



ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2022; 8(2): 389-398
www.allresearchjournal.com
Received: 06-12-2021
Accepted: 09-01-2022

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Ethnobotanical study of medicinal plants sold by women on Adjame markets in south of Cote d'Ivoire

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Abstract

Diabetes is one of the commonest diseases affecting the citizens of both developed and poor countries. In Côte d'Ivoire, the number of people suffering from diabetes was believed to be rising steadily. The aim of this study was to identify the medicinal plants traditionally used to treat diabetes and sold on Adjame markets at Abidjan district in south of Côte d'Ivoire. The ethnobotanical surveys were carried out using questionnaires using questionnaire with 40 saleswomen of medicinal plants in four markets on Adjame. The results allowed to inventory 62 species of medicinal plants belonging to 33 botanical families and divided into 60 genera. Among these plants, Euphorbiaceae (7 species), Fabaceae (7 species), Asteraceae (6 species), Rubiaceae (6 species) were the main medicinal plants families found in markets. Furthermore, *Tetrapleura tetraptera*, a specie of Fabaceae family, was the most recommended plant for their pods used in decoction for diabetes treatment (87.5%). On the other hand, the leaves were the most used organ parts during the study. Decoction was the mainly mode of medicine preparation and administration. In all cases, the treatment consisted of drinking the extracts for a long period. The effectiveness of the prepared extracts was generally recognized. The plants thus listed constitute a panel for the valorization of medicinal plants used in the treatment of diabetes through biological and phytochemical studies.

Keywords: Côte d'Ivoire, diabetes, ethnobotany, market sale, medicinal plants

1. Introduction

Diabetes is a common and widespread disease that affects citizens of both developed and developing countries. It is estimated that 25% of the of the world's population is affected by this disease. Diabetes is caused by an abnormality in carbohydrate metabolism that is related to low levels of insulin in the blood or insensitivity of target organs to insulin (Maiti *et al.*, 2004) [29]. According to the WHO, of the 57 million deaths worldwide, 36 million (63%) were due to non-communicable diseases (NCDs). In 2011, at its 66th General Assembly, the United Nations classified NCDs as a new challenge in the fight to improve health (WHO, 2011; 2018) [43, 44]. Among these diseases, diabetes occupies an important place. It is one of the most prevalent NCDs in the world (Jayakumar *et al.*, 2010) [22], it is directly responsible for 3.5% of NCD-related deaths (WHO, 2012) [42].

In Côte d'Ivoire, the number of people suffering from diabetes is reported to be steadily increasing over the past two decades. Several reports have highlighted the high mortality associated with diabetes (Tchacondo *et al.*, 2011) [37]. Recently, there has been renewed interest in herbal treatments for diabetes. The growing public interest and awareness of natural medicines has led the pharmaceutical industry and academic researchers to pay more attention to herbal medicines (Day, 1998) [13]. The apparent reversal of the trend from Western medicine to herbal medicine can be explained in part by the fact that synthetic drugs have always had adverse reactions and other undesirable effects. This has led to the belief that natural products are safe because they are more harmonious with biological systems (Atal, 1983; Erasto, 2003) [10, 17]. In addition, the cost of administering modern antidiabetic drugs is out of reach for low-income people, lead patients to turn to herbal medicine (Apema *et al.*, 2012; Siegel, 2020) [9, 36]. The use of plants for healing is a matter of culture and tradition in Africa. A large segment of the African population relies on traditional medicine, whose remedies are primarily plant-based (Weiss, 1997; Gbekley *et al.*, 2015) [41, 19]. Indeed, according to WHO, 65-80% of the world's population, especially in Africa, rely primarily on traditional herbal medicines for their primary health care (Konkon, 2009) [26].

Faced with the expansion of non-communicable diseases such as diabetes, whose care is high, WHO, has encouraged ethnobotanical studies and research on traditional treatments to improve herbal medicines in order to promote their optimal uses in health care delivery systems (WHO, 2002) [42]. In traditional medicine, the number of plants used in the treatment of diseases associated with physiological disorder such as diabetes is limited. These plant species are regarded as precious and highly valued. It is in that perspective, an ethnobotanical survey was conducted in the city of Abidjan to inventory medicinal plants used in the traditional treatment of diabetes and to valorize them for the subsequent production of improved traditional medicines. In Côte d'Ivoire, and particularly in Abidjan, the capital, most patients attend the Abidjan Antidiabetic Center (CADA), located in the municipality of Adjamé, for the screening and medical follow-up of diabetes. However, the high cost of services pushes patients to go to the markets in Adjamé, near the CADA, to buy medicinal plants in order to find an alternative treatment for their pathology. The aim of this study was to inventory and provide more information on the medicinal plants sold on the markets and used in traditional medicine for the treatment of diabetes through an ethnobotanical survey was performed in the municipality of Adjamé, district of Abidjan in the South of Côte d'Ivoire.

2. Material and Methods

2.1 Study Area

This study was carried out at Adjamé, one of ten municipalities of Abidjan district located in the South of Côte d'Ivoire. The geographic coordinates are 5°21'1" N and 4°1'38" W. The UTM position is UL89 and the Joint Operation Graphics reference is NB30-10 (Anonymous, 2021) [8]. The area falls within the latitude 5°21'1" N and the longitude 4°1'38" W. It is bounded by the sea in the south, Abobo in the north, Cocody in the east and Yopougon in the west. The elevation ranges from sea level to approximately 24 m (DB-CITY, 2021) [15]. Municipality of Adjamé is a commercial area where transport vehicles from all over the Côte d'Ivoire have their parking station. It is an area where a good portion of the population of Abidjan, or even of the whole of Côte d'Ivoire, moves daily. In this commune, where a heterogeneous and very cosmopolitan population circulates daily, most of the plants used for the traditional treatment of certain pathologies was found on the markets (Manouan *et al.*, 2010) [30]. Indeed, traditional medicine play an important role in the health system in Côte d'Ivoire. The study was conducted in four markets in Adjamé. They were selected because of their high number of visitors to the district of Abidjan, and the presence of medicinal plants in their markets. Adjamé is home to the largest wholesale markets for medicinal plants.

2.2 Collection of information

Adopting the method of Jovel *et al.* (1996) [23], a general

conversation and questionnaires were used to obtain ethnomedical information and questionnaires were used to obtain ethnobotanical information. Data collected included local plant names, plant parts used, method of plant preparation, and perceived use of plants. Data collected included local plant names, plant parts used, method of plant preparation, method of administration, dosage, and perceived efficacy of the drug. The plants were identified by their vernacular names and then validated at the herbarium of the Université Félix Houphouët-Boigny d'Abidjan-Cocody. In addition, the scientific names, families and morphobiological types of plants inventoried in the markets of Adjamé were determined.

2.3 Ethnobotanical survey

Ethnobotanical surveys were performed in four markets in the municipality of Adjamé: Delegation market, Gouro market, *Ebrié* neighborhood market and Williamsville market (Figure 1). These markets were selected because they are the main markets for supplying the markets of the municipality with medicinal plants. In each market, 10 sellers of medicinal plants were chosen randomly (total of 40 sellers) were surveyed during the study.

For 180 days over 7 months, all plants observed on the shelves of each medicinal plant vendor were counted. This gives an overview of the plants sold in concerned-markets by saleswomen. The data were collected with a questionnaire through an ethnobotanical survey based on semi-structured individual interviews. This questionnaire for medicinal plants-sellers contains questions about the name of the treated-dose, the recognition of diabetes symptoms, the number of patients received, the parts of used-plant, the vernacular name of the plant, method of plant preparation and administration. Similarly, the duration of treatment, the possible side effects of the use of the plant as well as the ethnobotanical and ethnopharmacological information's. At the end of each interview, a choice was made among the plants cited as having anti-diabetic effects, which were evaluated according to the principle of ethnobotanical validity (Konkon, 2009) [26]. The latter gave respectively the number of people using the plant for a medical or dietary purpose. As a general rule, a medicinal plant is only selected if it has been cited by at least four different female plant sellers (Weiss 1997) [41].

2.4 Identification of medicinal species

Some samples plants were purchased during the interviews to be identified, but also to encourage the women vendors to collaborate and provide more information. Plants were identified using the flora of Adjanohoun et Aké-Assi (1979) [2], Aké-Assi (1984; 2001; 2002) [3, 4, 5] and Arbonnier (2000) [1]. In addition, the list of medicinal species was cross-referenced with the IUCN list (www.iucnredlist.org) to complete the identification and usefulness of plant species collected in the markets for medicinal purposes.

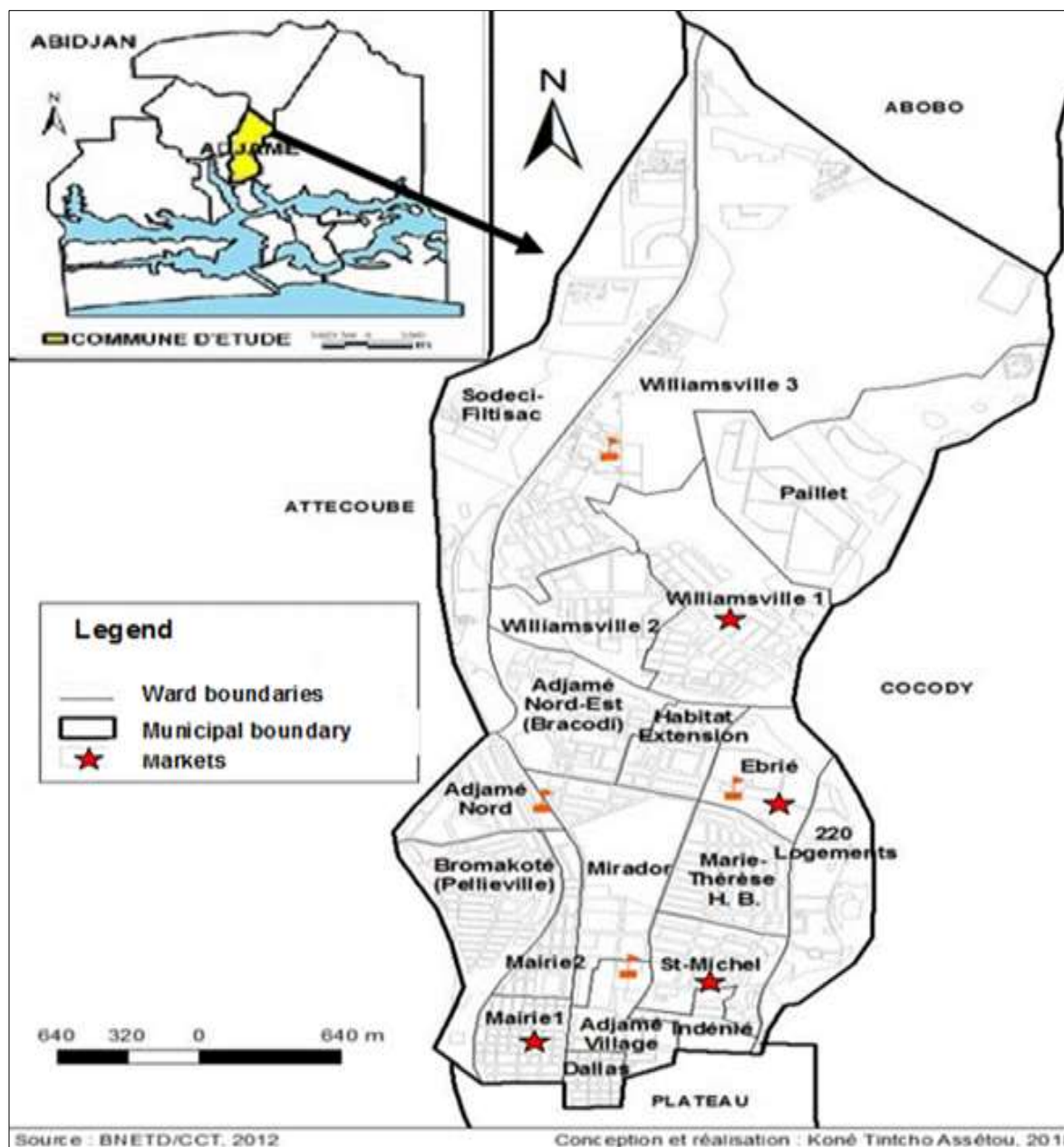


Fig 1: Markets surveyed in of Adjamé for the ethnobotanical survey

2.5 Data processing

The data recorded on the survey sheets were then entered and analyzed by Statistica 7.0 software. The comparison of the values was performed using the Newman-Keuls test at 5%. Moreover, as the percentages are non-parametric values, their comparison was carried out by the post hoc test of Kriskall Wallis at of 5%.

The citation frequency (FC) of each plant was determined by the formula:

$$FC = \frac{\text{number of citations of the plant considered}}{\text{total number of citations of plants}} \times 100$$

3. Results

3.1 Recognition of a diabetic patient

This ethnobotanical study was conducted in four markets in Adjamé. The medicinal plant saleswomen stated that they could recognize a diabetic patient by their testimonies. Indeed, they indicated that patients often report symptoms of severe fatigue. They have also an increased hunger, the

emission of abundant, foaming and frequent urine during the day accompanied by great thirst followed by tingling or numbness in the feet and or toes.

3.2 Inventory of plants with anti-diabetic effect

During the survey, 40 female plant-sellers aged 35-70 years, i.e. 10 vendors per market, were interviewed. A total of 62 plants with anti-diabetic effects were identified in the four markets of the municipality of Adjamé in the district of Abidjan (Table IX). These plants were classified into 60 genera and 33 families. The most represented families in terms of species richness are in order: Euphorbiaceae (7 species), Fabaceae (7 species), Asteraceae (6 species), Rubiaceae (6 species), Apocynaceae (3 species) and Amaryllidaceae (3 species). The other families have less than three representatives. In addition, 35 out of 40 plant-sellers, i.e. 87.5% (data not shown), claimed to offer the pods of *Tetrapleura tetraptera* to treat patient's diabetes. As a result, this specie was the most proposed in the four herbal markets in Adjamé by sellers to treat diabetes traditionally.

3.3 Distribution of plants according to morphological types

The taxa listed are divided into six morphological groups 2) which are trees, shrubs, bushes, lianas, herbs and suffrutex (Table 1). Herbs, trees and tiny trees represent statistically

the most important groups with respectively, 29.0%, 27.42% and 22.60%. Lianas, shrubs and suffrutex represented by nine species (14.51%), three species (4.86%) and one species (1.61%) are the least important morphological groups.

Table 1: Plants used for the treatment of diabetes encountered in Adjámé markets

N°	Local name	Scientific name	Family	Morphobiological type	Part used	Preparation of medicine	Dosage
01	Eugene's herb	<i>Ageratum conyzoides</i> L.	Amaranthaceae	Therophyte herb	Whole plant	Decoction	Drink the decoction in a beer glass 3 times a day
02	Witchweed	<i>Anacardium occidentale</i> L.	Asteraceae	Nanophanerophyte herb	Whole plant	Decoction	Drink the decoction in a beer glass 3 times a day
03	Sénéfo = véké Akye = Ebruké Baoulé = blôfoué Dioula = somon	<i>Anchomanes difformis</i> (Bl.) Engl.	Anacardiaceae	Microphanerophyte tree	Bark, Dry leaves	Maceration of the bark, Infusion and decoction of dry leaves	Drink as much as you like of the maceration, infusion and decoction
04	Akyé = Alomé Baoulé = Topi Gouro = Dridiri	<i>Allium cepa</i> L.	Araceae	Geophyte herb	Rhizome	Maceration	Drink a beer glass morning and evening
05	Onion Baoulé = Djawa	<i>Allium sativum</i> L.	Amaryllidaceae	Geophyte herb	Bulb	Maceration	Drink before meals every 2 days
06	Garlic	<i>Aloe buettneri</i> A. Berger	Amaryllidaceae	Geophyte herb	Bulb	Tincture Maceration	Drink before meals every 2 days
07	Aloe	<i>Annona muricata</i> L.	Amryllidaceae	Herb	Whole plant	Decoction, Maceration Infusion	Drink all day long the medicated forms
08	soursop tree or soursop	<i>Achyranthes Aspera</i> L.	Annonaceae	Nanophanerophyte tree	Dry leaves	Infusion	Drink as much as you want of the infusion during the day
09	Cinnamon apple tree or Attier	<i>Annona squamosa</i> L.	Annonaceae	Nanophanerophyte shrub	Leaves	Decoction	Drink as much as you like of the decoction all day long
10	African birch tree Bambaba = N'galâma	<i>Anogeissus leiocarpus</i> (D.C) Guill. Perr.	Combretaceae	Mesophanerophyte tree	Leaves	Decoction	Drink decoction all day long
11	Scarf or cancan	<i>Acalypha wilkesiana</i> L.	Euphorbiaceae	Microphanerophyte shrub	Leaves	Décoction	Drink 3 glasses/day
12	Nîme or neem Baoulé = Djabaouaka	<i>Azadirachta indica</i> A. Juss.	Meliaceae	Microphanerophyte tree	Leaves or bark	Decoction	Drink the decoction ½ liter /day
13	Bamboo or Chinese bamboo	<i>Bambusa vulgaris</i> Schrad ex. Wendel	Poaceae	Hemicryptophyte herb	Leaves	Decoction	Drink as much as you like of the decoction / day
14	Moré = Kinkirissabulga	<i>Bideus engleri</i> O.E.Schutz	Asteraceae	Therophyte herb	Whole plant	Decoction	Drink one glass of decoction 3 times a day
15	Baoulé = Allogoa Abouré = Abangoa Agni = djandjui	<i>Bidens pilosa</i> L.	Asteraceae	Therophyte herb	Whole plant	Decoction	Drink 3 times/day
16	Baoulé = Kaha Dioula = Fininzan Tagouana = Kou	<i>Blighia sapida</i> K. D. Koenig	Sapindaceae	Microphanerophyte tree	Seeds and immature fruits	Decoction	Drink 1 glass/day
17	Tagouana = Nakrou	<i>Bridelia ferruginea</i> Benth.	Euphorbiaceae	Microphanerophyte shrub	Leaves	Decoction	Drink the decoction 2 times for 14 days
	Bambaba = sumakala False kinkéliba	<i>Cassia occidentalis</i> L.	Fabaceae	Microphanerophyte tree	Leaves	Decoction	Drink the decoction every morning and evening
19	Gouro = N'Goué False Kapok tree cheese maker	<i>Ceiba pentandra</i> (L.) Gaertn.	Bombacaceae	Megaphanerophyte tree	Fresh leaves	Decoction	Drink the decoction as much as you like all day long
20	Lao grass or false ramie	<i>Chromolaena odorata</i> (L.) M. King & H. Robing	Asteraceae	Nanophanerophyte grass	Leaves Roots	Decoction	Drink the decoction all day long
21	Cranberry or milk apple	<i>Chrysophyllum cañito</i> L.	Sapotaceae	Microphanerophyte tree	Bark Leaves	Maceration	Drink the maceration 3 times a day
22	Lemon or lime tree	<i>Citrus aurantifolia</i> (Christm. Swengle)	Rutaceae	Microphanerophyte shrub	Leaves	Decoction	Drink decoction as much as you like during the day

23	-	<i>Cnestis ferruginea</i> D. C.	Connaraceae	Microphanerophyte liana	Leaves Root	Decoction	Drinking decoction all day long
24	Brown coffee	<i>Coffea mauritiana</i> Lam.	Rubiaceae	Microphanerophyte shrub	Leaves	Decoction Infusion	Drink decoction as much as you want
25	Lemongrass	<i>Cymbopogon citratus</i> (D. C.) Stapf.	Poaceae	Nanophanerophyte herb	Rhizome	Decoction	Drink the decoction 3 times a day
26	Carrot	<i>Daucus carota</i> var. sativa L.	Apiaceae	Geophyte herb	Tuber	Expression Râpage-Jus	Drink the juice all day long
27	White Eclipta	<i>Eclipta prostrata</i> L.	Asteraceae	Herbetherophyte	Leaves	Decoction	Drink as much as you like of the decoction all day long
28	The heart of the sea	<i>Entada gigas</i> (L.) Fawc & Rendle	Fabaceae	Lianemesophanerophyte	Leaves Roots	Decoction	Drink the decoction 2 times during 14 days
29	Akyé: Atodou Baoulé: Akôlôlo Malinké: Débasigui	<i>Euphorbia hirta</i>	Euphorbiaceae	Chamaephyte herb	Leafy stem or whole plant	Decoction	Drink every morning and evening one glass of the decoction
30	Fig tree	<i>Ficus platyphylla</i> Delile	Moraceae	Microphanerophyte tree	Bark	Decoction	Brink 3 times a day the decoction
31	Balan des savanes	<i>Flueggea virosa</i> (Roxb. Ex Willd) Royle	Euphorbiaceae	Nanophanerophyte shrub	Root	Decoction	Drink as much as you like during the day
32	Gardenia	<i>Gardenia ternifolia</i> Schum. &Thonn. <i>Subsp ternifolia</i>	Rubiaceae	Microphanerophyte shrub	Leaves	Decoction	Before meals, drink 3 glasses/day
33	-	<i>Harrisonia abyssinica</i> Oliv.	Simaroubaceae	Microphanerophyte tree	Leaves	Decoction	Drink the decoction ½ glass every morning and evening
34	Harungua wood or haronga	<i>Harungana madagascariensis</i> Lam. Ex Poir.	Hypericaceae	Microphanerophyte tree	Leaves	Decoction	Drink the decoction all day long
35	Holarrhena	<i>Holarrhena floribunda</i> (G. Don.) var. floribunda	Apocynaceae	Nanophanerophyte shrub	Leaves	Decoction	Drink as much as you like the decoction
36	Potato	<i>Ipomea batatas</i> (L.) Lam.	Convolvulaceae	Microphanerophyte shrub	Leaves	Decoction	Drink as much as you like the decoction
37	Sénoufo: nakono Baoulé: Apôplô Akyé: Mpôpô	<i>Jatropha curcas</i> L.	Euphorbiaceae	Nanophanerophyte shrub	Leafy stem	Maceration	Drink the maceration 3 times a day in 1 glass of beer (adult) and 1 glass of liquor for children
38	Malinké: Djou ou djoum	<i>Mitragyna inermis</i> (Willd) O. Kuntze	Rubiaceae	Microphanerophyte shrub	Leaves Stem bark	Decoction	Drink 1 glass 3 times a day
39	-	<i>Mognania faginea</i> (Guill. & Perr.) O. Kuntze	Fabaceae	Shrub	Leaves	Decoction	Drink the decoction all day long
40	Baoulé: Dania Dioula: Trèkèbou Akyé: Ato m'bomou	<i>Momordica charantia</i> L.	Cucurbitaceae	Nanophanerophyte liana	Fresh fruit	Decoction	Drink as much as you like of the decoction
41	-	<i>Morinda morindoides</i> (Bak.) Milne-Redh.	Rubiaceae	Microphanerophyte liana	Stem	Decoction	Drink 1 glass of the decoction 3 times a day
42	Baoulé: Tôlè Dioula: Badi Akyé: Monleuh	<i>Nauclea latifolia</i> Smith	Rubiaceae	Microphanerophyte shrub	Roots	Decoction	Before the decoction 3 times a day
43	Baoulé: Aromagnrin	<i>Ocimum gratissimum</i> L.	Lamiaceae	Nanophanerophyte shrub	Leaves	Decoction	Drink as much decoction as you want/week
44	Sénoufo: Naniguè Baoulé: Kpalè Malinké: Néré	<i>Parkia biglobosa</i> (Jaccq.) Benth	Fabaceae	Mesophanerophyte tree	Leaves	Decoction	Drink the decoction as much as you like per day
45	Avocado tree	<i>Persea americana</i> Mill.	Lauraceae	Mesophanerophyte tree	Leaves	Decoction	Drink the decoction as much as you like during the day
46	Soja	<i>Phaseolus vulgaris</i> L.	Fabaceae	Therophyte herb	Dry pods	Décoction	Drink 1 glass every morning on an empty stomach for 1 week
47	Small white tamarind	<i>Phyllanthus amarus</i> Schum. &	Euphorbiaceae	Nanophanerophyte suffrutex	Whole plant	Decoction Maceration	Drink 3 glasses/day

		Thonn.				Tincture Infusion	
48	Forest pepper tree	<i>Piper guineense</i> Schum. & Thonn.	Piperaceae	Microphanerophyte liana	Whole fruits	Decoction	1 teaspoon of the decoction once every morning/month
49	Purslane or porcellana	<i>Portulaca oleracea</i> L.	Portulacaceae	Therophyte herb	Leafy stem	Decoction	Drink the decoction 3 times a day
50	Guava	<i>Psidium guajava</i> L.	Myrtaceae	Microphanerophyte shrub	Leaves	Decoction	Drink the decoction as much as you like for 1 week
51	Akuamma	<i>Picalima nitida</i> Staff.	Apocynaceae	Microphanerophyte shrub	Seeds	Maceration Decoction	Drink 2 times a day in a glass of beer
52	-	<i>Rawolfia obscura</i> K. Schum.	Apocynaceae	Nanophanerophyte shrub	Roots Leaves	Decoction	Oral decoction
53	african peach tree	<i>Sarcocephalus latifolius</i> (Sm.) Bruce	Rubiaceae	Microphanerophyte tree	Bark	Decoction	Drink the decoction all day in a glass of beer
54	Morula	<i>Sclerocarya birrea</i> (A. Rich.) Hochst Subsp birrea	Anacardiaceae	Mesophanerophyte tree	Dry leaves	Powder	Mix the powder daily with food
55	Dioula: bala-bala Baoulé: Niassouébaka Bété: Genakwo	<i>Securinea virosa</i> (Roxb. ex Willd.) Baill.	Euphorbiaceae	Mesophanerophyte tree	Leafy branches	Decoction	Drink the decoction morning and evening in 1 glass of beer
56	Balai savane	<i>Scoparia dulcis</i> L.	Scrophulariaceae	Nanophanerophyte herb	Whole plant	Decoction	Drink the decoction all day long
57	Tamarind tree	<i>Tamarindus indica</i> L.	Fabaceae	Mesophanerophyte tree	Leaves Roots - Barks	Decoction	Drink the decoction for 1 week
58	Dandelion wood	<i>Tecoma staus</i> (L.) Kunth	Bignoniaceae	Microphanerophyte shrub	Leaves	Decoction	Drink the decoction for 1 week
59	4-sided fruit Aidontree Baoulé: Kplèkèssè	<i>Tetrapleura tetraptera</i> Schumach & Thonn.	Fabaceae	Microphanerophyte tree	Pod	Decoction	Drink the decoction 1 glass in the morning and evening
60	Bitterleaf Mooré: Koa-safan	<i>Vernonia colorata</i> (Willd.) Drake	Asteraceae	Microphanerophyte shrub	Leaves	Decoction	Drink the decoction all day long
61	Cowpea	<i>Vigna unguiculata</i> (L.) Walp.	Fabaceae	Therophyte herb	Pods	Decoction	Drink the decoction 3 times a day
62	Jujube tree Bambara: Ntomono	<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	Microphanerophyte shrub	Leaves	Decoction	Drink all day in a glass the decoction

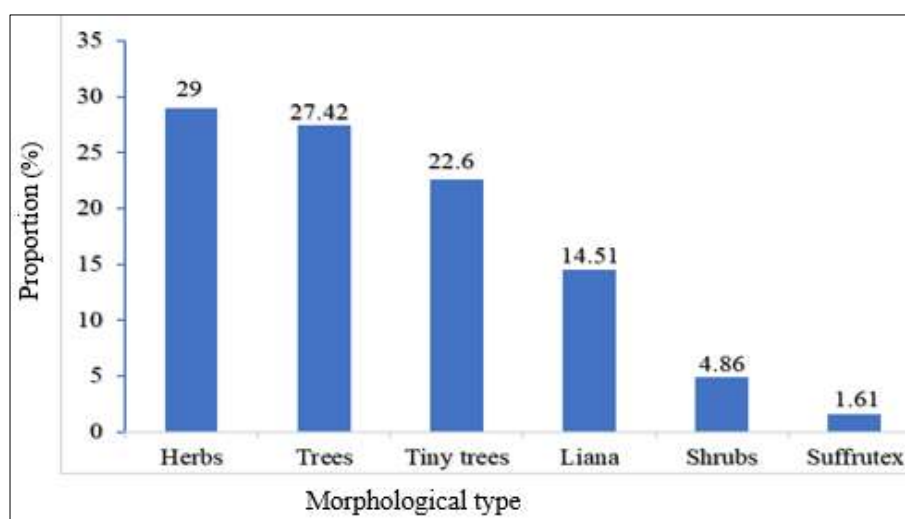


Fig 2: Proportion of species according to morphological type

3.4 Distribution of plants according to biological types

Figure 3 distinguishes four biological types of plants among the plants inventoried in the markets. Thus, Phanerophytes with a proportion of 77% are the statistical most important, followed by Therophytes (12.4%), Geophytes (9.3%).

Hemicryptophytes with a rate of 1.3% have the lowest proportion. Moreover, among phanerophytes, microphanerophytes are the best represented (48%), followed by nanophanerophytes.

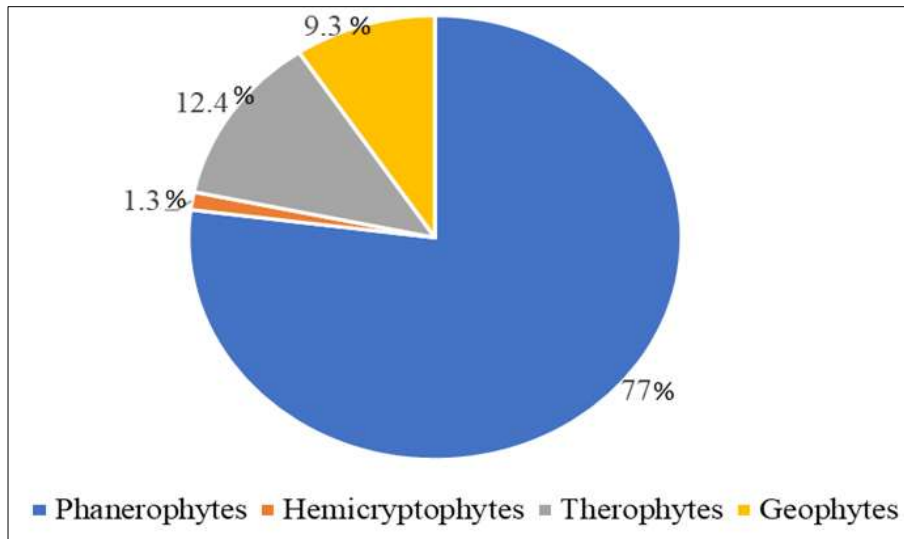


Fig 3: Species spectrum distribution of plant biological type

3.5 Diabetes treatment

3.5.1 Part of the plants used

To treat diabetes, plant sellers in Adjamé markets recommend 11 different parts of plant. These include the whole plant, the bark, the leaves, the rhizomes, the bulbs, the seeds, the fruits, the roots, the tubers, the stems and the leafy branches or stems (Figure 4). The organs used for

treatment are predominantly leaves with a proportion of 43% followed by the whole plant (11.2%), roots (10.2%) and bark (10.2%) which are statistically identical. Fruits and pods (7.6%), leafy stems or branches (6.4%) followed by seeds, bulbs, rhizomes with a proportion of 2.5% each and finally tubers (1.3%) are the other associated plant represent together only 25.3% of the organs used to treat diabetes.

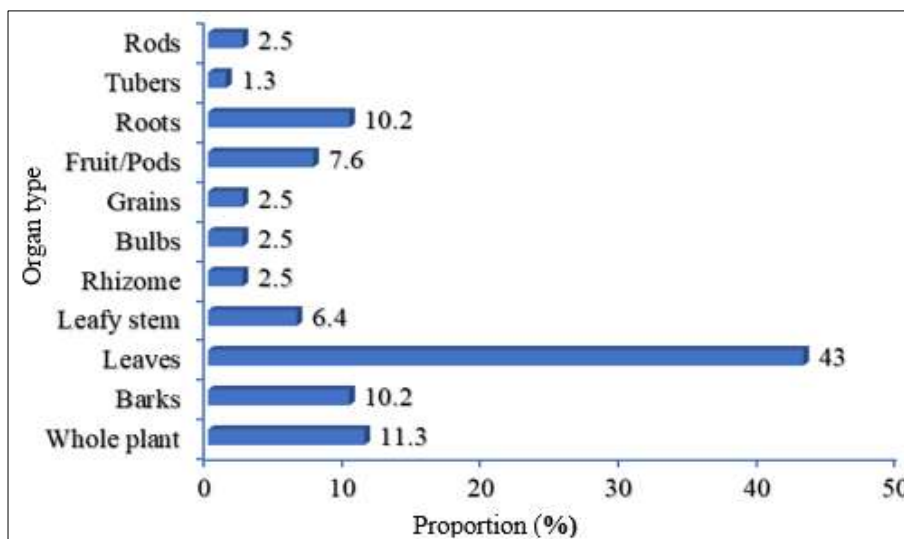


Fig 4: Proportion of species according to plant organs

3.5.2 Methods of preparation of plant organs and administration of medicines

Eight different methods of preparation and administration were identified during the interview with the women selling medicinal plants in the markets of Adjamé (Figure 5). Analysis of the results revealed that decoction was the most

common method of preparation and administration form of medicines, with 73%, followed by maceration (12.2%) and infusion (6.8%). Tincture (2.8%) followed by other forms (expression, grating, juice powder) with 1.3% are the weakest methods of preparation and administration of medicines observed.

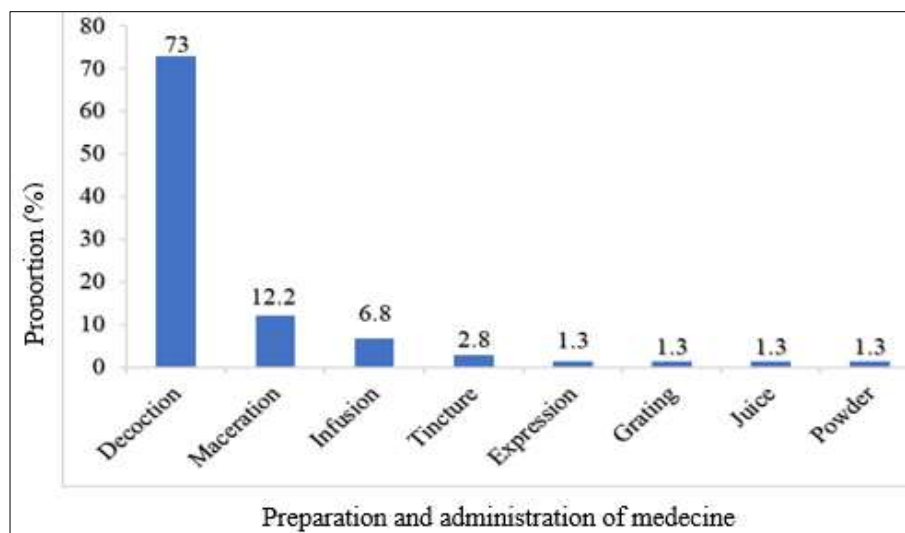


Fig 5: Proportion of species according to the method of medicines preparation

4. Discussion

The surveys conducted in the four markets of the municipality of Adjamé have identified 62 species divided into 33 families. Euphorbiaceae, Fabaceae, Asteraceae and Rubiaceae are the families of plants with an antidiabetic effect that are the most represented in the markets surveyed in Adjamé. Furthermore, as regard to plants, the survey reveals that 35 plant-saleswomen out of 40 interviewed in the medicinal plant markets in the municipality of Adjamé, i.e. 87.5%, offer *Tetrapleura tetraptera* pods to their patients for the phytotherapeutic treatment of diabetes and that they would appreciate. Indeed, ethnomedical studies have reported that the dried fruits of this plant possess analgesic, anti-inflammatory, antimicrobial and especially anti-diabetic properties (Nwaichi *et al.*, 2013; Erukainure *et al.*, 2017; Saague *et al.*, 2019) [33, 18].

In addition, it is worth mentioning that the saleswomen have recognized diabetes by the description of the symptoms made by the different patients received on their market stalls. Indeed, diabetes is manifested by great fatigue, increased hunger, the emission of abundant, foaming and frequent urine during the day accompanied by great thirst followed by tingling or numbness in the feet and or toes. This suggests that the diagnosis made by the saleswomen were correct and the treatment of diabetes administered to patient seems adequate (Harmonium-pharma, 2021) [21]. Moreover, as the fruits are consumed for making several dishes, its taste would offer interest organoleptic characteristics the patients, hence its strong demand (Abdou, 2009; Akintola and Bodede, 2015) [1, 7]. The high representation of Euphorbiaceae and Fabaceae in particular was also observed during the ethnomedicinal surveys conducted in other regions of the country by Kamanzi *et al.* (2002) [24], Diehl (2004) [16], Ouattara (2006) [34] and Konkon (2009) [26]. This can be explained by the fact that these families are among the most important of the Ivorian flora (Ake-Assi, 1984; 2011; Kouamé, 1998) [3, 6, 27]. Elsewhere in Africa, their predominance has also been observed in Uganda (Hamill, 2003; Kamatenesi-Mugisha and Oryem-Origa, 2007) [20, 25]. These plant families are more important the families that provide the most plants to the African Pharmacopoeia. The medicinal plants identified are mostly herbs and trees. Herbs and shrubs are the most used in the treatment of diabetes. The results are similar to those of Tra

Bi (1997) [38], Konkon (2009) [26] and Aké-Assi (2011) [6]. The predominance of herbs and shrubs in the antidiabetic arsenal in the municipality of Adjamé could be explained by the fact that these plants are frequently found in the immediate environment with easy access. The rate of 38% for each biological type, Microphanerophytes and Mesophanerophytes, makes them the most used in the markets of the municipality of Adjamé. These are exactly the same biological types that were ranked best according investigation of Yapo (2014) [45]. The results are similar to those of Konkon (2009) [26] and Yapo (2014) [45] which revealed that Microphanerophytes (35.05%) and Mesophanerophytes (33.33%) are the most used. In addition, Ouattara (2006) [34] and N'Guessan (2008) [32] also showed that these biological types of plants are the most sought after in the traditional treatment of diabetes in Côte d'Ivoire.

Leaves are the most used organs in medicinal preparations. They are the organs available throughout the year, easy to access and remove and easy to handle. The whole plant, the bark, the leaves, the rhizomes, the bulbs, the seeds, the fruits, the roots, the tubers, the stems and the leafy branches or stems follow them. The predominance of the leaves and the whole plant as an organ used in traditional medicine for the treatment of patients has also been highlighted in the work of Tra-Bi *et al.* (2008) [39] and Sidio (2015) [35]. In addition, the other authors has shown that leaves are mainly used as medicine for the preparation of medicinal recipes used in traditional medicine (Ouattara, 2006; N'Guessan *et al.*, 2009; Konkon, 2009) [34, 26]. The use of leaves is justified by the abundance of chemical groups they contain, as they are known as the site of secondary plant metabolites synthesis (Bourgau *et al.*, 2001; Kumar and Lalramnghinglova, 2011; Dilipkumar and Amit, 2020) [12, 28, 14]. According to Monnet (2013) [31] and Sidio (2015) [35], the intense removal of leave does not harmful to the plant. In addition, the most requested preparation method is decoction with a rate of 91.5%. The preponderance of decoction could be justified by the fact that boiling the plant organs allows the rapid extraction of the active ingredients (Konkon, 2009; Sidio, 2015) [26, 35]. However, it should be noted that other forms of use such as kneading, powder, crushing exist but were reported very poorly in this study (Vangah, 1986; Zirihi, 1991; Ouattara, 2006) [40, 46, 34].

5. Conclusion

The main limitations in the treatment of diabetes are the high cost of modern medical treatments, in addition to the uncomfortable side effects. These limitations may justify seeking new therapeutic approaches through the traditional medicinal plants used. According to the study, the municipality of Adjamé, has a biodiversity of antidiabetic plants sold on the market. Ethnobotanical surveys conducted among women selling medicinal plants identified 62 plant species belonging to 33 families and 60 genera. The majority of these species are grasses and trees. Foliage is the most used part of the plants, while the decoction is the main widely used method for the phytotherapeutic treatment of diabetes. The plants thus listed constitute a panel, which can be used for biological and phytochemical screening for their valorization against diabetes.

Tetrapleura tetraptera pods were the most recommended by the herbal vendors in Adjamé markets for the management of their pathology. This study, although limited by its scope, forms the basis further studies for the valorization of medicinal plants used against diabetes through biological and phytochemical studies of the inventoried plants.

6. References

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