	Urogenital infections
	R51	Gr	Decoction	5	8	0.02	0.02	0.6	0.04	0.08	High blood pressure
	R52	F	Maceration	2		0.01		0.3	0.04		Anthrax
	R53	Fr	Infusion	1		0.00		0.1	0.04		Cancer
Morinda lucida[Y]	R54	F	Maceration	4	4	0.01	0.01	1.0	0;04	0.04	Cancer
Musanga cecropioides[W]	R55	F	Maceration	4	4	0.01	0.01	1.0	0.08	0.08	High Blood Pressure, Cough, and Tuberculosis

Plant species	R_{EC}	P_U	Preparation	E_R	E_{esp}	IC_R	IC_p	IF_R	VU_O	VU_P	Other indications
Nauclea latifolia[Y]	R56	F	Decoction	3	5	0.01	0.02	0.6	0.08	0.12	Malaria, toothache, and sore
	R57	R	Decoction	2		0.01		0.4	0.06		Bronchitis and dysentery
Ocimum gratissimum[Y]	R58	F	Decoction	4	4	0.01	0.01	1.0	0.08	0.08	Diarrhea, wound, and sinusitis
Palisota schweinfurthii[X]	R59	F	Maceration	27	27	0.08	0.08	1.0	0.06	0.06	Snakebite and rheumatism
Pentaclethra macrophylla[W]	R60	ER	Decoction	6	6	0.02	0.02	1.0	0.04	0.04	Amibe
Persea americana[X]	R61	F	Maceration	100	100	0.31	0.31	1.0	0.04	0.04	High blood pressure
Phaseolus vulgaris[W]	R62	Gr	Infusion	5	5	0.02	0.02	1.0	0.06	0.06	Wounds and ulcer
Phyllanthus niruri[Y]	R63	ET	Maceration	6	8	0.02	0.02	0.8	0.04	0.08	Wounds
	R64	PA	Infusion	2		0.01		0.3	0.06		Urogenital infections and ulcers
Piliostigma reticulatum[X]	R65	ER	Decoction	58	58	0.18	0.18	1.0	0.08	0.08	Bronchitis, Headaches, and rheumatism
Piliostigma thonningii[Y]	R66	ER	Decoction	5	5	0.02	0.02	1.0	0.08	0.08	Diarrhea, wound, and ulcer
Piper guineense[W]	R67	Fr	Infusion	2	2	0.01	0.01	1.0	0.04	0.04	Asthma
Platymitra arborea[Y]	R68	Fr	Maceration	8	8	0.02	0.02	1.0	0.02	0.02	NR
Psidium guajava[W]	R69	F	Maceration	2	2	0.01	0.01	1.0	0.08	0.08	Diarrhea, hepatitis, and malaria
Quassia amara[X]	R74	R	Decoction	2	2	0.01	0.01	1.0	0.10	0.10	Malaria, sexual weakness, typhoid, and rheumatism
Rauvolfia mannii[X]	R70	F	Maceration	3	3	0.01	0.01	1.0	0.06	0.06	Jaundice and female infertility
Schwenckia americana[Y]	R71	PE	Decoction	8	8	0.02	0.02	1.0	0.06	0.06	Diarrhea and cholera
Senna alata[X]	R72	F	Maceration	100	100	0.31	0,31	1.0	0.04	0.04	Constipation
Senna occidentalis[V]	R73	F	Infusion	7	7	0.02	0.02	1.0	0.06	0.06	Sexual weakness and malaria
Syzygium cordatum[Y]	R75	F	Maceration	5	5	0.02	0.02	1.0	0.06	0.06	Diarrhea and cough
Tephrosia vogelii[X]	R76	F	Infusion	26	26	0.08	0.08	1.0	0,02	0.02	NR
Terminalia mollis[Y]	R77	F	Maceration	8	8	0.02	0.02	1.0	0.08	0.08	Cough, ulcer, measles, and

Plant species	R_{EC}	P_U	Preparation	E_R	E_{esp}	IC_R	IC_p	IF_R	VU_O	VU_P	Other indications
											gastroduodenal.
Vachellia karroo[X]	R78	R	Decoction	58	58	0.18	0.18	1.0	0.08	0.08	Constipation, diarrhea, and cough
Voacanga africana[W]	R79	F	Maceration	2	2	0.01	0.01	1.0	0.06	0.06	Sexual weakness and high blood pressure
Ziziphus mucronata[W]	R80	ER	Decoction	4	4	0.01	0.01	1.0	0.06	0.06	Angina and sickle cell disease

E_R= number of citations per recipe (organ); Eesp= number of citations per plant; ICR: consensus index of the recipe = number of people who cited the recipe out of the total number of people consulted; ICp: consensus index of the plant = number of people who mentioned the plant out of the number of people conferred, IFR = recipe reliability index is the number of people who mentioned the recipe out of the number of people who mentioned the species. VUo: usual value of the organ is the number of uses of the plant organ over the number of uses of the plants in the study. VUp = is the number of uses of the plant out of the number of uses of the set of species, Nu= 52 (number of uses), N = number of people consulted = 326. NR: Nothing to report.

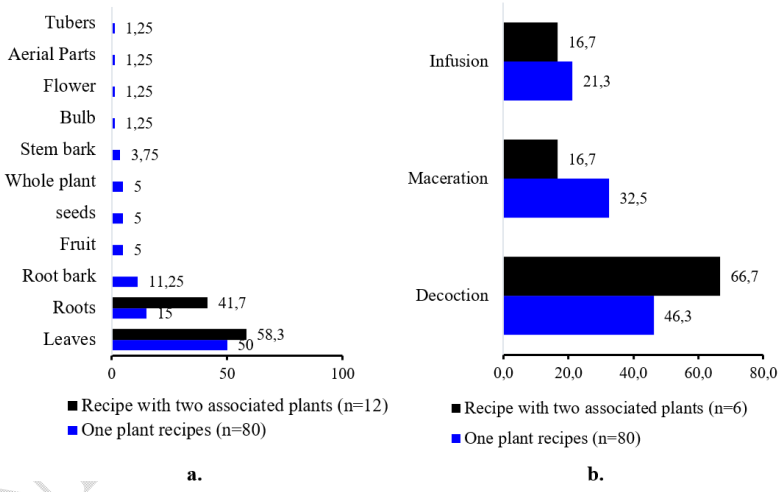

Figure 4: Parts used (a) and mode of preparation of antidiabetic recipes (b).

Only 12 of the 71 plants are involved in the recipes combining two plants. In these recipes (R81-R86), we can observe the associations leaves - leaves, roots - roots, and leaves - roots, representing half of these associations. For these recipes of plants in association, the treatment duration varies between 30 and 45 days, and it is the combination *Albizia adianthifolia* (leaves) and *Annona senegalensis* (roots) with an RCF of 4.6 which is the most cited: R85 (Table 3).

Table 3: Antidiabetic recipes that use two herbs in combination

N°	Taxon1	Taxon 2	N° Recipe	PU - Ratio	Preparation	DT (D)	F_{CR}
1	*Chromolaena corymbosa*[X]	*Dioscorea dumetorum*[X]	R81	F-F (1÷2)	Decoction	30	3,1
2	*Senna alata*[X]	*Alchornea cordifolia*[Y]	R82	F-R (1÷1)	Maceration	45	3,7
3	*Morinda lucida*[Y]	*Nauclea latifolia*[Y]	R83	F-R (2÷1)	Infusion	30	2,5
4	*Platymitra arborea*[Y]	*Schwenckia americana*[Y]	R84	R-R (1÷1)	Decoction	45	3,7
5	*Albizia adianthifolia*[W]	*Annona senegalensis*[W]	R85	F-R (2÷1)	Decoction	45	4,6
6	*Garcinia kola*[V]	*Gymnanthemum amygdalinum*[V]	R86	F-F (2÷1)	Decoction	45	1,8

Legend - PU-Ratio: Part used and proportion of the mixture; F: leaf; R: root; DT: duration of treatment; D: Day; the F_{CR} is expressed in %, n= 326; N° Recipe. = antidiabetic recipe.

The consensus indexes of the antidiabetic recipes (ICR) identified during this study varied between 0.01 and 0.31, the highest values having been observed for the recipes R61, based on *Persea americana*[X] leaves and R72 based on leaves of *Senna alata*[X]; For the 11 plants reported for the first time by this study as antidiabetics, the ICRs vary between 0.08 and 0.01, *Tephrosia vogelii*[X] (0.08), *Chromolaena corymbosa*[X] (0.06), and *Baphia capparidifolia*[X] (0.06) showing the highest values. Usual plant UVp values vary between 0.02 and 0.12; the highest values were observed in Annona senegalensis W, *Nauclea latifolia*[Y,] and *Erythrina abyssinica* [W] with an UVp = 0.12 each. Note also that in the group of 11 taxa reported for prayer times by this study, UVp varies between 0.02 and 0.08; these are *Marsdenia latifolia*[W] (UVp = 0.08) and *Rauvolfia mannii* [X] (UVp = 0 .06) which presented the highest values in this class (Table 2).

The 71 plants inventoried are involved in 51 other causes of consultation, including malaria (12%), cough (9%), diarrhea (7%), wounds (6%), and sexual weakness, which occupy the first 5 places. The other pathologies are below the 5% mark (Figure 5).

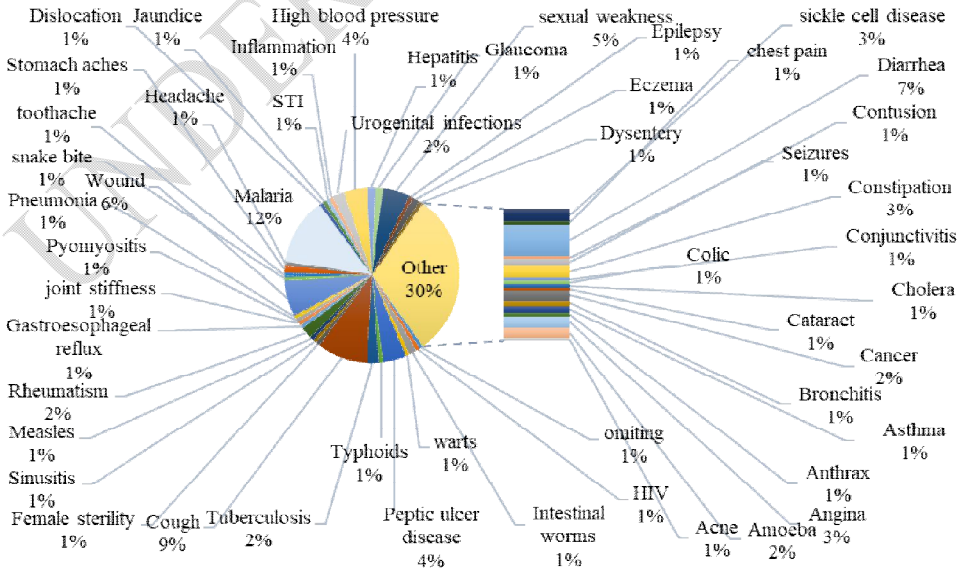

Figure 5: Other diseases are cured by the plants inventoried.

3.3. Socio-demographic profile of subjects consulted. The subjects consulted during this study are either diabetics (38.7%) or herbalists (24.5%), or practitioners of traditional medicine (36.8%), primarily women (62.3%) whose majority age is between 48 and 58 years old, but the extremes are 18 and 70 years old. They mainly live either in the municipality of Kalamu (29.8%) or of Makala (29.4%), and their level of education is, on average, secondary (47.2%). They mainly exercise 4 types of profession, the most representative of which is either commerce (28.5%) or the liberal profession (24.2%). They have, in most cases and, experience more than 11 years of use of medicinal plants in managing diabetes (Table 4).

Table 4: General characteristics of the subjects consulted.

Class	**Category**	**People with diabetes (n=126)**		**Herbalists (n=80)**		**TMP (n=120)**		**Total % (n=326)**
		E	**%**	**E**	**%**	**E**	**%**	
Age	18-28	3	2.4	6	8	7	5.8	4.9
	28-38	21	16.7	6	8	18	15.0	13.8
	38-48	7	5.6	12	15	27	22.5	14.1
	48-58	35	27.8	41	51	60	50.0	41.7
	>58	60	47.6	15	19	8	6.7	25.4
Experience (Year)	1-5	10	7.9	14	18	10	8.3	12.9
	6-10	15	11.9	7	9	58	48.3	24.5
	11-15	20	15.9	40	50	26	21.7	26.4
	16-20	78	61.9	8	10	20	16.7	32.5
	21-25	3	2.4	11	14	6	5.0	6.1
Profession	Trade	21	16.7	68	85	4	3.3	28.5
	Public sector	3	2.4	0	0	5	4.2	2.5
	Liberal	57	45.2	12	15	10	8.3	24.2
	Housework	45	35.7	0	0	3	2.5	14.7
	TMP	0	0.0	0	0	98	81.7	30.1
Gender	Feminine	84	66.7	64	80	55	45.8	62.3
	Male	42	33.3	16	20	65	54.2	37.7
Habitation	Bumbu	15	11.9	16	20	32	26.7	19.3
	Kalamu	45	35.7	23	29	29	24.2	29.8
	Lemba	11	8.7	10	13	6	5.0	8.3
	Limete	25	19.8	10	13	8	6.7	13.2
	Makala	30	23.8	21	26	45	37.5	29.4
Level of studies	None	2	1.6	20	25	6	5.0	8.6
	Primary	21	16.7	15	19	18	15.0	16.6
	Professional	7	5.6	3	4	10	8.3	6.1
	Secondary	47	37.3	41	51	66	55.0	47.2
	University	49	38.9	1	1	20	16.7	21.5

TMP: practitioner of traditional medicine; experience in the diabetic category is the number of years since the patient was diagnosed with diabetes.

Comment [WBMD12]: Female

Comment [WBMD13]: Location… ?

We also sought to determine a correlation between a few variables that characterize the subjects consulted within the framework of this study. The results show a positive linear correlation (R = 0.95 y = 0.4134x - 6.5581) between the age of diabetic subjects and the number of years they have lived with diabetes. Similarly, a positive linear correlation is also observed between the age of herbalists and their years of experience (y = 0.5148x - 13.198, R^2 = 0.8372). This is also the case for the correlation between the age of the TMPs as well as their experience of the profession (y= 0.4076x - 8.3606, R^2 = 0.807) and their age with the number of patients they receive per quarter, y = 0.4525x - 10.394, R^2 = 0.9482 (Figure 6).

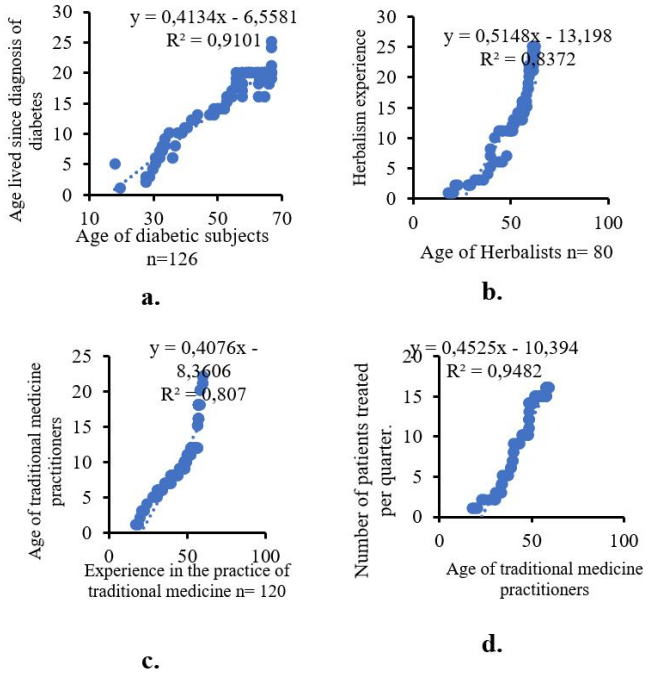

Figure 6:Correlations between various variables of the characteristics of the subjects surveyed.

4. Discussion

The Congolese and particularly flora of Kinshasa has plants that both traditional medicine practitioners and general population resort to in the management of diabetes. This study was interested in inventorying these plants and presenting their ethnobotanical and ethnomedicinal profiles. The study reported 71 taxa used in 86 recipes to treat diabetes mellitus.

These 71 plants are primarily trees from the Fabaceae family, endemic to tropical Africa, and are named mainly in Kikongo (Table 1, Figures 2.3). These results are in agreement with the literature. Indeed, the Fabaceae are reported to be the ~~and~~ most prominent family of trees in Africa's tropical and dry forests [75]. This importance of Fabaceae is observed both within the plant kingdom [76] and within African medicinal plants in particular [77].The numerical predominance of Fabaceae in sub-Saharan Africa has been attributed to their ability to scavenge atmospheric nitrogen, allowing

Comment [WBMD14]: Rephrase ; confusing

Comment [WBMD15]: Rephrase : The objectiveof this study is to make an inventory of ….

them to grow in nutrient-poor and rich soils [78]. In our experimental framework, no accessible study has addressed the question of the preponderance of a botanical family over all the taxa used in traditional medicine in Kinshasa. Such a study would be desirable. However, the analysis of some ethnobotanical studies in Kinshasa shows that the Fabaceae constitutes one of the three most evoked families. Some of these studies targeted a specific ethnomedicinal use, in particular the survey of feminine intimate hygiene plants: n= 37 Rubiaceae 14%, Fabaceae 11% [79] and a study on plants used against symptoms of tuberculosis in Kinshasa: N= 24, Fabaceae, Apocynaceae and Lamiaceae with F_{CR} = 8.3% each in the lead [80]. Other works reported untargeted ethnobotanical knowledge. This is particularly the case for the study on plants marketed in Kinshasa: n= 47 Rubiaceae and Fabaceae with an F_{CR} = 12.7% for each [81] or the survey of plants used in traditional medicine in Lukunga district: n= 37, Fabaceae, Rubiaceae, and Zingiberaceae each with an RCF of 7.7% [82]. There are also studies done on the management of diabetes in the region. This is the case of a survey carried out in the Kimbanseke and Selembao communes: n = 21, Rubiaceae F_{CR} = 33.3%, Fabaceae F_{CR} =19.1% [6] or the study in Kwango and Kinshasa: n= 68, Fabaceae F_{CR} = 19.1% [5]. It would nevertheless be interesting to carry out an inventory of plants known to be medicinal in the DRC to highlight their specific ethnobotanical characteristics. This concern has not been the subject of this study, which nevertheless contributes to highlighting the need for such data.

The review of the literature carried out on these 71 taxa makes it possible to group them into 3 classes: species for which no ethnobotanical or pharmacological information is reported on the management of diabetes mellitus (Class α), species whose ethnopharmacological use as an antidiabetic is reported without no study aimed at validating this use is accessible (Class δ) and, the plant species which have already been the subject of the evaluation of the antihyperglycaemic activity: Class β (Figure 3d). The fact that 70% of the species listed during this study are reported to be antihyperglycaemic in vivo on the rat reinforces the credibility of the information obtained during this investigation. It suggests a high probability of finding among the 30% of the remaining species, those with antihyperglycemic activity.

The 11 plant species whose antidiabetic ethnomedicinal knowledge is reported for the first time during this study and, for which no pharmacological antidiabetic activity survey is registered in the accessible literature are: *Chromolaena corymbosa, Platymitra arborea, Crinum ornatum, Crotalaria medicaginea, Acalypha paniculata, Brillantaisia owariensis, Mitragyna stipulosa, Marsdenia latifolia* and *Rauvolfia mannii* (Table 1). Although these species are reported for the first time as plants for antidiabetic use through this study, except for *Chromolaena corymbosa*, these taxa have been reported in previous studies as medicinal plants: *Tephrosia vogelii*[83], *Baphia capparidifolia*[84], *Platymitra arborea*[85], *Crinum ornatum*[86], *Crotalaria medicaginea*[87], *Acalypha paniculata*[88], *Brillantaisia owariensis*[89], *Mitragyna stipulosa*[90], *Marsdenia latifolia*[91] and *Rauvolfia mannii*[92]. Therefore, this study reports the first ethnomedicinal information for *Chromolaena corymbosa* whose leaves are used by people with diabetes in Kinshasa for the management of tuberculosis and diabetes (Table 2).

Concerning ethnobotanical indexes, it should be noted that for an ethnobotanical study targeted towards a specific pathology, the relative frequency of citations corresponds to the consensual citation index of the plant, which translates the consensus which is reached around a particular plant species on targeted use. For the 11 taxa not studied, there is a higher consensus on the use of *Tephrosia vogelii* leaves (ICp = 0.08) as an antidiabetic than any other species of the same category (Table 2). This precedence which may result from this ethnobotanical index (ICp) is, however to be put into perspective by the fact that a single category only told the plant of the subjects consulted, namely diabetics, unlike, in particular, the leaves of the *Crinum ornatum*[Z] species which present the weakness of ethnobotanical index whose value is twice lower than that of *Tephrosia vogelii*

(ICp=0.04), but whose strength lies in the fact that it was informed simultaneously by the three sources: diabetics, TMPs and herbalists, which reinforces the consensus around its use as an antidiabetic in the study environment.

The study population uses three plant species most because of their highest VU of the series (0.12). These are *Annona senegalensis*, *Erythrina abyssinica* and *Nauclea latifolia* (Table 2). All of its plants belong to the taxa category whose ethnobotanical and pharmacological knowledge of diabetes has previously been reported. The most common plants in the study would, therefore, not be the most interesting in the context of this study, which aims to enhance the ethnopharmacological knowledge of Kinshasa. If, in most cases, each plant inventoried during this study is also known and used by our resource persons for at least one other pathology, it should be emphasized that this is not the case with *Tephrosia vogelii*[X] and *Platymitra arborea*[Y] for which taxa, our informants only use it in the management of diabetes mellitus. This is what justifies their lower usual value of 0.02 (Table 2).

Malaria (FCR = 12%), cough (FCR = 9%), and diarrhea (FCR = 7%) constituted the 3 first pathologies, apart from diabetes, for which the plants listed during this study are used. These pathologies are among the 10 most deadly pathologies in the DRC [93], suggesting that traditional medicine from Kinshasa has the knowledge likely to contribute to the management of specific pathologies of concern in DR Congo. It would be interesting to carry out studies aimed at validating this ethnopharmacological knowledge to rightly understand the assistance of conventional medicine from Kinshasa in managing pathologies such as diabetes.

The 71 plant taxa inventoried during this study made it possible to list 86 antidiabetic recipes, 80 of which use a single plant (Table 2) and 6 combine 2 plants (Table 3). Unlike previous ethnopharmacological studies carried out in DR Congo on antidiabetic plants [5,18,33,94], this one reports antidiabetic recipes of the plants used in association for the first time.

Of all the antidiabetic recipes using a single plant and reported during this study, the leaf and the decoction constitute, the most used organ and mode of preparation. These results are in agreement with the studies carried out on the plants of Kisangani: leaf (57.6%), decoction (78.8%), n= 33 [94] and plants of DR Congo gathered in a review article, leaves 39.2%, decoction: 60.5%, n= 213 [33]. Some disparities are nevertheless observed in a study carried out in South Katanga, where the decoction (62.5%) was found to be theprimary way of preparation and the root of the most used organ: 41.3%, n= 95 [18]. The same is true in the study carried out simultaneously in Kwango and Kinshasa (n= 68) where the leaves at 65% proved to be the most used organ, and maceration with 63%, the most common mode of preparation solicited [5]. The herbal antidiabetic recipes used in Kinshasa are in line with the national trend, unlike those used in Lubumbashi, the country's second-largest city.

According to the subjects consulted, using a decoction would aim not only to extract the active ingredient but also to activate it, a mixed idea, especially since this extraction procedure is just as beneficial as it is harmful. Indeed, as much as it could facilitate the release of certain active principles often present in the plant in the form of glucosides, it could not only release specific toxic secondary metabolites such as cyanogenic glycosides [95] but also deteriorate the active ingredient when the latter is thermolabile [96–98]. Therefore, this practice remains to be assessed on a case-by-case basis, and only experimental work could determine its fair value.

About the various correlations established on specific characteristics of the subjects consulted (Figure 6), this study shows that the older the diabetic issues, the longer they have lived with diabetes, which suggests that most of the subjects consulted would be diabetics from type 1. Similarly, the study reveals that the oldest TMPs are the most experienced and the most experienced are those who see more patients. This supposes that traditional medicine requires time to retain

Comment [WBMD16]: Rephrase, confusing.

patients who would be more confident towards the most experienced. This attitude is also observed in conventional medicine, where rationality would like the patient to be reassured by the doctor's experience before being consulted, especially for specific pathologies.

5. Conclusion

Comment [WBMD17]: Conclusion should be more constructive highlighting the main findings, limitations and significance of the study.

Several plants are used in Kinshasa to manage diabetes mellitus by herbalists as well as by people with diabetes and traditional medicine practitioners. This study highlights not only antidiabetic recipes but also plants that are reported only in Kinshasa for the management of diabetes. It also evokes their usual values in this environment. It opens the way towards a subsequent study to validate the antidiabetic use, in particular of particular species of the environment and those of particularspecial interest there.

Data available statement
The data used in this study are provided and include within the article.

References

Comment [WBMD18]: Reference no.93 authors to many. Does this follow the citation format ?

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