Journal of Advances in Medical and Pharmaceutical Sciences

22(10): 11-22, 2020; Article no.JAMPS.62878
ISSN: 2394-1111

Ethnopharmacological Study of Plants Used against Malaria by Traditional Healers in the Department of Bouna, North-Eastern Côte d'Ivoire

Koffi Akissi Jeanne[1*], Tano Konan Dominique[1], Kangah Orphée Michelle Alerte[1], Rasmane Na Ahou Kaddy[1,2], Ehoulé Kroa[1,3], Dable Marius Trésor[1] and Yavo William[1]

[1]National Institute of Public Health, Abidjan, Côte d'Ivoire.
[2]Nangui Abrogoua University, Abidjan, Côte d'Ivoire.
[3]National Program for the Promotion of Traditional Medicine, Abidjan, Côte d'Ivoire.

Authors' contributions

This work was carried out in collaboration among all authors. Authors KAJ, EK and YW initiated and elaborated the protocol. Authors KAJ, RNAK and DMT investigated and collected the samples. Authors KAJ and KOMA elaborated the questionnaire. Authors KAJ, TKD, RNAK, KOMA and YW wrote and proofread the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMPS/2020/v22i1030196
Editor(s):
(1) Dr. Sadaf Jamal Gilani, The Glocal University, India.
Reviewers:
(1) Md. Abdullah-Al-Mamun, Khulna University, Bangladesh.
(2) Muluh Emmanuel Khan, Federal University Lokoja, Nigeria.
(3) Florence Nisabwe, Charisma University, UK.
Complete Peer review History: http://www.sdiarticle4.com/review-history/62878

Original Research Article

Received 05 October 2020
Accepted 10 December 2020
Published 28 December 2020

ABSTRACT

Mosquitoes have developed resistance, hence the need for anti-malarial medicines. This resistance calls for therapeutic an interest to therapeutic alternatives, including the medicinal plants. An ethnopharmacological survey was conducted amongst 15 Traditional Healers, recommended by the National Program for the Promotion of Traditional Medicine using semi-structured interviews in the city of Bouna. The ethnobotanical survey conducted in 2019 has enabled the identification of 32 plant species belonging to 30 genera and grouped into 19 families. The most represented families were Fabaceae (5 species) Anacardiaceae (4 species), Annonaceae (3 species), Rubiaceae, Zingiberaceae, Asteraceae, and Combretaceae with 2 species each. The species were mostly trees (63.63%). Leaves were the most frequently used parts of the plants (44.4%). The results of our investigations show that the most used mode is the decoction (42.22%). The oral route (60%) is the

**Corresponding author: E-mail: akissijeanne4@gmail.com;*

most used mode of administration. These species complete the non-exhaustive list of medicinal plants that the populations of Cote d'Ivoire use. It was found out that, people in this area commonly use medicinal plants with trust they have built on the curative outcome witnessed. However, this creates a further work to test for the antiplasmodial activity and to develop of Traditional Improved Medicines (MTAs).

Keywords: Medicinal plants; malaria; traditional healers; Bouna; Côte d'Ivoire.

1. INTRODUCTION

According to the WHO, 80% of the world's population is treated more or less completely by plants, because of their high cost of access to modern drugs [1]. Today, the effectiveness of this therapy is proven and its benefits for human health have allowed natural medicine to enter in our daily habits. Even the most developed countries are not left behind [2]. Traditional medicine is, therefore, as an alternative to the economically disadvantaged populations especially in sub-Saharan African countries, affected many infectious diseases. Among these pathologies, malaria remains by far the one with the highest mortality rate [3,4].

It affects 40% of the world's population in more than 106 countries. In 2017, WHO recorded 219 million malaria cases that caused 435,000 deaths [5].

The best means of combating this disease, once diagnosed, is the use of antimalarial drugs. However, the parasites responsible for this condition are resistant and render the treatments ineffective. The appearance of this phenomenon of chemo resistance of *Plasmodium falciparum*, pathogenic agent responsible for severe malaria attacks, seriously compromises the viability of the operations currently carried out globally to reduce the burden of malaria and justifies a continuous effort to search for new molecules [6].

Today, Artemisinin- based Therapeutic Combinations, extracted from Artemisia annua (ACTs) advocated by WHO despite their effectiveness on the parasite, are inaccessible to many African populations because of their high costs [7]. In this context, traditional medicine is an interesting alternative. In Côte d'Ivoire, recent decades have been marked by the publication of various works by several authors on the pharmacological study of plants traditionally used in different localities to treat malaria [1,4,7,8].

However, to our knowledge, no data have been reported for the plants used in the Bouna Department to treat malaria. Thus, the present study will consist initially of an ethnobotanical survey aiming at the fundamental knowledge of the plants used to treat malaria by the traditional healers of Bouna.

2. MATERIALS AND METHODS

2.1 Location

Located in the western part of Africa, Côte d'Ivoire covers an area of 322 462 square kilometers. Our study took place in the East, in the District of Zanzan, specifically in the city of Bouna, located 9°16'0.001"N 3°0'0 " W. Bouna is a town of 22 091 km², the capital of the region Bounkani, at 603 km north of Abidjan, bounded by Burkina Faso to the north, east by Ghana and the Black Volta, south by Bondoukou and to the west by Kong. It is one of the gateways to the Comoé National Park (Fig. 1) [9] (OIPR) Office Ivoirienne des Parcs et Reserves. Ethnic groups encountered in the area are the Lobi, the Malinke and Koulango.

2.2 Materials

Composed among other things of fact sheets, a pruner, newspapers and presses, digital camera 20.1 mega pixels, allowed to gather the various information and to collect the samples of plants.

2.3 Traditional Practitioners Met

This study was approved by the administrative and customary authorities of Bouna. The ethnobotanical field investigations were conducted from 8 at 12 July 2019.

The involvement of the National Program for the Promotion of Traditional Medicine (NPPTM) has the opportunity to meet and question 15 healers coming from different villages. These Practitioners of Traditional Medicine (PTM) have been recommended for their affiliation to NPPTM, their knowledge and their credibility in the management of malaria among populations. Two met have been done are: (i) Objectives and the importance of the study; (ii) Collection of data. The investigations were conducted in the

local language Lobi and Malinké, using interpreters, through interviews following a structured questionnaire (Appendix 1). Our interview guide focused on the identity of the respondent, the source of the knowledge, the name of the disease in the local language, the symptoms that help to make the diagnosis, the plants used in the treatment of the disease, the state of use (fresh or dry), the plant organs used, their methods of preparation and administration of recipes, the pathologies treated.

Later, accompanied by informants and traditional healers, we went to the field to collect plant materials for preparation of herbaria of the voucher specimens.

2.4 Collection of Plants and Preparation of Herbaria

The identification of species was carried out with the help of the flora of the Ivory Coast and other works [10-12]. Their confirmation took place at the National Centre of Floristry (NCF) at the University Félix HOUPHOÜET-BOIGNY. In this study, the use of the Angiosperm Phylogeny Group IV (APG IV) has made it possible to update the names and families of the various species mentioned.

2.5 Data Analysis

The data were processed at from the citation frequency (Fc), the use value (UV) and the confirmation number (ICs).

The frequency (Fc) of citation is given by the following formula:

$$Fc = (n / N) \times 100$$

where n is the number of respondents citing the plant and N is the total number of respondents in the survey. This is a good indicator for assessing the credibility of the information received and the level of knowledge of the plants in the survey population [13].

Use value makes it possible to determine in a meaningful way which species have a high use value in a given environment [13].

It is calculated according to the following formula:

$$UVs = U / N$$

U is the number of uses where the species is mentioned, and N is the number of informants who mentioned the species (s).

The Confirmation Index or Informant Consensus (ICs) is useful for assessing informant agreements on reported therapies. It is calculated for each species according to the formula below [14].

$$ICs = Na / Nt.$$

With Na = number of people citing this species, Nt = total number of people interviewed. The ICs range from 0 to 1. A low value, close to 0, indicates that informants disagree about the plants used. A high value, close to 1, indicates a high or total consensus around the use of the plant [14].

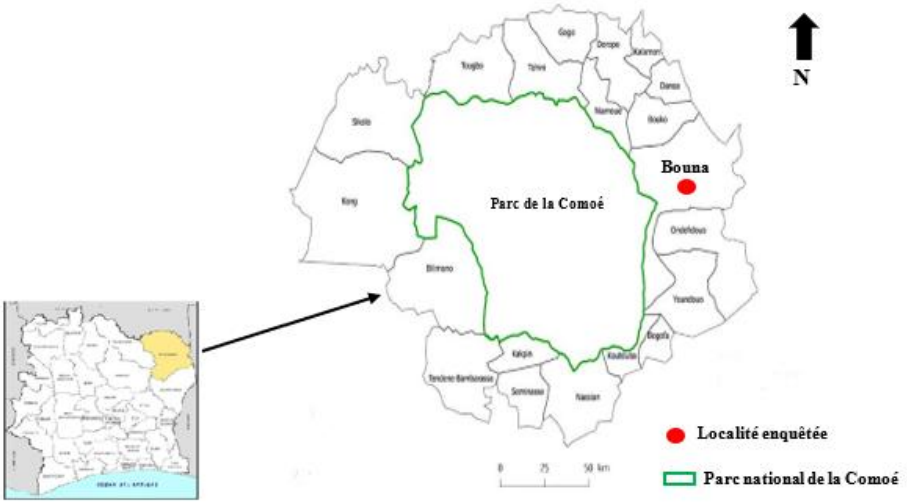

Fig. 1. Location of the Bouna region

3. RESULTS

3.1 Floristic Composition and Importance of the Species Mentioned

The survey carried out among the traditional healers of Bouna, identified 32 species divided into 19 families and 30 genera (Fig. 2) (Table 1). The species mentioned are largely composed of trees (63.6%) and shrubs (18.2%). Herbs (12.1%) and finally lianas (60%) are underrepresented as shown in Fig. 4 and Table 1. Chorological affinity analysis shows that 50.0% of the species are plant species. Guinean-Congolese Sudano-Zambezian transition zone (Fig. 5). Typical savanna species are represented by 37.5% while 12.5% are imported species.

The plants the most used and cited by practitioners are in decreasing order of their citation frequency: *Anogeissus leiocarpus* (DC.) Guill. & Perr. (38.46%); *Sarcocephalus latifolius* (Sm.) Bruce (15.38%); *Opilia amentacea* Roxb (30.77%); *Crossopteryx febrifuga* (Afzel, ex G.Don) Benth. (15.38 %). No species has a consensus index close to 1. Species with a higher index are: *Anogeissus leiocarpus* (DC.) Guill. & Perr. (0.38); Sarcocephalus latifolius (Sm.) Bruce (0.15); *Opilia amentacea* Roxb (0.3); *Crossopteryx febrifuga* (Afzel, ex G.Don) Benth . (0, 15).

Plant species cited by traditional practitioners and their therapeutic uses are grouped in Table 1.

3.2 Parts of the Plants Used

The biological types of the listed species are shown in Fig. 3. For the preparation of their various potions, the traditional healers surveyed use the leaves, the roots, the barks, the fruits and the whole plant. They use them in association or in mono-specific preparations. According to recipes, leaves are the most used parts (44.4%). Roots, with 28, 8%, are the second most used organ group. Then come the bark with 20%. Finally, the other parts or plant organs have a low frequency of use (Fig. 4).

Leafy stem of *Lophira lanceolata*

Leafy twig with *Sarcocephalus latifolius fruit*

Leafy twig of *Crossopteryx febrifuga*

Fig. 2. Pictures of some plants

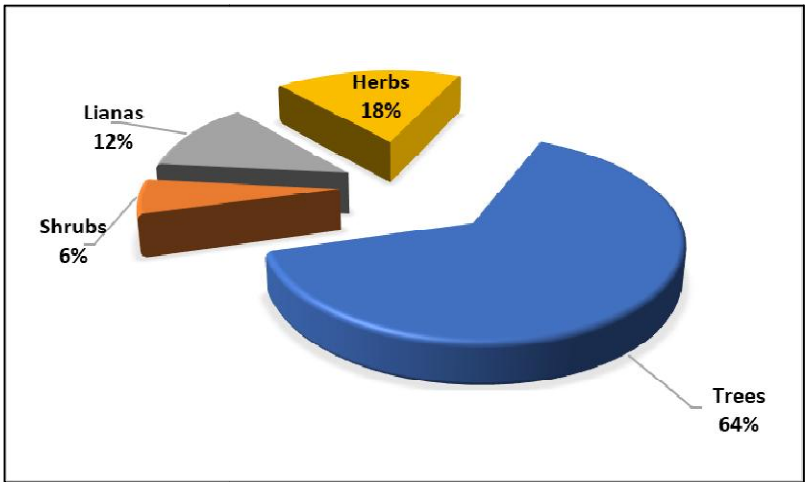

Fig. 3. Distribution according to biological types

3.3 Methods of Preparation

The preparation of the potions is made by decoction, maceration and trituration. The results of our investigations show that the most used mode is the decoction (63.3%), maceration, with 33.3% frequency of use, is also strongly represented (Fig. 5).

3.4 Route of Administration of Drugs

For traditional healers, the administration of potions is done by drinking, bathing, massage, purging and poultice. The most requested mode of administration is, however, drinking of decoction (60%), bathing (28.8%), purging and poulticing (4.4% both) and massaging (2.2%) (Fig. 6).

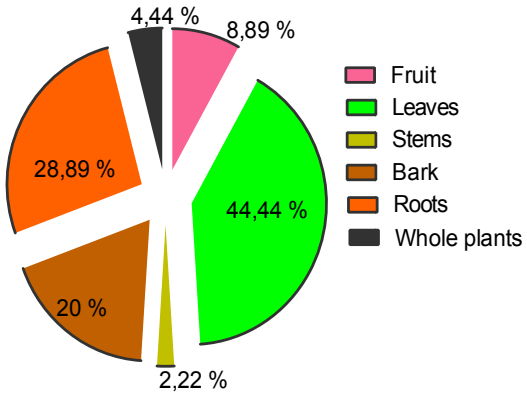

Fig. 4. Spectrum of plant organs used in preparations

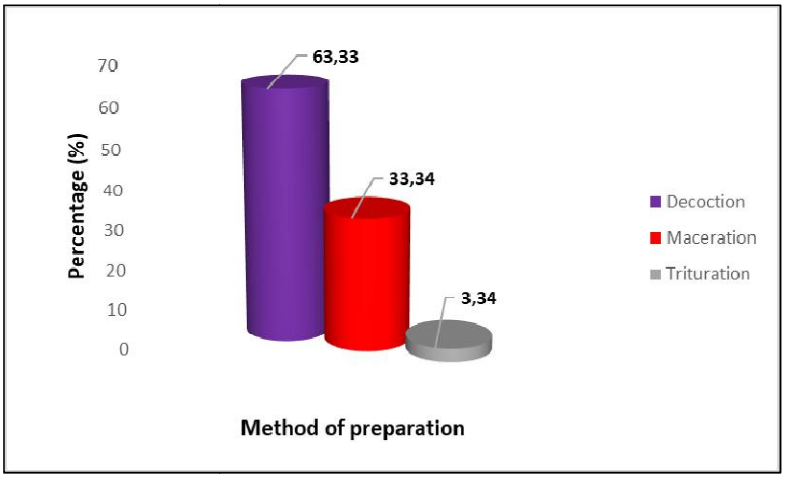

Fig. 5. Recipe preparation mode

Table 1. Species identified in Bouna region and ethno-pharmacological data

N	Taxa	Families	Vernacular names	Biological types	Chorological affinity	FC (%)	VU	ICs	PU	MP	MA	Number of citation
1	*Acanthospermum hispidum* DC.	Asteraceae	Kpanpouwou	Grass	S	7.69	0.07	0.07	F	D	Oral + Bath	1
2	*Aframomum melegueta* K. Schum .	Zingiberaceae	Fefe	Grass	GC-SZ	7.69	0.07	0.07	Fr	M	Oral	1
3	*Annona senegalensis* Pers.	Annonaceae	Mandessoussou / dodopko	Tree	S	7.69	0.07	0.07	F	D	Oral + Bath	1
4	*Anogeissus leiocarpus* (DC.) Guill . & Perr .	combretaceae	Crêkété / kelpoho	Tree	S	**38.46**	**0.38**	**0.38**	F	D	Oral + Bath	6
5	*Carica papaya* Aké Assi.	Caricaceae	Papaya	Tree	i	7.69	0.07	0.07	F	T	Oral + Bath	1
6	*Cassia sieberiana* DC.	Fabaceae	Prinbi / sidjan	Tree	GC-SZ	7.69	0.07	0.07	F + R	D	Oral + Bath	1
7	*Cochlospermum planchonii* Hook.f .	Cochlospermaceae	Soso / N ' dribala	Shrub	S	7.69	0.07	0.07	F	D	Oral + Bath	1
8	*Crossopteryx febrifuga* (Afzel, ex G.Don) Benth .	Rubiaceae	Cheers / dodoyelé	Tree	GC-SZ	**15.38**	**0.15**	**0.15**	R	M	Oral + Bath	3
9	*Erythrina senegalensis* DC.	Fabaceae	Tanbicoukou	Tree	GC-SZ	7.69	0.07	0.07	F	M	Oral + Bath	1
10	*Entada africana* Guill . & Perr .	Fabaceae	Ilissedoum	Tree	S	7.69	0.07	0.07	F + E	D	Oral + Bath	1
11	*Flueggea virosa* (Willd .) Voigt.	Euphorbiaceae	Tinglôhô	Shrub	GC-SZ	7.69	0.07	0.07	R	D	Oral + Bath	1
12	*Lannea acida* A.Rich .	Anacardiaceae	Lâbelâ	Tree	GC-SZ	7.69	0.07	0.07	R	D	Purge	1
13	*Lannea barteri* (Oliv .) Engl .	Anacardiaceae	Djikablô	Tree	GC-SZ	7.69	0.07	0.07	F	D	Oral + Bath	1
14	*Lannea velutina* A.Rich .	Anacardiaceae	S oulafissan	Tree	S	7.69	0.07	0.07	F + R	D	Oral + Bath	1
15	*Lophira lanceolata* Van Tiegh . ex Keay	Ochnaceae	Biligou	Tree	S	7.69	0.07	0.07	F + E	D	Oral + Bath	1
16	*Mangifera indica* L.	Anacardiaceae	Mango	Tree	i	7.69	0.07	0.07	F	D	Purge	1
17	*Ocimum basilicum* L.	Lamiaceae	BAWE	Grass	i	7.69	0.07	0.07	P	D	Oral + Bath	1
18	*Opilia amentacea* Roxb .	opiliaceae	Nedebouchi-Kadiman	Liana	GC-SZ	**30.77**	**0.3**	**0.3**	P	D or M	Oral + Bath	5

N	Taxa	Families	Vernacular names	Biological types	Chorological affinity	FC (%)	VU	ICs	PU	MP	MA	Number of citation
19	*Parkia biglobosa* A.Chev .	Fabaceae	dum	Tree	S	7.69	0.07	0.07	F + R	D	Oral + Bath	1
20	*Paullinia pinnata* L.	Sapindaceae	Guiflohinou	Liana	GC-SZ	7.69	0.07	0.07	F	M	Oral + Bath	1
21	*Piliostigma thonningii* (Schumach .) Milne-Redh .	Fabaceae	Koukan	Tree	GC-SZ	7.69	0.07	0.07	F	D	Oral + Bath	1
22	*Pseudocedrela kotschyi* (Schweinf .) Harms	Meliaceae	Dodopko	Tree	S	7.69	0.07	0.07	F + R	M	Oral + Bath	1
23	*Sarcocephalus latifolius* (Sm .) Bruce	Rubiaceae	Bati	Tree	S	**15.38**	**0.15**	**0.15**	E	M	Oral	3
24	*Strychnos spinosa* Lam .	Strychnaceae	Silabalani	Tree	GC-SZ	7.69	0.07	0.07	F	D	Oral + Bath	1
25	*Tamarindus indica* L.	Caesalpiniaceae	Taumibro	Tree	GC-SZ	7.69	0.07	0.07	F	D	Oral + Bath	1
26	*Terminalia mollis* Mr. A.Lawson	combretaceae	Honronyiri	Tree	S	7.69	0.07	0.07	F or R	D	Oral + Bath	1
27	*Trema orientalis* L.	Ulmaceae	Bouawork	Tree	GC-SZ	7.69	0.07	0.07	F	D	Oral + Bath	1
28	*Uvaria chamae* P.Beauv .	Annonaceae	Golgol	Shrub	GC-SZ	7.69	0.07	0.07	R	D	Oral + Bath	1
29	*Vernonia amygdalina* Delile	Asteraceae	Balkala	Shrub	GC-SZ	7.69	0.07	0.07	F	T	Oral + Bath	1
30	*Ximenia americana* L.	Olacaceae	Lyiêman	Shrub	S	7.69	0.07	0.07	F	D	Oral + Bath	1
31	*Xylopia aethiopica* (Dun.) A.Rich .	Annonaceae	Kanifi	Tree	GC-SZ	7.69	0.07	0.07	Fr	D	Oral	1
32	*Zingiber officinale* Will. Roscoe	Zingiberaceae	Kakadro	Grass	i	7.69	0.07	0.07	Fr	D	Oral	1

FC : frequency of citation UVs : usual values ; ICs : confirmation index ; PU : part used ; MP : method of preparation; MA : method of administration ; E : Bark; F : Leaf; Fr : Fruit ; R : Root; Pl : Whole plant ; Aff. Ch.: chorological affinity; GC: Guinean-Congolese region taxon, SZ: Sudano-Zambezian region taxon, GC-SZ: Taxon of the transition region and the Guineo-Congolese and Sudano-Zambezian regions, i: Taxon introduced and often cultivated

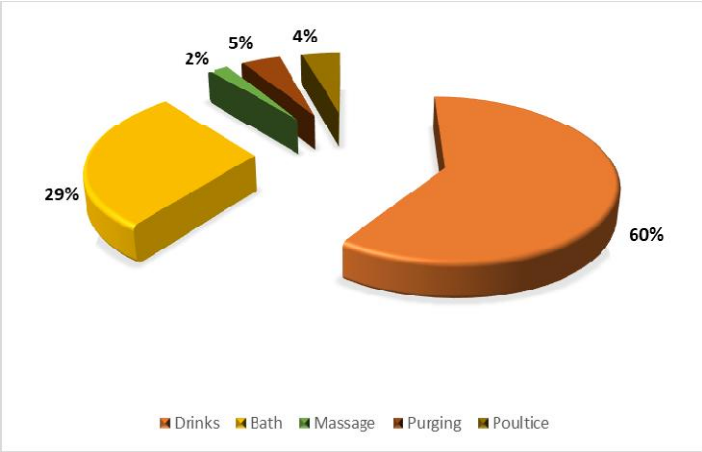

Fig. 6. Recipes administration method

4. DISCUSSION

This study made an inventory 32 species distributed among 30 genera and 19 families, used for the treatment of malaria in Bouna in the north-east of Côte d'Ivoire. Several studies have also been carried out in other regions in Côte d'Ivoire. The work of different authors [1,7,8]. made it possible to inventory 54, 57 and 57 species respectively in the District of Abidjan and the Department of Agboville. In Mali, surveys conducted by Denou *et al*. identified 54 species [15]. The small number of our species is due to number of traditional healers surveyed. However, NPPTM's involvement in and contribution to the Coast is an assurance of the value of the practitioners surveyed and the importance of the plants cited for future research. Moreover, in the Central African Republic the investigations of Lakouéténé et al. identified 27 antimalarial species in Bangui [16] and 26 species for studies by Bla et al. [4]. Our results (32 species) are better than these two studies. Fabaceae (5 species) are the most commonly mentioned family in the treatment of malaria. These results are similar to those of others authors for which the contribution of this family was of the order of 7.41% and 8.80%. Trees are the most widely used biological type, accounting for 50% of the species studied, as is the case in several studies [4,16,17]. This is certainly due to the type of vegetation in the area of Bouna. Also, the Sudano-Zambezian Guinea-Congolese transition zone and savannah species are highly represented in relation to the typology of vegetation. The department of Bouna is dominated by Guinean Sudanese woodland. *Anogeissus leiocarpus*, *Opilia amentacea*, *Crossopteryx febrifuga* and *Sarcocephalus latifolius* are the most widely used species. Many studies confirm the therapeutic use of these plants. *Anogeissus leiocarpus* is indicated for the treatment of a number of diseases such as urinary schistosomiasis, malaria, amoebic dysentery, burns, trypanosomiasis and helminthiasis [18,19]. According to Kone [20], the species of *Anogeissus leiocarpus* present in Côte d'Ivoire has reported significant activities in the treatment of malaria, trypanosomiasis and helminthiasis. *Crossopteryx febrifuga* has been used in the treatment of malaria and cough [20] and also has analgesic properties [15]. *Sarcocephalus latifolius* roots are used against respiratory diseases such as asthma, bronchitis, coughs and colds [21]. A leaf decoction is prescribed to treat fever and chickenpox, and the bark of the stem to treat infertility [21]. In Nigerian traditional medicine, the bark of the stem of *Sarcocephalus latifolius* and the roots of the plant are used against fever, jaundice, malaria, diarrhea, dysentery, hypertension and diabetes [22]. In this study, the most used organs are the leaves as reported by several works [1,4,7]. This high percentage of use would be explained by the ease of access of these organs and the concentration of products of secondary metabolism in this part of the plant. According to Mangambu et al. [23], the leaves are the site of photosynthesis and sometimes the place of storage of secondary metabolites responsible for the pharmacological properties of the plant [23]. Roots are the second most used organ. Harvesting roots is harmful to plants and does not contribute to the sustainable management of biodiversity. Indeed, according to Yapi [24], harvesting the roots may eliminate the possibility of feeding nutrients to the plant, affecting its vegetative appearance and physiology [24]. In

this study, as for the majority of traditional preparations, the decoction is the most used followed by maceration. The work of Yasser et al. have shown that decoction is the most sought-after pharmaceutical form. A decoction can collect the most active ingredients and reduce or cancel the toxic effect of certain drugs [25]. Maceration, on the other hand, preserves the integrity of the active ingredient [26]. These preparations are almost all administered as a drink (oral) and bath (dermal). This mode of administration can be explained by the fact that the active ingredient is easily absorbed and also by the reduction of risk of toxicity. For Sylla et al. [4] oral absorption is the least dangerous because of the assimilation of the active ingredients in the small intestine.

A literature reviews some pharmacological activities of plants cited by practitioners identified allowed us to understand that the information provided by PTM interviewed for this study were credible [18,19,22,27]:

Anogeissus leiocarpus, *Opilia amentacea*, *Crossopteryx febrifuga*, and *Sarcocephalus latifolius* are the species most commonly used by populations. Many studies confirm the therapeutic uses of the plants mentioned. *Anogeissus leiocarpus* is indicated for the treatment of a number of diseases such as urinary schistosomiasis, malaria, amoebic dysentery, burns, trypanosomiasis and helminthiasis [18,19]. The leaves of Anogeissus leiocarpus were presented antibacterial activity was tested against organisms such as *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* [28]. In 2004, studies demonstrated the antiparasitic activities (antimalariale *vitro* against *Plasmodium falciparum*, trypanocidal *in vitro* leishmanicidal *vitro*, anthelmintic trial) leaves, trunk bark and roots *Anogeissus leiocarpus* [29]. According to Kone, the species of *Anogeissus leiocarpus* present in Côte d'Ivoire has reported significant activities in the treatment of malaria, trypanosomiasis and helminthiasis. *Crossopteryx febrifuga* has been used in the treatment of malaria and cough. It also has analgesic properties [15]. An ethnomedicinal study carried out on the antimalarial plants in Guinea showed that *Crossopteryx febrifuga* were among the regularly listed antimalarial plants [30,31]. In Mali and Togo, leaves, stems and roots of *Opilia amentacea* against malaria in [32,27]. *Sarcocephalus latifolius* roots are used against respiratory diseases such as asthma, bronchitis, coughs and colds [21]. A leaf decoction is prescribed to treat fever and chickenpox, and the bark of the stem to treat infertility [21]. In traditional Nigerian medicine, stem bark of *Sarcocephalus latifolius* and roots of the plant are used against fever, jaundice, malaria, diarrhea, dysentery, hypertension and diabetes [22]. We have few pharmacological data for *Opilia amentacea* and *Crossopteryx febrifuga* [15,32].

5. CONCLUSION

This study showed a diversity of 32 species of plants used by traditional healers in Bouna to treat malaria. From a literature review we understand that most of the plants mentioned in this study are also used in other African countries where traditional medicine still contributes to health care services. This proves that the information provided by the traditional healers we met in this study was credible. The leaves and the decoction are respectively the organs of the plant and the most commonly used method of drug preparation. Phytochemical and pharmacological studies will be carried out on some of these plants to help validate their traditional use. Thus, it will be necessary to evaluate the clinical efficacy, ensure the safety of medicinal plants, strengthen the knowledge and performance of traditional healers by disseminating the practice of efficacy tests and toxicity risk control on antimalarial plants used to treat malaria in Côte d'Ivoire among traditional healers.

6. RECOMMENDATIONS

It is important to set up routine tests (efficacy and toxicity) among traditional healers.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

ACKNOWLEDGEMENTS

We sincerely thank the traditional healers for their frank collaborations and the focal point of traditional healers in the city of Bouna. We also thank the Malaria Research and Control Center (CRLP) through the CTA study for its financial support.

COMPETING INTERESTS

There are no competing interests in this work.

REFERENCES

1. Sylla Y, Silué KD, Ouattara K, Koné MW. Ethnobotanical study of plants used against malaria by traditional therapists and herbalists in the district of Abidjan (Ivory Coast). International Journal of Biological and Chemical Sciences. 2018; 12(3):1380-1400.
2. Béné K., Camara D, Fofie NBY, Kanga Y, Yapi AB, Yapo YC, Ambe SA, Zirihi GN. Ethnobotanical study of medicinal plants used in the Department of Transua, District of Zanzan (Ivory Coast). Journal of Animal and Plant Sciences. 2016;2:4230-4250.
3. WHO. World Malaria Report 2011. Summary and key points. 2011;3.
4. Bla KB, Trebissou JND, Bidie AP, Assy YJ, Zihiri-Guedé N, Djaman AJ. Ethno-pharmacological study of antimalarial plants used in the Baoulé-N'Gban of Toumodi in the center of Côte d'Ivoire. Journal of Applied Biosciences. 2015;85: 7775-7783.
5. WHO. World Malaria Report 2018. This year's report at a glance. 2018;210.
6. Pradines B, Dormoia J, Briolanta S, Bogreaua H, Rogiera C. Resistance to antimalarials. Francophone Journal of Laboratories. 2010;422:51-61.
7. Kipré GR, Offoumou MBR, Silue KD, Bouabre GM, Zirihi-Guédé N, Djaman AJ. Ethno-pharmacological survey of antimalarial plants in the department of Agboville, south-eastern Cote d'Ivoire. Journal of Applied Biosciences. 2017;109: 10618-10629.
8. N'Guessan K, Tra-Bi FH, Koné MW. Ethno-pharmacological study of antimalarial plants used in traditional medicine among the Abbey and Krobou of Agboville (Ivory Coast). Ethnopharmacologia. 2009;44:42-50.
9. OIPR. Ivorian Office of Parks and Reserves. Available:https://oipr.ci> index.php>oipr Consult on July 08, 2019.
10. Aké-Assi L. Compendium of African medicine and pharmacopoeia: Some plants traditionally used in the coverage of primary health care. NEI-CEDA, Abidjan. 2011;157.
11. Akobundu IO, Agyakwa CW. A handbook of West African Weeds: International Institute of Tropical Agriculture. Oyo Road, PMB 5320, Ibadan (Nigeria). 1987;521.
12. Adjanohoun E, Aké Assi L. Contribution to the census of medicinal plants in Côte d'Ivoire. National Floristic Center. Abidjan. 1979;358.
13. Hussain W, Ullah M, Dastagir G, Badshah L. Quantitative ethnobotanical appraisal of medicinal plants used by inhabitants of lower Kurram, Kurram agency, Pakistan. Avicenna Journal of Phytomedicine. 2018; 8(4):313–329.
14. Ilumbe GB, Van-Damme P, Lukoki FL, Joris V, Vissier M, Lejoly J. Contribution to the study of medicinal plants in the treatment of hemorrhoids by the Twa pygmies and their neighbor Oto from Bikoro, DRC. Congo Sciences. 2004;2(1): 46-54.
15. Dénou A, Koudouvo K, Togola A, Haïdara M, Dembélé SM, Ballo FN et al. Traditional knowledge on antimalarial plants with analgesic properties, used in the district of Bamako (Mali). Journal of Applied Biosciences. 2017;112:1098510995.
16. Lakouéténé DPB, Ndolngar G, Berké B, Moyen J-M, Kosh Komba E, Zinga I et al. Ethnobotanical survey of plants used in the treatment of malaria in Bangui. Bull. Soc. Pharm. Bordeaux. 2009;148:123-138.
17. Ouattara D. Contribution to the inventory of significant medicinal plants used in the Divo region (southern forest of Côte-d'Ivoire) and to the diagnosis of the Guinea pepper tree: *Xylopia aethiopica* (Dunal) A. Rich. (Annonaceae). Doctoral thesis, University of Cocody, Abidjan. 2006; 184 p.
18. Bah S, Diallo D, Dembélé S, Paulsen BS. Ethnopharmacological survey of plants used for the treat¬ment of schistosomiasis in Niono District, Mali. Journal of Ethnopharmacology. 2006; 105: 387-399.
19. Inngjerdingen K, Nergard CS, Diallo D, Mounkoro PP, Paulsen BS. An Ethnopharmacological survey of plants used for wounds healing in dogoland, Mali, West Africa. Journal Ethnopharmacology. 2004;92:233-244.
20. Kone D. Ethnobotanical investigation of six Malian medicinal plants, extraction, identification of alkaloids, characterization, quantification of polyphenols: study of their antioxidant activity. Doctoral thesis, University of Bamako, Mali. 2008;18.

21. Mann A, Amupitan JO, Oyawale AO, Okogun JI, Ibrahim K. An ethnobotanical survey of indigenous flora for treating tuberculosis and other respiratory diseases in Niger State. Journal of Phytomedicine and Therapeutics. 2008;12:1-12.
22. Okwori AEJ, Okeke CI, Uzoechina A, Etukudoh NS, Amali MN, Adetunji JA, et al. The antibacterial potentials of *Nauclea latifolia*. African Journal of Biotechnology. 2008;7(10):1394-1399.
23. Mangambu MJD, Mushagalusa KF, Kadima NJ. Contribution to the phytochemical study of some anti-diabetic medicinal plants in the city of Bukavu and its surroundings (Sud-Kivu, R.D. Congo). Applied Biosciences Journal. 2014;75: 6211-6220.
24. Yapi A.B. Inventory of medicinal plants of the Asteraceae family in the markets of the municipality of Abobo (Abidjan, Ivory Coast). Master's thesis in botany, Félix Houphouët-Boigny University, Abidjan. 2013;50.
25. Yasser K, Abdallah M, Abdelmadjid B. Ethnobotanical study of some medicinal plants in a hyper arid region of southwest Algeria "Case of Touat in the wilaya of Adrar". Journal of Animal & Plant Sciences. 2018;2(36):5844-5857.
26. Koudouvo K, Karou DS, Kokou K, Essien K, Aklikokou K, Glitho IA, et al. An ethnobotanical study of antimalarial plants in Togo Maritime Region. Journal of Ethnopharmacology. 2011;134:183–190.
27. Salhi S, Fadli M, Zidane L, Douira A. Floristic and ethnobotany studies of medicinal plants from the city of Kénitra (Morocco). Lazaroa. 2010;31:133-146.
28. Umar HY and Muhammad AI. Antibacterial activity of leaves extract of *Anogeissus leiocarpus* and *Vitex doniana* against some bacteria. American Journal of Innovative Research and Applied Sciences. 2015; 1(10):384-388.
29. Okpekon T, Yolou S, Gleye C, Roblot F, Loiseau P, Bories C, et al. Antiparasitic activities of medicinal plants used in Ivory Coast. Journal of Ethnopharmacology. 2004;90:91–97.
30. Sanon S, Gansane A, Ouattara LP, Traore A, Ouedraogo IN, Tiono A. In vitro antiplasmodial and cytotoxic properties of some medicinal plants from western Burkina Faso. African Journal of Laboratory Medicine. 2013;2:7.
31. Diallo D, Diakité C, Mounkoro PP, Sangaré D, Graz B, Falquet J, et al. Treatment of malaria by traditional therapists in the health areas of Kendie (Bandiagara) and Finkolo (Sikasso) in Mali. Mali Medical. 2007;12:1–8.
32. Nordeng H, Al-Zayadi W, Diallo D, Ballo N, Paulsen BS. Traditional medicine practitioners' knowledge and views on treatment of pregnant women in three regions of Mali. Journal of Ethnobiology and Ethnomedicine. 2013;9:67.

APPENDIX 1

Appendix 1 is available in this link:
https://www.journaljamps.com/index.php/JAMPS/libraryFiles/downloadPublic/14

© 2020 Jeanne et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/62878