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RESEARCH ARTICLE

PRELIMINARY ETHNOBOTANIC STUDY OF PLANTS USED TO TREAT INFANT DIARRHEA BY THE MITSOGHO PEOPLE IN GABON

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Abstract

An ethnobotanical study of medicinal plants was carried out among the Mitsogho people of the four (4) villages located from Oyane 4 to Four-Place (Estuaire-Gabon). The objective of this study was first todraw up an inventory of plants used in their traditional medicine against infant diarrhea and then to describe the recipes applied by the local population. Sixteen (16) plants species belonging to sixteen (16) genus and eleven (11) families were identified. The most species cited were *Sida rhombifolia* (18%), *Cyathula prostrata* (12%), *Desmodium adscendens* (12%), and *Psidium guineense* (12%). Those with the lowest frequencies were among others *Picralima nitida* (6%) and *Santiria trimera* (6%). The most represented families are Malvaceae (25%), Apocynaceae (12.5%) and Fabaceae (12.5%). The plants inventoried are mainly woody (81%); trunk bark (56%) and leaves (37%) are the most used plant parts. Twenty-two (22) recipes have been described, of which 77% contain a single plant and 23% are mixture.

Introduction:-

Worldwide, 780 million people lack access to drinking-water and 2.5 billion lack improved sanitation (WHO, 2019). Diarrhea, one of the leading cause of children mortality and morbidity globally, is usually a symptom of a gastro-intestinal infection, mostly resulting from contaminated food and water. This faecal-oral cycle allows dissemination of enteric microorganisms promoted by heat, humidity, and poor hygiene. It is a condition linked to faecal hazard ; whose epidemiological characteristics differ from one region to another depending on the level of development of the health care system (WHO, 2017). In low-income countries, children under three years of age experience an average of three episodes of diarrhea per year. Each of which deprives the infant of essential nutrients and thus resulting

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in malnutrition. Since malnourished children are more likely to fall ill from diarrhea, this disease is also the second leading cause of death in children under five years old (WHO & UNICEF, 2017).

In Gabon, the infant mortality rate due to diarrhea was 16% in 2012 (DGS & ICF International, 2013). In reference to the 2013 general population and housing census (BAD, 2016), 34% of the Gabonese population live in poverty with a high unemployment rate and represent around 26% of the active population. Most of this population (75%) lives in urban areas while the rest in rural areas (Ministère de la Santé, 2010).

According to the EGEP (« Enquête Gabonaise pour l'Evaluation de la Pauvreté »), the probability of consulting a health service center is depending on social status (Ministère de la Santé, 2010).Thus, 8% of poor households use health services centers much less compared to 16% of wealthy households because social protection is weak. Public health insurance, introduced in Gabon in December 2008, is only partially operational (Sounda, 2018).

In the large cities, as Libreville, the road and waste infrastructures are inadequate, and the sewage evacuation is far from efficient, resulting in floods, unhealthy conditions, and the proliferation of disease vectors. About hygiene and sanitation, only 6.5% of rural households have improved latrines and 18.8% in urban areas. Potable water is provided to 93.2% of households in urban areas compared to just 39.3% in rural areas (Ministère de la Santé, 2010). To cope with episodes of childhood diarrhea, rural people of the Mitsogho ethnic group, who live far from health facilities, resort to traditional medicine, especially those based on plants.

All around the world, traditional medicine (TM) is either the primary mode of health care delivery or it is an important complement (OMS, 2013). In Africa, medicinal plants are precious resources for most rural population, of whom more than 80% use them for health care (Jiofack et al., 2008; Jiofack et al., 2009). Numerous ethnobotanical surveys have been carried out in Africa and elsewhere to identify medicinal plants used in the treatment of various diseases (Agnaniet et al., 2016 ; Betti & Lejoly, 2009 ; Rahul, 2013 ; Ikram et al., 2014 ; Malan et al., 2015; Sima et al., 2015 ; Kebede et al., 2016 ; Nga et al., 2017).

Many studies focus also on plants used in the treatment of diarrheal diseases (Agbankpé et al., 2014 ; Ambe et al., 2015; Ayena et al., 2016 ; Pragada et al., 2012 ; Raju et al., 2005 ; Sharaibi & Osuntogum, 2017). In Gabon, several ethnobotanical and ethnophamacological surveys relating to medicinal plants have been conducted. These surveys have focused on various pathologies such as malaria (Betty et al., 2013a), helminthiases (Bajin ba Ndob et al., 2016), diabetes (Tjeck et al., 2017), and cancer (Ngoua-Meye-Misso et al., 2019). However, to date, bibliographic research has not revealed ethnobotanical surveys concerning especially anti-diarrheal plants in Gabon.The present study was carried out to remedy this deficiency. The objective is to convert this traditional knowledge into scientific knowledge by identifying and characterizing the plants involved in view of their valorization.

Material And Methods:-

Choice of study:

The study area, which includes four inhabited areas, is in Estuaire district between Oyane 4 and Four-Place villages (Fig 1), situated in the department of Komo-Kango, less than 100 km from Libreville alongNational Road 1 (N1). The primary health care system is inoperative due to a lack of essential medicines, and none of the four villages surveyed has a drinking water supply system. For their daily needs, people obtain water from wells or directly from rivers. Wastewater, electrification, and sanitation infrastructures are also lacking. This population mainly use single pit latrines, not covered by a slab or platform, to cover their needs. Finally, the practice of traditional medicine is the main economic activity for all these villages.

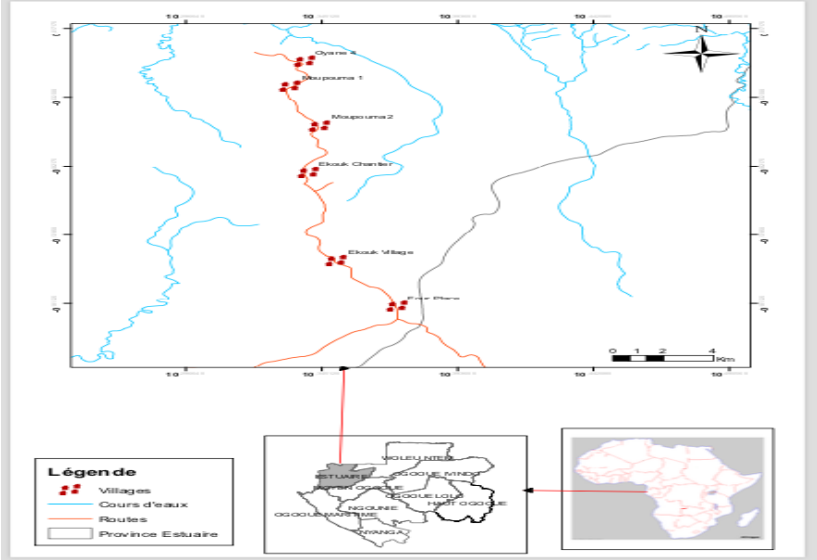

Fig 1:- Study area
Audrey-Pamela MAROUNDOU IRET/06/19

Methodological Approach:-

1. Choice of ethnicity: Mitsogho people was undoubtedly among the first to join the pygmies in currently Gabon, settling into Ngounie district, in the south of the country. To date, several of these villages have avoided rural population exodus. The Mitsogho occupy almost the entire region west and north of Mimongo in the central Chaillu massif. They are known to be awfully close to their habits and customs. Because of their constant interaction with indigenous pygmy people, reputed exceptionally good at traditional medicine, the Mitsogho enriched their own knowledge of medicinal plants.

2. Survey methodology: ethnobotanical survey was carried out based on interviews, guided by a survey sheet, on the plants used in the treatment of childhood diarrhea. Verbal agreement was also obtained from participants after providing them with information explaining the importance of the study and the need for their collaboration. This consent was acquired following our commitment not to disclose the primary composition of the remedy recipes. In addition, participants were made aware of the possibility of sharing with them the possible benefits arising from the use of their knowledge in accordance with the "Nagoya Protocol". This sharing would be subject to mutually agreed terms.

3. Profile of informants: Nine informants (five men and four women), aged between thirty and eighty, voluntarily agreed to participate in the survey. According to their level of training, these informants were classified into three levels of instruction which are illiterate, primary school and high school.

4. Collection and identification of plants materials: The plants were collected in August 2018 in the villages of Oyane 4, Ekouk, Ekouk Chantier and Four-Place. Two types of samples were prepared: botanical samples (BS) and samples for chemical and pharmacological screening (CPS). All the samples were collected according to a traveling inventory after a recognition of the plants in the field by the informants. The botanical samples were photographed, and the geographical coordinates of their respective collection locations were recorded. The identifications were made in two phases : first by one of author (Raymonde Mboma) and by Raoul Niangadouma of the National Herbarium of Gabon in Libreville where each sample was compared to a reference sample and stored.

5. Floristic analysis of the samples: the citation frequencies (CF) of each species, families, and habitus (biological form) by all informants were determined according to the following formula in Fah et al. 2013 : FC = (Number of citations for the plant considered / Total number of citations for all plants) X 100. This frequency indicates the local importance of each element.

6. Ethnopharmacological analysis: the citation frequencies of the parts used, and the modes of administration by all informants were calculated according to the same formula to also highlight their respective local importance.

Results:-

Floristic analysis:

The ethnobotanical survey indicated that 16 species belonging to 16 genera in 11 families are used for the treatment of childhood diarrheal diseases (Table 1). The sum of the respective occurrences of species and families is 21 and 16 (Table 1). Vernacular names weren't given for two recorded plants.

Table 1:- Antidiarrheal plants used by Mitsogho people in four villages of Estuaire province (Gabon).

N°	Species	Family	Mitsogho name	O. N. S	O. N. F.
1	*Acanthus montanus* (Nees) T. Anderson	Acanthaceae	Patchango	1	1
2	*Alchornea cordifolia* (Schumach. & Thonn.) Müll.Arg	Euphorbiaceae	Mbondjè	1	1
3	*Alstonia congensis* De Wild	Apocynaceae	Okouka	1	2
4	*Barteria fistulosa* Mast.	Passifloraceae	Mungumina	1	1
5	*Ceiba pentandra* (L.) Gaertn.	Malvaceae	Oghouma	1	4
6	*Cola acuminata* (P.Beauv.) Schott & Endl.	Malvaceae	Obeghi	1	*
7	*Coula edulis* Baill.	Olacaceae	Oghouda	1	1
8	*Cyathula prostrata* (L.) Blume	Amaranthaceae	Bongui	2	1
9	*Desmodium adscendens* (Sw.) DC.	Fabaceae	Penda a bongo	2	2
10	*Picralima nitida* (Stapf) T. Durand & H.Durand	Apocynaceae	Ghedo avido	1	*
11	*Psidium guineense* Sw.	Myrtaceae	_____	2	1
12	*Pterocarpus soyauxii* Taub.	Fabaceae	_____	1	*
13	*Santiria trimera* (Oliv.) Aubrév.	Burseraceae	Oghungu	1	1
14	*Sida rhombifolia* L.	Malvaceae	Kandji/Kanzi	3	*
15	*Triumfetta cordifolia* A.Rich.	Malvaceae	Ponga ponga	1	*
16	*Uapaca guineensis* Müll.Arg.	Phyllantaceae	Ossambi	1	1
Total		11		21	16

O.N.S = Occurrence number by species; **O.N.F =** Occurrence number by family
_____ : No vernacular name
* : Occurrence number already indicated.

In addition, the 16 species inventoried included nine (9) tree species, three (3) shrub species, one (1) sub-shrub, and three (3) herbaceous species.

The most represented species and families are highlighted in fig 2 and 3.

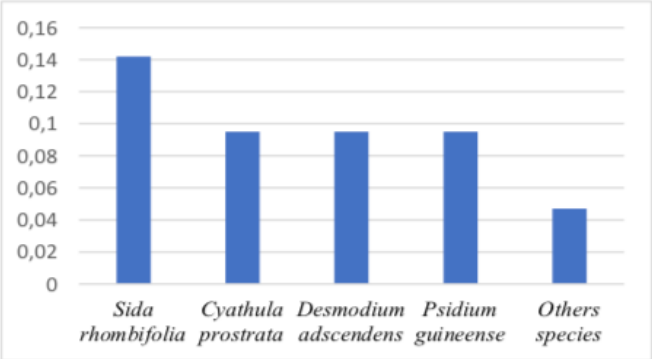

Fig 2 :- Frequency of citations by species

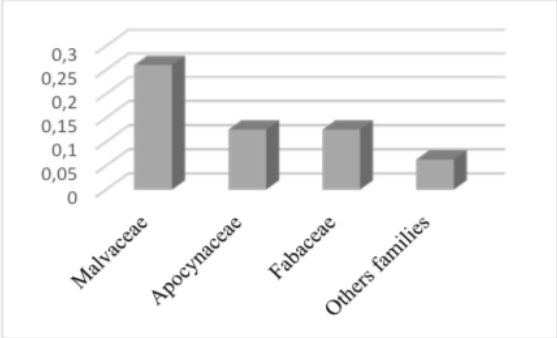

Fig3 :- Plants Families frequencies

Ethnopharmacological analysis

The plant parts used for each species along with their respective recurrence are indicated in Table 2.

Table 2:- Used plant parts in the treatment of childhood diarrheal diseases.

Species	Trunk bark	Leaves
Acanthus montanus		X
Alchornea cordifolia		X
Alstonia congensis	X	
Barteria fistulosa	X	
Ceiba pentandra	X	
Cola acuminata	X	
Coula edulis	X	
Cyathula prostrata		
Desmodium adscendens		X
Picralima nitida	X	
Psidium guineense		X
Pterocarpussoyauxii		
Santiria trimera	X	
Sida rhombifolia		X
Triumfetta cordifolia	X	X
Uapaca guineensis	X	
Occurrence number by used parts	9	6

Looking at the number of occurrences of each species, this table reveals that the most used parts are trunk bark (50%) and leaves (33 %). The other parts namely, wood, root bark and inflorescences represent 17%. Wood is used only for *Pterocarpus soyauxii* and root bark is used only for *Uapaca guineensis*. Also, the use of inflorescence only concerns the species *Cyathula prostrata*. Furthermore, the different methods of preparation and administration route are listed for each species in Table 3.

Table 3:- Methods of preparation and administration route

Species	Part used	Preparation method	Administration route
Acanthus montanus	Leaves	Decoction	Oral
		Maceration	Oral
Alchornea cordifolia	Leaves	Decoction	Oral
Alstonia congensis	Trunk bark	Decoction	Oral
Barteria fistulosa	Trunk bark	Maceration	Oral
Ceiba pentandra	Trunk bark	Decoction	Oral
Cola acuminata	Trunk bark	Maceration	External (enema)
Coula edulis	Trunk bark	Powder	Oral
Cyathula prostrata	Flowers	Powder	Oral
		Maceration	Oral
Desmodium adscendens	Leaves	Maceration	Oral
Picralima nitida	Trunk bark	Maceration	Oral
		Decoction	Oral
	Leaves (Young)	Decoction	Oral
Psidium guineense	Leaves (Young)	Decoction	Oral
	Leaves (Old)	Decoction	External
Pterocarpus soyauxii	Wood or heartwood	Decoction	Oral
Santiria trimera	Trunk bark	Maceration	Oral
Sida rhombifolia	Leaves	Maceration	Oral
			External
Triumfetta cordifolia	Leaves	Decoction	Oral
	Trunk bark	Maceration	Oral
Uapaca guineensis	Root bark	Powder	Oral

During this survey, maceration is the most common method used by traditional healers (43%) to prepare antidiarrheal remedies. This method consists of soaking the plant organ in water for a given time at room temperature. Decoction (39%) which is a process in which the plant is boiled for a period in water is the second method of preparation (Fig 4). Thus, the oral route (Fig 5) remains the main mode of administration (83%). The other route of administration is external in a small portion (17%).

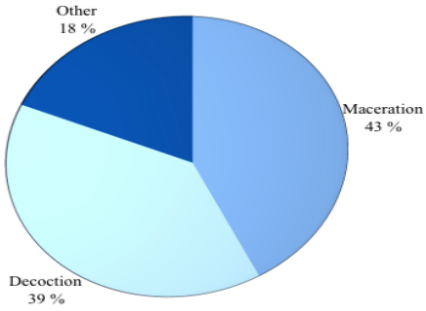

Fig 4 : Plants preparation **Fig 5 : Administration routes**

Composition :-

The 16 cited plant species constitute the main ingredients of 22 medicinal preparations, of which 77% involve a single plant species and 23% are used in mixture. Most of the remedies mentioned in this study are consumed without specific dosage indications. They must be taken as desired throughout the day. Only a few preparations of *Alchornea cordifolia*, *Alstonia congensis* and *Psidum guinensis* are administered in dosed quantities. Treatments are prepared daily, and their duration is determined by the necessary time for the sumptoms to disappear. Water is the only solvent used in liquid preparations.

Discussion:-

The results of our study show that, among the Mitsogho people men (56%) are more interested in the practice of traditional medicine than women (44%). This preponderance of Mitsogho men in traditional medicine could be explained by the existence of male initiatic societies and corporations such as the “Bwete” and the “Mweyi”, which facilitate the transmission of knowledge between generations. This result corroborates that of Lebbie et al., 2017 who showed that 64% of men had an in-depth knowledge of the use of plants comparatively with women (36%).

The study shows that 80% of these traditional healers have not completed high school, this could be explained by the fact that schooling is compulsory in Gabon until the age of 16.

The present study revealed 16 species used as antidiarrhoeal plants, two of which seem to be new recordings for this purpose. These species belong to 11 families, of which the more represented families are the Malvaceae (25%), Apocynaceae (12.5%) and Fabaceae (12.5%).

The 16 species inventoried included several habits (tree, shurb, sub-shrub and herbaceous).The abundance of woody species in Gabon could be explained by forest being the of vegetation in this country while, the savannah type is the most dominant vegetation in Benin (PNUD-Bénin & Ministère de l’Environnement et de la Protection de la Nature, 2009).

The results of the analysis of the cited plant life forms are consistent with previous findings that woody plants are widely used in traditional pharmacopoeia (Adomou et al., 2012 ; Zerbo et al., 2007 ; Soladoye et al., 2010 ; Diatta et al., 2013 ; Uzodomma, 2013). However, Agbankpé et al. (2014) found more herbaceous species among the antidiarrheal plants they inventoried.

The Malvaceae and Fabaceae families have been reported in the treatment of diarrhea by several recent authors, among them (Semenya and Maroyi, 2012 ; Sam et al., 2013 ; Afolayan & Wintola, 2014 ; Sharaibi & Osuntogum, 2017). These families also include widely used medicinal plants in general (Bekalo et al., 2009 ; Rahmatullah et al., 2009 ; Fongod et al., 2014 ; Ikram et al., 2014). According to same authors, *Sida rhombifolia*, most cited species, has several other uses such as against skin infections, menstrual pain, and insomnia (Balakrishnan et al., 2009 ; Shukla et al., 2010 ; Borokini & Omotayo, 2012 ; Swapna, 2015). However, its use as anti-diarrheal is rarely mentioned in the literature. *Acanthus montanus* is used against intestinal helminthiasis and gastritis (Ndip et al., 2007) and *Alchornea cordifolia* is reported to be effective against dysentery and diarrhea (Obaji et al., 2020).

Overall, the trunk bark is the most used part for the preparation of medicinal recipes. This trend has also been observed by Mbayo et al. (2016). This could be explained by the fact that the branches of trees and shrubs are located above 3 m in height, which makes the leaves inaccessible for harvesting. On the other hand, these woody species are available and do not require much effort to reach them in the forest. For their part, Giday and Ameni, 2003 ; Magassouba et al., 2007 ; Bekalo et al., 2009 ; Chekole, 2017 ; Mpondo Mpondo et al., 2017 ; Benaiche et al., 2018 ; Etame-Loe et al., 2018 ; and Yohannis et al., 2018 reported that the leaves are the most used parts in herbal medicine.

The use of leaves according to these authors could be due to traditional healers' awareness mentioned in the various studies for the sustainable harvest of plant organs. Indeed, the harvesting of leaves from medicinal plants represents a lesser threat to their survival (Giday et al., 2003b). The investigation shows that maceration is the most used method of preparation, as revealed by many studies (Ipona et al., 2018 ; Betti et al., 2013 ; Tchouya et al., 2015).

However, other authors (Jiofack et al., 2009 ; Adomou et al. 2012 ; Progada et al., 2012 ; Sam et al., 2013) highlight that the decoction is the most used recipe. This could be explained by the fact that the decoction makes it possible to extract the active ingredients more quickly than maceration.

During this investigation, two types of recipes were highlighted. Medicinal preparations based on a single plant and those from a combination with other elements in accordance with the works of Tor-Anyiin et al., 2003 ; N'guessan et al., 2009 and Kedebe et al., 2016. Regarding mixtures, the associated elements could be considered as excipients to facilitate either the administration or the delivery of the active components.

The results of this study accentuate the use of water as the sole solvent for medicinal preparations and the oral route as the main route of drug administration. This information corroborates that of other studies which reveal a predominance of oral absorption of remedies in animals and humans (Sharaibi & Osuntogum, 2017 ; Dibong et al., 2011 ; Giday & Ameni, 2003 ; Gnagne et al., 2017). This combination is very suitable for the treatment of diarrheal diseases because it makes it possible to rehydrate patients, especially since drinks are generally taken at will. In this way, the dehydration that could result from diarrhea is avoided or controlled in the treated patients. The other advantage of drug oral administration is that it allows the localization of the deep organs. To reach them, all the compounds must pass through the digestive system, to facilitate their assimilation and their action (Tra Bi et al., 2008).

The medicinal preparation is most often taken at will by the patient and the duration of treatment is conditioned by the disappearance of symptoms. This information is in agreement with the work of Mpondo Mpondo et al., 2017 which revealed that the respondents have no unit of measure concerning the solvents and the preparation time of traditional remedies. Likewise, the dosage of these remedies is uncertain (Mpondo Mpondo et al., 2017).

The medicinal preparation is brewed daily. Indeed, according to Dibong et al. (Dibong et al., 2011), plant organs in the fresh state cannot be preserved because they deteriorate rapidly. These authors also reveal that after five days, the preparation becomes unfit for consumption due to the deterioration of the chemical molecules (Dibong et al., 2011).

Most of the plants in our study are mentioned in numerous ethnobotanical surveys. Thus, Tsabang et al., 2016 report that *Acanthus montanus* is used in the treatment of rheumatism while *Cola aluminata* is indicated for the treatment of pathological gas or air accumulation in the colon. Frazão-Moreira, 2016 mentions the use of *Alstonia congensis* against fatigue and swelling. By the same authors, *Ceiba pentendra* is used to heal open wounds. Ajuru et al., 2010 mention *Coula edulis* to combat pain, kidney problems, asthma, constipation, and toothache.

In addition, several of the plants identified have antibacterial activity, which could explain their use in the treatment of diarrhea (Assam Assam et al., 2010 ; Adeniyi et al., 2013 ; Anosike et al.,2012 ; Nwafor et al., 2011 ; Tamokou et al., 2008 ; Obasi et al., 2012 ; Bikanga et al., 2010). Antidiarrhoeal activity was highlighted by Nwafor et al., 2011 on *Triumfetta cordifolia* and suggests that the respondents have a good knowledge of medicinal plants, particularly anti-diarrhoeal ones.

Although an ethnobotanical survey reveals that *Aucoumea klaineana* Pierre (Burseraceae) and is used by the Masango people in Gabon to combat diarrhea (Akendengué, 1992 ; Akendengué and Louis, 1994). As well as, Betty et al., 2013b report that *Schumaniophyton magnificum* (K.Schum.) Harms (Rubiaceae), *Xylopia hypolampra* Mildbr. (Annonaceae) and *Aframomum melegueta* (Roscoe) K.Schum. (Zingiberaceae) have antidairrheic claims based on Baka pygmies living on the periphery of the Ipassa Biosphere.

Conclusions and Recommendations:-

The use of plants for the treatment of childhood diarrhea, is an alternative solution in Gabon faced with not only the inaccessibility of health centers and their dysfunction but also the high cost of conventional drugs.

Plants are veritable reservoirs of biomolecules of great interest for human health. However, the chemical instability of medicinal preparations, the lack of knowledge of active ingredients, the uncertainty of dosages about the amounts administered and the duration of treatment are all weaknesses of the current practice of traditional medicine.

The identified plants listed in the study have significant potential value for the manufacture of improved traditional medicines (ITM), which would facilitate the standardization of both their dosage and method of administration.

Although the development of traditional medicine is a potentially powerful alternative in the WHO's poverty alleviation policy, it should be promoted and practiced in a way that is compatible with the sustainable management and conservation of the plant resources on which it depends. Despite the small number of traditional practitioners interviewed and the small number of plants harvested, the trends observed are consistent with other studies in Africa.

The results of this preliminary study are promising and point to the need to conduct further research involving other rural communities throughout Gabon to enrich the checklist of antidiarrheal plants. These new plants will be opportunities to obtain new active compounds

Following the ethnobotanical studies, chemical investigations of the plants identified should be carried out to identify the active compounds involved in the treatment of diarrhea.

Author's contribution:
The study was designed by MBOMA and OMBOUMA. The ethnobotanical documentation was produced by MBOMA. MBOMA and OMBOUMA wrote the manuscript.

Professor AKENDENGUE had put her great deal of is experience in Ethnopharmacology to improve he quality of writing in English of this paper and to refine bibliographical research about treated topic. Our collaborators of Benin namely GBAGUIDI and HOUNGBEME of the Faculty of Sciences and Health as well as HOUINATO of the Faculty of Agricultural Sciences of University of Abomey-Calavi have contributed as reviewer of the manuscrit.

Declaration of conflict of interest:
The researchers declare that there are no competing interests in this published work.

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