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Ethnobotanical survey of plants used in the management of malaria in the Guinée Forestière region, Guinea

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Abstract

In Africa, malaria is a major public health issue, often managed in the traditional way by traditional practitioners. This study aimed to identify traditional practitioners and medicinal plants used in malaria treatment. The sample included 53 traditional practitioners interviewed and 35 plant species identified as being used against malaria. The interviews explored the socio-demographic characteristics of traditional practitioners and the medicinal plants used. Each interview was followed by field trips to collect or acquire plant samples from herbalists. The study took place from September to December 2022. The results showed that the majority of traditional therapists (74.19%) were men, while herbalists (77.27%) were mostly women. As regards the age distribution, 83.87% of traditional therapists and 86.36% of herbalists were 35 years or older. Among the ethnic groups, Tomas and Guerzés were the most represented, with 35.48% and 22.58% of traditional therapists and 36.36% and 27.27% of herbalists, respectively. Leaves (60%) were the most commonly used plant parts, decoction (57.14%) was the main method of preparation, and the oral route (65.71%) was the most frequent route of administration. This descriptive ethnobotanical study provides valuable data on traditional malaria treatment practices and knowledge and highlights the importance of developing and promoting methods for preserving medicinal plants.

Keywords: Swamp fever; Traditherapists; Herbalists; African medicinal plants; Decoction

1. Introduction

Malaria, the main disease of tropical regions, remains a major public health concern (Tsabang et al., 2012; Sylla et al., 2018; Samuel and Adekunle, 2021). It is one of the leading causes of morbidity and mortality worldwide, particularly in Sub-Saharan Africa (Cissé et al., 2020). According to the World Health Organization (WHO), around 229 million cases of malaria, including 409,000 deaths, were recorded in 2019 compared with 238 million cases including 738,000 deaths in 2020. Sub-Saharan Africa is disproportionately affected by this disease, where it accounts for more than 92% of cases and causes 91% of deaths recorded worldwide between 2015 and 2018 (Habeebullah et al., 2021).

Plants have always been an essential part of the care practices of humanity in various cultures around the world. They have been used for generations in traditional medicinal therapies by different communities around the world (Vitalini et al., 2013; Nguyen et al., 2019). Worldwide, 80% of the population still relies more or less completely on herbal

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remedies (Sylla et al., 2018), as they are unable to access modern medicines due to their high cost. Traditional medicine therefore appears to be an alternative for economically poor populations, especially in Sub-Saharan African countries where many infectious diseases are prevalent (Sylla et al., 2018). In the same context, Belhouala and Banaba (2021) stated that traditional medicine is the cornerstone that stimulates scientific research to explore new therapeutic approaches. Around 50% of the therapeutic agents currently used come from natural sources (plants, mushrooms, animals, etc.) (Belhouala and Banaba, 2021). However, less than 10% of plants have been biologically deciphered for their therapeutic capacity (Nounagnon et al., 2017). This proves that traditional medicine still has unexplored potential. Effective medicine such as quinine (the leading anti-malarial), morphine (a powerful analgesic), ergot (anti-migraine virtues), and curare (muscle relaxant properties) are of plant origin.

In Guinea, ethnobotanical surveys conducted by the Institute of Research and Development of Medicinal and Food Plants of Guinea (in French: Institut de Recherche et de Développement des Plantes Médicinales et Alimentaires de Guinée IRDPMAG), have made it possible to compile a list of antimalarial plants and to validate some of them biologically. This work has led to extensive research including the therapeutic validation of *Caesalpinia benthamiana* leaves in children with uncomplicated malaria (Loua et al., 2017) and the identification of bioactive molecules from this plant, targeting the 3D7 strain of *Plasmodium falciparum* (Jansen et al., 2017). To address the many health problems of the Guinean population and contribute to malaria research efforts, IRDPMAG conducted ethnobotanical surveys in the four regions of Guinea (Camara, 2020). As a result of these surveys, 113 species of interest were recorded among which 109 were identified botanically and divided into 84 genera and 46 families (Camara, 2020; Traore et al., 2013). Traditional medicine in Guinea uses a wide range of mainly plant-based remedies to treat malaria. The medicinal plants used generally differ according to ethnic groups or regions (Barry et al., 2006). An ethnobotanical study conducted in 2019 on medicinal plants used in the treatment of malaria in traditional medicine in Guinea revealed that the traditional practitioners interviewed were distributed geographically as follows: 38.16% in Basse Guinée, 28.72% in Haute Guinée, 21.18% in Moyenne Guinée and 16.94% in Guinée Forestière (Barry et al., 2019). In Guinée Forestière, traditional medicine plays a key role in the management of malaria, mainly through the use of medicinal plants. The approach used integrates a set of knowledge, skills, and practices based on theories, beliefs, and experiences specific to different cultures, and is used to prevent, diagnose, treat, or improve health status in relation to disease. This is the context of the present study, whose objectives were to identify the traditional practitioners involved in the treatment of malaria and to record medicinal plants used in the management of this disease.

2. Material and methods

2.1. Study area

The study area lies within the Guinée Forestière, one of the four natural regions of the Republic of Guinea. It is located in Southern Guinea between latitude 8° 39′ North and longitude 8°57′ West. It has a population of around 1,989,740 (INS, 2016). With an area of 49,374 km^2, it represents 20% of the total area of Guinea. The Guinée Forestière region shares borders with the Haute Guinée region to the North, the Republics of Côte d'Ivoire to the East, Liberia to the South and Sierra Leone to the West (Camara, 2021). This region is characterized by a humid tropical climate (or sub-equatorial climate) with an extended rainy season of about nine (9) months. There are two main seasons during the year: a rainy season, which runs from April to November, and a dry season from December to March. Annual rainfall varies between 1,700 and 3,000 mm and temperatures between 19ºC and 29ºC (with an annual average of 24ºC), which promotes the multiplication of malaria vectors (Camara, 2021). Vegetation cover is characterized by the dense humid rainforest that forms the natural landscape of this region. The rich fauna favors the development of parasites, and the varied flora includes medicinal plants of various species (Camara, 2021). In this study, respondents were traditional practitioners belonging to different ethnic groups residing in the prefectures of Guinée Forestière, such as Kissidougou, Guéckédou, Beyla, Macenta, Lola, Nzérékoré, and Yomou as shown in Figure 1.

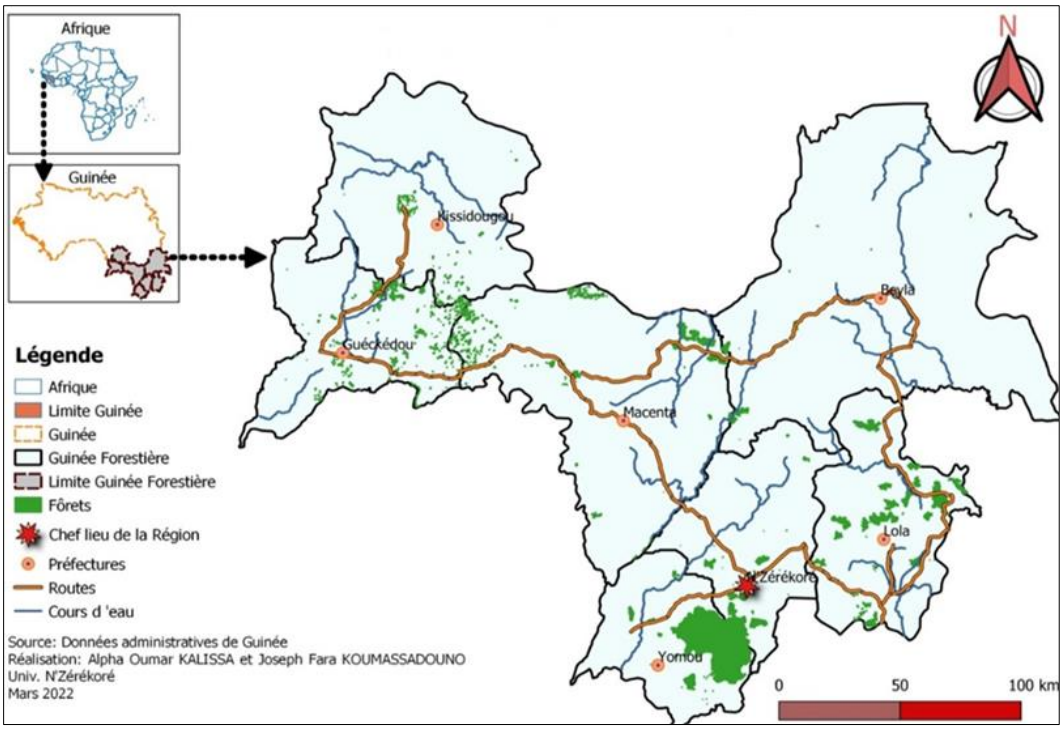

Figure 1 Map of the study area (and prefectures) in Guinée Forestière region, Guinea

2.2. Study methods

Identification and selection of traditherapists and herbalists were done by adopting the non-probabilistic convenience sampling technique. Each respondent was invited to choose a suitable location for a confidential interview either on the field, at home, or at a market where medicinal plants are sold. The distribution of respondents by prefecture is shown in Table 1.

Table 1 Distribution of respondents in the study area

Prefectures	Number of respondents		Subtotal
	Traditherapists	Herbalists	
Kissidougou	05	02	07
Beyla	02	01	03
Guéckédou	03	02	05
Macenta	10	08	18
Lola	03	01	04
Nzérékoré	06	06	12
Yomou	02	02	04
Total	31	22	53

2.3. Ethnobotanical survey

The surveys were carried out between the beginning of September and the end of December 2022, using a questionnaire developed for the purposes of the study. The questionnaire was used to identify traditherapists and herbalists treating malaria, and to collect information on their socio-demographic characteristics (age, gender, ethnicity). It was also used to collect ethno-medical data related to traditional knowledge of malaria, its perceived causes, as well as the use of plants in the tradition, including signs and symptoms treated, parts of plant used, methods of preparation ethnomedical, and administration. Two meetings were held with the respondents. The first meeting was to explain the survey

objectives and present plant samples. At the second meeting, we recorded the interviews and completed the survey forms prepared in advance. These forms served as a basis for semi-structured one-to-one interviews of approximately one hour. The interviews enabled to collect information about the respondents (age, level of education, main occupation, seniority in the field) and about the plants used to treat malaria (therapeutic use, dose, duration of treatment, galenic form, mode of administration, harvest period and origin of the plants).

2.4. Knowledge of plant preparation methods

Each interview was followed by field trips to collect samples of the species mentioned by the respondent, or to purchase from herbalists based on the vernacular names of plant species. Machetes, dabas, secateurs, bags, boots, gloves, goggles, helmets, and water containers were the materials used to collect and prepare plant samples. Harvesting of plant parts (leaves, barks, and roots) was done early in the morning or late in the afternoon when temperatures were cooler or in dry weather in order to maximize the concentration of active substances while minimizing the water content. First data collected from the traditherapists interviewed revealed that there are three main traditional methods used to prepare herbal products: decoction, maceration, and infusion.

The decoction method consists of extracting the active ingredients from the plant by dissolving it in a liquid kept boiling (Bla et al., 2015; Kipré et al., 2017). Preparation is as follows:

- Cut off the parts of the plant (either leaves, barks or roots),
- Place in a container containing water,
- Heat over low heat, cover, and boil slowly for about 20 minutes,
- Remove from the heat and allow to cool, then filter to obtain the final product called decoction.

The maceration method involves extracting the active ingredients from the plant by dissolving it in a cold liquid (Bla et al., 2015; Kipré et al., 2017). Preparation is as follows:

- Place the cut-up parts of the plant in a container filled with cold water,
- Leave to macerate under cover for 10 to 12 hours, depending on the plant,
- Filter the mixture to obtain the final product called the macerate.

The extraction technique by infusion consists of releasing the active ingredients from the plant in hot water (Bla et al., 2015; Kipré et al., 2017). The steps are:

- Place plant parts (either leaves, barks, or roots) in a container containing hot water,
- Allow to infuse for 5 to 20 minutes, depending on the type of plant,
- Filter the mixture to obtain the final product called infused.

2.5. Data processing

Once the survey forms had been tabulated, the data collected was entered into a database using Microsoft Excel software. Microsoft Excel software was also used to create tables and graphs, enabling interpretation of the level of knowledge about malaria, the plants used to treat it and the therapeutic methods employed.

3. Results

The results of this study reveal that out of a total of 53 traditional practitioners surveyed, 31 traditherapists and 22 herbalists were identified. During the survey, 35 medicinal plants used to treat malaria were identified. These data highlight that traditional management of malaria is the main therapeutic remedy used by communities in Guinée Forestière.

3.1. Socio-demographic characteristics of traditherapists and herbalists surveyed

The results presented in Table 2 show the distribution of traditional practitioners by gender (number of men and women), age range, and ethnic groups. The majority of traditherapists surveyed were men (74.19%), while herbalists were mainly women (77.27%). The majority of traditherapists and herbalists were over 35 years of age, representing 83.87% and 86.36% of respondents, respectively. Traditherapists and herbalists interviewed belonged to six ethnic groups: Kissis, Koniankés, Tomas, Konöh, Guerzés, and Manöh. Among them, Tomas and Guerzés were the most represented with 35.48% and 22.58% traditherapists, and 36.36% and 27.27% herbalists, respectively. Moreover,

results indicate that men possess more traditional knowledge, and have a particularly high cultural level. Women play a key role in the conservation and marketing of medicinal plants.

Table 2 Distribution of traditional practitioners by gender, age group, and ethnic group

Socio-demographic variables		Traditherapists	%	Herbalists	%
Type	Men	23	74.19	05	22.73
	Female	08	25.81	17	77.27
Age range	< under 18	00	00	00	00
	18 – 35 years old	05	16.13	03	13.64
	> over 35	26	83.87	19	86.36
Ethnic groups	Kissis	05	16.13	02	9.09
	Koniankés	03	9.68	01	04.55
	Tomas	11	35.48	08	36.36
	Konöh	03	9.68	02	09.09
	Guerzés	07	22.58	06	27.27
	Manöh	02	06.45	03	13.64

% : percentage of total workforce; < : lower ; > : higher

3.2. Distribution of medicinal plants by botanical families, species, and treatment methods for malaria

Figure 2 shows the distribution of identified medicinal plant species by botanical families. The results show that 35 medicinal plant species were identified and distributed among 13 botanical families, including Fabaceae (2 species), Moraceae (1 species), Caesalpiniaceae (2 species), Asteraceae (3 species), Rutaceae (4 species), Apocynaceae (5 species), Rubiaceae (5 species), Anacardiaceae (4 species), Caricaceae (2 species), Poaceae (3 species), Combretaceae (2 species), Musaceae (1 species) and Lauraceae (1 species). The most represented families were Apocynaceae and Rubiaceae with 5 species, followed by Rutaceae and Anacardiaceae with 4 species.

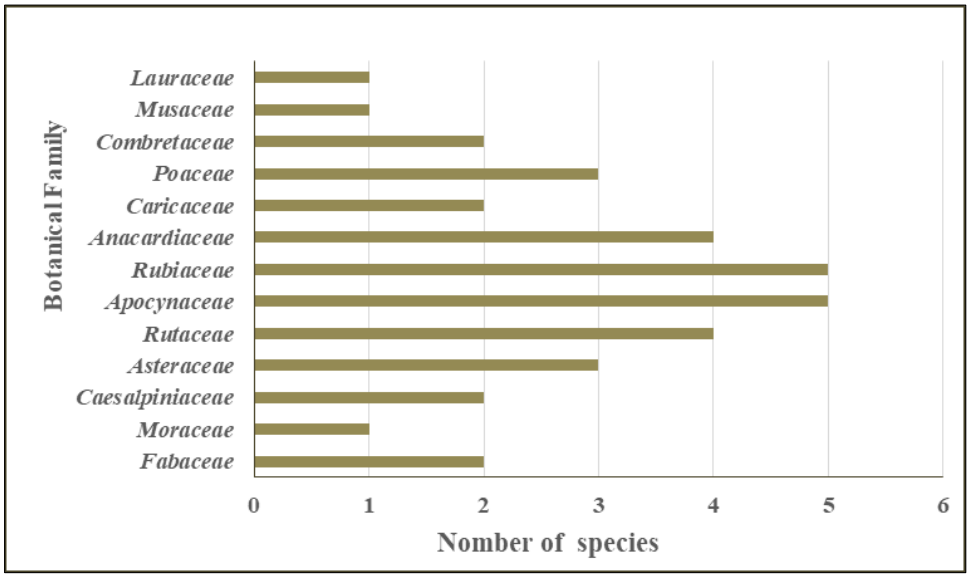

Figure 2 Distribution of identified medicinal plant species by botanical families

Table 3 shows the distribution of medicinal plant species by treatment method. When considering the plant parts, methods of preparation and routes of administration used for each medicinal plant species, it was found that the leaf was the most widely used plant part for the species *M. cecropioides, D. oliveri, M. afzelii, C. limon, C. sierberiana, F.*

africana, S. mombin, G. obvallata, M. indica, B. vulgaris, M. geminata, M. morindoides, H. stipulosa, C. scandens, I. cylindrica, M. paradisiaca, C. papaya, P. americanum, and *A. conizoïdes,* followed by bark for the species *P. santalinoides, A. polycarpa, A. boonei, F. africana, N. diderichii, R. vomitoria,* and *T. ivoirensis.*

The most common method of preparation for the majority of species was decoction *(P. santalinoides, M. cecropioïdes, M. afzelii, S. mombin, G. obvallata, M. indica, B. vulgaris, M. geminata, M. morindoides, C. odorata, M. indica, H. stipulosa, B. vulgaris, I. cylindrical, M. paradisiaca, C. papaya, R. vomitoria, P. americanum* and *T. ivoirensis)* followed by maceration for the species *A. polycarpa, A. boonei, F. Africana,* and *N. diderichii* (Table 3).

The oral route was widely used to administer remedies based on plant species such as *M. cecropioides, D. oliveri, M. afzelii, C. limon, A. polycarpa, C. sierberiana, A. boonei, F. africana, N. diderichii and N. diderichii. africana, N. diderichii, S. mombin, G. obvallata, M. indica, N. latifolia, M. morindoides, C. odorata, A. boonei, C. scandens, B. vulgaris, I. cylindrical, C. papaya, R. vomitoria* and *T. ivoirensis* (Table 3).

Table 3 Medicinal plants used to treat malaria

Plant species	**Family**	**Local name**	**Plant parts**				**Method of preparation**			**Route of administration**			
			L	**B**	**R**	**S**	**D**	**M**	**I**	**O**	**B**	**Re**	**Fu**
Prefecture of Kissidougou													
Pterocarpus santalinoides D.C	Fabaceae	Dyégou		X			X			X	X		
Musanga cecropioïdes R.Br.	Moraceae	Péedo	X				X			X			
Daniellia oliveri (Rolfe) Hutch.	Caesalpiniaceae	Sianden	X				X	X		X			
Microglossa afzelii O.Hoffm.	Asteraceae	Yenyölö	X				X			X			
Citrus limon (L.) Burm. F.	Rutaceae	lémoulo	X				X	X		X			
Prefecture of Beyla													
Aninckia polycarpa (DC.) Setten & Maas	Apocynaceae	Gbeli		X				X		X			
Cassia sierberiana DC.	Fabaceae	Cassia	X						X	X			
Alstonia boonei De Wild.	Apocynaceae	Yolo		X				X		X			
Funtumia africana (Benth.) Stapf	Apocynaceae	Héyelé	X					X		X			
Nauclea diderichii De Wild et Merr.	Rubiaceae	Gnakounea		X				X		X			
Prefecture of Guéckédou													
Spondias mombin L.	Anacardiaceae	Léwo	X				X			X			
Geophila obvallata (Schumach.) F.Didr.	Rutaceae	Bembo lendo	X				X			X			
Citrus limon (L.) Burm. F.	Rutaceae	lémoulo	X				X	X		X	X		
Mangifera indica L.	Anacardiaceae	Mangollo	X				X			X			
Prefecture of Lola													
Carica papaya L.	Caricaceae	Yérétiqué	X	X	X		X	X		X	X		
Cassia siamea Lam.	Caesalpiniaceae	Cassia	X	X	X		X	X		X	X		
Bambusa vulgaris H. Adolf Schrader.	Poaceae	Böo	X				X			X	X		
Morinda geminata DC.	Rubiaceae	Zorogbon	X				X				X		
Prefecture of Macenta													

Nauclea latifolia Sm.	Rubiaceae	Gala hiébougui	X	X			X		X	X			
Morinda morindoides (Bak.) Milne-Redh.	Rubiaceae	Souwolémié	X				X			X			
Chromolaena odorata R. M. King	Asteraceae	Noupaye	X	X			X			X			
Citrus limon (L.) Burm.f.	Rutaceae	Noumönö tabaï loufeï	X				X	X		X	X		
Alstonia boonei De Wild.	Apocynaceae	Zoloouli		X					X	X			
Mangifera indica L.	Anacardiaceae	Mangolo loufeï	X				X			X			
Hallea stipulosa (DC.) J.-F.Leroy – MNHN	Rubiaceae	Pöwöouli	X				X				X		
Prefecture of Nzérékoré													
Combretum scandens Exell	Combretaceae	Kalnwanalaa	X				X	X		X			
Bambusa vulgaris H. Adolf Schrader	Poaceae	Bôo	X				X			X			
Imperata cylindrica Ferrante Imperato	Poaceae	Deinn la			X		X			X			
Musa paradisiaca Antonius Musa	Musaceae	Gwui wulu	X				X			X	X		
Carica papaya L.	caricaceae	Yélé tia	X				X			X			
Prefecture of Yomou													
Rauwolfia vomitoria Afzen	Apocynaceae	Wonignaguéléi		X			X			X			
Percea americanum Mill	Lauraceae	Péawoulou	X				X				X		
Mangifera indica L.	Anacardiaceae	Mangolovoulou	X	X			X				X		
Ageratum conizoïdes L.	Astéraceae	Gougnogougno	X						X	X	X		
Terminalia ivoirensis A. Chev	Combretaceae	Bahi		X			X			X			

L : Leaf ; B: Bark ; R : Root; S : Seed ; D : Decoction ; M : Maceration ; I : Infusion ; O : Oral ; B : Bath ; Re : Rectal ; Fu : Fumigation.

3.3. Techniques for the use of medicinal plants in malaria treatment

The results presented in Table 4 show that the plant parts most used by traditherapists and herbalists were leaves (60%) and stem barks (22.86%). When the simultaneous use of two plant parts was recommended, the combination of leaves and barks (8.57%) appeared to be slightly preferred than the combination of leaves, barks and roots (5.71%). The methods of preparation used were as follows: decoction (57.14%), combination of decoction and maceration (20%), and maceration (11.43%). Most preparations were administered orally (65.71%) as a drink, followed by the combination of oral route and body bath (22.86%).

Table 4 Techniques for the use of medicinal plants in malaria treatment

Study parameters		**Number of plants**	**Percentage (%)**
Plant organs	Leaves	21	60
	Leaves + Barks	3	8.57
	Roots	1	2.86
	Leaves + Roots	0	0
	Bark	8	22.86
	Bark + Root	0	0
	Leaves + Barks + Roots	2	5.71
	Seeds	0	0
Method of preparation	Decoction	20	57.14
	Decoction + Maceration	7	20
	Maceration	4	11.43
	Decoction + Infusion	1	2.86
	Maceration + Infusion	0	0
	Infusion	3	8.57
Route of administration	Oral route	23	65.71
	Oral + Bath	8	22.86
	Body bath	4	11.43
	Oral + Rectal	0	0
	Rectal route	0	0
	Fumigation	0	0

4. Discussion

Medicinal plants are still regarded as important and promising sources of medicines for various diseases. Their therapeutic applications, vernacular names, methods of preparation, and routes of administration have been passed on orally to constitute a local ancestral knowledge specific to each population or ethnic group living in a given region (Belhouala and Banaba, 2021). This ethnobotanical study aimed to identify and analyze medicinal plants used in the treatment of malaria across seven prefectures in Guinée Forestière. The results reveal that out of a total of 53 traditional practitioners interviewed, 31 traditherapists and 22 herbalists were identified. A total of 35 medicinal plants were recorded for the treatment of malaria in the study area. A study by Barry et al, (2019) reported a rate of 16.94% of traditional practitioners in Guinée Forestière. Our results confirm that traditional care is the main health care privileged by local populations, due to the availability of traditherapists and medicinal plants used as malaria remedies.

In addition, the majority of traditherapists were men (74.19%), while the majority of herbalists were women (77.27%). The majority of traditherapists and herbalists surveyed were over 35 years of age, with participation rates of 83.87% and 86.36%, respectively. The traditherapists and herbalists surveyed belonged to six main ethnic groups (Kissis, Koniankés, Tomas, Konöh, Guerzés, and Manöh). Among ethnic groups, Tomas and Guerzés were the most represented, with 35.48% and 22.58% traditherapists and 36.36% and 27.27% herbalists, respectively (Table 2). A similar observation was reported by Sylla et al. (2018), who recorded 78.26% male traditherapists and 89.18% female herbalists in Abidjan in Côte d'Ivoire, with a predominance of practitioners aged over 35 (83.87% traditherapists and 86.36% herbalists). Among ethnic groups surveyed, they found a strong representation of the Akan (52.2% traditherapists and 29.7% herbalists) and Mandé (39.1% traditherapists and 64.9% herbalists) ethnic groups.

The predominance of men among traditherapists can be explained by the fact that men play a central role in the transmission of traditional knowledge, with strong cultural recognition and expertise rooted in tradition and experience. The predominance of women among herbalists can be explained by the fact that women stand out as the main actors in the conservation and commercialization of medicinal plants on the markets of Guinée Forestière. The same observations were made by Sylla et al. (2018) in Côte d'Ivoire.

The two categories of actors interviewed (traditherapists and herbalists) were mostly over 35 years of age (Table 2). Those over 35 years of age benefit from a greater maturity and a thorough mastery of traditional and cultural knowledge related to the use of medicinal plants. Knowledge of the uses and properties of medicinal plants is usually the result of long-term experience accumulated over time and passed on from generation to generation (Benlamdini et al., 2014). This intergenerational transmission of knowledge is particularly marked among certain ethnic groups, notably the Tomas and Guerzés, who are distinguished by their commitment to preserving their traditional knowledge.

The study identified 35 medicinal plant species divided into 13 botanical families. Of these, the Apocynaceae and Rubiaceae were the most represented (05 species each) (Figure 2), and thus occupy a central place in the treatment of malaria. These results are similar to those of Sylla et al. (2018) who identified Rubiaceae (5 species) and Combretaceae (5 species) as the most frequent families. Research carried out in Morocco by Benlamdini et al. (2014) on the medicinal flora of the High Atlas has also identified several predominant plant families including Fabaceae, Poaceae, and Asteraceae, which are used for their medicinal properties. In 2017, a study carried out in Benin highlighted the presence of quinone derivatives in extracts of *Combretum adenogonium*, a plant of the Combretaceae family commonly used in the treatment of parasitosis, particularly malaria (Nounagnon et al., 2017). Data of this study indicate that species of medicinal plants identified were widely used by traditional practitioners from different ethnic groups in the region, highlighting their central role in local traditional medicine. Treatment with these plant species is a preferred therapeutic option in communities (Table 3). This reflects the importance of traditional pharmacopeia in the management of common diseases, particularly malaria. However, the use of these species in the treatment of malaria varies from one species to another. The differences observed are related not only to the plant part used (root, leaf, bark), but also to preparation methods (infusion, decoction, maceration) and administration routes (oral, bath etc.). These variations reflect the richness and diversity of local therapeutic practices, adapted to the specific characteristics of plants and the needs of patients.

Among the plant parts used in preparations, leaves predominate (60%), followed by stem barks and finally roots. Several authors among which Zirihi (2006), Mangambu et al. (2014), Bla et al. (2015), and Kipré et al. (2017) have also reported the predominance of leaves in recipes used to treat malaria. The high frequency of use of leaves in malaria treatment recipes can be explained by several practical and biological factors. First, the leaves are relatively easy and quick to harvest, making them easy for traditional practitioners to use. Second, the leaves contain many active substances responsible for the pharmacological properties of the plant, and their use is explained by the abundance of chemical groups they contain, as they are known to be the site of synthesis of secondary metabolites of the plant (Mangambu et al., 2008; Rai and Lalramnghinglova, 2011; Mangambu et al., 2014).

Decoction (57.14%) is the most commonly used method. Most preparations are administered orally (65.71%) as a drink (Table 4). Results from this study are similar to those of Sylla et al. (2018) who reported that leaves (68.89%), decoction (76.97%), and oral route (84.04%) were the most commonly plant part, preparation method, and administration route used by traditional practitioners in Côte d'Ivoire. Other authors as Aïssata Camara (2020) found that leaves (61%), decoction (58.07%), and the oral route (84.04%) were the most commonly used. and the oral route (78.54%) were the most commonly used in Guinea. According to the traditional practitioners interviewed in this study, decoction is the preferred method because it allows to extract a maximum amount of active ingredients while reducing or eliminating the toxic effects of the substances used. Finally, the oral route is the most popular and could be the least risky, allowing rapid absorption of active ingredients. However, other techniques for the use of medicinal plants (seeds, combination of leaves and roots, combination of maceration and infusion, rectal route, fumigation, and combination of oral and rectal routes) have not been noted in the treatment of malaria.

5. Conclusion

This ethnobotanical study investigates the medicinal plants used in the management of malaria in Guinée Forestière. The results revealed that traditherapists and herbalists specializing in the treatment of malaria are present throughout the region. Among the participants, traditherapists were predominantly men, while herbalists were predominantly women, with participation rates of 74.19% and 77.27% respectively. The majority of traditional practitioners (83.87%) and herbalists (86.36%) were over 35 years of age, and belonged to six ethnic groups, with a predominance of Tomas and Guerzés ethnic groups which represented 35.48% and 22.58% of traditherapists, and 36.36% and 27.27% of

herbalists, respectively. Traditional treatment of malaria is essential and is the first line of treatment in the communities across the Guinée Forestière region. Plant species used to treat malaria are both available and effective. Leaves (60%) were the most commonly used plant parts, decoction (57.14%) the preferred method of preparation, and oral route (65.71%) the main route of administration. This study highlights the wealth of local traditional knowledge and the availability of plant-based remedies to combat this endemic disease. It is essential to develop and promote methods for preserving these medicinal plants within communities. In addition, traditional practitioners should be monitored and supported by the government as part of the traditional treatment of malaria. These results could provide a basis for future pharmacological research, crucial for the development of new antimalarial medecine in Guinée Forestière, Guinea.

Compliance with ethical standards

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Authors' Contributions

Joseph Fara Koumassadouno participated in the design of the study and preparation of the manuscript. Joseph Fara Koumassadouno and Nadège Adoukè Agbodjato participated in data collection and analysis, Nadège Adoukè Agbodjato, Michel Mathurin Kamdem, and Martial Nounagnon participated in the correction of the manuscript. Mamadou Samba Barry, and Mamadou Cellou Baldé participated in the proofreading of the manuscript. All authors read and approved the final version of the manuscript.

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Data availability

The authors do not have permission to share data.

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