



Plants Traditionally Used to Manage Malaria in the Guinean Prefecture of Macenta: An Ethnobotanical Survey

Traore MS^{1,2,4*}, Diallo MST^{1,2}, Bah TV², Camara AK¹, Balde MA^{1,3}, Camara T^{1,3}, Camara A^{1,2}, Diane S^{1,2}, Guilavogui M¹, Sacko Sitan¹ and Balde AM.^{1,2}

¹Department of Pharmacy, Gamal Abdel Nasser University of Conakry (UGANC), Guinea

²Institute for Research and Development of Medicinal and Food Plants of Guinea (IRDPMAG-Dubrêka), Dubrêka, Guinea

³Centre for Research and Training in Infectious Diseases (CERFIG), Conakry, Guinea

⁴African Center of Excellence for the Prevention and Control of Communicable Diseases (CEA-PCMT/UGANC), Conakry, Guinea

*Corresponding author: sahartra1900@gmail.com

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Abstract: The contribution of medicinal plants in malaria treatment is well recognized. This study aimed to identify and review selected plant species used as antimalarials by traditional healers in the Macenta prefecture of Forest Guinea. Traditional healers in the region of Macenta, Guinea guided the collection of samples of ethnomedical and ethnobotanical substances that they used to treat malaria. The collected species were submitted to botanical identification, followed by a literature review of their respective antiplasmodial activity. The sixty (60) traditional healers participating in the study indicated that their local languages had several names for malaria. We identified at least 33 species from 25 botanical families, including 5 species from Fabaceae and 3 each from Apocynaceae and from Compositae. The most cited plants were *Chromolaena odorata* (L.) R.M.King & H.Rob., *Terminalia superba* Engl. & Diels, *Alchornea cordifolia* (Schum et Thonn.) Mull.Arg, *Ageratum conizoides* Hieron, *Voacanga Africana* Stapf ex Scott-Elliot. These findings enrich the database of antimalarial plants used in the Republic of Guinea. Our continuing research will use bio-guided fractionation of the most active plants to specify the active metabolites.

Keywords: Malaria; Guinea; Medicinal plants; Ethnobotany

INTRODUCTION

Malaria remains a major public health problem across sub-Saharan Africa, particularly among children and pregnant women. The World Health Organization (WHO) estimated that 228 million cases occurred worldwide in 2018, resulting in 405,000 deaths; 94% of cases occurred in Africa (WHO 2019). Malaria control faces many challenges, including Anopheles resistance to insecticides, lack of chemoprophylaxis, and the pathogenic protozoa's resistance to antimalarial drugs. (Keïta et al 2021, Dong et al 2018, Sinha et al 2014 Diakit   et al 2019). Thus, the search for new and more effective antimalarial drugs is imperative. As traditional herbal remedies have been a

source of most conventional antimalarials, notably quinine and artemisinin and its derivatives, (Oladeji et al 2020) documenting data on medicinal plants traditionally used in malaria treatment is an important direction in this search. Indeed, studies in malaria-endemic areas have found wide use of plants in malaria management (Oladeji et al 2020, Zirihi et al 2005, Koudouvo et al 2011, Traore et al 2013) and in West Africa, plants such as *Terminalia albida* Scott-Elliot, *Terminalia macroptera* Guill. & Perr, *Cochlospermum tinctorium* Perrier ex A.Rich., *Nauclea latifolia* Sm, *Azadirachta indica* A. Juss, *Vernonia colorata* (Willd.) Drake, have shown *in-vitro* and/or *in-vivo* antiplasmodial activities through (Soh et al 2007, Traore et al 2014).

Malaria prevalence in the Republic of Guinea, varies from 14 to 30% depending on the region and age group (EIPAG 2012). It is the leading reason for medical consultations and hospitalizations and thus represents an enormous burden for the national health system and economy. This is why this pathology is a priority in terms of health research. For this reason, the “Institut de Recherche et Développement des Plantes Médicinales et Alimentaires de Guinée (IRDPMAG)” has conducted ethnobotanical and ethnomedical surveys across the four regions of Guinea, botanically identifying 109 plant species and classifying them into 84 genera and 46 families (Traore et al 2013). That research more or less validated the traditional uses of specific plant species against Plasmodium, such as *Terminalia albida* Scott-Elliot (IC₅₀ = 0.6 µg/mL), and *Terminalia macroptera* Guill. & Perr, (IC₅₀ = 0.25 µg/mL) (Camara et al 2019). The Guinean forest region has been little explored, however, so the present research was initiated to broaden investigation and expand the database on antimalarial plants in Guinea. Traditional healers are men and women who generally live in rural areas and who perform traditional diagnoses of diseases (healers) or who sell plants in the various markets (herbalists). These traditional medicine practitioners, most of whom acquired their knowledge by learning from their parents or grandparents, have shown good knowledge of malaria symptoms during their previous studies. The aim of this study was to identify and review selected plant species used as antimalarials by traditional healers in the Macenta prefecture of Forest Guinea.

MATERIALS AND METHOD

Study area: This descriptive cross-sectional ethnobotanical survey was conducted among traditional healers in the Macenta prefecture during the period January 2 to 30, 2020. The Macenta prefecture (latitude 8.53 North and longitude: 9.47 West) is one of 7 prefectures in the Forest Guinea Region (figure 1), is characterized by dense forest and high rainfall with an annual 8-month rainy season. Agriculture and livestock are the population’s main activities.

Study population: The main ethnic groups are Toma and Koniankee. Traditional healers residing in the prefecture of Macenta, who were very well-known, served as the study’s informants on a voluntary basis. The herbarium of collected plant species provided the study material. Inclusion criteria Any traditional healer with at least 5 years of experience in the traditional treatment of malaria who agreed to share their knowledge and to participate in the collection of plant species.

Exclusion criteria: Traditional healers who did not use herbal recipes or who were reluctant to collaborate in identifying plants or collecting samples.

Data collection: Ethnomedical and ethnobotanical investigations were carried out among traditional healers by direct interview in order to collect the plants used in the treatment of malaria. Questions focused on three areas: general information of the traditional therapist (age, sex, neighborhood, professional experience, status, mode of knowledge acquisition), malaria knowledge (local disease name, signs of the disease), and the recommended treatment (parts of the plant used, mode of preparation, mode of administration, quantity used, treatment duration, treatment cost). A specimen of each plant species mentioned was collected to form an herbarium with the traditional therapist. The plant species were identified by the botany departments of the Guinea Agronomic Research Institute of Sereidou and the Institute for Research and Development of Medicinal and Food Plants of Guinea (IRDPMAG) Dubreka where the specimens were deposited. The scientific names and botanical families were verified on <http://www.worldfloraonline.org>.

Literature review: Following botanical identification, we performed a literature review of the plant species by searching scientific databases (Scifinder, Sciencedirect, Google Scholar, PubMed, Web of Science), covering peer-reviewed journals. Search terms used the scientific name of the plant in combination with “antiplasmodial” or “antimalarial”, “pharmacological activity”, or “chemical composition.”

Data analysis: Data were entered using Epi-data software and then a descriptive analysis was performed with SPSS version 21 statistical software. The data for the qualitative variables were presented as counts and proportions. For quantitative variables, the data were described by mean, standard deviation, minimum and maximum. The percentage of respondents who have knowledge (PRK) regarding the use of a species in the treatment of malaria was estimated using the formula: number of people interviewed citing species (FC)/total number of interviewed people using plants (N) ×100. The relative frequency of citation (RFC) was calculated using the standard method of (Vitalini et al 2013) which is $RFC = FC/N$. To determine the similarity with previous studies we calculated the Jaccard Index (JI) with the formula: $JI = c \times 100 / a + b - c$ where “a” is the number of plant species in area A, “b” is the number of plant species in area B, and “c” is the number of plant species common to both A and B (Gonza et al 2008).

Ethical considerations: The protocol was approved by the institutional ethics committee of the IRDPMAG-Dubreka (04-19 CEIRDPMAG). Data were collected with the verbal, free and informed consent of the traditional healers.

RESULTS

Applying the selection criteria, 60 traditional healers were included, with almost equality between men and women (n=31; 51.7%). The participant's average age was 55.43 ± 13.84 years, they had an average of 28.35 ± 13.85 years of professional experience (Table S1). The high number of years of experience is often needed to acquire mastery of the traditional medical art. The acquisition of traditional knowledge at the family level was the most frequently reported (91.7%) mode of learning (Table S1). Malaria is locally called "Koleivile" (56.7%), "Koleibadi" (30%) or "Kolei" (3.3%) in

the Toma language and "Nainai" (10%) in the Kpele language. Traditionally malaria diagnoses were based on symptoms, specifically: fever and headache (100%), vomiting (93%), dizziness (35%) and fatigue (15%). Each of the traditional healers affirmed that malaria is transmitted by mosquito bites. A total of thirty-three plant species were identified and classified into 25 botanical families (Table S2). As indicated in Table S2, the most represented botanical families were Fabaceae (5 species), Apocynaceae (3 species), Compositae (3 species), and Rubiaceae (2 species).

The most cited plants were *Chromolaena odorata* (L.) R.M.King & H.Rob. (FC =15, PRK =25%), *Terminalia superba* Engl. & Diels (FC 12, PRK=, 20%), *Alchornea cordifolia* (Schum et Thonn.) Mull.Arg. (FC=9, PRK=15%), *Ageratum Conyzoides* Sieber ex Sieber ex Studel and *Voacanga africana* Stapf ex Scott-Elliot. (FC=5, PRK=8.33% each). The parts of the plants used to prepare the recipes were leaves (82%) and trunk bark (18%). The preparation methods used included decoction (79%), maceration (12%), and infusion (9%). Preparations sometimes included using two or more plant species and involved different parts of the plant. Different dosages described by the traditional healers as two or three handshakes 3 times a day, one coffee cup two or three times a day, etc. Treatment duration was imprecise: the traditional healers recommended taking the recipes until symptoms disappeared, which they equated with recovery. Most traditional practitioners (n=33; 55%) sold a treatment for between 8,000 and 24,000 GNF (\$1 and \$3). Some (n=6; 10%) asked for either a rooster or a loincloth suit.

DISCUSSION

Documenting data on medicinal plants traditionally used in the treatment of malaria could be an important task, not only to preserve valuable indigenous knowledge, but also to facilitate future research on the identification of active compounds against *Plasmodium*. The interviewed traditional healers had acquired their knowledge mainly in the family sphere from their parents or grandparents. This finding supports the large body of previous literature (Cheikhyoussef et al 2011), including in Guinea (Traore et al 2013). They diagnosed malaria exclusively on the basis of the disease signs and symptoms which, notably, does not allow for differentiation from other diseases with similar manifestations. We found that the most represented botanical families in Macenta differed from previous study across the four regions of Guinea (Traore et al 2013). The most represented botanical families we found in Macenta were Fabaceae (5 species), Apocynaceae (3 species) and Compositae (3 species), whereas elsewhere Caesalpiniaceae (11 species), Rubiaceae (10 species), and Combretaceae (7 species) were more common.

The plants most cited in Macenta also differed. These Macenta healers most frequently cited three plants: *Chromolaena odorata* (L.) R.M.King & H.Rob, *Terminalia superba* Engl. & Diels and *Alchornea cordifolia* (Schum et Thonn.) Mull.Arg, whereas in the previous Guinean study, *Vismia guineensis* (L.) Choisy, *Parkia biglobosa* (Jacq.) G.Don, *Nauclea latifolia* Sm, *Terminalia albida* Scott-Elliot and *Terminalia macroptera* Guill. & Perr, were cited most often. (Traore et al 2013). Such variation is not surprising as the use of different plants from one place to another will be linked to the immediate plant environment of the traditional therapist. Numerous ethnobotanical surveys on malaria have been conducted in many malaria-endemic countries. (Oladeji et al 2020, Dike et al 2012, Oyeyemi et al 2019, Koudouvo et al

2020, Stangeland et al 2011) Both the number of species and the number of botanical families recorded vary from study to study. In Africa south of the Sahara, however, studies note plants are commonly used across different countries.

Therefore, we used the Jaccard Index (JI) to compare our findings with those of some previous ethnobotanical studies, namely Togo (Agbodeka et al 2016) (61 plants recorded, of which 7 are common, JI =8), Mali (Diarra et al 2015) (97 plants recorded, of which 5 are common, JI=4), Ghana (Komlaga et al 2015) (98 plants recorded, of which 16 are common, JI=13), in Nigeria (Oyeyemi et al 2019) (97 plants recorded, of which 11 are common JI=9).

The frequent use of these plants by traditional healers with salutary results in some cases has led some African countries to reflect further on the place of herbal medicine in the repertoire for malaria management. In Guinea, for example, an ethnotherapeutic approach has been undertaken to validate traditional recipes used as antimalarials (Baldé et al 2021). Laboratory studies evaluating the *in-vitro* or *in-vivo* antiplasmodial activities of 20/33 (60.60%) plant species have confirmed the traditional uses (Table S2). They focused on assessing antiplasmodial activities *in-vitro* (12 species), *in-vivo* (3 species) and *in-vivo* and *in-vitro* (5 species). Some plants have shown remarkable antiplasmodial activity with $IC_{50} < 5 \mu\text{g/mL}$: *Rauvolfia vomitoria* Afzel. ($2.5 \mu\text{g/mL}$) (Zirih et al 2005), *Terminalia superba* Engl. & Diels ($0.57\text{-}1.26 \mu\text{g/mL}$), (Mbouna et al 2018), *Ageratum Conyzoides* ($IC_{50}=2.15\text{-}3.44 \mu\text{g/mL}$), (Owuor et al 2012), *Bambusa vulgaris* Ness ($IC_{50}=4.7$), (Valdés et al 2010) *Chromolaena odorata* (L.) R.M.King & H.Rob. ($IC_{50} = 4.8 \mu\text{g/mL}$), (Ezenyi et al 2014) *Carica papaya* ($IC_{50} = 2.96\text{-}3.98 \mu\text{g/mL}$), (Melariri et al, 2011) and *Mitragyna inermis* (Willd.) Kuntze ($IC_{50} = 2.75 \mu\text{g/mL}$) (Fiot et al 2005).

Molecules with some evidence of antiplasmodial activity have been isolated from some plant species. *Persea americana* Mill. has shown remarkable antiplasmodial activity *in-vitro* and the active molecule identified is 9,9'-Di-O-feruloyl-5,5'-dimethoxysecoisolariciresinol ($IC_{50}= 0.05 \mu\text{M}$) against *P. falciparum* (Bankeu et al 2021). Xylopic acid has been identified as the active molecule of *Xylopiya aethiopica* (Dunal) A.Rich (Osei et al 2021) and ellagic acid is one of the molecules responsible for the antiplasmodial activity of *Alchornea cordifolia* (Schum et Thonn.) Mull.Arg, (Banzouzi et al 2002). The molecule responsible for the antiplasmodial activity isolated from *Chromolaena odorata* (L.) R.M.King & H.Rob. is quercetin -5-methyl ether which resulted in 81% suppression of parasite load in mice at 2.5 mg/kg (Ezenyi et al 2014). Given that traditional healers' malaria diagnoses were based exclusively on signs and symptoms, some of the collected plants that do not show antiplasmodial activity might act beneficially in other ways, such as by relieving fever or inflammation. Thus, focusing on action related to the signs underlying healers' diagnoses could be another avenue for research to valorize the plants used by traditional healers. The valorization of these plants will be conducted by the Institute of Research and Development of Medicinal and Food Plants of Guinea through the development of improved traditional medicines. Thus, the traditional therapists will be included in the value chain of these medicines by the production of the raw material but also the marketing of the finished products

CONCLUSION

These findings enrich the database of antimalarial plants in Guinea and serve to preserve indigenous knowledge that could stimulate future investigations into the

efficacy and safety of medicinal plants with potential to be developed into new phytomedicines.

Further research is needed to assess these plant species' *in vitro* and/or *in vivo* antiplasmodial and antimalarial potency.

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DECLARATION OF CONFLICT OF INTEREST

No conflicts of interest have been declared. The authors alone are responsible for the accuracy and integrity of the paper content.

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Table S1: sociodemographic characteristics and ethnomedical knowledge of traditional healers from the prefecture of Macenta

Characteristic	Effective	Proportion
Gender		
Women	31	51.7
Men	29	48.3
Age range	55.43±13.84 years	
34-44	15	25.0
45-55	17	28.3
56-66	19	31.7
67-77	4	6.7
78-88	3	5.0
89-95	2	3.3
Professional experience (Mean)	28.35±13.85 years	
Status		
Healer	54	90
Herbalist	6	10
Mode of acquisition of knowledge		
Old patient	1	1.7
Dream	5	8.3
Experience	1	1.7
Family	55	91.7
Learning	2	3.3
« Kolei »	2	3.3
« Koleibadi »	18	30
« Koleivile »	34	56.7
« Nainai »	6	10
Signs of malaria diagnosis according to the traditional healer		
Fever	60	100
Headache	60	100
Vomiting	56	93.3
Dizziness	21	35.0
Fatigue	9	15.0
Chills	7	11.7
Malaria crisis	2	3.3

Table 2: List of plants cited by traditional healers in the prefecture of Macenta and their antiplasmodial activity

N°	Family	Scientific name of the plant	Number Herbarium	Local name (language)	Plant part used	Preparation method	How to use	FC	RFC	PRK	Review of antiplasmodial activities						
											extracts/fraction/compounds		Model	Parasite	IC ₅₀ (µg/mL) or inhibition of parasitemia (%)		References
											Used part	Type of extract			IC ₅₀ or MIC	IP %	
1	Anacardiaceae (1)	<i>Mangifera indica</i> L.	D3HK2	Magrowologui (Toma)	Bark	Decoction	Drink about 200 mL 3 times/day	4	0.067	6.70	Stem bark	methanolic	<i>In vivo</i>	<i>P. yoelii nigeriensis</i>	78.2% at 400 mg/kg	(Eawe et al 1998)	
2	Annonaceae (1)	<i>Xylopia aethiopica</i> (Dunal) A.Rich	D5HK3	Vevegui (Toma)	Bark	Infusion	Drink about 150 mL 2 times/day	3	0.050	5.00	Stem bark	hydro-ethanolic		<i>P.fw5</i>	17.8	(Boyom et al 2003)	
											Xylopic acid isolated from fresh unripe fruits	petroleum ether	<i>In vivo</i>	<i>Plasmodium berghei ANKA</i>	9.0±3.2 mg/kg	(Osei et al 2021)	

3	Apocynaceae (3)	<i>Funtumia africana</i> (Benth.) Stapf	D7HK2	Browloye (Toma)	Leaves	Decoction	Drink about 200 mL 2 times / day	2	0.033	3.30							
		<i>Rauvolfia vomitoria</i> Afzel.	D7HK4	Kalaloubohou (Toma)	Leaves	Decoction	Drink about 150 mL 3 times/day	3	0.050	5.00	Trunk bark	ethanolic	<i>In vitro</i>	FcB1.	2.5		(Zirihi et al 2005)
		<i>Voacanga africana</i> stapf	D7HK7	Gnemidouwi (Toma)	Leaves	Decoction	Drink about 250 mL 3 times/day	5	0.083	8.33	Voacamine isolated from stem bark	Total alkaloids	<i>In vitro</i>	D6 W2	238 ng/mL 290 ng/mL		(Federici et al 2000)
5	Boraginaceae (1)	<i>Heliotropium indicum</i> L.	D21HK1	Nonsiko (Malinké)	Leaves, stem	Décoction	In bath and drink 250 mL 2 times/day	1	0.017	1.70							
7	Combretaceae (1)	<i>Terminalia superba</i> Engl. et Diels	D36HK14	Bagi (Toma)	Bark, leaves	Decoction	In bath and drink about 250 mL 3 times/day	12	0.20	20.00	Leaves	Aqueous extract	<i>In vitro</i>	P,fINDO 3D7	0.57 1.26		(Mbouna et al. 2018)

4	Compositae (3)	<i>Ageratum Conyzoides</i> Sieber ex Sieber ex Studel	D13HK4	Toumoukou ngnooui (Toma)	Leaves	Decoction	Drink about 100 mL 3 times/day	5	0.083	8.33	Whole plant	dichloromethano lic	<i>In vitro</i>	W2 D6	3.44 2.15		(Owuor et al 2012)
		<i>Bidens pilosa</i> L.	D13HK5	Kpakpatia (Toma)	Leaves	Decoction	Drink about 250 mL 2 times/day	2	0.033	3.30	Roots	ethanolic 80%	<i>In vivo</i>	<i>P. berghei</i> - NK- 65		36 % at 250 mg/kg	(Oliveira et al 2004)
		<i>Chromolaena odorata</i> (L.) R.M.King & H.Rob.	D13HK6	Noupatouma la (Guerzé) Noupai(Tom a)	Leaves	Decoction	Drink about 200 mL 3 time/day	15	0.250	25.00	Leaves	Aqueous fraction	<i>In vivo</i>	<i>P. berghei</i> <i>berghei</i> NK 65		99.46 % at 100 mg/kg	(Ezenyi et al 2014)
									CH ₂ Cl ₂ - Fraction 11	<i>In vitro</i>		HB3, FCM29	4.8 6.74				
										CH ₂ Cl ₂ - Fraction 13		HB3, FCM29	4.28 5.04				
6	Caricaceae(1)	<i>Carica papaya</i> L.	D29HK1	Toma	Roots	Infusion	Drink 100 mL 3 times/day	3	0.050	5.00	Leaves	Ethyl acetate	<i>In vitro</i>	D10 DD2	2.96 3.98		(Melariri et al 2011)

8	Convolvulaceae (1)	Ipoemoea sp (L)		Hopolateigui (Toma)	Leaves	Infusion	Drink about 150 mL 3 times/day	1	0.017	1.70							
9	Costaceae (1)	<i>Costus afer</i> ker-Gawl.	172HK1	Tofoye (Toma)	Leaves	Decoction	Drink about 150 mL 2 times/day	1	0.017	1.70							
10	Dilleniaceae (1)	<i>Tetracera potatoria</i> Afzel. ex G.Don	D37HK2	Dopanaigui (Toma)	Leaves	Decoction	Drink about 200 mL 2 times/day	1	0.017	1.70							
11	Euphorbiaceae (1)	<i>Alchornea cordifolia</i> (Schum et Thonn.) Mull.Arg	D50HK1	Zokaye (Toma)	Leaves	Decoction	Drink about 250 mL 3 times/day	9	0.150	15.00	Leaves	Ethanolic	<i>In vitro</i>	FcM29 Nigerian	7.1		(Banzouzi et al 2002)
											ellagic acid		<i>In vitro</i>	FcM29 Nigerian	0.08 µM 0.14 µM		
13	Fabaceae (5)	<i>Albizia zygia</i> (DC). JFMacbr.	D51HK2	Gbanagui (Toma)	Leaves	Decoction	Bath and drink about 200 mL 2 times/day	4	0.067	6.70	Two compounds Acetylated derivatives	Methanolic	<i>In vitro</i>	3D7	7.5 µM 6.8 µM		(Koagne et al 2020)

		<i>Cassia sieberiana</i> DC	D51HK3	Sindjan (Malinké)	Leaves	Decoction	Drink about 100 mL 2 times/day	2	0.033	3.30	Root Stem bark	Ethanollic	<i>In vivo</i> <i>In-vivo</i>	<i>P.berghei</i> NK 65	43.3 µg/mL	55.8% at 300 mg/kg 63,9% at 300 mg/kg	(Abdulrazak et al 2015)	
		<i>Millettia zechiana</i> Harms	D51HK9	Fanhanlife (Toma)	Leaves, Bark	Decoction	Drink about 150 mL 2 times/day	1	0.017	1.70								
		<i>Parkia biglobosa</i> Benth	D51HK3	Nerai (Malinké)	Bark	Decoction	Drink about 200 mL 3 times/day	4	0.067	6.70	Leaves	Aqueous	<i>In vitro</i> <i>In vivo</i>	<i>P.falciptarum</i> <i>P.berghei berghei</i>	> 50 µg/mL	55,6 % at 600 mg/kg	(Builders et al 2011)	
14		<i>Senna siamea</i> Lam	D51HK14	Cassia (Malinké)	Leaves	Decoction	Drink about 150 mL 2 times/day	2	0.033	3.30								

12	Lauraceae (1)	<i>Persea americana</i> Mill	D67HK1	Piyalaye (Toma)	Bark	Decoction	Drink about 150 mL 3 times/day	4	0.067	6.70	9,9'-Di-O-feruloyl-5,5'-dimethoxysecoisolariciresinol		<i>In vitro</i>	3D7	0.05 µM		(Bankeu et al 2021)
15	Gentianaceae (1)	<i>Anthocleista nobilis</i> G.Don	D73HK1	Zudeye (Toma)	Leaves	Maceration	Bain, Drink about 150 mL 3 times/day	1	0.017	1.70							
16	Loranthaceae (1)	<i>Tapinanthus bangwensis</i> Engl.et K.Krause	D74HK3	Zanikole (Toma)	Leaves	Maceration	Drink about 100 mL 3 times/day	2	0.033	3.30							
17	Malvaceae (1)	<i>Sida rhombifolia</i> L.	D77HK5	Heli (Guerzé)	Leaves, stems	Decoction	Drink about 200 mL 3 times/day	1	0.017	1.70	Oleanolic acid	Ethanol 70%	<i>In vitro</i>	3D7 Dd2	3.56 2.02		(Kamdoum et al 2021)

18	Meliaceae (1)	<i>Carapa procera</i> DC	D80HK1	Kovelaye (Toma)	Bark	Decoction	Drink about 100 mL 3 times/day	2	0.033	3.30	Stem bark	Ethanolic	<i>In vivo</i>	<i>P. berghei Anku</i>	46.3% at 100 mg/kg 56.7% at 250 mg/kg	(Benjamin et al 2021)
19	Moringaceae (1)	<i>Moringa oleifera</i> Lam	D87HK1	Monigye (Toma)	Leaves	Decoction	Drink about 100 mL 2 times/day	2	0.033	3.30	Leaves	Ethanolic	<i>In vitro</i>	3D7	15.18	(Donkor et al 2015)
20	Musaceae (1)	<i>Musa Paradisiaca</i> L.	D158HK1	menadaye (Toma)	Leaves	Maceration	Drink about 250 mL 3 times/day	3	0.050	5.00						
21	Poaceae (1)	<i>Bambusa vulgaris</i> Ness	D162HK1	Tamoulaye (Toma)	Leaves	Decoction	Drink about 250 mL 3 times/day	2	0.033	3.30	Aerial parts	Ethanol 80%	<i>In vitro</i>	<i>Pf</i> Ghana	4.7	(Valdés et al 2010)
22	Rubiaceae (2)	<i>Coffea canephora</i> pierre	D117HK1 2	Cafelagui (Toma)	Leaves	Decoction	Drink about 150 mL 2 times/day	1	0.017	1.70						

		<i>Mitragyna inermis</i> (Willd.) Kuntze	D117HK2	Polaye (Toma)	Leaves	Decoction	Drink about 200 mL 3 times/day	3	0.050	5.00	Leaves	Alkaloids	<i>In vitro</i>	W2	2.75	(Fiot et al 2005)
23	Rutaceae (1)	<i>Citrus limon</i> Burm.	D118HK4	Noumouloud aye (Toma)	Leaves	Decoction	Drink about 200 mL 3 times/day	1	0.017	1.70						
24	Sapindaceae (1)	<i>Paullinia pinnata</i> L.	D121HK1	Ponidaye (Toma)	Leaves	Maceration	Drink about 250 mL 3 times/day	1	0.017	1.70			<i>In vitro</i>	PfGhana	17.3	(Traore et al 2014)
25	Zingiberaceae (1)	<i>Aframomum giganteum</i> (Oliv. & D.Harb.) K.Schum	D171HK2	Kalaloubohou lou (Toma)	Leaves	Decoction	Drink about 200 mL 3 times/day	2	0.033	3.30						



Some pictures from the survey of traditional healers in the Prefecture of Macenta