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ORIGINAL ARTICLE

Ethnobotanical Study of Medicinal Plants Used for the Treatment of Malaria in the Plateau Region, Togo

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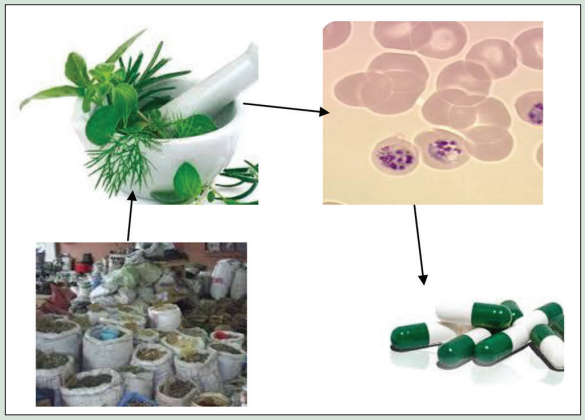
ABSTRACT

Background: In Togo, malaria constitutes a major public health problem but, until now, the population still mostly relies on herbal medicine for healing. This study aimed to document medicinal plants used for malaria therapy in the Plateau region of the country. **Methodology:** Semi-structured questionnaire interviews were used to gather ethnobotanical and sociodemographic data from traditional healers of the study area. **Results:** A total of 61 plants species belonging to 33 families were found to be in use for malaria therapy in the Plateau region. *Caesalpiniaceae* were the most represented family with 7 species, followed by *Euphorbiaceae* and *Poaceae* with 4 species each. According to the relative frequency of citation (RFC), *Newbouldia laevis* Seem. (RFC =0.52), *Sarcocephalus latifolius* (Sm.) E.A. Bruce (RFC =0.48), *Acanthospermum hispidum* DC. (RFC =0.43), and *Senna siamea* (Lam.) H.S. Irwin and Barneby (RFC =0.40) were the most cited in the treatment of malaria in the traditional medicine in the Plateau region. The parts of plants used could either be the barks, roots, leaves, or whole plants. The recipes also could be a combination of various species of plants or plant parts. **Conclusion:** This study highlights the potential sources for the development of new antimalarial drugs from indigenous medicinal plants found in the Plateau region of Togo. Such results could be a starting point for *in vitro* antimalarial screenings.

Key words: *Caesalpiniaceae,* malaria, medicinal plants, relative frequency of citation

SUMMARY

- 61 plants species from 33 families are use for malaria therapy in the Plateau region of Togo
- The main families are Caesalpiniaceae Euphorbiaceae and Poaceae
- The most used species are *Newbouldia laevis* Seem. (RFC = 0.52), *Sarcocephalus latifolius* (Sm.) E.A. Bruce (RFC = 0.48), *Acanthospermum hispidum* DC. (RFC = 0.43), and *Senna siamea* (Lam.) H.S. Irwin and Barneby (RFC = 0.40)



Abbreviations Used: RFC: Relative frequency of citation, FC: Frequency of citation, Dec: Decoction, Orl: Oral route, Mac: Maceration, Jui: Juice, Inf: Infusion, Sau: Sauce, Kne: Kneading, Le: Leaves, Rt: Roots, Wp: Whole plant, St: Stem, Stb: Stem bark, Rh: Rhizome, Fr: Fruits, Pf: *Plasmodium falciparum*, IC50: Concentration of extract killing 50% parasites

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INTRODUCTION

Malaria is a global disease that is predominant in the tropics and caused by blood parasites, *Plasmodium falciparum*, *Plasmodium ovale, Plasmodium malariae*, *Plasmodium vivax*, and *Plasmodium knowlesi*.[1] About 3.3 billion people worldwide are at risk of malaria. In 2013, there were about 216 million cases and approximately 528,000 malaria deaths (range: 315,000–689,000). Globally, 90% of all deaths from the disease were recorded in the World Health Organization (WHO) African Region, mainly in children under five years of age.[2]

In Togo, malaria was on average 40% of outpatient visits and 26% of hospitalizations in public health facilities in 2010 with an average hospital stay of 5 days. The hospital mortality rate of malaria was 21% in 2010 and children of 0–5 years old were the most affected in a proportion of 48%.[3] Currently, the programs against malaria integrate several areas including the prevention and the treatment. Since the declaration of WHO Alma-Ata in 1978,[4] the WHO recognizes and encourages the use of resources of medicine and traditional pharmacopeia in primary health care. Despite the scientific advances made by modern medicine, the WHO estimates that 80% of Africa's population still use traditional medicine for primary health care.[5]

An effective management of malaria requires the use of all resources available, accessible, and culturally acceptable.[2] Worldwide, the traditional pharmacopeia has played and continues to play a very

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important role in the discovery of new molecules of therapeutic interest and particularly in the fight against malaria. With the emergence of resistance of the parasite *P. falciparum* to conventional synthetic drugs, the research for new therapeutic targets by ethnopharmacological methods is an interesting approach, including the search for new antimalarial drugs.[5]

In Togo, few studies had focused on medicinal plants used in the treatment of malaria.[6-11] Koumaglo *et al*. evaluated the antimalarial activity of compounds isolated from *Azadirachta indica* and *Morinda lucida*.[8,9] Other studies conducted by Gbeassor *et al*. concerned the crude extracts of some widely used plants;[6,7] however, these screenings were not preceded by an ethnobotanical survey. Only the study of Koudouvo *et al*. was a complete study including the survey and the *in vitro* screening of the most cited plants.[10,11] This study was conducted in the maritime region of the country and until now; there is no published data on the medicinal plants used to treat malaria in the four other regions of Togo. Therefore, this study was conducted in the Plateau region of Togo, to further explore these antimalarial plants and to assess for the validity of their traditional therapeutic uses through phytochemical information and pharmacological characteristics.

METHODOLOGY

The study area

Togo is the West African country located in the tropics (6°6'N to 11°8'N) bounded on the North by Burkina Faso, to the south by the Atlantic Ocean, to the East by Benin and West by Ghana [Figure 1]. The country is divided into five economic regions from North to South: The savannah region, Kara region, central region, Plateau region, and Maritime region.

The survey was conducted in the Plateau region from May to July 2014. This region covers an area of 16.980 km^2 that represent about 30% of Togo area. Its administrative center is Atakpamé. It prevails in the region a tropical humid climate. There are two rainy seasons and two dry seasons. The longest rainy season is from April to July and the lowest September-October. Annual rainfall average is about 1200–1600 mm. In South-West is a mountainous zone where there are still tropical and subtropical forests, despite expansion of coffee and cocoa plantations. Three major ethnic groups are native to the area: The Adja-Ewe, Ana-Ife, and Akposso-Akébou.

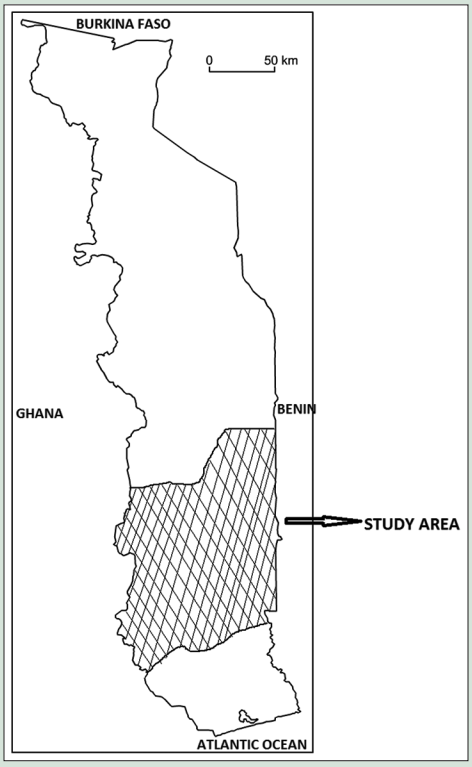

Figure 1: Map of Togo showing the study area, the Plateau Region

Ethnobotanical survey

The ethnobotanical survey was conducted using a full oral questioning of traditional healers.

Questions were focused on the sociodemographic profile of the traditional healer and the knowledge of medicinal plants used in to fight malaria:

- Traditional healer identity, i.e., name and surname, sex, age, and educational level
- Knowledge origin
- Diagnosis, i.e. main symptoms
- Remedy: Local names of the plants, used parts, period of harvest of plants materials, remedy formulation, administration route, dosage, and duration of the treatment.

Plant samples were collected in the field and pictures were taken to aid in the identification. Identification was made by Botany Department of Lomé University by comparison with available voucher specimens. Nomenclature of species was done using the online data base of IPNI website: Http://www.ipni.org/ipni/plantnamesearchpage.do.

Data analysis

Microsoft Excel was used to calculate the different average and to draw graphics. The importance of each plant in the treatment of malaria was assessed by the relative frequency of citation (RFC) calculated using the following formula:[12]

$$RCF = \frac{FC}{N}$$

where FC was the number of people who mentioned the use of the species and N the total number of individuals.

RESULTS

Demographic data and knowledge about malaria

Investigations were conducted with 62 respondents who had knowledge of antimalarial plants including 22 women and 40 men. The knowledge of plants uses was received from parents and society, by learning from other traditional healers or in academic or professional studies [Table 1].

Table 1: Demographic data of the informants (*n*=62)

	Group	*N*	%
Gender	Male	40	64.52
	Female	22	35.48
Age	Less than 30 years	1	1.61
	30-40	18	29.03
	41-50	28	41.16
	51-60	8	11.90
	More than 61 years	6	9.68
Educational background	Illiterate	24	38.71
	Primary level	20	32.26
	Secondary level	15	24.19
	High educational level	3	4.84
Mode of acquisition of the knowledge	Inheritance	55	88.71
	Learning	30	48.38
	Personal experience	9	14.52

Malaria diagnosis in patients was done with some clinical signs that include fever (82.25%), headache (70.97%), shivering (51.61%), weakness (29.03%), and lack of appetite (16.13%). However, 7 respondents (11.29%) asserted that they used parasitological diagnostic of malaria before the treatment.

Plants used for the treatment of malaria

A total of 61 plant species belonging to 33 families were mentioned by respondents as curing malaria. *Caesalpiniaceae* family, with 7 species was the most represented, followed by *Euphorbiaceae* and *Poaceae* with 4 species each. For the rest, 19 families were represented by only one species [Figure 2]. The calculated RFC indicated that species such as *Newbouldia laevis* (RFC = 0.52), *Sarcocephalus latifolius* (RFC = 0.48), *Acanthospermum hispidum* Dc (RFC = 0.43), and *Senna siamea* (RFC = 0.40) were the most used in the treatment of malaria in traditional medicine in the Plateau Region [Table 2].

A bibliographic research was made to seek for previous citations of the recorded species in similar studies. The results revealed are presented in Table 2. According to these results, only four plants namely *Bambusa vulgaris* Schrad. Ex J.C. Wendl, *Gomphrena celosioides* C. Mart., *Imperata cylindrica* (L.) Raeusch. and *Nephrolepis undulata* (Afzel. Ex Sw.) J. Sm. were not previously cited in similar studies. In addition, the bibliographic research focused the screened species cited by the healers in the Plateau region was achieved. This allowed assessing the recorded inhibitory concentrations (ICs) of extracts through *in vitro* test against *Plasmodium* strains [Table 3]. According to this bibliographic data, *Sida acuta, S. latifolius*, and *Combretum micrathum* are the cited plants with IC50 values below 1 µg/mL.

Used parts, method of preparation and administration of drugs

In healers' habit of Plateau region, the most used parts of plants in recipes preparation are leaves (60%), roots (11%), and stem bark (11%) [Figure 3]. Recipes are prepared as decoction, infusion, maceration, and kneading in water or sauce [Figure 4]. The main route of administration is oral. However, some are taken by simple bath or steam bath. These plants are used alone or in combination in the preparation of recipes. The dosage is ranging from one to four doses per day and up to 10 days of treatment depending on recipe, severity of malaria, and patient's age.

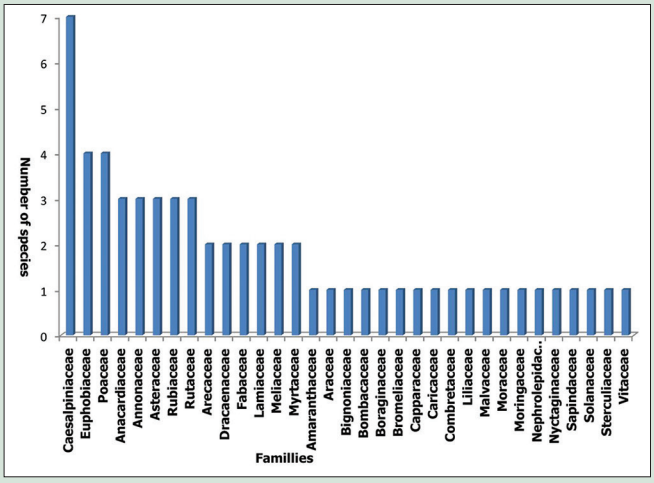

Figure 2: Antimalarial plant species distribution among families

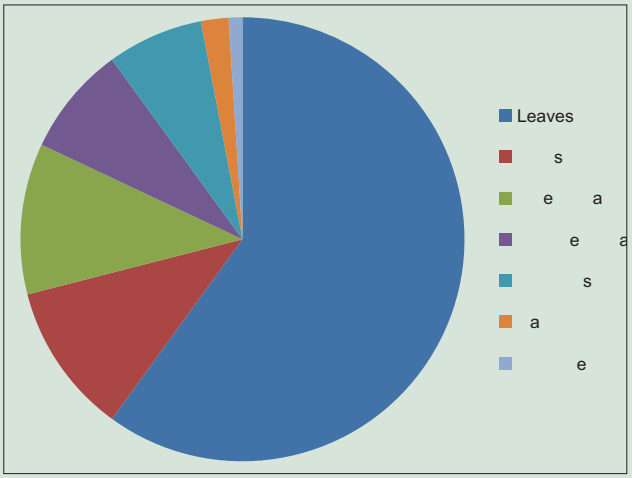

Figure 3: Proportion of different plants parts used in the management of malaria on Plateau region in Togo

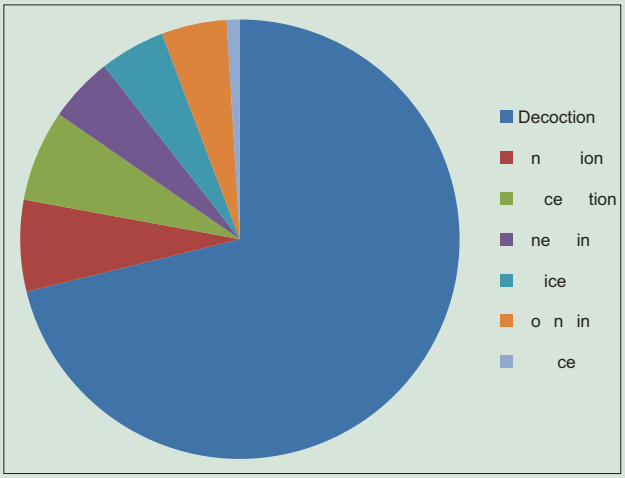

Figure 4: Methods of preparation of remedies in the management of malaria on Plateau Region in Togo

DISCUSSION

The issue of this investigation revealed that plants of families *Caesalpiniaceae*, *Euphobiaceae*, *Poaceae*, *Rubiaceae*, and *Rutaceae* were particularly well known by the people interviewed. They were widely used and contribute to malaria treatment, used either alone or in combination with other species. In a similar study conducted in the Maritime region of Togo, Koudouvo *et al*.[11] had identified 52 species of plants used in traditional malaria treatment belonging to 29 families.[10] *Caesalpiniaceae*, *Euphobiaceae*, *Rubiaceae*, and *Rutaceae* were generally predominant as families with the greatest number of species treating malaria in previous studies 2009.[11,25,30] These plants were similar to those used in the treatment of malaria in Benin,[24] Nigeria,[19,22,23] Ivory Coast,[17] Ghana,[36] and Guinea.[30] The *Rubiaceae* and *Caesalpiniaceae* were often cited for their antimalarial properties due to their alkaloids contents (Karou *et al*.,[39,59] Amoa Onguéné *et al*.[55]). The four most cited plants *S. siamea*, *S. latifolius*, *N. laevis*, and *A. hispidum* were also well documented in several studies: *N. laevis*, *A. hispidum*, and *S. siamea* by Yetein *et al*.[24] The species *B. vulgaris, G. celosioides*, *I. cylindrica*, and *Nephrolepis undulaata* were not found in the literature for their antimalarial uses and need be explored. Antimalarial properties of some recorded species in this study were also reported by previous studies

Table 2: Plant species used against malaria

Botanical name (family)	Local name	Voucher specimen nº	Used part	Mode of preparation/ Administration	Citation		Reference to similar ethnopharmacology use
					Fc	RFC	
Acanthospermum hispidum Dc. (Asteraceae)	Dameleatsunugon ou Adekpi	Togo 00747	Le	Dec/Orl	26	0.43	(Ganfon *et al*., 2008)[13]
Adansonia digitata L. (Bombacaceae)	Adoditsi	Togo 02476	Stb	Dec/Orl	12	0.19	(Moshi, 2012)[14]
Alchornea cordifolia Müll.Arg. (Euphorbiaceae)	Avovlo	Togo 03021	Le	Dec/Orl	09	0.15	(Koudouvo *et al*, 2011)
Aloe vera (L.) Burm. F. (Liliaceae)	Aloes	Togo 11615	Le	Jui/Orl	17	0.27	(Soejerto, 2012)[15]
Ampelocissus bombycina (Bak) Planch. (Vitaceae)	Adidoyo	-	Le	Dec/orl	20	0.32	(Uzodimma, 2013)[16]
Ananas comosus L. (Bromeliaceae)	Atoto	Togo 02007	Fr	Dec/Orl	17	0.27	(N'Guessan *et al*., 2009)[17]
Anacardium occidentale L. (Anacardiaceae)	Yovotsan	Togo 01768	Le ; Stb	Dec/Orl	15	0.24	(Koyode, 2006; Tchacondo *et al*. 2011)[18,20]
Annona muricata L. (Annonaceae)	Votsi	Togo 02267	Le	Dec/Orl	10	0.16	N'Guessan *et al*., 2009)[17]
Annona senegalensis Pers. (Annonaceae)	Dzogbinyibli	Togo 01881	Le	Dec/Orl	21	0.34	(Ajaiyeoba *et al*., 2007)[21]
Azadirachta indica A. Jus (Meliaceae)	Kinitsi	Togo 04649	Le	Inf/Vpb	23	0.37	(Koumaglo *et al*., 1992; Odugbemi *et al*., 2007)[8,22]
			Stb	Mac/Orl			
Bambusa vulgaris Schrad. ex J.C.Wendl (Poaceae)	Pamplotsi	-	Fl	Dec/Orl	03	0.049	-
Bredilia ferruginea Benth (Euphorbiaceae)	Kolou	Togo 03068	Le ; Stb	Dec/Orl	12	0.19	(Tchacondo *et al*., 2012)[23]
Boerhavia diffusa L. (Nyctaginaceae)	Babakou	Togo 05308	Le	Sau/Orl	09	0.15	(N'Guessan *et al*., 2009)[17]
			Stb	Pou/Lap			
Caesalpinia bonduc (L.) Roxb. (Caesalpiniaceae)	Adikou	Togo 00151	Rt	Inf/Orl	11	0.18	(Yetein *et al*., 2013)[24]
Caesalpinia pulcherrima Sw. (Caesalpiniaceae)	Orgueil de Chine	Togo 00152	Le	Dec/Orl	06	0.098	(Yetein *et al*., 2013)[24]
Carica papaya L. (Caricaceae)	Adibatsi	Togo 00341	Le	Dec/Orl	19	0.31	(Odugbemi *et al*., 2007; Lakouetene *et al*, 2009)[22,25]
			Fr	Inf/Orl			
Citrus aurantifolia (Christm.) Swingle (Rutaceae)	Dontsi	Togo 02480	Fr	Jus/Orl	24	0.39	(N'Guessan *et al*., 2009)[17]
Citrus maxima (Burm.) Merril (Rutaceae)	Pamplemousse	-	Fr	Jus/Orl	09	0.15	(N'Guessan *et al*., 2009)[17]
			Rt	Dec/Orl			
Cleome viscosa L. (Capparaceae)	Sombitsou	Togo 00306	Wp	Pet/Orl	11	0.18	(N'Guessan *et al*., 2009)[17]
Cocos nucifera L.(Arecaceae)	Netsi	Togo 02481	Rt	Dec/Orl	19	0.31	(Adebayo *et al*., 2012)[26]
Cola millenii K. Schum (Sterculiaceae)	Kpandotsi	Togo 08606	Le	Dec /Orl	25	0.40	(Yetein *et al*., 2013)[24]
Combretum micranthum G. Don (Combretaceae)	Kinkeliba	Togo 00582	Le	Dec/Orl	17	0.27	(Ancolio *et al*., 2002)[27]
Cymbopogon citratus staff. (Poaceae)	Tsigbe	Togo 10749	Le	Dec/Orl	20	0.32	(Barrows, 2012)[28]
Dracaena arborea (Dracaenaceae)	Anyantsi	Togo 09453	Le	Dec/Orl	14	0.22	(Ajibesin *et al*., 2008)[19]
Elaeis guineensis Jacq (Arecaceae)	Detsi	Togo 02485	Le	Dec/Orl	07	0.11	(Kayode, 2006)[18]
Eucalyptus camaldulensis Dehn. (Myrtaceae)	Kalitus	-	Le	Dec/Orl	08	0.13	(Zofou *et al*., 2011)[29]
Ficus exasperata (Moraceae)	Sampepa/Sassaplala	Togo 05094	Le	Dec/Orl	13	0.21	(N'Guessan *et al*., 2009)[17]
Fluggea virosa (Roxb. Ex Willd.) Voigt (Caesalpiniaceae)	Tsakatsaka	-	Le	Dec/Orl	21	0.38	(Diallo *et al*., 2013)[30]
Gliricidia sepium (Jacq.) Kunth ex Walp (Fabaceae)	Gbondutsi	Togo 06137	Le	Dec.Orl	13	0.21	(Thomas *et al*., 2014)[31]
Gomphrena celosioides C.Mart. (Amaranthaceae)	Amegatahe	Togo 01731	Wp	Dec/Orl	15	0.24	-
Heliotropium indicum L. (Boraginaceae)	Agamashike	Togo 02508	Le	Dec/Orl	08	0.13	(Tardio and Pardo-De-Santayana, 2008)[12]
Hibiscus surattensis L. (Malvaceae)	Kponde	Togo 04423	Wp	Dec/Orl	16	0.26	(Koudouvo *et al*., 2011)
Imperata cylindrica (L.) Raeusch. (Poaceae)	Ebe	Togo 10999	Rt	Dec/Orl	02	0.033	-
Indigofera pulchra Willd. (Fabaceae)	Okamon/Hungbe	Togo 06308	Le	Dec/Orl	09	0.15	(Isah *et al*., 2003)[32]
Jatropha gossypiifollia L. (Euphobiaceae)	Babatsidji	-	Wp	Dec/Orl	09	0.15	(Tchacondo *et al*., 2012)[23]
Khaya senegalensis (Meliaceae)	Mawug'n	Togo 04673	Le ; Stb	Dec/Orl	14	0.26	(Lakouetene *et al*., 2009)
Mangnifera indica L. (Anacardiaceae)	Mangotsi	Togo 01797	Le	Dec ; Mac/Orl	15	0.24	(Lakouetene *et al*., 2009)
			Stb	Inf/Oal			
Morinda lucida Benth (Rubiaceae)	Kaklan	Togo 07503	Wp	Dec/Orl	12	0.19	(Tor-Anyii *et al*., 2003)[33]
Moringa oleifera Lam. (Moringaceae)	Yovovitsi	Togo 05252	Le	Dec; Mac/Orl	17	0.27	(Shuaibu *et al*., 2008)[34]
Nephrolepis undulata (Afzel. Ex Sw.) J. Sm. (Nephrolepidaceae)	Fougère de palmier	Togo 12492	Le	Dec/Orl	01	0.016	-
Newbouldia laevis (P. Beauv.) Seeman ex. Bureau (Bignoniaceae)	Kpatsima, Avahi	Togo 02453	Le	Pet/Orl	32	0.52	(Adodo, 2004)[35]

Contd...

Table 2: Contd..

Botanical name (family)	Local name	Voucher specimen nº	Used part	Mode of preparation/ Administration	Citation		Reference to similar ethnopharmacology use
					Fc	RFC	
Ocimum canum Sims (Lamiaceae)	Ahamè	Togo 04196	Le	Dec/Orl	10	0.16	(Asase *et al*., 2005)[36]
				Kne/Bat			
Ocimum gratissimum L. (Lamiaceae)	Djovetsi / Dogotsui	Togo 04225	Le	Dec;Kne/Orl	14	0.23	(Ancolio *et al*., 2002)[27]
Paullinia pinnata L. (Sapindaceae)	Tegbekpasso / Ashiaton	Togo 08171	Le	Dec/Orl	13	0.21	(Asase *et al*., 2005)[36]
			Rt	Mac/Orl			
Pavetta corymbosa (DC) F.N. Williams (Rubiaceae)	Tsifafan	Togo 07655	Le	Dec/Orl	13	0.21	(Koudouvo *et al*., 2011)[53]
Phyllanthus amarus Schum et Thonn (Euphorbiaceae)	Kpavidetume	Togo 03349	Wp	Dec/Orl	12	0.19	(Tchacondo *et al*., 2011)
Physalis angulata L. (Solanaceae)		Togo 08510	Le	Dec/Orl	06	0.097	(Ankrah *et al*., 2003)[37]
Piliostigma thonningii (Schum.) Milne-Redh. (Caesalpiniaceae)	Klo / Agoemakpa	Togo 0024	Le	Dec/Orl	21	0.34	(Ganfon *et al*., 2008)
Pistia stratiotes (Araceae)	Flavi	Togo 09566	Wp	Dec/Orl	03	0.049	(Koudouvo *et al*., 2011)
Psidium guajava L. (Myrtaceae)	Gouatsi	-	Le	Dec/Orl	20	0.32	(Ajaijeoba *et al*., 2007)
			Stb	Inf/Orl			
Saccharum officinarum (Poaceae)	Fofun	Togo 11350	St	Dec/Orl	03	0.049	(Asase *et al*., 2005)[36]
Sansevieria liberica Hort. ex Gérôme et Labroy (Dracaenaceae)	Yobu	Togo 09465	Rh	Dec/Orl	07	0.11	(Koudouvo *et al*. 2011)
Sarcocephalus latifolius (Sm.) E.A. Bruce (Rubiaceae)	Nyimon	Togo 07535	Rt	Dec ; Mac/Orl	30	0.48	(Asase *et al*., 2005)[36]
Senna siamea (Lam.) H.S. Irwin and Barneby (Caesalpiniaceae)	Zangaratsi	Togo 00121	Le	Dec/Orl	25	0.40	(Sanon *et al*., 2003)[38]
Sida acuta L. Burm. F. (Caesalpiniaceae)	Afidemè	Togo 04446	Le	Dec/Orl	12	0.23	(Karou *et al*., 2003)
Spondias mombin L. (Anacardiaceae)	Aklikotsi	Togo 01853	Le	Dec/Orl	22	0.36	(Diallo *et al*., 2013)
Tamarindus indica L. (Caesalpiniaceae)		Togo 00235	Le	Dec/Orl	09	0.15	(Ganfon *et al*., 2008)
			Fr	Jui/Orl			
Tridax procumbens L. (Asteraceae)	Abossangbe	Togo 01153	Le	Dec/Orl	10	0.16	(Tchacondo *et al*., 2012)
Uvaria chamae P.Beauv. (Annonaceae)	Agbanletsi	Togo 01955	Le ; Rt	Dec/Orl	24	0.39	(Okokon *et al*., 2006)[40]
Vernonia amygdalina Delile (Asteraceae)	Aluma/Gbondutsi	Togo 01204	Le	Dec/Orl	09	0.14	(Omoregie *et al*. 2011)

focused on *in vitro* antiplasmodial activity of these species. For example, the aqueous extract of root of *S. latifolius* tested *in vitro* against the strains of *P. falciparum* FCB1 was active with IC50 = 0.6 µg/ml.

Leaves were the most used part of the plant (60%). The same result was found by Lakouetene in 2008 with 60%;[25] 68% by Yetein *et al*. in 2013.[24] Therefore, it was noted an intense collection of leaves, levy that did not have at all an important danger to the plant, according to Poffenberger *et al*.[56] According to these authors, the levy of 50% of the leaves of a plant does not significantly affect its survival, while uprooting and debarking participate in the destruction of the plant. In addition, to the preference of leaves is that they are the main photosynthetic organs and, therefore, tanks and photosynthesizes exudates containing secondary bioactive compounds that protect against external aggressions. These compounds have medicinal values for human body.[24,57]

Samples were collected in forests, fields, and home gardens that grow rare species.

Most recipes used were prepared by decoction (77%) followed distantly by infusion and maceration. In general, plant material amount and the volume of water used and preparation duration were not precisely defined. The oral route of administration was the most used in the Plateau region for taking antimalarial traditional recipes (97%). Koudouvo *et al*. also had obtained in the Maritime region in Togo this mode as the principal (82.05%).[11]

The drugs were taken with gourds, glass (beer or liquor), spoon, or cup. In general, the amount administered to the patient is not very accurately measured, and the dosage is very difficult to estimate. In all cases, there was a wide variation depending on the experience of each traditional therapist. These inaccuracies make difficult the standardization of the use of these plants. The direct consequence is the development of resistance of *Plasmodium* toward drug use.

Traditional medicine of the Plateau region sometimes had used combinations of plants to increase the efficiency of the recipe in the treatment of malaria and its symptoms such as fever, headache, vomiting, and anemia. These plants associations, mismatched, are sometimes dangerous. In Africa, for example, about 30% of the fatal accidents were caused because of mixtures that were complex remedies.[58] These products create in the long-term complications such as kidney and liver failure.

Only 7/62 respondents had used parasitological diagnostic of malaria (thick blood film, blood smear, and rapid diagnostic test) before treatment. The rest had used signs such as fever, headache, vomiting, conjunctival pallor, diarrhea, chills, and generalized tiredness. This raised the problem of definitive diagnosis before treatment because other diseases had almost same clinical signs as malaria.

Informants ranged from 29 to 75 years old. Younger informants were less represented than old ones. From 62 traditional herbalists, 1.61% was aged <30 years while 29.03% were from 30 to 40 years, and 69.36% were more than 50 years old. This is in agreement with previous results described by Traore.[30] Consequently, there is an urgent need for documentation of this invaluable knowledge since there is a persistent gap in knowledge of herbal practice between the younger and older generations. The educational level of the interviewees was low: 32.26% had some primary schooling, and 24.19% had some secondary schooling. Only 4.84%

Table 3: Bibliographic record of ethnopharmacological work done on some of the most cited species during the ethnobotanical survey

Plant species	Used part	Extract	In vitro activity (IC50 µg/ml)	Authors
Acanthosermum hispidum D.C	Leaves	Lactone	2.33 ($3D_2$)	(Tardio and Pardo-De-Santayana, 2008)
		Dichroromethane	4.8 (W_2)	
		Methanol	9.02 (3D7)	(Bero *et al*., 2009)[42]
			2.82 (Dd2)	
Annona muricata	Leaves	Aqueous extract	20 (F32)	(Bilda *et al*., 2004)[43]
Azadirachta indica A. Jus	Leaves	Aqueous extract	2.50 (D6)	(Isah *et al*., 2003)[32]
Carica papaya L.	Leaves	Aqueous extract	15.19-18.09 (strain FCK2)	(Bhat *et al*., 2001)[44]
Citrus aurantifilia	Leaves	Methanol	40.0±2.1	(Messia *et al*., 2008)[45]
Combretum micranthum	Leaves	Aqueous extract	0.8 (W2)	(Ancolio *et al*., 2002)
Cymbopogon citratus (DC.) Stapf	Leaves	Methanol	42.2	(Messia *et al*., 2008)
		chloroform/ethanol (1:1)	20 (F32)	(Bilda *et al*., 2004)[43]
Mangifera indica	Leaves	Chloroform/methanol (1:1)	20 (F32)	(Bilda *et al*., 2004)[43]
			>50 (FcB1)	(Zirihi *et al*., 2005)[46]
Sarcocephalus latifolius	Root	Aqueous extract	0.6 (FCB1)	(Menan *et al*. 2006)[47]
		Ethanol	(8.9)Columbian CQR*Pf* strain	(Zirihi *et al*., 2005)[46]
		Aqueous extract	0.6 (Resistant *Pf* CQRPf FcB1)	(Benoit-Vical *et al*., 1998)[48]
Ocimum gratissimum L.	Leaves	Aqueous extract	29.5 (F32)	(Ngemenya *et al*., 2005)[49]
Psidium guajava	Stem bark	Aqueous extract	10-20 (D10 stain)	(Nundkumar *et al*., 2002)[50]
Securinega virosa	Leaves	Aqueous extract	7.81	(Willcox *et al*., 2011)[51]
	Root	Aqueous extract (decoction)	8.69	
		Aqueous extract (maceration)	9.68	
Sida acuta	Leaves	Ethanol extract	3.9-5.4 (FcM29-Cameroon)	(Banzouzi *et al*., 2004)[52]
		Aqueous extract	0.92 (F_C M_{29})	(Karou *et al*., 2003)
Spondias mombin L.	Leaves	Aqueous extract (decoction)	7.89	(Willcox *et al*., 2011)[51]
		Aqueux (maceration)	7.66	
Tamarinus indica	Fruit	Aqueous extract	4.786 (fresh isolates of Pf)	(Koudouvo *et al*., 2011)[53]
	Leaves	Methanol	55.544 (fresh isolates of Pf)	
Veronia amygdalina Delile	Leaves	Ethanol	11.2 (fresh isolates of Pf)	(Sha'a *et al*.,2011)[54]
		Aqueous extract	13.6 (Fresh isolates of Pf)	(Omoregie *et al*., 2011)[41]
		Ethanol extract	9.82 (3D7)	
		Aqueous extract	41.69 (3D7)	
		Hydroalcohol	44.03 (3D7)	

had attended a higher education institution. Many traditional medical practitioners (38.71%) were illiterate and consequently could not document their practice. Inheritance (88.70%) was the major source of knowledge acquisition. It is advocated that knowledge of treatment of the disease acquired by inheritance and training must be documented for future generation.[30]

CONCLUSION

Investigations results had identified 61 species commonly used in Togolese traditional medicine to treat malaria. Given the high prevalence of malaria and the widespread use of traditional medicine, it is capital to rationalize the use of these medicinal plants. These medicinal plants may probably contain yet undiscovered antimalarial properties, which can serve as a template for the production of cheap antimalaria drug from indigenous plants in Togo. There is a need for a multidisciplinary approach to develop potentially effective drugs while noting dangerous drugs and practices that should be discarded.

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Conflicts of interest

There are no conflicts of interest.

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