

Antidiarrheal plants sold by the herbalists of Abobo commune market in the north Abidjan (Côte d'Ivoire)

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1 ABSTRACT

The present study was done in seven markets of Abobo (Côte d'Ivoire) for inventory vegetal antidiarrheal resources. Ethnobotanical information obtained beside 44 traditional herbalists, based on interviews, show that 18 plants species are used to cure to diarrhoea. They are belonging to 17 genera and 11 families. The best represented families were: Euphorbiaceae. Three species commonly cited by healers were: *Psidium guajava*, *Alchornea cordifolia* and *Euphorbia hirta*. Various plant organs are used for the preparation of drug recipes. Leaves are the most used. These receipts which are mainly multispecific require different preparation methods (decoction, soaking and kneading). Most remedies are prepared as a decoction. Administration was essentially oral. This study constitutes a source of very precious information for subsequent researches for the domains of the phytochemistry and pharmacology in order to search for new natural substance.

RÉSUMÉ

Plantes antidiarrhéiques vendues par les herboristes des marchés de la commune d'Abobo, au nord d'Abidjan (Côte d'Ivoire).

La présente étude a été conduite dans sept marchés de la commune d'Abobo (Côte d'Ivoire) pour inventorier les ressources végétales antidiarrhéiques. À l'aide de fiches questionnaires, les informations ethnobotaniques obtenues auprès de 44 herboristes, révèlent que 18 espèces de plantes sont utilisées pour combattre la diarrhée. Elles sont réparties en 17 genres et 11 familles avec une importante représentativité des Euphorbiaceae. Les trois espèces couramment citées par ces herboristes sont : *Psidium guajava*, *Alchornea cordifolia* et *Euphorbia hirta*. Différents organes de plante sont utilisés pour la préparation des recettes médicamenteuses. Les feuilles sont les plus employées. Les recettes, majoritairement plurispécifiques, nécessitent diverses méthodes de préparation (décoction, macération et pétrissage). La majorité des remèdes est préparée par décoction. L'administration des remèdes est faite essentiellement par la voie orale. Cette étude constitue une source d'informations très précieuse pour les recherches ultérieures dans les domaines de la phytochimie et de la pharmacologie en vue de rechercher de nouvelles substances naturelles.

2 INTRODUCTION

Diarrhea is defined as an increase in defecation frequency (more than 3 times per day), stool volume (more than 200 g per day) and stool liquidity that can reach a water content of more than 85% (Dong and Zeng, 2019). It is a common problem and can have life-threatening causes (Bourée, 2018). However, most causes of diarrhoea are benign. According to the Canadian Government, (2017) citing the WHO, diarrhoea kills approximately 7,600,000 children under the age of five every year worldwide. It is the second leading cause of death for this age group. To date, enormous progress has been made in the management and control of diarrheal diseases in industrialized countries, but the reality is quite different in developing countries where faecal and food hygiene is precarious. In Côte d'Ivoire, diarrheal diseases aggravated by high malnutrition and limited health care, including basic rehydration, account for significant proportion of illness cases and death in both children and adults (WHO, 2010). Morbidity and mortality rates associated with diarrheal diseases is excessively high. The According to Koné *et al.* (2015), the main risk factors identified in Abidjan in the onset of diarrhoea include: the location of drinking water storage, the storage container and the location of latrines in

households. These authors have also criticized certain risky behaviours: children who eat without washing their hands, flies that swarm and cover the meals they eat, garbage cans without closing and covered with flies. In view of such rather worrying situations, the WHO, in its resolution AFR/RC50/R3 of 31 august 2000 (WHO, 2001), encouraged African countries to develop regional strategies on traditional medicine to undertake research on medicinal plants and promote their optimal uses in health care delivery systems. In fact, for thousands of years, our ancestors have used plants to relieve their pain, heal their ailments and wounds (N'Guessan, 2008). From generation to generation, they passed on their knowledge and experience. Today, despite the progress of modern medicine, the traditional use of plants with therapeutic virtues is very present in Africa, especially in Côte d'Ivoire. Diarrhoea has been countered using medicinal recipes made up of medicinal plants. The aim of this work is to contribute to the inventory of plants with antidiarrheal potential and to value traditional medical knowledge with a view to taking traditional herbal medicine into account in the global strategies for the fight against diarrheal diseases.

3 EQUIPMENT AND METHODS

3.1 Study area: The town of Abobo is located north of the city of Abidjan (Figure 1) which is itself located on the Atlantic coast, south of Côte d'Ivoire, between latitude 4°80' and 5°27' N and between longitude 3°90' and 4°52' W. Abobo is limited by the sub-prefecture of Anyama in the North, by the commune of Adjamé in the South. To the east, by the commune of Cocody and to the west by the Banco forest and the sub-prefecture of Songon. The population of this town, estimated at 1,030,658 inhabitants (RGPH, 2014) is made up of Ébrié and Attié natives as well as foreign communities, including the Mahou and other foreign communities : Beninese; Burkinabe,

Malians, Ghanaians, Guineans, Nigerians, Senegalese, Chadians and Togolese. Abobo has long played the role of refuge for migrants with little financial means. It is a dormitory town with a high proportion of illiterates and is home to a cosmopolitan population that is very active in small business and the informal sector. For municipal authorities, one of the priorities remains, sanitation and drinking water supply. Thus the prevalence rate of waterborne diseases, of which diarrheal diseases are considerably high in Abobo. To maintain good health, a large part of the communal population uses medicinal plants.

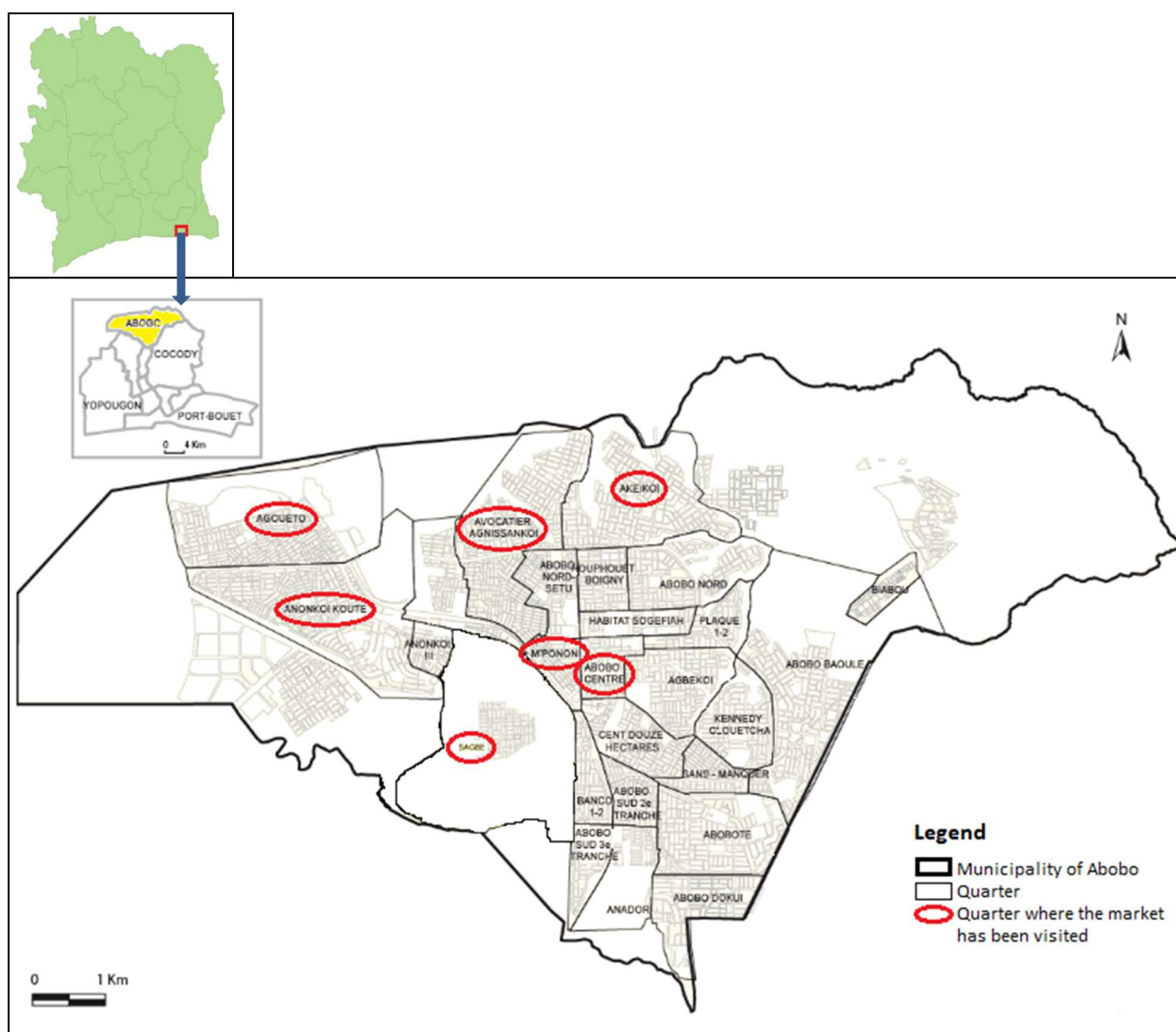


Figure 1: Geographical location of the areas housing the markets visited

3.2 Ethnobotanical Survey: A preliminary survey was needed to select the most accessible markets and herbalists willing to collaborate. The survey itself was carried out for 8 weeks in 7 Abobo markets. The markets covered are those of Akékoi, Anonkoi, Avocatier, Agouéto and Sagbé. The Chaka Koné market and the large market of Abobo commune located in the center of the town were also visited. The information was collected using ethnobotanical survey sheets with a semi-structured questionnaire. The questions were focused on plants used to treat diarrhoea, their local names, the different organs used as drugs, the techniques of preparation, the methods of

administration of remedies, the duration of treatment. Samples of medicinal plants were purchased from herbalists, photographed and identified at the National Floristic Center. The phylogenetic classification, based on the work of the "Angiosperm phylogeny Group", in its latest version designated APG IV (2016) was used to name the species of plants identified and to designate the different taxonomic groups. The samples collected were used to make a single herbarium available at home. The botanical description of these species was carried out through a bibliographical review. All information collected was expressed in percentages to highlight the floristic and

ethnobotanical characteristics of the listed plants. The citation frequency for each of these species was calculated according to the formula in Monnet (2013) : $FC = (n/N) \times 100$ and their therapeutic efficacy was estimated by reporting the sum of treatment times before healing; as reported by interlocutor (i) by number of these (n i) : $EI = n Ti / n i$. In case of appearance of antidiarrheic effect from the first hour of

treatment, the plant is considered potentially very effective; if the cure occurs 2 to 3 hours after administration of the remedy, the plant is said to be potentially effective; if the cure occurs between 4 and 6 hours after taking the remedy, the plant is considered potentially ineffective and when the cure occurs beyond 6 hours after the administration of the medication, the plant is said to be potentially very ineffective.

4 RESULTS

4.1 Profil of the respondents: Forty-four (44) herbalists, unevenly distributed across all the markets visited were interviewed (Table 1). The largest number of herbalists was registered at the Chaka Koné market (9 out of 44, or 20.45%). In total, thirty-nine women (88.64%) and five men (11.36%) constitute this target population from various departments of Côte d'Ivoire and three neighbouring countries: Mali, Burkina Faso and Guinea. Herbalists from the departments of northern Côte d'Ivoire and those from the countries of the West African sub-region are the most represented. These sellers of medicinal plants are strongly composed of illiterates (79.55%). Those who have been educated are mostly at the primary level: 11.36% (Figure 2). The breakdown of informants by marital status reveals that 75% of them live as a

couple. However, only one claims to have his knowledge of the gods. They receive an average of five (5) patients a day in search of antidiarrheal therapy and report living a sober life due to the financial means generated by their activities. Forty-three people interviewed (97.73%) said that their introduction to traditional medical practice was by learning from a parent. These women and men between the ages of 36 and 63 years are mostly composed of individuals between the ages of 40 and 50 years (Figure 3). They have 22 to 46 years of experience as herbalists. This indicates that their initiation to the sale of medicinal plants was made between 14 and 17 years of age. Plant resources marketed by herbalists generally come from within the country

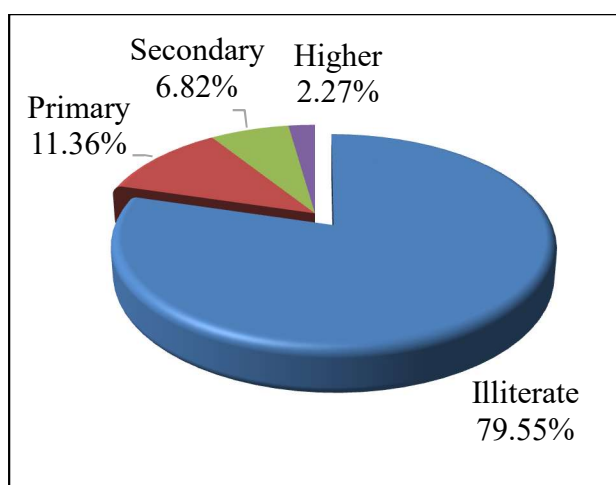


Figure 2: Distribution spectrum of herbalists by level of education.

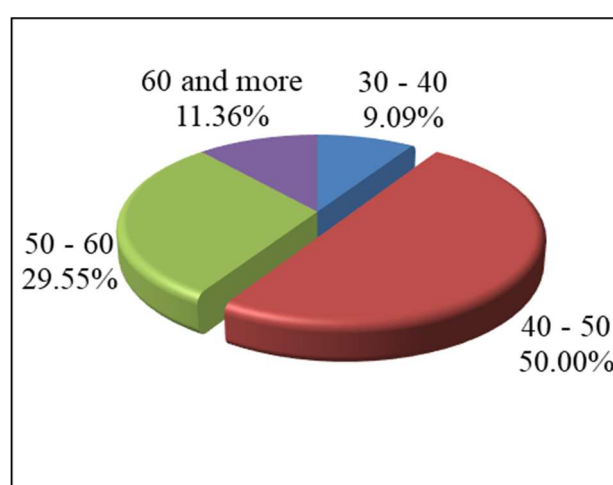


Figure 3: Distribution spectrum of herbalists by age

Table 1: Data related to the respondents profile

Markets		Big market	Avocatier	Anonkoi	Akéikoi	Sagbé	Chaka Koné	PK 18	Total
Number of herbalists		8	6	4	4	6	9	7	44
Number of plants surveyed		7	8	5	7	8	17	9	
Sex	Men	0	1	0	1	2	1	0	5
	Women	8	5	4	3	4	8	7	39
age (years)	30 – 40	2	0	0	0	0	1	1	4
	40 – 50	3	3	4	3	3	4	2	22
	50 – 60	1	2	0	1	2	3	4	13
	60 and more	2	1	0	0	1	1	0	5
Year of experience		24 – 45	28 – 45	34 – 40	27 – 39	25 – 45	27 – 46	22 – 43	
origin	neighbouring countries	3	2	1	1	2	5	4	18
	North of Côte d'Ivoire	4	3	1	2	3	3	2	18
	Elsewhere in Côte d'Ivoire	1	1	2	1	1	1	1	8
level of study	Illiterate	8	4	3	2	4	7	7	35
	Primary	0	1	1	1	0	2	0	5
	Secondary	0	1	0	1	1	0	0	3
	Higher level	0	0	0	0	1	0	0	1

4.2. Floristic and ethnobotanical characteristics of the species surveyed:

Eighteen species of plants with antidiarrheal potential have been inventoried following ethnobotanical investigations conducted in the markets of the commune of Abobo (Table 2). They belong to seventeen genera and eleven families grouped in two clades: Paedodicotyledonous and Eudicotyledonous, mostly represented. The three families best represented are the Euphorbiaceae (4 species or 22.22%), the Fabaceae and the Combretaceae each comprising 3 species, or 16.67%. All other families are represented by a single species. The listed taxa are divided into five morphological groups dominated by trees and shrubs each representing 38.89% of the species. Two biological types were identified: Chamephytes (01 species, 5.56%) and Phanerophytes (17 species, 94.44%). Among the Phanerophytes, the Microphanerophytes and the

Mesophanerophytes have the largest number of species (7 species each, 38.89%). The distribution by phytogeographical type carried out showed that the taxa common to the Guineo-Congolese region and the Soudano-Zambezian region (GC-SZ) are best represented with 10 species, or 55.56%. The number of antidiarrheal plants identified varies from market to market. All plant species have been identified at the Chaka Koné market, with the exception of one, *Microglossa pyrifolia*. So, 17 species of plants have been inventoried in this market. The lowest number of species identified (5) was recorded in the Anonkoi market (Table 3). The scientific names of these plant species are unknown to herbalists who, in most cases, use local names. These are four (4) local languages, namely Agni, Akyé, Baoulé and Malinké, which herbalists use to designate plants. Thirteen appellations out of 18 are formulated in Malinké, or 72.22% (Table 2).

**Table 2:** Floristic characteristics of the plants identified in the markets of the Abobo commune

No	Scientific names	Families	Local names	Morphological types	Biological types	Phytogéographical types
1	<i>Acacia nilotica</i>	Fabaceae	Bangana (Malinké)	Tree	mP	GC-SZ
2	<i>Alchornea cordifolia</i>	Euphorbiaceae	Djéka (Baoulé)	Shrub	mp	GC-SZ
3	<i>Anogeissus leiocarpus</i>	Combretaceae	Kêrêkêrê (Malinké)	Tree	mP	GC-SZ
4	<i>Bridelia ferruginea</i>	Euphorbiaceae	Sagba (Malinké)	Shrub	mp	GC-SZ
5	<i>Senna podocarpa</i>	Fabaceae	Sénéfé (Malinké)	Shrub	mp	GC-SZ
6	<i>Senna sieberiana</i>	Fabaceae	Sindian (Malinké)	Tree	mp	GC-SZ
7	<i>Cochlospermum planchonii</i>	Cochlospermaceae	Ndourou bara (Malinké)	Shrub	np	GC
8	<i>Combretum racemosum</i>	Combretaceae	Nayanka (Malinké)	Liana	mP	GC
9	<i>Euphorbia hirta</i>	Euphorbiaceae	Akololo (Agni)	Grass	Ch	GC-SZ
10	<i>Khaya senegalensis</i>	Meliaceae	Djala (Malinké)	Tree	mP	SZ
11	<i>Microglossa pyrifolia</i>	Asteraceae	Cimoliè (Baoulé)	Shrub	np	GC
12	<i>Nauclea latifolia</i>	Rubiaceae	Bati (Malinké)	Shrub	mp	GC-SZ
13	<i>Psidium guajava</i>	Myrtaceae	Adamba (Akyé)	Shrub	mp	I
14	<i>Pteleopsis suberica</i>	Combretaceae	Treinifou (Malinké)	Liana	mp	SZ
15	<i>Ricinodendron heudelotii</i>	Euphorbiaceae	Akpi (Akyé)	Tree	mP	GC
16	<i>Tectona grandis</i>	Verbenaceae	Teckibrou (Malinké)	Tree	mP	I
17	<i>Waltheria indica</i>	Malvaceae	Dabada (Malinké)	Grass	np	GC-SZ
18	<i>Xylopia aethiopica</i>	Annonaceae	Kanifi (Malinké)	Tree	mP	GC-SZ

Legend: Biological types:

mP: Mesophanerophyte; mp: Microphanerophyte; np: Nanophanerophyte; Ch: Chamephyte.

Phytogeographical types:

GC: Guineo-Congolese; GC-SZ: Guineo-Congolese region and Soudano-Zambezian; SZ: Soudano-Zambezian; I: introduced.

Table 3: Ethnobotanical characteristics of medicinal plants identified in Abobo markets

No	Composition of medicinal recipes	Parts used	State of employment	Method of preparation	Method of administration	Classification of recipes
1	<i>Psidium guajava</i>	Leaves	Dry	Decoction	Drink	Monospecific
2	<i>Psidium guajava</i> <i>Alchornea cordifolia</i>	Leaves Leaves	Dry	Decoction	Drink	Bispecific
3	<i>Euphorbia hirta</i>	Whole plant	Fresh	Kneading	Enema	Monospecific
4	<i>Alchornea cordifolia</i>	Leaves	Dry	Decoction	Drink	Monospecific
5	<i>Psidium guajava</i>	Leaves	Dry	Decoction	Drink	Bispecific



	<i>Ricinodendron heudelotii</i>	Stem bark				
6	<i>Psidium guajava</i> <i>Alchornea cordifolia</i> <i>Ricinodendron heudelotii</i>	Leaves Leaves Stem bark	Dry	Decoction	Drink	Trispecific
7	<i>Alchornea cordifolia</i> <i>Senna podocarpa</i>	Leaves Leaves	Dry	Decoction	Drink	Bispecific
8	<i>Euphorbia hirta</i> <i>Microglossa pyrifolia</i>	Whole plant Leaves	Fresh	Decoction	Drink	Bispecific
9	<i>Euphorbia hirta</i> <i>Microglossa pyrifolia</i>	Whole plant Leaves	Fresh	Kneading	Enema	Bispecific
10	<i>Bridelia ferruginea</i>	Stem bark	Dry	Decoction	Drink	Monospecific
11	<i>Bridelia ferruginea</i>	Stem bark	Dry	Maceration	Drink	Monospecific
12	<i>Psidium guajava</i> <i>Alchornea cordifolia</i> <i>Nauclea latifolia</i>	Leaves Leaves Stem bark	Dry	Decoction	Drink	Trispecific
13	<i>Psidium guajava</i> <i>Pteleopsis suberica</i>	Leaves Stem bark	Dry	Decoction	Drink	Bispecific
14	<i>Psidium guajava</i> <i>Anogeissus leiocarpus</i>	Leaves Stem bark	Dry	Decoction	Drink	Bispecific
15	<i>Euphorbia hirta</i> <i>Anogeissus leiocarpus</i>	Whole plant Stem bark	Dry	Decoction	Drink	Bispecific
16	<i>Euphorbia hirta</i> <i>Anogeissus leiocarpus</i>	Whole plant Stem bark	Fresh	Kneading	Enema	Bispecific
17	<i>Alchornea cordifolia</i> <i>Ricinodendron heudelotii</i>	Leaves Stem bark	Dry	Decoction	Drink	Bispecific
18	<i>Psidium guajava</i> <i>Senna podocarpa</i>	Leaves Leaves	Dry	Decoction	Drink	Bispecific
19	<i>Senna podocarpa</i>	Leaves	Dry	Decoction	Drink	Monospecific
20	<i>Psidium guajava</i> <i>Alchornea cordifolia</i> <i>Anogeissus leiocarpus</i>	Leaves Leaves Stem bark	Dry	Decoction	Drink	Trispecific
21	<i>Alchornea cordifolia</i> <i>Pteleopsis suberica</i>	Leaves Stem bark	Dry	Decoction	Drink	Bispecific
22	<i>Psidium guajava</i> <i>Alchornea cordifolia</i> <i>Senna podocarpa</i>	Leaves Leaves Leaves	Dry	Decoction	Drink	Trispecific
23	<i>Pteleopsis suberica</i>	Stem bark	Dry	Maceration	Drink	Monospecific



24	<i>Waltheria indica</i>	Leaves	Dry	Kneading	Enema	Monospecific
25	<i>Psidium guajava</i> <i>Waltheria indica</i>	Leaves Leaves	Dry	Decoction	Drink	Bispecific
26	<i>Psidium guajava</i> <i>Nauclea latifolia</i> <i>Senna sieberiana</i>	Leaves Stem bark Stem bark	Dry	Decoction	Drink	Trispecific
27	<i>Cochlospermum planchonii</i> <i>Senna sieberiana</i> <i>Tectona grandis</i> <i>Combretum racemosum</i>	Leaves Stem bark Leaves Leaves	Dry	Maceration	Drink	Tetraspecific
28	<i>Cochlospermum planchonii</i> <i>Senna sieberiana</i> <i>Tectona grandis</i> <i>Combretum racemosum</i>	Leaves Stem bark Leaves Leaves	Dry	Decoction	Drink	Tetraspecific
29	<i>Cochlospermum planchonii</i> <i>Senna sieberiana</i> <i>Tectona grandis</i> <i>Combretum racemosum</i>	Leaves Stem bark Leaves Leaves	Dry	Kneading	Enema	Tetraspecific
30	<i>Acacia nilotica</i> <i>Xylopi aethiopica</i> <i>Khaya senegalensis</i>	Leaves Seed Root bark	Dry	Kneading	Enema	Trispecific
31	<i>Psidium guajava</i> <i>Tectona grandis</i>	Leaves Leaves	Dry	Decoction	Drink	Bispecific
32	<i>Psidium guajava</i> <i>Euphorbia hirta</i>	Leaves Whole plant	Dry	Decoction	Drink	Bispecific

The results reported in Table 3 indicate that the listed plants are part of 32 medical recipes used in the treatment of diarrhoea. Bispecific recipes, 15 in number, or 46.88%, are the majority (Figure 4). They are followed in order of preponderance by monospecific recipes (25%), trispecific recipes (18.75%) and tetraspecific recipes (9.38%). The drugs used are diverse: root bark (1.47%), stem bark (26.47%), leaf (61.76%), seed (1.47%) and whole plant (8.82%). Leaves are mostly used (Figure 5). All these plant organs are available fresh or dry in all markets visited in the study area. To facilitate the administration of the active ingredients contained in plant drugs, three (3) methods of preparation are used: decoction, kneading and maceration (Figure 6).

Decoction is the method of preparation mainly requested with a representativeness amounting to 71.88% followed by kneading (18.75%). The minority preparation technique is maceration (9.28%). The herbalists interviewed do not combine animal and mineral resources in the techniques of preparation of antidiarrheal remedies. The medicinal recipes are prepared solely from vegetable drugs and are administered orally (as a drink) and anal (as an enema), until healing after up to three days. The oral route taken for the administration of 81.25% of the premium remedies on the anal route by which 18.75% of the recipes are administered (Figure 7).

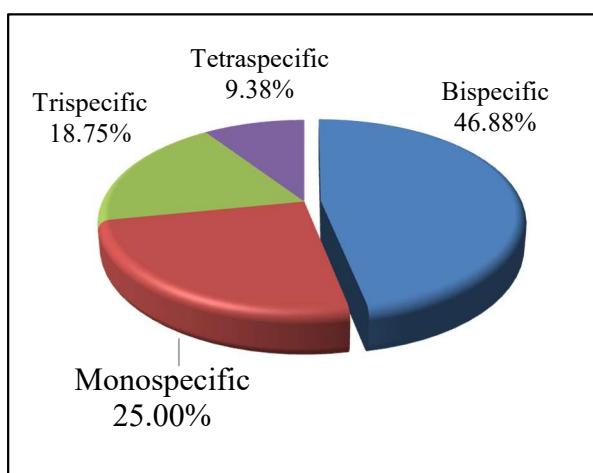


Figure 4: Spectrum of drug recipe specificities

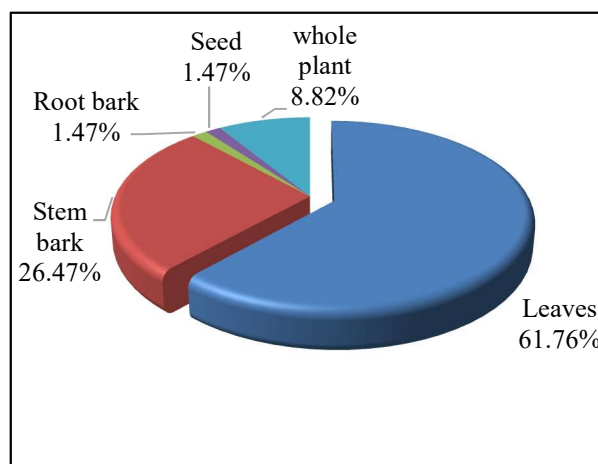


Figure 5: Distribution spectrum of plant parts used as drugs

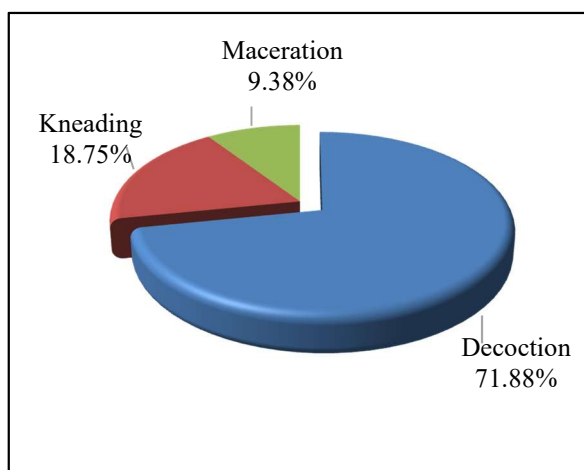


Figure 6: Distribution spectrum of recipe preparation methods

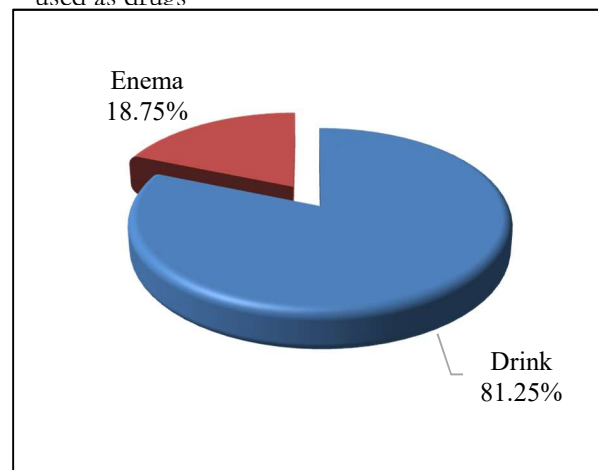


Figure 7: Distribution spectrum of administration methods

4.3 Cultural importance of the plants identified:

The herbalist's knowledge of antidiarrheal plants has been translated into quantifiable and therefore comparable results thanks to the calculations two indices of cultural importance: the frequency of citation (FC) and the therapeutic efficacy index (EI) of the inventoried species. *Psidium guajava*, *Alchornea cordifolia* and *Euphorbia hirta* reported by 84.09%, 70.45% and 36.36% of informants are the most cited species in this study (Table 4). The species *Cochlospermum planchonii*, *Acacia nilotica*, *Xylopia aethiopica*, *Khaya senegalensis*, *Microglossa pyrifolia*, *Combretum racemosum*, and *Walteria indica* are the least mentioned. They were each mentioned by 2.27% of respondents. The time at the end of which healing occurs in the user of a given antidiarrheal plant varies from one species to another according to the information provided by the herbalists. By indicating the time before the patient is cured after using a plant, it was possible to assess the therapeutic potential of

each of the plants inventoried (Table 4). *Psidium guajava*, *Euphorbia hirta* (Photo 1) and *Alchornea cordifolia* are the plant species that restore the patient within the hour. They are therefore considered potentially very effective. *Bridelia ferruginea*, *Anogeissus leiocarpus*, *Ricinodendron heudelotii*, *Senna podocarpa* and *Walteria indica* are said to be potentially effective. They allow patients to recover after 2 to 3 hours after they have been ingested by them. Plants that produce results between 4 and 6 hours after taking the drug have been described as potentially ineffective plants. These are *Acacia nilotica*, *Senna sieberiana*, *Microglossa pyrifolia* (Photo 1) and *Pteleopsis suberica*. The last group of plants consisting of *Cochlospermum planchonii*, *Combretum racemosum*, *Khaya senegalensis*, *Nauclea latifolia*, *Tectona grandis* and *Xylopia aethiopica* very potentially ineffective. The therapeutic effect of these plants is felt more than 6 hours after administration.



Photo 1: Bunch of whole plants of *Euphorbia hirta* (Euphorbiaceae)



Photo 2: Bunch of leaves of *Microglossa pyrifolia* (Asteraceae)

Table 4: Some ethnobotanical indices of antidiarrheal plants identified

No	Scientific names	Number of herbalists who cited the species	FC (%)	EI (h)	Therapeutic potential
1	<i>Acacia nilotica</i>	1	2.27	5	Ineffective
2	<i>Alchornea cordifolia</i>	31	70.45	1	Very effective
3	<i>Anogeissus leiocarpus</i>	13	29.55	3	Effective
4	<i>Bridelia ferruginea</i>	11	25.00	2	Effective
5	<i>Senna podocarpa</i>	9	20.45	3	Effective
6	<i>Senna sieberiana</i>	2	4.55	6	Ineffective
7	<i>Cochlospermum planchonii</i>	1	2.27	8	Very ineffective
8	<i>Combretum racemosum</i>	1	2.27	8	Very ineffective
9	<i>Euphorbia hirta</i>	16	36.36	1	Very effective
10	<i>Khaya senegalensis</i>	1	2.27	8	Very ineffective
11	<i>Microglossa pyrifolia</i>	1	2.27	4	Ineffective
12	<i>Nauclea latifolia</i>	3	6.82	7	Very ineffective
13	<i>Psidium guajava</i>	37	84.09	1	Very effective
14	<i>Pteleopsis suberica</i>	6	13.64	6	Ineffective
15	<i>Ricinodendron heudelotii</i>	8	18.18	2	Effective
16	<i>Tectona grandis</i>	2	4.55	7	Very ineffective
17	<i>Walteria indica</i>	1	2.27	2	Effective
18	<i>Xylopia aethiopica</i>	1	2.27	10	Very ineffective

5 DISCUSSION

This study, aimed at valuing traditional medical knowledge, was carried out among 44 herbalists of the commune of Abobo. It revealed that women (88.64%) are much more involved in the marketing of medicinal plants than men. The same observation was made by N'Guessan *et al.* (2010) and Béné *et al.* (2016). These authors recorded respectively 62.5% and 66.67% women at the end of their studies carried out with traders of medicinal plants in the departments of Agboville and Transua. Women would therefore have favourable abilities to market plant products with therapeutic potential which justifies their strong presence in this sector of activity. The predominance of sellers of medicinal plants from northern Côte d'Ivoire and neighbouring countries (Mali, Burkina Faso and Guinea), also reported by Yapo (2014) suggests an exodus to the city of Abidjan where economic activities are generally more flourishing. The lack of schooling or the low level of schooling of the majority of herbalists also observed by Ambé *et al.* (2015) shows that

the practice of this activity does not require a high level of schooling (Ouafae *et al.*, 2011). Moreover, the level of schooling does not necessarily reflect the level of knowledge or education. Although mostly illiterate herbalists hold knowledge of the properties and uses of medicinal plants that they have generally acquired following long years of learning and experience in the exercise of their art. This is evidenced by the 97.73% of sellers of medicinal plants who claim that their initiation into the trade of therapeutic plants was done by learning from a parent since childhood. However, according to Orch *et al.* (2015), the transmission of this know-how is currently at risk because it is not always assured. This statement is corroborated in this study by the low representation of the youngest aged between 30 and 40 (9.1%) compared to their elders aged 40 to 50 (50%), 50 to 60 (29.55%) and those aged 60 and over (11.36%). At the end of the ethnobotanical surveys, eighteen medicinal species were identified. Euphorbiaceae

(22.22%), Fabaceae (16.67%) and Combretaceae (16.67%) are the families of antidiarrheal plants most represented in the markets of the commune of Abobo. The important representativeness of Euphorbiaceae and Fabaceae, in particular, was also observed during ethno-medicinal surveys carried out in other parts of the country by Kamanzi *et al.* (2002) and Diehl (2004). Indeed, in the flora of Côte d'Ivoire, these families are among the largest groups of plant species (Kouamé 1998). Elsewhere in Africa, in Uganda for example, their predominance has also been recorded in the inventories of medicinal plants made by Hamill (2003); Kamatenesi-Mugisha and Oryem-Origa, (2007). Trees and shrubs are more used in the treatment of diarrhoea by Abobo herbalists. Ambé *et al.* (2015) made the same observation at the level of four municipalities in the city of Abidjan, including Abobo. Our results are similar to those of Aké-Assi (2011), which showed that shrubs are more used in the treatment of diarrhoea by the populations of West Africa. According to him; the predominance of shrubs in the antidiarrheic therapeutic arsenal would be explained by the fact that these plants frequently meet in the immediate environment of herbalists and their different organs are easily accessible. With an individual proportion of 38.89%, the two biological subtypes Microphanerophytes and Mesophanerophytes are mostly represented. These are exactly the same biological subtypes that were the best ranked in the investigations carried out by Yapó (2014) among the herbalists of the markets of the communes of Abobo and Cocody. This author recorded 35.05% of Microphanerophytes and 33.33% of Mesophanerophytes against less than 25% for each of the other biological types (Nanophanerophytes, Hemicryptophytes, Rhizomatic Geophytes and Therophytes). Ouattara (2006) and N'Guessan (2008) showed that the Microphanerophytes were mostly solicited in the different studies they conducted respectively at Divo (42%) and Agboville (35.18%), two cities. The majority of the species sold are of the GC-SZ phytogeographic type

(55.6%). The preponderance of taxa common to the Guineo-Congolese and Soudano-Zambezian region shows that medicinal plants used in the treatment of diarrhoea, sold on the markets of the communes of Abobo, have a broad geographical distribution. This is all to the advantage of herbalists who can obtain them without making long trips from one region to another. Twelve species (*Acacia nilotica*, *Alchornea cordifolia*, *Bridelia ferruginea*, *Senna sieberiana*, *Euphorbia hirta*, *Khaya senegalensis*, *Nauclaea latifolia*, *Psidium guajava*, *Pteleopsis suberica*, *Ricinodendron heudelotii*, *Tectona grandis* and *Xylopia aethiopica*) out of the eighteen species surveyed, 66.67% were also inventoried by Ambé *et al.* (2015) in their similar work. The six other species that are: *Anogeissus leiocarpus*, *Senna podocarpa*, *Cochlospermum planchonii*, *Combretum racemosum*, *Microglossa pyrifolia* and *Waltheria indica* were not found in any of the markets of the four communes visits by these researchers. Thus, these species constitute an additional list to the inventory of antidiarrheal medicinal plants sold in the markets of the city of Abidjan. Of all the inventoried species, *Psidium guajava*, *Alchornea cordifolia* and *Euphorbia hirta* are both the most effective and the most cited by the informants. They thus benefit from an important consensus around their antidiarrheal activity. The therapeutic powers of these plant species have been proven by some authors. Nicolas (2012) found that the leaves of *Psidium guajava* and *Euphorbia hirta* exert an antimicrobial action and reduce the gastrointestinal motility that justifies its antidiarrheic effect while Biswas *et al.* (2013) reveals that the antidiarrheal properties of *Alchornea cordifolia* are due to its richness in tannins and flavonoids highlighted by Nga *et al.*, (2017). The leaves are the most used in antidiarrheic drug preparations. The availability throughout the year, the ease of obtaining these organs are reasons that would explain their preponderance. Also, according to Monnet (2013), heavy leaf harvesting does not pose a risk to the plant. Various authors (Ouattara 2006; Zirih 2006; N'Guessan *et al.*, 2009) have revealed that, in general, leaves are mostly solicited for the development of traditional remedies. The use of

leaves is also justified by the abundance of the chemical groups they contain, as they are the site of secondary metabolite synthesis (Lumbu *et al.*, 2005; Kumar and Lalramnghinglova, 2011). They are followed by stem bark. The predominance of these plant parts used as drugs in the treatment of patients was also highlighted in the work of Tra Bi *et al.* (2008). All the collected organs are mainly used in dried form. For herbalists, the dry state is the one that best promotes the preservation of drugs. They argue that the retention of fresh organs would not exceed a week. This delay is even too long for Dibong *et al.* (2011) who, following their work in Douala (Cameroon), stated that the shelf life of a fresh organ should not exceed five days, and that beyond that period, the drug becomes unfit for consumption, ineffective, or even toxic, because of the degradation of chemical molecules. The species of plants listed are used for the preparation of 32 different antidiarrheal drug recipes, mostly plurispecific. For herbalists, diarrhoea is usually a symptom of other diseases

such as stomach sores, dysentery... They then propose to their clientele remedies composed of several species to solve the problem at the base rather than to tackle only symptomatic manifestations. The predominance of plurispecific recipes in the treatment of diarrhoea was also observed by Ambé *et al.* (2015). The remedies are largely obtained after a decoction. This is the most common method of preparation in herbal medical treatments (N'Guessan, 2008). It promotes an abundant extraction of active molecules and reduces the toxic effect of certain recipes (Salhi *et al.*, 2010). The internal route, in particular, the oral and/or anal route, is the only method recommended to patients for the administration of antidiarrheal drugs. It is recommended by herbalists in order to promote a direct action on the digestive tract in order to obtain an immediate result. Oral administration is most commonly used in the treatment of diarrhoea. Antidiarrheal plants cited by Roumy (2007), Ambé *et al.* (2015), for example, are mostly administered orally.

6 CONCLUSION

This ethnobotanical study made it possible to inventory 18 species of plants dominated by trees. They are mostly composed of species of the family Euphorbiaceae. The organs sold by the 44 herbalists met are mainly made of leaves and are used to make 32 antidiarrheal drug recipes. Three methods of medication preparation (decoction, maceration, and kneading) and two methods of medication administration (drink and enema) are indicated by the informants. *Psidium guajava*, *Alchornea cordifolia* and *Euphorbia hirta* are the most cited

species and are potentially more effective. This inventory is a source of information that helps to save traditional medical knowledge and local popular know-how. It also provides a database for the discovery of new active ingredients for use in conventional health systems. The present study will subsequently extend to the realization of phytochemical and pharmacological tests of extracts of the most significant plants with a view to the development of improved traditional medicines and the popularization of species recognized as being medically useful.

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