

## Botanical and ethnomedicinal characteristics of antidiabetic plants sold in the markets of Man, Côte d'Ivoire

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### Abstract

To inventory and provide the botanical characteristics of medicinal plants used in the treatment of diabetes in the city of Man, an ethnobotanical survey was conducted among 54 herbalists based on a survey form. These herbalists were interviewed at three markets in the city of Man: Commerce market, Grand-Gbapleu market, and Libreville market. The choice of these markets was justified by their impressive number of herbalists. Two indices of cultural importance were calculated to assess traditional knowledge: Citation Frequency (FC) and Contribution to Recipes (Cpr). These ethnomedicinal investigations made it possible to inventory 32 plant species, divided into 32 genera and 19 botanical families, with a predominance of the Fabaceae family. The calculated ethnobotanical indices revealed that *Phyllanthus amarus* is the most cited and most requested species in medicinal recipes. Regarding the organs used in medicinal recipes, the leaves are the most commonly used parts, mostly prepared by decoction and administered orally. The results of this work could encourage in-depth studies on the identified plants, particularly in the search for phytomedicines capable of effectively treating diabetes.

**Keywords:** Ethnomedicinal, medicinal plants, diabetes, man, côte d'ivoire

### Introduction

Diabetes is a complex and multifactorial chronic disease manifested by persistent hyperglycemia. This condition can be caused either by a deficiency in insulin secretion, an inability of cells to respond effectively to this hormone, or a combination of both (ADA, 2022) [1]. Produced by the beta cells of the islets of Langerhans located in the pancreas, insulin plays a key role in managing the metabolism of carbohydrates, lipids, and proteins. It facilitates the entry of glucose into cells to provide energy or be stored as glycogen, while reducing excessive glucose production by the liver (DeFronzo *et al.*, 2015) [8]. Today, diabetes has a worrying prevalence worldwide and represents a major public health issue. The number of adults affected by the disease is estimated at 537 million (IDF, 2021) [13]. According to the same source, this figure could rise to 783 million by 2045 if preventive measures are not quickly implemented. In sub-Saharan Africa, the situation is particularly worrying, with a predicted seroprevalence of 129% by 2045 (Mbanya *et al.*, 2010) [16]. In Côte d'Ivoire, diabetes is a growing health concern. The seroprevalence of the disease is 5.4% (Guiraud *et al.*, 2019) [12]. This high prevalence rate places diabetes as the most common endocrine disease (Gentilini, 1993) [10]. What can be done about this alarming situation? We must seek new, easily accessible, and inexpensive therapies capable of normalizing and stabilizing blood sugar levels. To research such therapies, numerous ethnopharmacological investigations have been conducted in Africa, particularly in Côte d'Ivoire (Aké-Assi, 2011; Ta *et al.*, 2020) [2, 4, 23]. It is with this perspective of searching for new therapies that we conducted this study. It focuses on medicinal plants with antidiabetic effects offered by herbalists encountered in the markets of Man. It aims to contribute to the search for plant

resources capable of effectively combating diabetes and providing their botanical characteristics.

### Material and Methods

#### Presentation of the study area

The study was conducted in Man (Figure 1). A city located in western Côte d'Ivoire, nearly 600 km from Abidjan. The city of Man is one of the largest cities in western Côte d'Ivoire. It is located at 7°24'0"N latitude and 7°33'0"W longitude (Kouadio, 2001) [14].

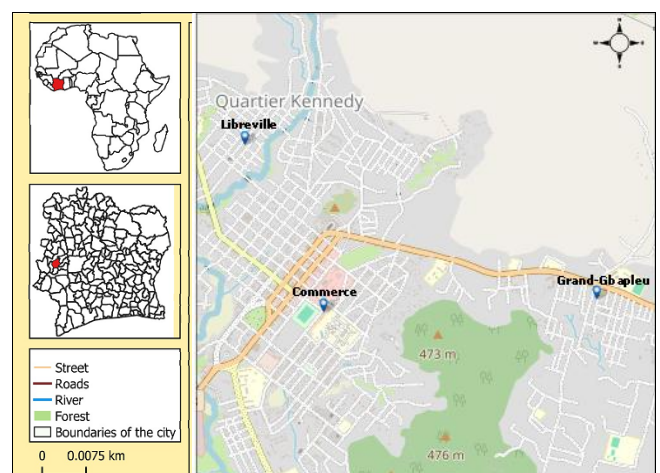


Fig 1: Location of the commune of Man in Cote d'Ivoire

### Material

The biological material includes all the plant species found in the markets of the city of Man. Technical equipment was also required. It consisted of a survey sheet for collecting information, pruning shears for collecting specimen samples, black plastic bags, old newspapers for storing the

samples, and cardboard to properly spread the samples in the newspapers. In addition, a notebook was used to record additional information. We also needed a laptop to enter and analyze the collected data.

### Ethnobotanical Survey

The survey on antidiabetic plants was conducted from January to March 2025 among herbalists interviewed in three markets in the city of Man: Libreville Market, Grand-Gbapleu Market, and Commerce Market. The approach used was to visit the herbalists at their workplaces. Based on a survey form, they were given a questionnaire. The information covered plants used to treat diabetes, the different organs used, and techniques for preparing and administering remedies. We purchased plant samples from markets to create a herbarium.

### Species Identification and Typology

The identification of the identified plant species was carried out at the National Center for Floristics at Félix Houphouët-Boigny University. Each species was characterized according to several fundamental criteria. First, the morphological characteristics were analyzed based on the size, structure, and consistency of the plant organs. Then, the biological typology was determined within the same structure. Furthermore, the phytogeographic distribution was established with reference to the work of Aké-Assi (2002) [5], allowing each species to be assigned a specific ecological area. Finally, the ecological status was specified, distinguishing between spontaneous species and those present in ecosystems modified by human activity. This methodical analysis made it possible to compile a directory of plants with anti-diabetic properties marketed in Man's markets.

### Evaluated Ethnobotanical Index

#### Citation Frequency (FC)

The level of knowledge can be assessed through citation frequency, which corresponds to the number of times a plant is mentioned in the lists compiled by the respondents. This index makes it possible to estimate both the reliability of the information collected and the degree of knowledge of plants within the markets studied (Schrauf and Sanchez, 2008) [22]. The citation frequency of a species is given by the following formula:

$$FC = 100 \left( \frac{\text{Number of times a species was mentioned}}{\text{Total number of all species mentioned}} \right)$$

#### Contribution to Recipes (Cpr)

The contribution of each species to medicinal recipes (Cpr) allows us to determine the frequency of a plant's involvement in recipes and was calculated using the formula of Dassou *et al.* (2014) [7]. It is calculated using the following formula:

$$CPR = 100 \left( \frac{\text{Number of recipes using a plant species}}{\text{Total number of recipes}} \right)$$

### Statistical Data Analysis

The calculated citation frequencies were analyzed using SPSS 20 software. These values were used to perform a

hierarchical classification using a dendrogram. To create this dendrogram, we followed the Bayer code for renaming plant species. This code consists of designating a plant using five-letter initials.

## Results

### Botanical Characteristics

#### Listed Plants and Botanical Characteristics

The survey conducted at three markets in the city of Man identified 32 plant species, spread across 32 genera and 19 botanical families. The list of plant species and their botanical characteristics are shown in Table 1. The table shows that the Fabaceae family is the most represented, with five species (15.63%). The *Rubiaceae* and *Apocynaceae* families are made up of three species each, representing 9.38%. The *Euphorbiaceae*, *Asteraceae*, *Myrtaceae*, *Crassulaceae*, and *Lauraceae* families are represented by two species each (6.25%). The other families are less abundant, with only one species each (3.13%).

### Species Typologies

The plants recorded fall into four morphological types: trees (37.5%), shrubs (25%), herbaceous plants (25%), and vines (12.5%). Among these morphological types, trees predominate, accounting for 37.5% of the species recorded. For biological types (Table 1), microphanerophytes are dominant, accounting for 43.75% of the species, followed by mesophanerophytes (21.88%), and megaphanerophytes (9.38%). Other types nanophanerophytes, therophytes, chamaephytes, hydrophytes, and hemicryptophytes are poorly represented, with proportions ranging from 3.12% to 6.25%.

Concerning the phytogeographic types, they are represented by Figure 2. Taxa from both the Guinean-Congolese and Sudano-Zambezian (GC-SZ) regions dominate with 13 species, or 40.63%. They are followed by taxa specific to the Sudano-Zambzian (SZ) region, which have 9 species (28.13%). Taxa belonging to the Guinean-Congolese (GC) region represent 6 species, or 18.75% while introduced species (I) are the least numerous, with 4 species (12.5%).

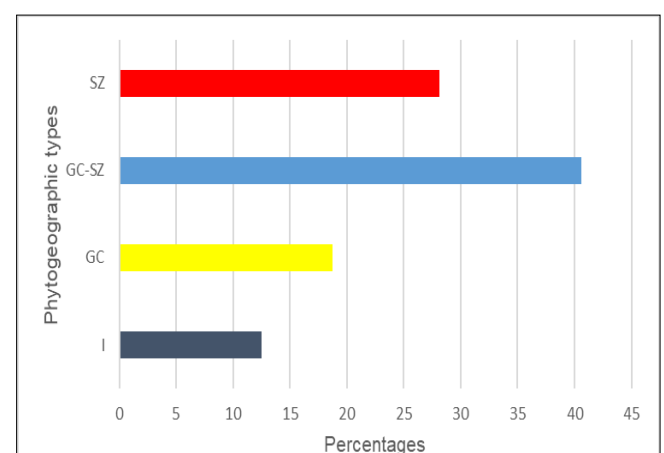


Fig 2: Histogram of species distribution by phytogeographic type

### Status of listed plants

The plants listed in the markets of the city of Man are divided into 20 wild species (62.5%), demonstrating a strong dependence on local natural resources, and 12 cultivated species (37.5%), reflecting a growing interest in the conservation and availability of certain medicinal plants

**Table 1:** Listed plants and botanical characteristics

Species	Families	Morphological Types	Biological Types	Phytographic types	Status
<i>Alchornea cordifolia</i>	Euphorbiaceae	Three	Mp	GC-SZ	Spontaneous
<i>Aorantho cladantha</i>	Rubiaceae	Shrub	Mp	GC-SZ	Spontaneous
<i>Artocarpus heterophyllus</i>	Moraceae	Three	Mp	I	Cultivated
<i>Calotropis procera</i>	Apocynaceae	Shrub	Mp	I	Spontaneous
<i>Calycosiphonia spathicalyse</i>	Rubiaceae	Shrub	Mp	GC-SZ	Spontaneous
<i>Carica papaya</i>	Caricaceae	Three	Mp	I	Cultivated
<i>Cassia siamea</i>	Fabaceae	Three	Mp	I	Cultivated
<i>Chromolaena odorata</i>	Asteraceae	Herb	Mp	I	Spontaneous
<i>Cnestis ferruginea</i>	Connaraceae	Wine	Np	I	Spontaneous
<i>Combretum micranthum</i>	Combretaceae	Three	Mp	GC-SZ	Spontaneous
<i>Eucalyptus robusta</i>	Myrtaceae	Three	MP	I	Cultivated
<i>Euphorbia hirta</i>	Euphorbiaceae	Herb	Th	GC-SZ	Spontaneous
<i>Irvingia gabonensis</i>	Irvingiaceae	Three	Mp	GC-SZ	Cultivated
<i>Kalanchoe crenata</i>	Crassulaceae	Shrub	Ch	I	Cultivated
<i>Kalanchoe pinnata</i>	Crassulaceae	Shrub	Ch	I	Cultivated
<i>Khaya senegalensis</i>	Meliaceae	Three	MP	GC-SZ	Cultivated
<i>Leptadenia lanceolata</i>	Apocynaceae	Shrub	Np	GC-SZ	Spontaneous
<i>Leucaena leucocephala</i>	Fabaceae	Three	Mp	I	Cultivated
<i>Litsea glutinosa</i>	Lauraceae	Three	Mp	GC-SZ	Spontaneous
<i>Moringa oleifera</i>	Moringaceae	Three	Mp	GC-SZ	Cultivated
<i>Morinda lucida</i>	Rubiaceae	Three	MP	GC-SZ	Spontaneous
<i>Nymphaea lotus</i>	Nymphaeaceae	Herb	Hyd	GC-SZ	Spontaneous
<i>Parkia biglobosa</i>	Fabaceae	Three	Mp	GC-SZ	Spontaneous
<i>Persea americana</i>	Lauraceae	Three	Mp	I	Cultivated
<i>Persicaria senegalensis</i>	Polygonaceae	Herb	H	GC-SZ	Spontaneous
<i>Phyllanthus amarus</i>	Phyllanthaceae	Herb	Th	GC	Spontaneous
<i>Picralima nitida</i>	Apocynaceae	Three	Mp	GC-SZ	Spontaneous
<i>Piliostigma thonningii</i>	Fabaceae	Three	Mp	GC-SZ	Spontaneous
<i>Psidium guajava</i>	Myrtaceae	Three	Mp	I	Cultivated
<i>Tamarindus indica</i>	Fabaceae	Three	Mp	GC-SZ	Spontaneous
<i>Tithonia diversifolia</i>	Asteraceae	Herb	Mp	I	Spontaneous
<i>Ziziphus mauritiana</i>	Rhamnaceae	Three	Mp	GC-SZ	Spontaneous

**LEGEND:** MP: Megaphanerophyte; Mp: Mesophanerophyte; mp: Microphanerophyte; np: Nanophanerophyte; Th: Therophyte; Ch: Chamaephyte; Hyd: Hydrophyte; H: Hemicryptophyte GC: Guinea-Congo Region; SZ: Sudano-Zambezi Region; GC-SZ: Guinea-Congo and Sudano-Zambezi Region; I: Introduced species.

**Ethnomedicinal Data**

**Sites Visited**

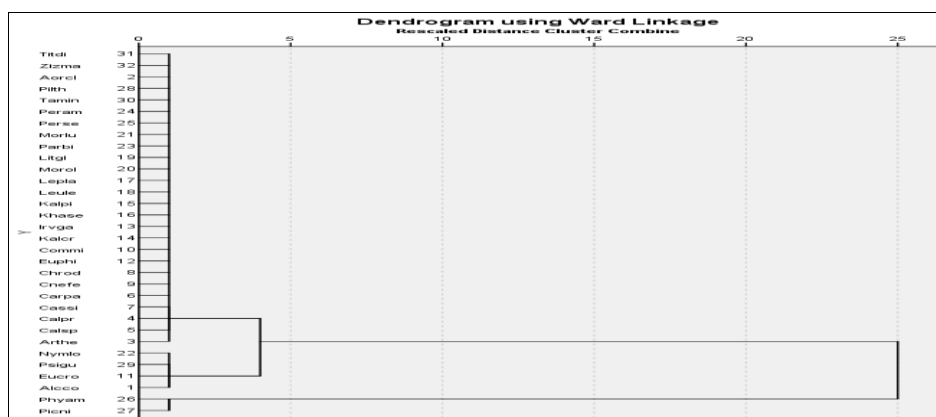
The ethnobotanical survey was conducted among 54 herbalists at three markets in the city of Man: The Grand-gapleu market, the Libreville market, and the Commerce market. Among the respondents, 39 were women (72.2%) and 15 were men (28.8%). In relation to the age of the

interviewees, they were between 35 and 55 years old.

**Evaluated Ethnomedic Indices**

**Citation Frequency (FC)**

The citation frequencies were used to create a hierarchical classification of the listed plants using a dendrogram (Figure 3).



**Fig 3:** Dendrogram of hierarchical classification of plants listed according to citation FC

Figure 5 presents three groups of plants with a cluster distance of 3. The first group is composed of the species most frequently cited by respondents, including *Picralima nitida* (FC = 13%) and *Phyllanthus amarus* (FC = 10%).

The second group consists of plants with intermediate citation frequencies, such as *Eucalyptus robusta* (FC = 4%), *Psidium guajava* (FC = 4%), *Euphorbia hirta* (FC = 2%), and *Alchornea cordifolia* (FC = 6%). The third group

consists of species with low citation frequencies (less than or equal to 2%).

### Contribution to Recipes (Cpr)

Cpr values are shown in Table 2. This table shows that

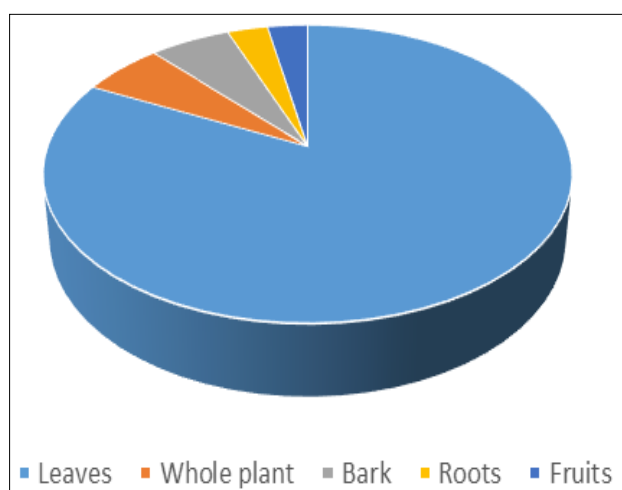
*Combretum micranthum*, *Ziziphus mauritiana*, *Morinda lucida*, *Phyllanthus amarus*, *Moringa oleifera*, *Chromolaena odorata*, *Kalanchoe crenata*, and *Leptadenia lanceolata* have high Cpr ( $\geq 6.5\%$ ). The other plant species have low Cpr ( $< 3\%$ ).

**Table 2:** Plants listed and ethnomedicinal characteristics

Plant species	Parts used	Preparation Technique	Administration Method	Cpr
<i>Alchornea cordifolia</i>	Leaves	Decoction	Drink	2.7
<i>Aoranche cladantha</i>	Leaves	Decoction	Drink	2.7
<i>Artocarpus heterophyllus</i>	Roots	Decoction	Drink	2.7
<i>Calotropis procera</i>	Leaves	Decoction	Drink	2.7
<i>Calycosiphonia spathicalyse</i>	Leaves	Decoction	Drink	2.7
<i>Carica papaya</i>	Leaves	Decoction	Drink	2.7
<i>Cassia siamea</i>	Leaves	Decoction	Drink	2.7
<i>Chromolaena odorata</i>	Leaves	Decoction	Drink	5.4
<i>Cnestis ferruginea</i>	Leaves	Decoction	Drink	2.7
<i>Combretum micranthum</i>	Leaves	Decoction	Drink	8.1
<i>Eucalyptus robusta</i>	Leaves	Decoction	Drink	2.7
<i>Euphorbia hirta</i>	Whole plant	Decoction	Drink	2.7
<i>Irvingia gabonensis</i>	Leaves	Decoction	Drink	2.7
<i>Kalanchoe crenata</i>	Leaves	Direct heating	Drink	5.4
<i>Kalanchoe pinnata</i>	Leaves	Direct heating	Drink	2.7
<i>Khaya senegalensis</i>	Leaves	Decoction	Drink	2.7
<i>Leptadenia lanceolata</i>	Leaves	Decoction	Drink	5.4
<i>Leucaena leucocephala</i>	Leaves	Decoction	Drink	2.7
<i>Litsea glutinosa</i>	Leaves	Decoction	Drink	2.7
<i>Moringa oleifera</i>	Leaves	Decoction	Drink	2.7
<i>Morinda lucida</i>	Leaves	Decoction	Drink	5.4
<i>Nymphaea lotus</i>	Leaves	Decoction	Drink	2.7
<i>Parkia biglobosa</i>	Bark	Decoction	Drink	2.7
<i>Persea americana</i>	Leaves	Decoction	Drink	2.7
<i>Persicaria senegalensis</i>	Leaves	Decoction	Drink	2.7
<i>Phyllanthus amarus</i>	Whole plant	Decoction	Drink	8.1
<i>Picralima nitida</i>	Leaves Fruits	Decoction Infusion	Drink	2.7
<i>Piliostigma thonningii</i>	Leaves	Decoction	Drink	2.7
<i>Psidium guajava</i>	Leaves	Decoction	Drink	2.7
<i>Tamarindus indica</i>	Leaves/Bark	Decoction	Drink	2.7
<i>Tithonia diversifolia</i>	Leaves	Decoction	Drink	2.7
<i>Ziziphus mauritiana</i>	Leaves	Decoction	Drink	5.4

### Plant Parts Used in Drug Recipes

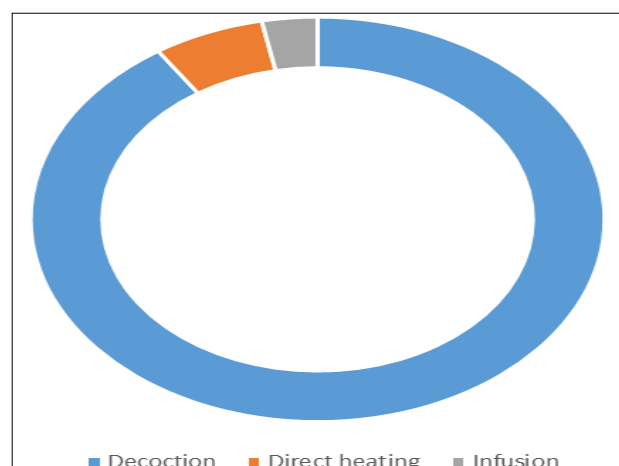
Analysis of the plant parts used in antidiabetic preparations reveals that leaves are the most commonly used (87.5%), representing 28 species. Other parts used include the whole plant (6.25%), bark (6.25%), roots, and fruits, each representing 3.12% of cases (Figure 4).



**Fig 4:** Spectrum of plant parts used in medicinal recipes

### Preparation Techniques and Administration of Drug Recipes

The study revealed three preparation techniques: decoction (90.60%), direct heating (6.25%), and infusion, which represented 3.12% of cases (Figure 5). Regarding administration methods, only one was distinguished: oral administration in the form of a drink (100%).



**Fig 5:** Different techniques for preparing medicines

## Discussion

### Botanical Characteristics

The ethnobotanical study conducted in the markets of the city of Man identified 32 plant species, distributed across 32 genera and belonging to 19 botanical families. Among these, the Fabaceae family is the most represented. Aké-Assi (1984)<sup>[3]</sup> highlighted that this family is among the most diverse and frequent in the Ivorian flora, which could explain its high representation in our study. Regarding biological types, microphanerophytes are the majority among the listed species (43.75%), followed by mesophanerophytes and megaphanerophytes. This result is consistent with the conclusions of Béné *et al.* (2016)<sup>[6]</sup>, in their study of medicinal plants in the Zanzan region of Côte d'Ivoire, as well as those of Saraka *et al.* (2018)<sup>[21]</sup>, who also reported a high proportion of microphanerophytes in local medicinal floras. These biological types, generally adapted to lightly disturbed areas or areas close to habitation, are more easily accessible for collection. From a phytogeographic perspective, species from the Guinean-Congolese and Sudano-Zambezian (GC-SZ) region dominate the list. These results are consistent with those of Konkon (2009)<sup>[15]</sup>, who indicated the same dominance of GC-SZ species among antidiabetic plants sold in Abidjan markets. Finally, the high proportion of spontaneous plants (62.5%) reflects a strong dependence on local natural resources. This result is consistent with those of Gnahoua *et al.* (2021)<sup>[11]</sup>, who observed a wide use of spontaneous species as antidiabetic plants in the department of Zuénoula.

### Ethnomedicinal Characteristics

The surveys were conducted in three main markets in the city of Man: Grand Gbapleu, Libreville, and Commerce, selected for their high concentration of herbalists. Among the 54 people surveyed, women represented 72.2%, confirming their central role in the transmission and use of traditional knowledge. This trend was also reported in Abidjan by Ta (2013)<sup>[24]</sup> and Béné *et al.* (2016)<sup>[6]</sup> who highlighted the prominent role of women in traditional medicine, particularly in the preparation and sale of remedies. Ethnomedicinal analyses, based on Citation Frequency (FC) and Contribution to Revenue (Cpr), reveal that *Phyllanthus amarus* is the most cited and most used species. This finding corroborates the work of Doh (2015)<sup>[9]</sup>, who also highlighted the high popularity of this species in the treatment of diabetes. The importance of this plant could be attributed to its availability, its reputation for effectiveness and its repeated use in traditional preparations. The most used plant organ is the leaf (87.5%). The preferential use of leaves can be explained by their year-round availability, their ease of harvesting and their richness in secondary metabolites with hypoglycemic properties, such as alkaloids, glucosides and tannins (Pamplona, 2001)<sup>[20]</sup>. As for preparation techniques, decoction dominates by a wide margin (90.60%). This result is close to that obtained by N'Guessan *et al.* (2009)<sup>[18]</sup>, who report 100% decoctions in the antidiabetic recipes of the Abbey and Krobou of Agboville. The predominance of this method could be explained by its ability to effectively extract the active ingredients and ensure good preservation of the preparations.

## Conclusion

This study conducted in the markets of the city of Man identified 32 plant species used in traditional medicine for diabetes. These plants belong to 32 genera and 19 botanical families, with a predominance of the Fabaceae family. The respondents were herbalists interviewed at three of the city's markets: The Commerce Market, the Grand-Gbapleu Market, and the Libreville Market. The choice of these markets was justified by their impressive number of herbalists. Two indices of cultural importance were calculated to assess traditional knowledge: Frequency of Citation (FC) and Contribution to Recipes (Cpr). They revealed that *Phyllanthus amarus* is the most cited and most frequently used plant in medicinal recipes. Regarding the organs used in medicinal recipes, the leaves are the most commonly used parts, prepared by decoction and administered orally. The results of this work could encourage in-depth studies on the identified plants, particularly in the search for herbal medicines capable of effectively treating diabetes.

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