Open Access

Contemporary Research Analysis Journal

e-ISSN: 3050-5909
p-ISSN: 3050-5895

Volume 01 Issue 03 September 2024

Page no: 93-102

CrossRef DOI: 10.55677/CRAJ/06-2024-Vol01I3

Ethnobotanical Study of Antidiabetic Plants and Local Practices in the Treatment of Diabetes in Benin

Akinyêlé Malick Dine Oloude[2], Adoté Hervé Gildas Akueson[1,2,3,4*], Sèdjro David Igor Thierry Kévin Ahouandjinou[2], Arcadius Yves Justin Akossou[1,2]

[1]Department of Natural Resources Management, Doctoral School of Agricultural and Water Sciences, University of Parakou, BP 123 Parakou, Benin

[2]Unit of Applied Statistics and Informatics (USIA), Laboratory of Studies and Research in Forestry (LERF), University of Parakou, BP 123 Parakou, Benin

[3]Institut supérieur agronomique et vétérinaire Valéry Giscard d'Estaing de guinée

[4]Institut de Recherche et de Développement des Plantes Médicinales et Alimentaires de Guinée

Corresponding Author: Adoté Hervé Gildas Akueson

ABSTRACT: As an important cultural element, people have used plants for centuries for various purposes. In Benin, the sale of medicinal plants in city markets is a reality that dates back years. To understand the practices in the field, an ethnobotanical survey on plants with antidiabetic properties in the communes of Gogounou, Parakou, Abomey-Calavi and Pobe was carried out during this study against the high prevalence of diabetes in the departments of these towns and the strong animation of the markets surveyed by herbalists. The objective is to determine the plants used in the treatment of diabetes and the related practices. To do this, 120 diabetic patients and 120 herbalists were sampled. The semi-structured interviews carried out with patients and herbalists made it possible to retain a total of 65 medicinal plants with antidiabetic properties grouped into twenty-seven botanical families with the dominance of Apocynaceae (FRC = 18.5%) and Combretaceae (FRC = 11.6 %). The frequency analyzes carried out showed *Phyllantus amarus* (FRC = 10.22%), *Khaya senegalensis* (FRC = 9.60%) as the species most cited by herbalists. On the other hand, those supposed to be effective by diabetics are: *Phyllanthus amarus, Bridelia ferruginea, Moringa oleifera, Khaya senegalensis, Momordica charantia*, and *Sarcocephalus latifolius*. The majority of the plants listed are microphanerophytes, mesophanerophytes and nanophanerohytes. The leaves are the most used parts. Likewise, a decoction of the leaves is the main method of preparation. However, after a hierarchical classification of the different local practices identified, there is a problem of effectiveness and efficiency of the local practices adapted in the traditional treatment of Diabetes. This is justified by the existence of several preparations, recipes and dosage for the same species. These results constitute a source of information for future research in the field of phytochemistry and pharmacology.

KEY WORDS: Inventory - Local Practices - Antidiabetic Plants - Benin

INTRODUCTION

Tropical forests provide human populations with reserves of various products and services (Gaoue and Ticktin 2007). They contribute to household economies, strengthen food security, and preserve biological diversity (Fandohan and *al*., 2008 ; Ticktin and *al*., 2016). Apart from agriculture, livestock, and fishing, the collection of non-timber forest products is an important source of income, food, and medicine for rural communities (Ezebilo and Mattsson, 2010). These forest products range from herbaceous plants (Achigan-Dako and *al*., 2010 ; Ezebilo and Mattsson, 2010) to various parts of numerous woody plants (Assogbadjo and *al*., 2009 ; Gouwakinnou and *al*., 2011 ; Ouinsavi, 2006). Moreover, medicinal plants are valuable resources for the vast majority of rural populations in Africa (Enneb and *al*., 2015). Indeed, active ingredients for the production of medicines are mostly derived from resources like plants, used in both traditional and modern medicine to treat various diseases and bodily disorders, such as reserpine from Rauwolfia vomitoria, a starting material for neuroleptics (Gning and *al*., 2014 ; Ladoh-Yemeda and *al*., 2016). In developing African countries, medical management of diabetes is limited by the inaccessibility of some populations to health centers and the high cost of conventional medicine. Modern medicine is often geographically, culturally, or financially inaccessible for the majority of the population in poor countries like Benin (Dresse and *al*., 2013). According to the WHO (2000), nearly 80% of the Beninese population resorts to traditional medicine (Dougnon and *al*., 2016), with more than 7,500 traditional healers compared to only 600 doctors for nearly 10 million inhabitants (Ministry of Health of the Republic of Benin, 2010). However, with increasing

globalization, the rural world is concerned about the deterioration of traditional cultures and lifestyles due to external pressures, particularly the loss of their knowledge and the reluctance of younger generations to continue traditional practices. So, what are the antidiabetic plants and local practices used in traditional medicine in Benin ? Is there not a diversity of these practices depending on the agro-ecological zones of Benin ? And what is the state of the effectiveness and efficiency of these local practices ? The relevance of this study lies in deepening research to valorize traditional medicine to make healthcare accessible to disadvantaged groups. Specifically, this study aims to identify the plants used in the treatment of diabetes and related local practices in northern Benin (cases of the communes of Gogounou and Parakou) and southern Benin (cases of the communes of Abomey-Calavi and Pobe) to create a specific database of antidiabetic plants that can be used to improve the quality of phytotherapy in Benin.

1 STUDY METHODOLOGY

1.1 Presentation of the Study Area

The present study was conducted in the Republic of Benin (6-12° 50 N and 1-3° 40 E) located in West Africa. Benin covers an area of 114,763 km² and is situated in the "Dahomey Gap" (Jenik, 1994) with 82.7 inhabitants per km² (INSAE 2015). The climate is generally dry, consisting of the Guineo-Congolian zone (6˚-7˚30 N), the Sudan-Guinean zone (7°30'-9°30' N), and the Sudanian zone (9°30' -12 N). Our investigations are located in four agro-ecological zones and cover four communes (Gogounou, Parakou, Abomey-Calavi, and Pobe) with one commune per agro-ecological zone.

The Commune of Gogounou is located at the southern entrance of the Alibori Department between 10°33' and 10°57' North latitude and 2°15' and 3°15' East longitude. It covers an area of 4,910 km², which represents 18.66% of the entire Alibori Department (26,303 km²). The climate is Sudanian, characterized by a rainy season from May to October and a dry season with the harmattan from November to April. The average annual rainfall is 1100 mm. The temperature ranges between 18°C and 38°C, especially during the dry season. The soils are mostly ferruginous, alluvial, and clay-sandy. The remaining area consists of protected domains (177,200 ha), pastures (123,500 ha), and lowlands (360 ha), of which only 150 ha are exploited. Along the waterways, gallery forests develop, promoting the growth of large trees.

Located in the Borgou department, the commune of Parakou covers an area of 441 km² and is the main city of northern Benin. With an average altitude of 350 m, it is located at 9°15' and 9°30 North latitude and 2°20' and 2°45' East longitude. The climate is tropical humid (southern Sudanian climate) with a dry season and a rainy season. The annual rainfall varies between 900 and 1300 mm per year. The average annual temperature is around 26°C. The observed vegetation cover is dominated by tree savanna.

The commune of Abomey-Calavi, a city in southern Benin, is located 18 kilometers north of Cotonou, the economic capital of Benin. Abomey-Calavi is situated on a plateau with sandy coasts. The city is bounded to the south and west by a lagoon, to the east by Lake Nokoue, with an estimated population of 656,358 inhabitants. The climate is south-equatorial with two rainy seasons and two dry seasons. Its hydrographic network includes Lake Nokoué and the coastal lagoon, swamps, streams, and marshes. The vegetation consists of mangrove with mangroves in the coastal zone and degraded savanna on the plateau.

The commune of Pobe, located in southeastern Benin and in the center-east of the Plateau department at the border with Nigeria, covers an area of 400 km², representing 11% of the department's area and 0.46% of Benin's area. The population density is 207 inhabitants/km², with a population of 123,677 inhabitants. The city's climate is sub-equatorial with two rainy seasons and two dry seasons alternating. Pobè is located in a median depression that spans the entire width of Benin from west to east, dividing the commune into two orographic zones : a depression zone (altitude 50 m) and a plateau zone (three-quarters ferralitic hydromorphic soil). The hydrographic network includes rivers with permanent flow. The vegetation is composed of tree savanna and some classified forest islands in the depression.

The criteria underlying the selection of the sample communes are : the high prevalence of diabetes in the Atlantic/Littoral departments (4.6% according to Djrolo, 2012), Oueme/Plateau (6.7% according to Amoussou, 2015), and especially the Borgou/Alibori departments (12% according to UNDP, 2016), the high activity of the markets surveyed by herbalists, the existence of plant formations as a source for sampling, the presence of phytotherapists and diabetes patients, and diabetes centers. Additionally, the objective is to include different agro-ecological zones of Benin. Figure 1 shows the map of the various communes in our study area.

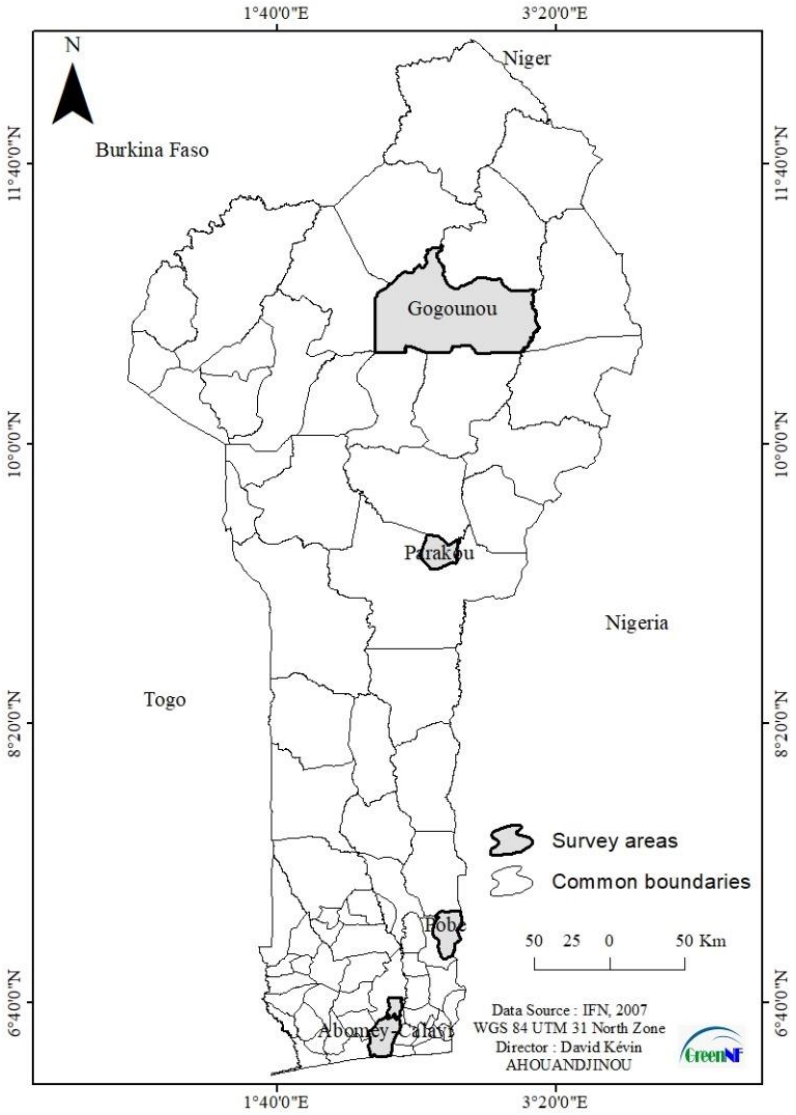

Figure 1 : Study Area

1.2 Data Collection and Analysis

Surveys based on the Semi-Structured Interview method (Dibong and *al*., 2011 ; Klotoé and *al*., 2013) were conducted with herbalists and diabetics. In total, 240 peoples were surveyed, including 120 herbalists and 120 patients. The selection criteria for the herbalists were primarily based on the richness of their stalls : "Purposive Sampling." The use of "Snowball" and "Accidental" sampling methods allowed the identification of the surveyed patients. The approach to the interviewed herbalists and patients was based on dialogue in the local languages (Bariba, Dendi, Peulh, Fon-Gbe, Mahi, Yoruba, Goun, and Nago) and French, accompanied by the purchase of some medicinal plants sold for the treatment of diabetes. Data were collected using two ethnobotanical questionnaires, one for the herbalists and the other for diabetic patients. The information collected from the herbalists pertained to ethnopharmacological data. For the patients, the information collected included geographical data, the profile of the respondent, information related to the disease, and information on local practices in the use of antidiabetic plants. An administrative map was used to locate the markets visited during our survey ; a portable device for taking pictures; a notebook and a pencil for note-taking; a bag to store the purchased plants; and the Analytic Flora of Benin, Trees, Shrubs, and Vines of the dry zones of West Africa, along with other documents that assisted in identifying the species of medicinal plants, represented the materials used for data collection in this study. The information recorded on the survey forms was manually processed and encoded into a database designed and processed with Excel 2013. The local importance of each species in the treatment of diabetes was determined by calculating the relative frequency of citation (Tardio and *al*., 2008) using the formula : $FRC = \frac{Fc}{N}$; where Fc is the number of respondents who mentioned the species, and N is the total number of respondents. Frequency analyses of the collected data were conducted to establish graphs based on the matrix generated by the database. The biological types used are those defined by Raunkiaer (1934).

2 RESULTS

2.1 Diversity of Plants with Antidiabetic Properties

The relative frequencies of citation of plants used for the treatment of diabetes are presented in Figure 2. This figure shows that several plants are recommended by herbalists for the traditional treatment of diabetes. In total, 65 plants were identified, with only one having a relative frequency of citation equal to or greater than 10% (Phyllanthus amarus = 10.22%). The species Khaya senegalensis (9.60%), Catharanthus roseus (6.81%), and Momordica charantia (6.81%) follow in the ranking. It should be noted that all the plants form various recipe associations and consist of single plants to combinations of two to five plants.

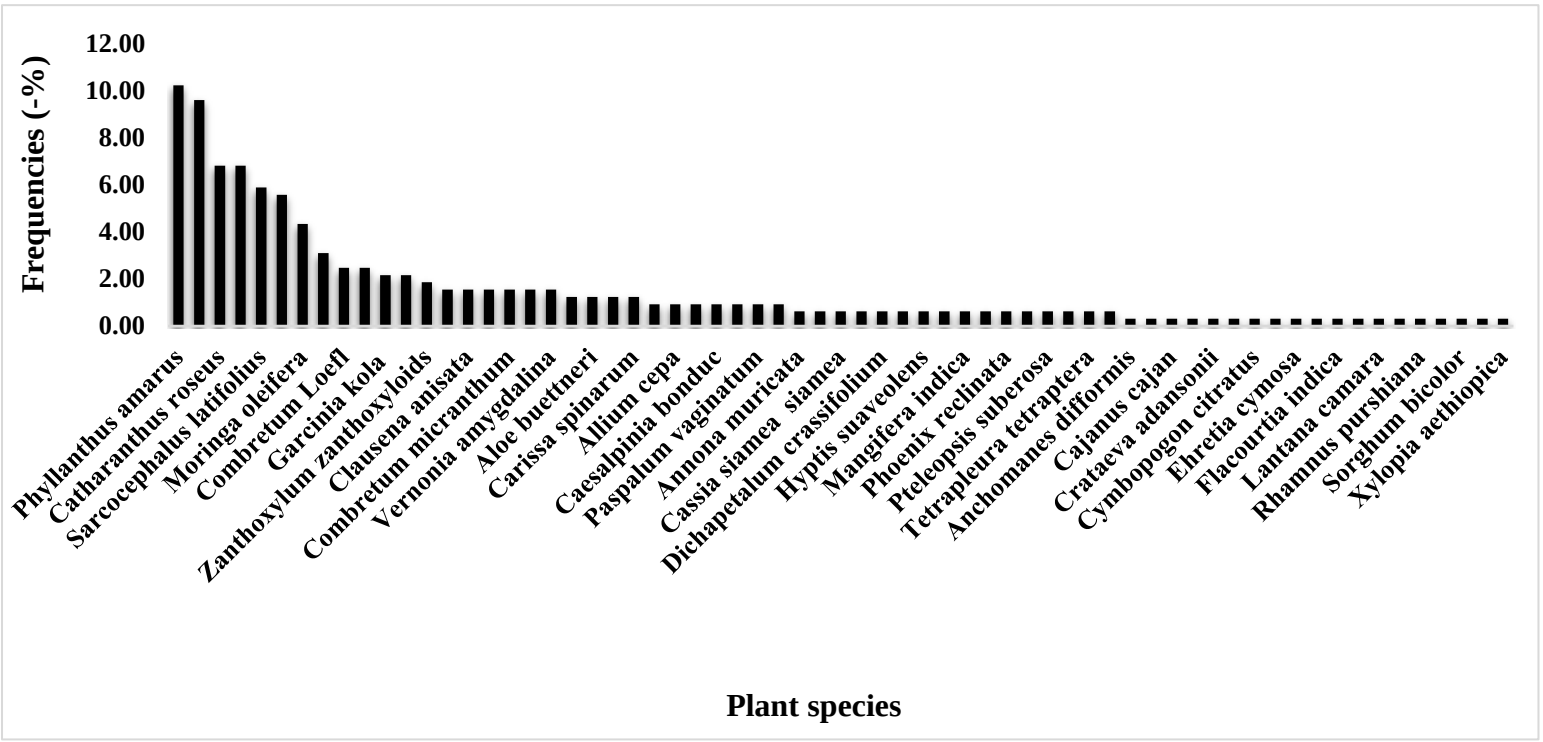

Figure 2: List of Recorded Antidiabetic Plants

2.2 Biological Diversity of Antidiabetic Botanical Families

The Figure 3 present the botanical families of the identified species. All the plant species identified in the surveyed communes are grouped into fifty (50) botanical families, with the most represented being the Apocynaceae family with a relative frequency of 11.46% (Figure 4). It is followed by the Phyllanthaceae (10.28%) and the Meliaceae (9.91%).

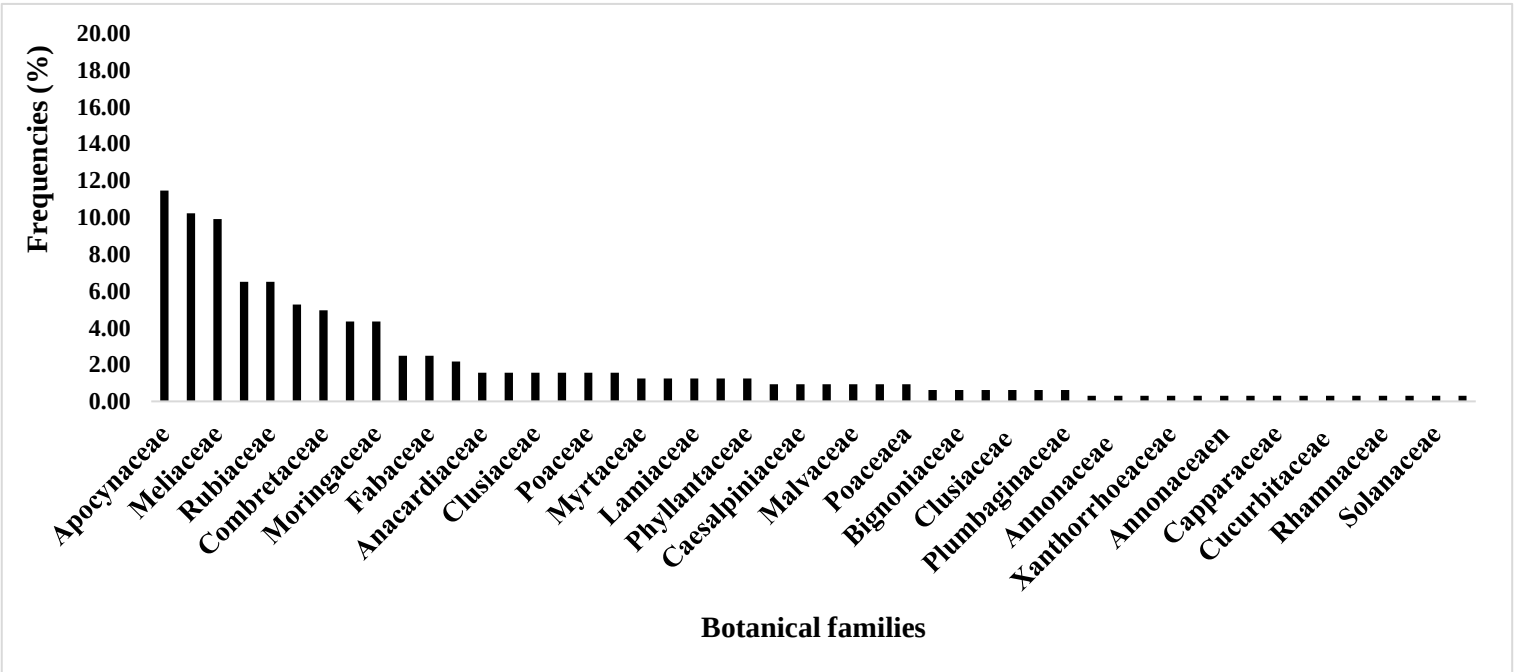

Figure 2 : Frequency of Identified Antidiabetic Botanical Families

2.3 Biological Types

In South Benin, nanophanerophytes (39.39% and 31.07%) are the most commonly used biological types by herbalists in the communes of Pobè and Abomey-Calavi (Figure 4). Mesophanerophytes are also used in the same proportion (31.07%) as nanophanerophytes in Abomey-Calavi. In contrast, in North Benin, microphanerophytes (34.48% and 34.88%) and mesophanerophytes (34.48% and 23.26%) are the most dominant in Gogounou and Parakou, respectively. They are followed by nanophanerophytes (10.34% and 18.60%) and chamaephytes (10.34% and 11.63%). Megaphanerophytes (3.45% and 6.98%) and hemicryptophytes (6.90% and 4.65%) are very weakly represented.

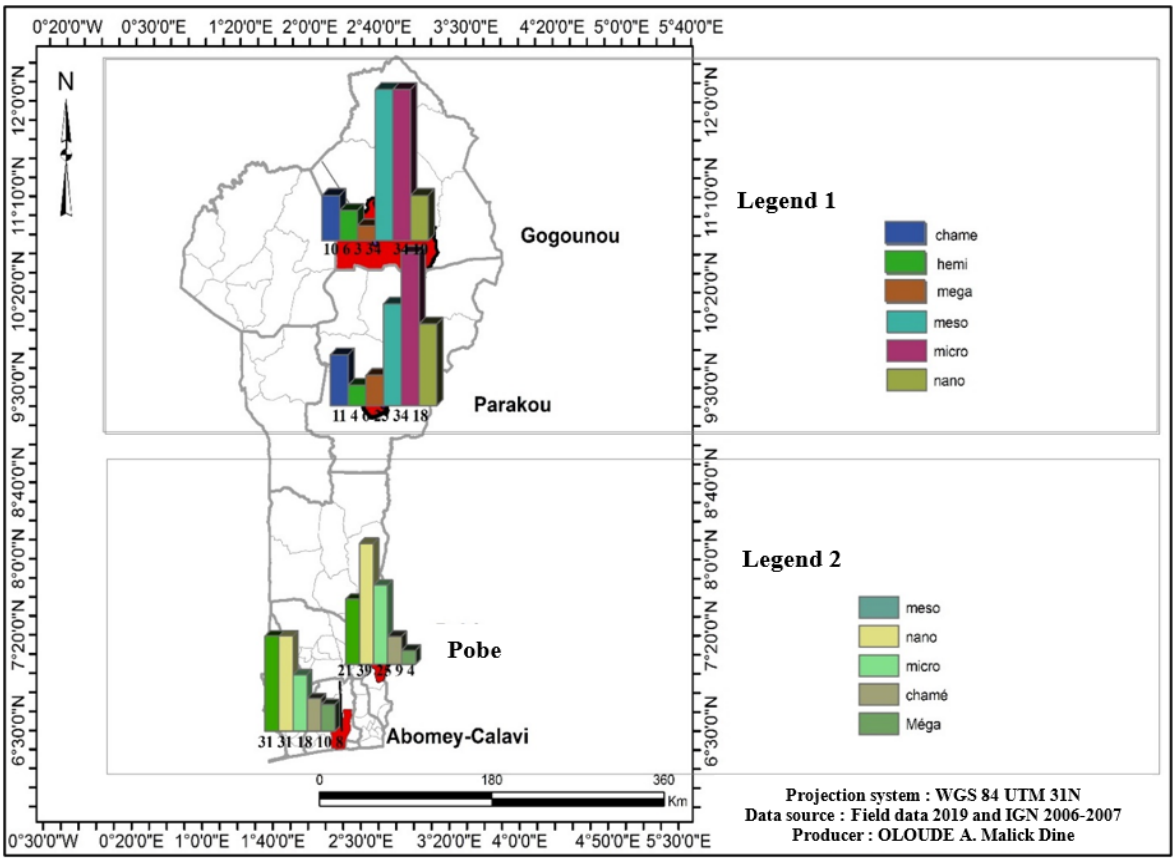

Figure 3 : Biological Types

2.4 Types of Medicine Used

The figure 5 presents the types of medicine used by patients in the treatment of diabetes. The results show that patients resort to three different types of medicine (modern, traditional, and a combination of modern and traditional medicine). The analysis of this figure reveals that 91.30% and 48% of patients use a combination of modern and traditional medicine in North and South Benin, respectively. The proportions of patients exclusively using modern medicine are 4.55% and 48% in North and South Benin, respectively. Patients exclusively using traditional medicine were observed in small proportions in our study.

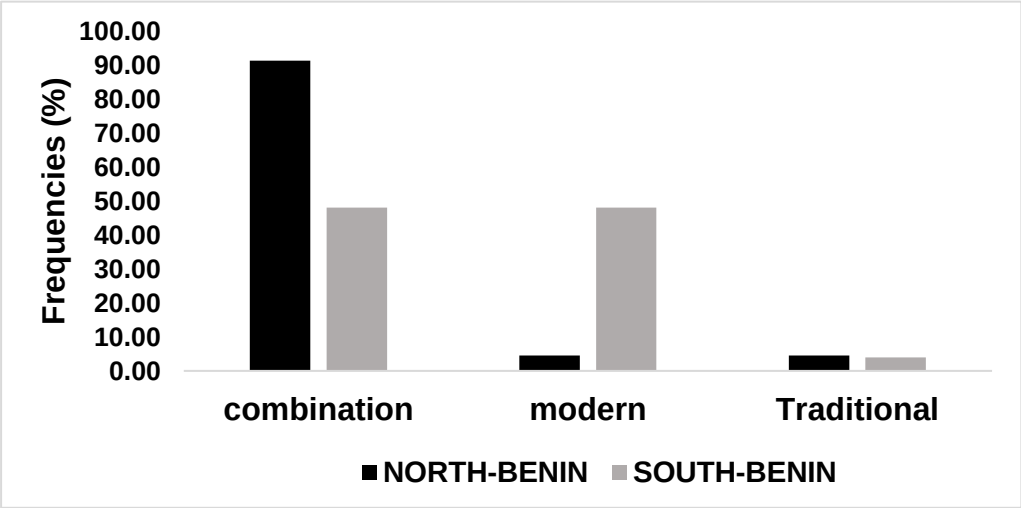

Figure 4 : Types of Medicine Used

2.5 Plant Parts Used for the Treatment of Diabetes

The plant parts identified in patients and proposed by herbalists are presented in Table 1. This figure reveals that leaves are the most used and recommended plant parts by herbalists for diabetics, with 56.18% and 75.96% in the north and 43.24% and 34.62% in the south, respectively, by herbalists and patients. They are followed by roots, bark, and seeds as proposed by herbalists. Indeed, patients combine roots with leaves more than bark in the north, whereas in the south, bark comes before roots. Note that other plant parts such as seeds, fruits, and bulbs are not absent.

Table 1 : Recorded Plant Organs

	HERBALISTS		PATIENTS	
	North-Benin	**South-Benin**	**North-Benin**	**South-Benin**
Leaf	**56,18**	**34,62**	**75,96**	**43,24**
Root	**17,98**	**23,08**	**12,50**	**14,86**
Bark	***9,55***	12,50	7,69	**24,32**
Seed	***9,55***	**20,19**	0,00	13,51
Fruit	6,18	1,92	3,85	4,05
Leafy Stem	0,56	1,92	0,00	0,00
Bulb	0,00	3,85	0,00	0,00
Whole	0,00	1,92	0,00	0,00

2.6 Local Practices Used in Traditional Diabetes Treatment

In traditional diabetes treatment, several local practices were observed in this study among diabetic patients. The Figure 6 presents the preparation methods of recipes according to herbalists and patients. The statistics reveal that the decoction is the most used preparation method by patients and recommended by herbalists, with 49.67% and 47.12% in the north and 62.64% and 80.56% in the south, respectively, by herbalists and patients. The decoction is followed by the infusion in both the north and the south, with few species prepared as the maceration. However, the maceration of plants is more recommended by herbalists in southern Benin.

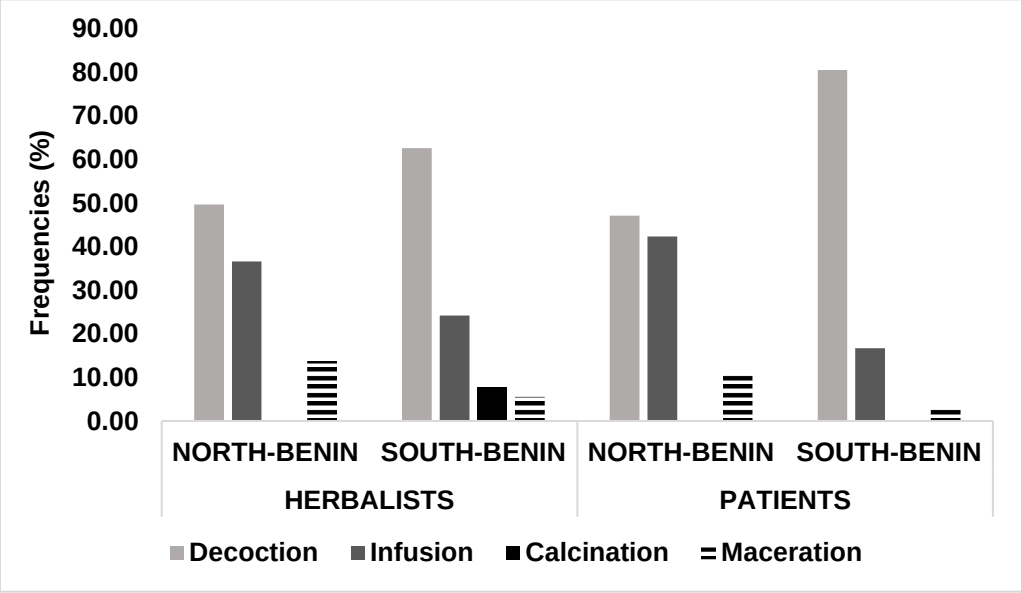

Figure 5 : Method of preparation of recipes according to the patients

2.7 Assessment of Treatment Efficacy According to Patients

The results obtained on the efficacy of antidiabetic plants cited by patients (Figures 7 and 8) show that three plants are considered more effective by patients in each surveyed commune. These species, with a relative frequency of citation (FRC) equal to or greater than 10%, are in order of importance *Phyllanthus amarus* (24.04%), *Bridelia ferruginea* (16.35%), and *Moringa oleifera* (16.35%) in North Benin. In contrast, in South Benin, *Khaya senegalensis* (17.57), *Momordica charantia* (14.86), and *Phyllanthus amarus* (13.51) are most noted. It should be noted that *Sarcocephalus latifolius* is also included in the list of effective plants.

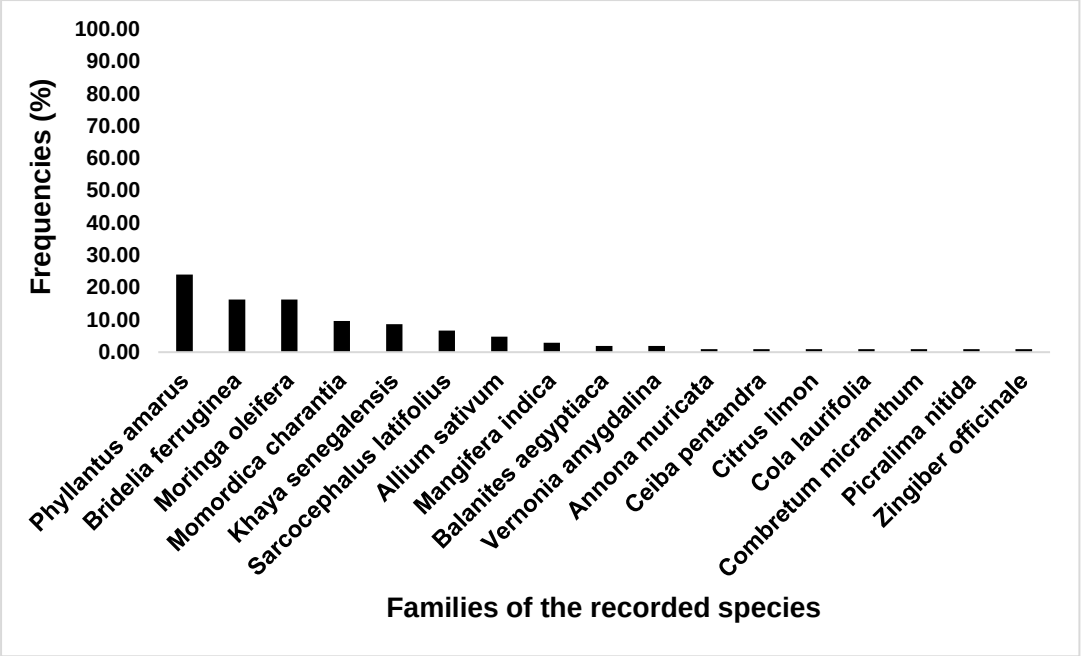

Figure 6 : Effective antidiabetic plants according to patients in north Benin.

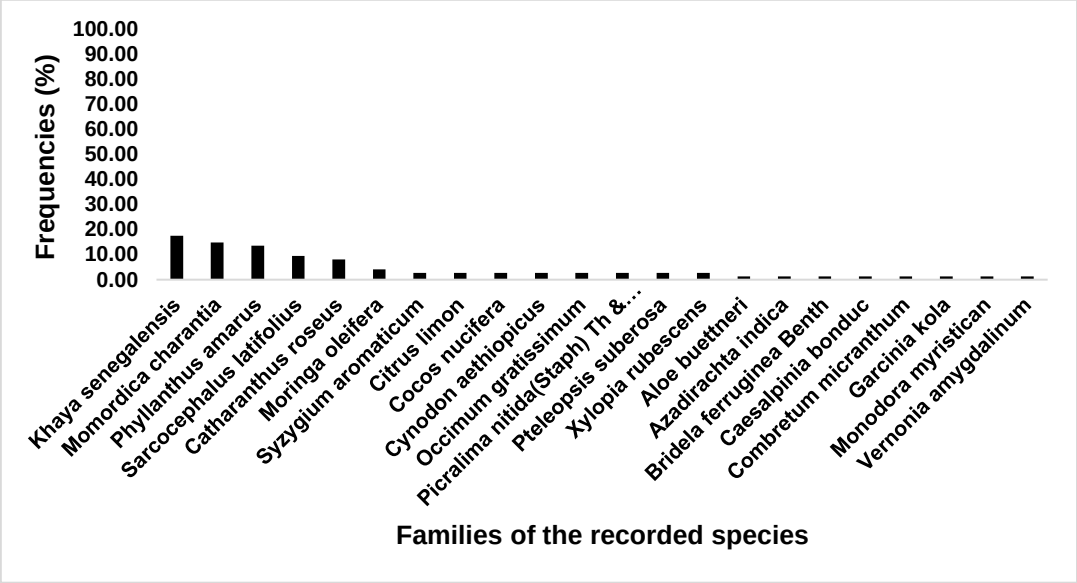

Figure 7 : Effective antidiabetic plants according to patients in south Benin.

3 DISCUSSION

In total, sixty-five (65) plants with antidiabetic properties were cited by herbalists, with *Phyllanthus amar*us (10.22%) being the most cited. The species *Khaya senegalensis* (9.60%), *Catharanthus roseus* (6.81%), and *Momordica charantia* (6.81%) follow in the ranking. They are grouped into fifty botanical families. Ethnobotanical studies of plants used in the treatment of diabetes among pregnant women in Cotonou and Abomey-Calavi (Benin) recorded sixty-one (61) plants belonging to thirty-five (35) botanical families (Fah and *al*., 2013). Similarly, an ethnobotanical study conducted in the communes of Glazoue and Save in Central Benin recorded 144 plants used in the traditional treatment of diabetes (Lawin and *al*., 2016). Other studies have revealed a similar diversity of antidiabetic plants Ziyyat and *al*. (1997) listed 41 plants belonging to 36 families, Adomou and *al*. (2012) 54 plants grouped into 29 families, and N'guessan and *al*. (2009)19 species grouped into 13 families). The most represented botanical family is Apocynaceae, followed by Phyllanthaceae. This result presents some similarities with the work of Abdullahi and *al*. (2011). However, it contrasts with the findings of Erasto and *al*. (2005) in South Africa and Benin by Fah and *al*. (2013) who found Asteraceae. These differences are related to the geographic area of the studies (as in the case of Erasto and *al*. 2005) and also the population concerned (Fah and *al*. 2013) studied exclusively gestational diabetes. The use of plants, therefore, varies according to countries. This study also reveals that the species with the highest citation frequency and most sold by herbalists is *Phyllanthus amarus*. Diabetic patients, on the other hand, consider the following plants effective : *Phyllanthus amarus*, *Bridelia ferruginea*,

Moringa oleifera, *Khaya senegalensis*, *Momordica charantia*, *Phyllanthus amarus*, and *Sarcocephalus latifolius*. Several studies have demonstrated the hypoglycemic activity of some plants mentioned in our study, including *Momordica charantia* (Bailey and *al*., 1985), *Phyllanthus amarus* (Ali and *al*., 2006 ; Karou and *al*., 2011), and *Catharanthus roseus* (Fah and *al*., 2013). The percentage of patients who resort to traditional medicine for diabetes control or treatment recorded in this study is 95.85% in the north and 52% in the south. According to Zahira (2017) in her ethnobotanical study of antidiabetic plants used by diabetics in the Fellaoucene region, Wilaya of Tlemcen, 21% of diabetics use plants. This difference can be explained by the difference in social class of the countries where the study is conducted. According to PNUD BENIN (2009), the use of medicinal plants remains the prerogative of poor people. According to information received from herbalists and diabetics, leaves are the most used plant parts, and decoction and infusion are the most used local practices. The recipes are exclusively administered orally. These results are consistent with those reported by Thirumalai and *al*. (2012) who conducted a similar study in India, as well as the work of Fah and *al*. (2013) in Benin who found the same local practices and modes of recipe administration. It should be noted that this study reveals an issue of dosage mastery and thus the effective use of antidiabetic plants. This situation can be explained by the lack of a specific recipe, conservation method, and unique dosage for each species in the traditional treatment of diabetes. Similarly, according to WHO (2014), in many regions of the world, authorities, healthcare professionals, and the population struggle with issues related to the safety, efficacy, quality, availability, preservation, and regulation of traditional medicine. It is also noteworthy that the virtues of plants are ancestral knowledge transmitted from generation to generation (Adjanohoun and *al*., 1989 ; Klotoé and *al*., 2013).

CONCLUSION

This research aimed to provide an overview of antidiabetic plants and local practices used in the treatment of diabetes in northern and southern Benin. The results showed that medicinal plants still have a place in the treatment of diseases in general and diabetes in particular in the surveyed communes, with a great diversity of antidiabetic medicinal plants. These plants can be included in several recipes with various preparation methods. *Phyllanthus amarus*, *Bridelia ferruginea*, *Moringa oleifera*, *Khaya senegalensis*, *Momordica charantia*, *Phyllanthus amarus*, and *Sarcocephalus latifolius* are the most effective according to patients and sold by herbalists. The most used plant parts are the leaves, and they are mostly taken in decoction form. It should be noted that the existence of multiples dosages for the same recipe indicates a problem of dose mastery. The essential role of traditional healers in the treatment of diabetes should be promoted to alleviate the problems faced by diabetic patients. Additionally, it would be very important for complementary studies to be conducted to evaluate the therapeutic effects and safety of using commonly used teas in the communities of the surveyed communes.

REFERENCES

1. Abdullahi, A.A., 2011. Trends and Challenges of Traditional Medicine in Africa. African Journal of Traditional, Complementary and Alternative Medicine, pp.: 115-123. (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3252714/).
2. Achigan-Dako E.G., Pasquini M.W., Assogba Komlan F., N'Danikou S., Dansi A. & Ambrose-Oji B., 2010. Traditional vegetables in Benin. National Institute of Agricultural Research of Benin. CENAP Printing Works, Cotonou, 285 pp.
3. Adjanohoun, E., Adjaktdjè, V., Ahyi, M.R.A, Aké Assi, L., Akoègninou, A., D'Almeida, J., Apovo, F., Boukef, K., Chadare, M., Cusset, G., Dramane, K., Eymé, J., Gassita, J.N., Gbaguidi, N., Goudoté, E., Guinko, S., Houngnon, P., LO, I., Saadou, M., Sodogandji, Th., De Souza, S., Tchabi, A., Zinsou Dossa, C., Zohoun, Th., 1989. Contribution to ethnobotanical and floristic studies in Benin, Paris: ACCT, 895 p.
4. Adomou, Ac, H Yedomonhan, B Djossa, Si Legba, M Oumorou, et A Akoegninou. 2012. « Ethnobotanical study of medicinal plants sold in the market of Abomey-Calavi in Benin". International Journal of Biological and Chemical Sciences 6 (2). traditional treatment of diabetes. Accessed October 28, 2019
5. Ali H, Houghton PJ, Soumyanath A., 2006. Alpha-Amylase inhibitory activity of some Malaysian plants used to treat diabetes; with particular reference to Phyllanthus amarus. J Ethnopharmacol.107(3):449–55. www.GoogleScholar.com. Accessed October 28, 2019
6. Amoussou-Guenou, D., Wanvoegbe, A., Hermans, M., Agbodande, A., Boko, M., Amoussou-Guenou Fandi, A., et al. (2015). Prevalence and Risk Factors of Diabetes Mellitus in the Adult Population of Porto-Novo (Benin). Journal of Diabetes Mellitus, 5, 135-140
7. Assogbadjo A.E., Amadji G., Glèlè L.R., Mama A., Sinsin B. & Van Damme P., 2009, Ecological and ethnobotanical evaluation of Jatropha curcas in Benin. International Journal of Biological and Chemical Sciences, 3, 5, 1065-1077.
8. Bailey CJ, Day C, Turner SL, Leatherdale BA. Cerasee, a traditional treatment for diabetes: Studies In Normal And Streptozotocin Diabetic Mice. Diabetes Res. 1985 Mar;2(2):81–4. Www.Googlescholar.Com.
9. Dibong SD, Mpondo Mpondo E, Ngoye A, Kwin M F, Betti Jean Lagarde. Ethnobotany and Phytomedicine of Medicinal Plants of Douala. J. Appl. Biosci. 2011 (37) ; 2496-2507.
10. Djrolo, F., Kerekou, A., & Amoussou-Guenou, D. (2012). Bacteriological Aspects of the Diabetic Foot in Cotonou. Journal de la Société de Biologie Clinique du Bénin, 22, 5-8

11. Dougnon, T. V., Agbankpe, J., Klotoe, J. R., Loko, F., Kpenavoun, C. S., & Yedomonhan, H. (2016). Medicinal plants used in the treatment of mental and neurological diseases in southern Benin. African Journal of Traditional, Complementary, and Alternative Medicines, 13(6), 9-13.
12. Dresse, A., Dresse, F., Baranzini, N., Bonvin, C., & Von Rohr, P. R. (2013). Development of a new method for monitoring the quality of honey based on viscosity measurements. Journal of Food Engineering, 115(4), 454-459.
13. Enneb, H, A. Be Kadhi, F. Cheour, Et A. Ferchichi. 2015. « Comparison of Phenolic Compounds and Antioxidant Power of Henna Plant (Lawsonia Inermis L.) - Journal Of New Sciences ». 2015. Http://Www.Jnsciences.Org/Agri-Biotech/42-Volume-10/93-Multiplication-De-L-Arganier-Argania-Spinosa-L-Skeels.
14. Erasto P., Adebola P.O., Grierson D.S., Afolayan A.J., 2005. An ethnobotanical study of plants used for the treatment of diabetes in the Eastern Cape Province South Africa. African J. of Biotech, 4: 1458-1460.
15. Ezebilo E.E. & Mattsson L., 2010, Contribution of non-timber forest products to livelihoods of communities in southeast Nigeria. International Journal of Sustainable Development and World Ecology, 17, 3, 231-235.
16. Fah L., Klotoé J., Dougnon, V., Koudokpon H., Fanou V., Dandjesso C., & Loko F. (2013). Ethnobotanical study of plants used in the treatment of diabetes in pregnant women in Cotonou and Abomey-Calavi (Benin). Journal of Animal &Plant Sciences, 18(1), pp. 2647-2658. Consulté le 28 octobre 2019
17. Fandohan, B., R. Glele Kakai, B. Sinsin, and D. Pelz. 2008. Dendrometric and spatial characterization of three medicinal woody species in the Wari-Maro classified forest in Benin. Rev. Ivoirienne Sci. Technol 12: 173–186.
18. Gaoue, O. G., and T. Ticktin. 2007. Patterns of harvesting foliage and bark from the multipurpose tree Khaya senegalensis in Benin: Variation across ecological regions and its impacts on population structure. Biol. Conserv. 37: 424–436.
19. Gning, O. N., O. Sarr, et L. E. Akpo. 2014. « Richness of the Malinke Pharmacopoeia: Medicinal Role of the Khossanto Tree: (Kedougou, Eastern Senegal) ». Journal of Applied Biosciences 74 (1): 6043-58. https://doi.org/10.4314/jab.v74i1.11.
20. Gouwakinnou G.N., Lykke A.m., Assongbadjo A.E. & Sinsin B., 2011, Knowledge, pattern and diversity of use Sclerocarya birrea. Journal of Ethnobiology and Ethnomedicine, 7, 8, 17466-4269.
21. INSAE. 2015. General census of population and housing - Benin (RGPH 4).
22. Jenik, J. 1994. The Dahomey-Gap: an important issue in African phytogeography. Mem. la Soc. Biogeogr. (3e Ser. iV: 125–133).
23. Karou, S. D., Tchacondo, T., Tchibozo, M. A., Abdoul-Rahaman, S., Anani, K., Koudouvo, K., et al. (2011). Ethnobotanical survey of medicinal plants used in the management of diabetes mellitus and hypertension in the Central Region of Togo. Pharmaceutical Biology, 49(12), 1286-1297.
24. Klotoé JR., Dougnon TV, Koudouvo K, Atègbo J-M, Loko F, Akoègninou A, Aklikokou K, Dramane K, Gbeassor M, 2013. Ethnopharmacological survey on antihemorrhagic medicinal plants in South of Benin. European Journal of Medicinal Plants 3(1): 40-51.
25. Ladoh-Yemeda, C. F., T. Vandi, S. D. Dibong, E. Mpondo Mpondo, J. D. Wansi, J. L. Betti, F. Choula, Din Ndongo, et M. Tomedi Eyango. 2016. « Ethnobotanical study of medicinal plants marketed in the markets of the city of Douala, Cameroon». Journal of Applied Biosciences 99 (1): 9450-66.
26. Lawin, H., Agodokpessi, G., Schlünssen, V., Sigsgaard, T., Fayomi, B., & Hounsou, E. (2016). Respiratory health in cotton ginners exposed to organic dust in Benin. Occupational Medicine, 66(3), 228-234
27. Ministry of Health of the Republic of Benin (2010). National Health Development Plan 2009-2018. Cotonou: Ministry of Health.
28. N'Guessan K, Kadja B, Zirihi G, Traoré D, Aké-Assi L. Phytochemical screening of some Ivorian medicinal plants used in Krobou country (Agboville, Ivory Coast) Sciences & Nature (Internet) 2009;6(1). Available from: http://www.ajol.info/index.php/scinat/article/view/48575. www.GoogleScholar.com.
29. Ouinsavi, C., Sokpon, N., & Biaou, H. (2006). Ecological studies on the regeneration and sustainable management of iroko (Milicia excelsa) in Benin. Forest Ecology and Management, 229(1-3), 190-199.
30. PNUD BENIN (2009). Human Development Report 2009: Overcoming barriers: Human mobility and development. New York: United Nations Development Programme.
31. Raunkiaer, C. (1934). The Life Forms of Plants and Statistical Plant Geography. Oxford: Clarendon Press.
32. Tardio J., & Pardo-De-Santayana. (2008). Cultural Importanc Indice: A Comparative Analysis Baesd on the Useful Wild Plants of Southern Cantabria (Northern Spain). Economic Botany, 62(1), pp. 24-39.
33. Thirumalai T., Beverly C D, Sathiyaraj K., Senthilkumar B., David E. 2012. Ethnobotanical Study of Anti-diabetic medicinal plants used by the local people in Javadhu hills Tamilnadu, India. Asian Pacific Journal of Tropical Biomedicine, S910-S913.
34. Ticktin, T., D. Mondragon, and O. G. Gaoue. 2016. Host genus and rainfall drive the population dynamics of a vascular epiphyte. Ecosph. 7(11) 01580. 10.1002/ecs2.1580 7: 1–13.

35. United Nations Development Programme (2016). Human Development Report 2016: Human Development for Everyone. New York: United Nations Development Programme.
36. World Health Organization (2000). The World Health Report 2000: Health Systems: Improving Performance. Geneva: World Health Organization.
37. World Health Organization (2014). World Health Statistics 2014. Geneva: World Health Organization.
38. Zahira, A., Al-Junid, S. M., Razak, M. A., Omar, M. A., Mohamed, A. K., & Kassim, M. Z. (2017). Prevalence of Obesity and Its Associated Factors among Adults in a Rural Community in Malaysia. Malaysian Journal of Public Health Medicine, 17(2), 49-58.
39. Ziyyat A, Legssyer A, Mekhfi H, Dassouli A, Serhrouchni M, Benjelloun W. Phytotherapy of hypertension and diabetes in oriental Morocco. J Ethnopharmacol. 1997 Sep;58(1):45–54. www.Google.com , consulté le 28 octobre 2019.