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Biodiversity and phytochemistry of medicinal plants used against diarrhea in Benin

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ABSTRACT

Diarrheal diseases are still a public health problem in developing countries and for this, it is essential to take care of them with the use of traditional medicine because for its effectiveness and character in using natural molecules. In this work, 140 people including traditional healers, sellers of medicinal plants, herbal healers, were identified and chosen at random in the 4 major cities of Benin, namely: Porto-Novo, Cotonou, Abomey and Parakou. For information collection the method of individual semi-structured interviews was used and took into account the names of the plants, the conditions treated, the parts of plants used, the methods of preparation, and the therapeutic and traditional use against diarrhea. Phytochemical analysis of plants was carried out using the method based on coloring and precipitation reactions. The results showed that 40% were respondents are traditional healers, 45% were medicinal plant dealers, 10% were herbal healers and 5% represented mothers with babies. The survey carried out indicated a list of 14 species divided into 13 genera and 11 families, among which Combretaceae and Fabaceae (27.27%) are the most represented families. The leaves (85.71%) were the most used with the decoction (71.42%) as the frequent mode of preparation. The preparations were administered orally (67.38%) in the form of a drink. The phytochemical profile showed the presence of 13 chemical groups for all species. The most common being steroids, tannins, reducing compounds, mucilages, saponosides and alkaloids. The tannins and saponins justify preliminary the antidiarrheal properties attributed to these plants. This study was showed the chemical characterization of diarrheal Beninese species.

Keywords: Diarrheal diseases, survey, phytochemical profile, Benin.

INTRODUCTION

Diarrhea is a transit disorder that is characterized by loose stools, even liquid in abnormally high quantities or with an increased frequency of occurrence of the order of several times a day (Bryce et al., 2005; Randremanana et al., 2012). It is one of the symptoms of enteric infections and food toxicity. Diarrheal

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diseases account for 20% of all diseases in developing countries. They are the second leading cause of death in children under 5 years. They represent a real public health problem throughout the world where they are responsible for 4 to 6 million deaths per year (Bryce et al., 2005; Lin et al., 2012).

The use of traditional medicine and medicinal plants in most developing countries as a normative basis for the maintenance of good health has been widely observed (WHO, 2015). In most developing countries, between 70 and 95% of the population rely on traditional medicine, which has always occupied a central place in the global health system, to cure myriad ailments (WHO, 2015; Moses et al., 2015; Gandonou et al.,2017; Agbodjogbe et al.,2022). Plants offer new bioactive compounds with the added benefit of ethnobotanical observations, since many species are used in natural and traditional medicine systems (Cox, 2000). Herbal medicinal products are labeled finished products which contain active ingredients such as in the form of above or below ground parts of plants or other plant materials or a combination thereof, either raw or in form of herbal preparations.

The Beninese flora is very rich in medicinal plants and can be exploited for research into new non-toxic pharmacophores with very good efficacy against diarrheal diseases, whether microbial or parasitic.

It is in this perspective that the present work fits, the general objective of which was to promote the antidiarrheal plants of Benin by determining the chemical composition of the plants listed after an ethnobotanical survey.

MATERIALS AND METHODS

Plant material

The plant material consisted of the fresh organs of antidiarrheal plants listed obtained upon the ethnobotanical survey. They were spreaded out in a cold drying room (22°C) for approximately 14 days, and grinded using an electric grinder (Retsch type SM 2000/1430/Upm/Smf). The shredded material was separated with a 710 µm diameter sieve and used for phytochemical analysis.

Methods

Survey areas

The survey areas or markets were targeted taking into account their accessibility and ethnic diversity with the aim of having a much more general and diversified data. Thus, markets of municipalities with special status of 4 large cities are prospected. These are mainly the commune of Calavi in the department of Atlantique, the communes of Porto-Novo and Adjarra in the department of Ouémé, the commune of Bohicon in the department of Zou, and the commune of Parakou in the department of Alibori. Figures 1, 2, 3 and 4 below indicate the geographical maps of the survey areas with the markets visited.

Ethnobotanical survey

The survey took place from August to November 2020 on Beninese territory and involved traditional healers, herbalists, and traders in medicinal plants. A total of 140 people were interviewed in the 4 major cities of Benin, namely Porto-Novo, Calavi, Abomey and Parakou. Traditional therapists and herbalists were identified and chosen at random in each of the four cities of Benin. Contacts were established with traditional therapists and herbalists and appointments were generally made in the markets on the sales sites of medicinal plants.

To collect information, the individual semi-structured interview method was used (Diarra et al., 2016; Moyabi et al., 2020). The open-ended questions addressed in the local language and under the interpreter guides concerned the names of the plants, the conditions treated, the parts of plants used and the methods of preparing the recipes, and the therapeutic and traditional use against diarrhea. Each interview was accompanied by the purchase of fresh medicinal plants, marketed and used for the treatment of diarrhea. The information collected also concerned the profile of the people interviewed (age, sex).

Processing survey data

After analyzing the survey sheets, the data analysis focused on determining, for each species, the frequency of citation (CF). Response calculations were performed with Excel 2016 software for various variables

(plants, plant organs used, family, method of preparation, route of administration).

The frequency of citation (CF) of each species makes it possible to appreciate the regularity in the distribution of a species. It was determined, for each species, by the formula used in literature in several work (Gandonou et al., 2017; Fah et al., 2013; Privanaka et al., 2014; Ouachinou et al.,2019):

FC = (NP/NT) x 100, with

NP: number of times the species is cited, NT: total number of citations.

Phytochemical analysis

The phytochemical screening was carried out in accordance with the classic method of differential coloring and precipitation reactions of the main groups of chemical compounds contained in the matrix (Agbodjogbe et al., 2022; Bruneton, 2009; Houngbeme et al., 2014; Ombouma et al., 2021). The various tests performed were summarized in Table 1.

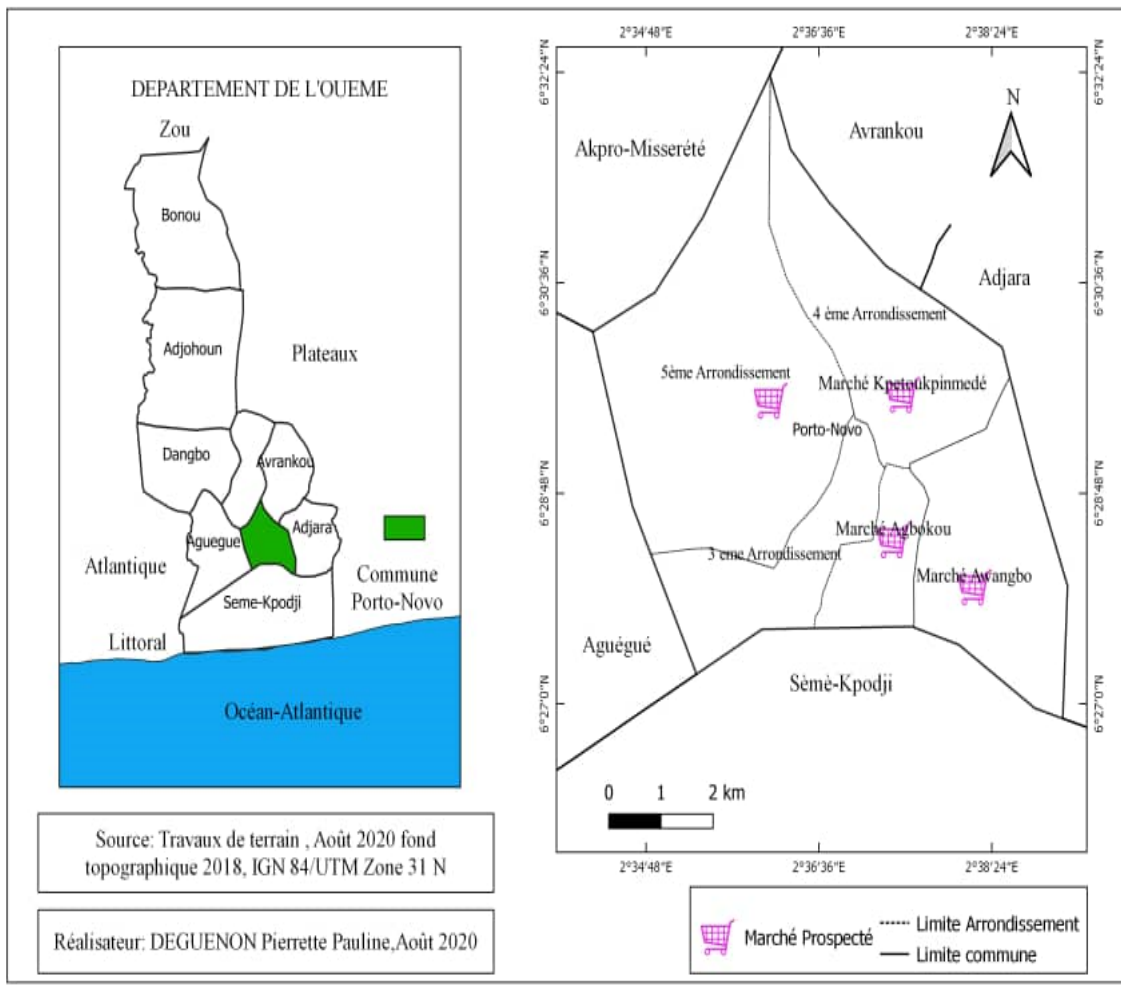

Figure 1: Geographical map showing the survey sites in the Department of Ouémé
Source: Deguenon Pierrette Pauline Memonsso, (2020).

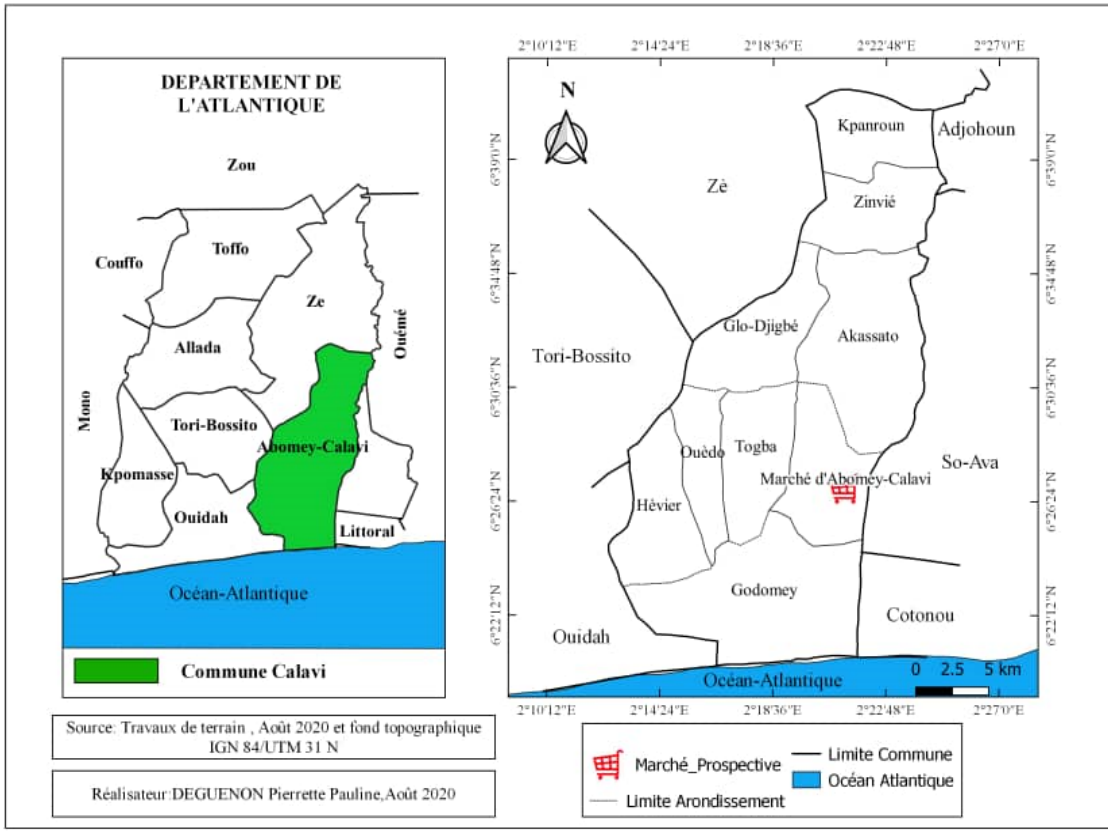

Figure 2: Geographical map showing the survey sites in the Atlantic Department.
Source: Deguenon Pierrette Pauline Memonsso, (2020).

Table 1: Chemical reactions for the identification of secondary metabolites.

Classes of metabolites	Specific reagent and Reaction
Alkaloids	-Dragendorff (potassium iodobismuthate): orange precipitate -Mayer (potassium iodomercurate): yellowish precipitate
Tannins	-FeCl3: dark blue color
Flavonoïds	- Shinoda (reaction to cyanidin): orange-red coloration
Anthocyanins	- Red color in acid medium and purplish blue in alkaline medium
Leucoanthocyanins	Hydrochloric alcohol (EtOH 50°/HClcc 2:1 v/v): cherry red color
Quinone derivatives	-Bornträger (reaction between quinone cycles in NH4OH medium): purplish red coloration
Saponosides	--Determination of the foam index (positive if IM>100)
Steroids and Terpenes	--Liebermann-Burchard (Acetic anhydride-H2SO4cc 50:1 v/v) : violet color -Kedde (dinitrobenzoic acid 1% in EtOH + NaOH 1N 1:1): purple red color (cardenolides)
Cyanogenic derivatives	- Guignard (Paper impregnated with picric acid): brown color

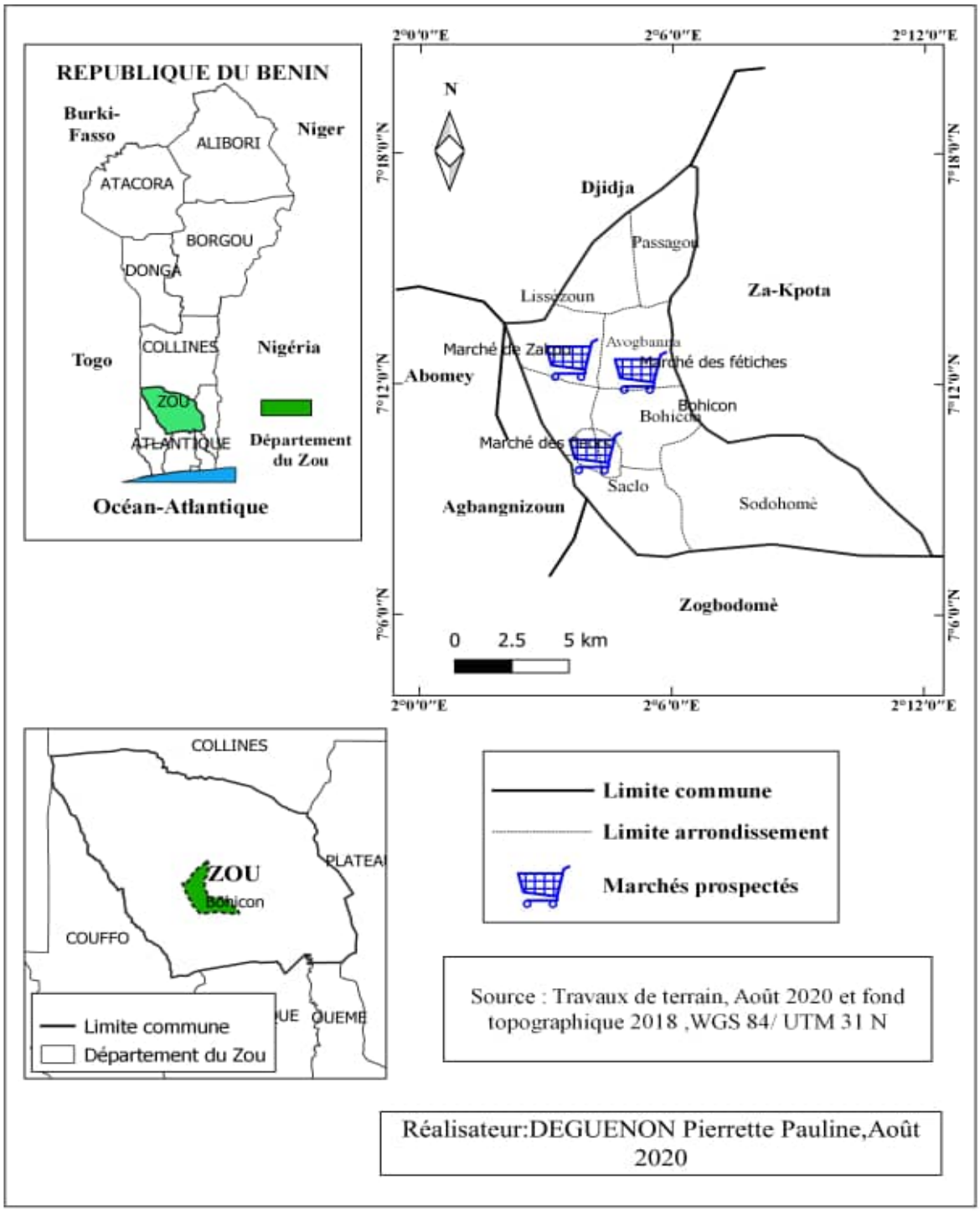

Figure 3: Geographical map showing the survey sites in the Department of Zou.
Source: Deguenon Pierrette Pauline Memonsso, (2020).

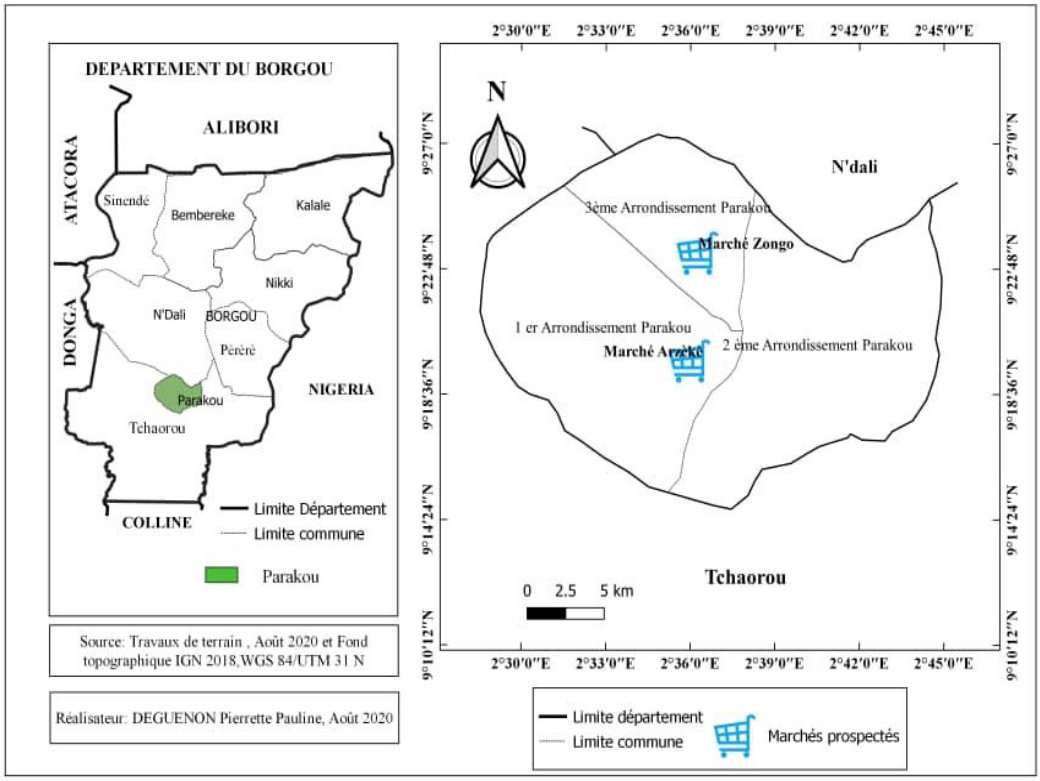

Figure 4: Geographical map showing the survey sites in the Department of Borgou.
Source: Deguenon Pierrette Pauline Memonsso, (2020).

RESULTS

Socio-demographic characteristics

Respondents were made up of 13.38% men against 86.62% women. 40% of those surveyed were traditional healers, 45% resellers of medicinal plants, 10% herbalists and 5% mothers with babies. The levels of study of the respondents as well as their age group are indicated by Figures 5 and 6.

Figure 5 shows that 88% of respondents are educated against 12% for the ones non educated. Thus, the people surveyed not only knew how to read but could also write, which was an advantage in the data collected during field exchanges.

It can be seen from Figure 6 that the respondents were between 31 and 80 years old.

Inventory of antidiarrheal plants

The survey carried out made it possible to list 14 species of plants used against diarrhea, divided into 13 genera and 11 families, among which the Combretaceae (3 species) and the Fabaceae (3 species) were the most represented with a percentage of 27.27%. The most used organs were the leaves (85.71%) and the method of preparation most proposed by traditional therapists was the decoction (71.42%). Most of the preparations were administered orally (67.38%) in the form of a drink. The Table 2 below summarizes the various results of the survey.

These parts of plants are prepared mainly in the form of decoction and maceration.

Identified chemical groups

The 14 plants identified during the ethnobotanical survey are subjected to phytochemical analysis in order to have knowledge of the major phytochemical groups that govern the antidiarrheal activity attributed by practitioners of traditional medicine. The results obtained are summarized in Table 3.

Table 3 shows that antidiarrheal plants from Benin are rich in secondary metabolites (13 chemical groups present for all species). They do not contain toxic compounds such as cyanogenic derivatives and cardiotonic glycosides.

The most common compounds encountered are: steroids, tannins, reducing compounds, mucilages, saponosides and alkaloids. The pharmacological properties of these major chemical groups may indeed justify this antidiarrheal property.

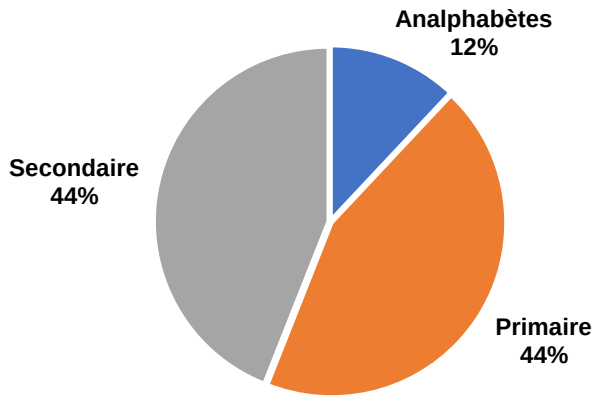

Figure 5: Education level of respondents.

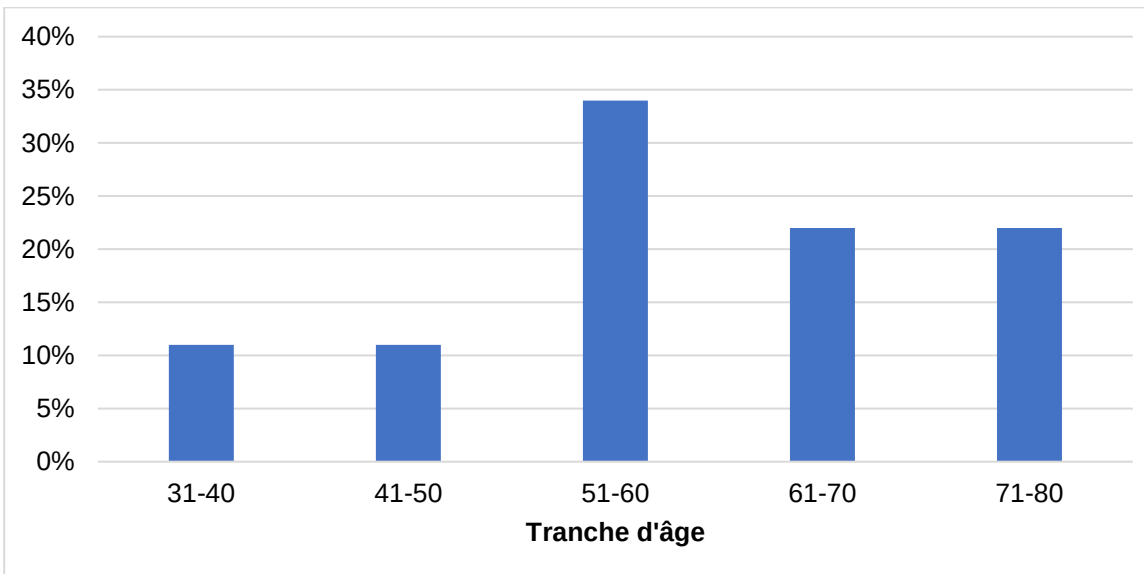

Figure 6: Age group of respondents.

Table 2: summary of the plants identified by the ethnobotanical survey.

Code	species	Familly	Local names	Citation frequency (%)	Use parts	Use form
A	*Pteleopsis suberosa engl. & diels*	Combretaceae	tima, bangobokourou	3,05	Bark and Leaves	Decoction
B	*Detarium microcarpum guill. & perr.*	Fabaceae	dakpa, kokouaka	5,53	leaves, bark and roots	Decoction
C	*Sida rhombifolia*	Malvaceae	adonman	2,06	leaves	Decoction
D	*Combretum micranthum g. Don*	Combretaceae	kinikiniba	01,74	leaves	Decoction
E	*Desmodium ramosissimum g. Don*	Fabaceae	zèdali	3,42	Leaves and stem	Decoction and maceration
F	*Heterotis rotundifolia (sm.) Jacq.-fél.*	Melastomataceae	hêhêman	4,35	leaves	Decoction
G	***Sarcocephalus latifolius***	Rubiaceae	koman	34,81	roots	Decoction
H	*Crateva adansonii*	Capparaceae	hontonzuzouè	1,68	leaves	Decoction
I	*Acanthospermum hispidum dc.*	Asteraceae	kpononmi	2,47	leaves	Decoction
J	*Cnestis ferruginea dc.*	Connaraceae	gboviahu	1,23	leaves and stem	Decoction
K	*Papillonacées pterocarpus*	Papilionaceae	gbèngbèman	1,62	leaves	Decoction et maceration
L	*Psidium guajava*	Myrtaceae	kinkounman	8,25	bark, leafy stem and roots	Decoction
M	*Vitex doniana sweet*	Verbenaceae	fonman	1,43	leaves and stem	Maceration and decoction
N	***Combretum grandiflorum g. don***	Combretaceae	adounsitoman	39,46	leaves	Decoction and maceration

Table 3: Secondary metabolites of the plants inventoried.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	Totaux*
CATECHIC TANINS	-	-	-	+	-	-	+	+	-	+	++	++	++	++	07
GALLIC TANINS	++	++	-	++	++	++	++	++	++	++	++	-	-	++	11
FLAVONOID	-	-	-	++	-	-	+	++	-	++	-	++	++	-	05
ANTHOCYANIN	++	++	-	++	-	-	-	-	-	+	++	++	++	++	08
LEUCOANTHOCYANIN	-	-	-	-	-	+	+	-	++	++	-	++	-	-	05
ALCALOID	++	-	++	+	++	-	-	-	-	-	-	-	++	++	06
REDUCED COMPOUNDS	++	++	-	++	-	++	++	++	++	++	++	++	++	++	12
MUCILAGE	++	++	+	++	++	-	-	-	++	-	++	++	-	++	09
SAPONOSID	++	-	++	++	++	++	++	-	-	++	++	++	++	++	11
CYANOGENIC DERIVATIVES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00
TRITERPEN	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00
STEROID	++	++	++	++	++	++	++	++	++	++	++	++	++	++	14
COUMARIN	-	+	+	-	+	-	-	-	-	-	-	-	-	-	03
QUINONIC DERIVATIVES	-	-	++	-	-	-	-	+	+	-	-	-	++	-	04
FREE ANTHRACENIC	-	-	-	-	-	-	-	-	-	-	-	++	-	-	01
C-HETEROSIDE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00
O-HETEROSIDE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00
CARDIOTONIC DERIVATIVES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	00

*: Total number of species containing a given chemical group;
+: present;
++: high present;
-: absent

A- Pteleopsis suberosa engl. & diels ; B- Detarium microcarpum guill. & perr. ; C- Sida rhombifolia ; D- Combretum micranthum G. Don; E- Desmodium ramosissimum G. Don; F- Heterotis rotundifolia (Sm.) Jacq. -Fél. ; G- Sarcocephalus latifolius ; H- Crateva adansonii ; I- Acanthospermum hispidum ; J- Cnestis ferruginea ; K- Papillonacées pterocarpus ; L- Psidium guajava ; M- Vitex doniana ; N- Combretum grandiflorum

DISCUSSION

The most surveyed age group is 51-60, i.e. 34% of respondents, followed by that of 61-70 years (22%) and 71-80 years (22%). The majority of people interviewed are over 50 years old (78%). This makes it possible to say that the information collected really comes from wise people and resource persons. This information would represent reliable data to be kept for valuation.

Leaves are the most commonly used parts of plants. Several authors in their work have also found that the leaves were the most used parts (Lakouéténé et al., 2009; Hoekou et al., 2016; Manzo et al., 2017; Kpabi et al., 2020). Indeed, the removal of the leaves does not present any danger for the plant. According to some authors, removing 50% of a plant's leaves does not significantly affect its survival, unlike bark and roots (N'Guessan et al., 2009). Leaves were primary sources of photosynthesis organs.

The decoction makes it possible to collect the most active ingredients and attenuates or cancels the toxic effect of certain recipes; which explains the preferential use of this method compared to other extraction methods (Lakouéténé et al., 2009; Manzo et al., 2017; Gnagne et al., 2017). *Sarcocephalus latifolius* was one of the plants cited for their use against malaria (Sema et al., 2018). These results provide a data bank for the research and development of improved traditional medicines effective against diarrhea.

The anti-diarrheal action would involve saponins, tannins and flavonoids (Nwafor and Bassey, 2007). Similarly, other authors have reported the same results as flavonoids, tannins (Dosso et al., 2012), polyphenols, polyterpenes, and saponins (Ojowole et al., 2009; Méite et al., 2009) would be responsible for the antidiarrheal properties of certain plants.

The two species most strongly cited by traditional healers, namely *Combretum grandiflorum* and *Sarcocephalus latifolius*, contain the metabolites responsible for the antidiarrheal activity, which justifies in a preliminary way the use of these plants in traditional medicine against diarrhea. *Sarcocephalus latifolius* contain secondary metabolites (terpenoids and indole alkaloids) with antiplasmodial activities (Koudouvo et al., 2011). So, this plant can be used also against diarrhea which caused by the parasits

Conclusion

This study has identified 14 species of plants used against diarrhea in Benin. These plants belong to 11 families among which the Combretaceae and the Fabaceae are the most represented. The phytochemical analysis of the 14 species showed the presence of metabolites involved in the fight against diarrhea. It is essential to determine the quantitative value of antidiarrheal metabolites in the two species of *Combretum grandiflorum and Sarcocephalus latifolius* which are the most cited by the traditional healers.

COMPETING INTERESTS

The authors declare that they have no competing interest.

AUTHORS' CONTRIBUTIONS

MPPD carried out the ethnobotanical survey throughout the national territory. She participated in data processing and laboratory work on the species identified and wrote this manuscript. AGH contributed to the treatment of the data work and carried out the phytochemical screening in the laboratory. GJO contributed to the work of data processing and writing then corrected the manuscript. FAG and BRMH supervised the work and corrected the different versions of this manuscript.

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