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Ethnobotanical survey of medicinal plants used in malaria management in South Benin

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In Bénin, malaria is a major public health concern, especially for children under five years and pregnant women. Considering the inefficiency of the health centers in some regions, people use plants for their primary health care. This study aimed to identify and document the medicinal plants used in the treatment of malaria in four departments (Littoral, Ouémé, Plateau and Zou) of south Bénin. Data were recorded using interview and field observation. 42 informants including 15 traditional healers and 27 medicinal plants sellers with an average of fourteen years of experience were interviewed. Plants were identified by a botanist from the National Herbarium of Bénin. The study revealed that a total of 34 plants species belonging to 33 genera and 24 families were collected. The most frequently cited plant species was *Chamaecrista rotundifolia*, *Senna siamea* and *Dialium guineense*. Caesalpinioideae and Rubiaceae are the most families mentioned by the informants. The most common preparation method is decoction and the route of administration is oral. The results contributed to the conservation of empirical knowledge of medicinal plants used for the treatment of malaria and could help to identify new research topics in connection with the implementation of Traditional Medicines.

Key words: Medicinal plants, malaria, traditional knowledge, Bénin.

INTRODUCTION

Plants have been used for centuries to treat diseases in native communities. The use of medicinal plants as a source of remedy of illness can be traced back over five millennia (Kabita et al., 2015). Many plants, especially those used by traditional healers have numerous pharmacological activities. About, 85% of world population uses traditional medicine for primary health care and the demand is increasing in developed and developing countries (Balcha et al., 2014). Drugs from medicinal plants have been used worldwide in traditional medicine for the treatment of various diseases. Thus, medicinal plants are the main source of drugs in traditional medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs (Tiwari et al., 2011).

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Figure 1. Traditional remedies and medicinal plants in a market in southern Benin.

All over the world, people have old tradition in the use of herbs for the treatment of several diseases, including malaria. It is an important parasitic disease which has the potential to affect nearly 37% of the world's population and is responsible for 438000 deaths at 2015 (WHO, 2015). It is the most crucial problem of public health in African sub-Saharan countries where 74% of the population lives in area of strong endemic and 18% in epidemic area (Weniger et al., 2008). According to World Health Organization, a total of 95 countries are endemic of malaria in the world and 45 African countries are concerned by this endemic (WHO, 2014, 2015). In Africa, as in other malaria-endemic regions, inaccessibility of health centers, the inequitable distribution of medical staff and socio-cultural attitudes lead people to use traditional medicines for their primary health care (Ngbolua et al., 2013). New antimalarial drugs are also expensive for the majority of population in most countries where malaria is endemic. The cost of malaria in a region of Burkina Faso is high given the economic income of villagers and the fact that in every family there are several episodes of malaria per year. Thus, malaria is a major public health problem in his mortality, but also in its economic weight at the level of the community and the budgets allocated for health services (Guiguemdé et al., 1997).

In Benin and neighboring countries, many plants with antiparasitic properties are widely used in the traditional medicine system. Many antimalarial investigations have also been done on plants used traditionally to treat infectious diseases with satisfactory results. This was demonstrated by results achieved with numerous studies on species from Benin Pharmacopoeia (Bero et al., 2013; Attioua et al., 2012; Djikpo-Tchibozo et al., 2011). Unfortunately, empirical and traditional knowledge are not registered and disappear over time. It is important to focus research on the identification of traditional plant. This study allows identification and documentation of traditional uses of medicinal plants used in the management of malaria in South Bénin.

METHODOLOGY

Study area

Our study was conducted exclusively in the markets of plants (Figure 1) including plants sellers and traditional healers in four departments: Littoral, Ouémé, Plateau, and Zou (Figure 2), selected for their demographic weight, diversified geographical space, and sanitary status.

These regions are relatively humid agroecological zone with two rainy seasons and means annual rainfall varying from 1100 to 1400 mm for Littoral, Ouémé, Plateau (Yabi and Afouda, 2012) and 900 and 1200 mm for Department of Zou. Mean annual temperatures range from 26 to 28°C and vegetation types are semi-deciduous forests or woodland and savannah woodland (Akoègninou et al., 2006). To adequately cover the study area, the surveys were conducted taking into account the movement of the population and sales areas of medicinal plants. The selected markets for survey are listed in Table 1. In these departments, some segments of the population live in slums which are always full of water even during the dry season. This promotes the development of mosquito larvae and thus the development and persistence of parasite vector mosquitoes of the genus *Plasmodium* that causes malaria. Considering this and the failed management of malaria due to inadequate public health services, the use of medicinal plants has become the leading source of drug for the treatment of the disease.

Selection of informants

Before starting data collection, the objectives of the survey are explained to the managers of the selected markets and informants

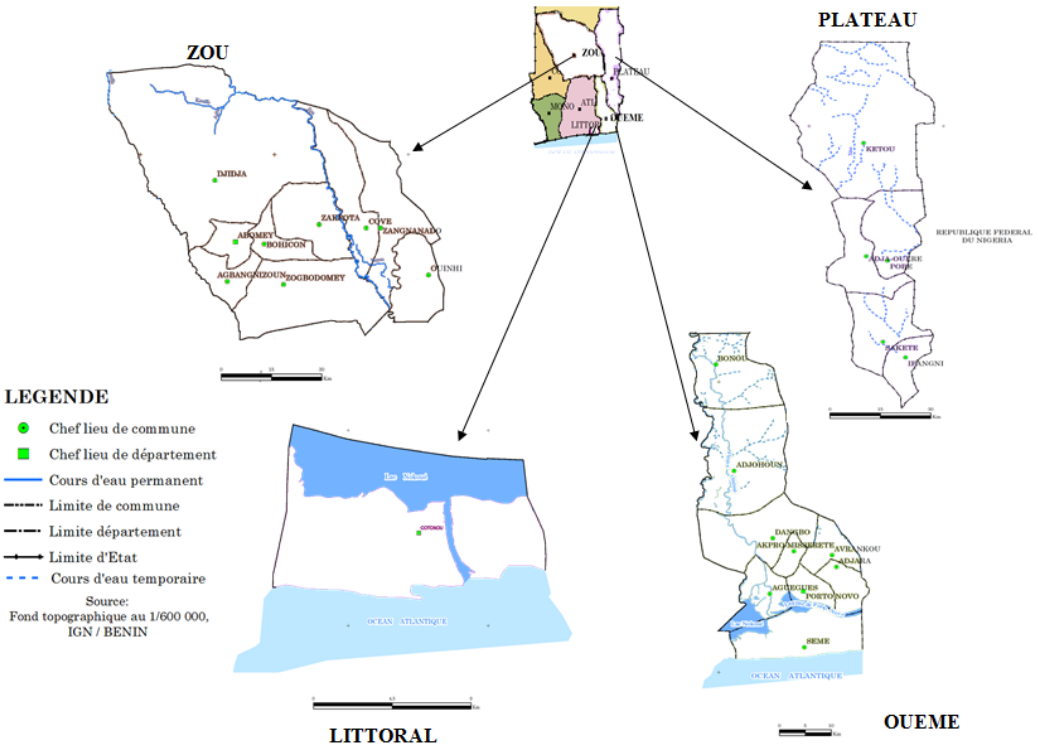

Figure 2. Maps of departments where survey was conducted.

Table 1. Selected markets name and number of plants sellers in study area.

Departments	City	Markets	Number of vendors and traditional healers
Littoral	Cotonou	Kindonou	04
		Mènontin	05
		Vèdoko	03
Ouémé	Porto-Novo	Ouando	04
	Apkro-missérété	Missérété	04
Plateau	Ifangni	Ifangni	03
	Sakété	Takon	02
	Pobè	Ikpinlè	02
		Itadjèbou	03
Zou	Bohicon	Bohicon	07
	Abomey	Houndjro	05

in order to have their consent and facilitate the exchange of information. Indeed, plants and recipes used to treat malaria were recorded and listed as part of the work of the Team of Biochemistry and Bioactive Natural Substances of University of Abomey-Calavi. The final document will be returned to each respondent in order to preserve the data collected and to avoid loss of information through the time. Informants were selected with the support of market managers and resource persons. Forty two (42) informants (29 women and 13 men) with the age over 40 were included.

Data collection

Data were collected from November 2014 to March 2015 in

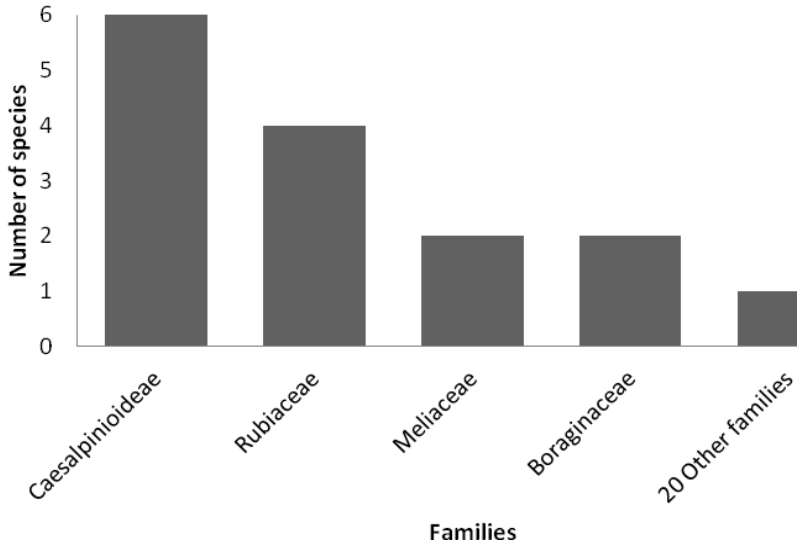

Figure 3. Distribution of reported plants among family.

selected markets. The survey was conducted according to ethnopharmacological approach such as interviews and field visits (Mahomoodally and Muthoorah, 2014). According to informants, questions were asked in local language (Fon, Goun, Yoruba, Nagot or Adja) and data provided are related to the knowledge of malaria (depends on the language), causes and symptoms to diagnose malaria, medicinal plants used in the treatment of malaria, the local name of plants, the parts used, modes of preparation and administration, the availability of plants, the habitats where the species are harvested and the source of the traditional knowledge on medicinal plants.

Plant identification

Collected plants were authenticated by botanist from National Herbarium of University of Abomey-Calavi where voucher numbers were obtained. Many important medicinal plants species are becoming rare and some of them are critically endangered (Qayum et al., 2016). According to the International Union for Conservation of Nature and Natural resource (IUCN), the status of the collected plants has been verified.

Data analysis

Qualitative data were analyzed using the descriptive statistics (percentage) and the results presented in tables and figures. The importance of each plant was calculated based on the relative frequency of citation (RFC) (Tardio and Pardo-De-Santanyana, 2008). The RFC was calculated using formula in which, Fc is number of informants who mentioned the use of the species and N the total number of informants.

RFC = Fc / N

RESULTS

Socio-demographic data of informants

A total of forty-two vendors of plants and healers over 40 years old were interviewed. They include 31 plants sellers comprised 29 women (93.54%), 2 men (6.4%) and 11 healers who are men. The educational level of the informants is variable. Most of them have a low level of formal education. Only nine out of twenty-seven vendors were in primary school while two women and seven men were in secondary school.

Medicinal plants used in malaria management in study area

A total of 34 species used traditionally to manage malaria were recorded in selected markets. These medicinal plants distributed in 33 genera and 24 families were reported to treat malaria by informants in the study area (Table 2). Among reported plants, trees were the most cited (41.18%), followed by shrubs (38.23%) and herbs (20.59%). Among collected species, Caesalpinioideae are the most represented family with six species (17.65%), followed by Rubiaceae with four species (11.76%), Meliaceae and Boraginaceae with two species, respectiveley (5.88%). Other families were represented by one species (Figure 3).

Relative frequency of citation (RFC)

The most frequently cited plant species was *Chamaecrista rotundifolia* with a RFC of 0.88, followed by *Senna siamea*, *Dialium guineense* with RFC of 0.79, and *Dichapetalum madagascariense* with RFC of 0.62. *Dissotis rotundifolia* and *Erhetia cymosa* are also listed among the most used with RFC value of 0.55. Many important medicinal plants species are becoming rare

Table 2. Medicinal plants used to treat malaria in the study area and their IUCN status.

Family	Scientific name	Morphology	Vernacular name	Part use	Method of preparation and administration	Voucher number	RFC	IUCN status
Annonaceae	*Uvaria chamae* P. Beauv.	Shrub	Aylaha, Gbanan (g, f)	Leaves, roots	Decoction, oral	YH241/HNB	0.02	Not yet been assessed
Asteraceae	*Acanthospermum hispidum* DC.	Shrub	Ahouanglon (g, f)	Leaves	Decoction, oral	YH252/HNB	0.26	Not yet been assessed
Bignoniaceae	*Newbouldia laevis* (P. Beauv.) Seem. Ex Bureau	Tree	Désréguéman (g, f)	Leaves	Decoction/maceration, oral	YH254/HNB	0.06	Not yet been assessed
Boraginaceae	*Ehretia cymosa* Thonn. ex Schum.	Tree	Zozoman (g, f)	Leaves	Decoction, oral	YH255/HNB	0.55	Not yet been assessed
	Heliotropium indicum L.	Herb	Kokloviden gbadja (g, f)	Leaves	Decoction, oral	YH256/HNB	0.06	Not yet been assessed
Bromeliaceae	*Ananas comosus* (L.) Merr.	Herb	Ananas (g, f)	Fruit	Decoction, oral	YH258/HNB	0.08	Not yet been assessed
Capparaceae	*Crateva religiosa* DC. Syn.: *C. adansonii* Forst. f.	Tree	Wontonzonzwen (g, f)	Leaves	Decoction, oral	YH260/HNB	0.16	Not yet been assessed
Caricaceae	*Carica papaya* L.	Tree	Kpinman (g, f)	Leaves	Decoction, oral	YH261/HNB	0.08	Not yet been assessed
Caesalpinioideae	*Chamaecrista rotundifolia* (Pers.) Greene	Herb	Aziiman (g, f)	Aerial part	Decoction, oral	YH282/HNB	0.88	Not yet been assessed
	Senna siamea (Lam.) H. S. Irwin & Barneby	Tree	Kassiaman (g, f)	Leaves	Decoction, oral	YH289/HNB	0.79	Not yet been assessed
	Caesalpinia bonduc (L.) Roxb.	Tree	Adjikouindô (g, f)	Root	Infusion, oral	YH280/HNB	0.02	Not yet been assessed
	Caesalpinia pulcherrima (L.) Sw.	Shrub	Hèviviman (g, f)	Leaves, fruit	Decoction, oral	YH281/HNB	0.06	Not yet been assessed
	Dialium guineense Willd.	Tree	Asswènsswèn (g, f); Atitwépa (w); Ewéany (y)	Leaves, bark	Decoction, oral	YH284/HNB	0.79	Not yet been assessed
	Abrus precatorius L.	Shrub	Viviman (g); Amama (y)	Leaves	Maceration, oral	YH302/HNB	0.10	Not yet been assessed
Dichapetalaceae	*Dichapetalum madagascariense* Poir.	Tree	Gbonymisso, Gbaglo (g, f)	Leaves	Decoction, oral	YH267/HNB	0.62	Not yet been assessed
Dracaenaceae	*Sansevieria libertica* Hort. Ex Gerome & Labroy	Herb	Kpoyan (g, f)	Leaves	Decoction, oral	YH233/HNB	0.04	Not yet been assessed
Euphorbiaceae	*Phyllanthus amarus* Schumach. & Thonn.	Tree	Hlènwé (g, f) ; Aribisohou (y)	Leaves	Decoction, oral	YH273/HNB	0.08	Not yet been assessed
Flacourtiaceae	*Flacourtia indica* (Burm.f.) Merr.	Herb	bohoucadjè, Assanhoun (g, f)	Leaves	Decoction, oral	YH274/HNB	0.02	Not yet been assessed
Lamiaceae	*Ocimum americanum* L. Syn.: *O. canum* Sims	Shrub	Hissi-hissi (g, f); Hessi-hessi (a)	Aerial part	Decoction, oral	YH277/HNB	0.08	Not yet been assessed
Malvaceae	*Hibiscus surattensis* L.	Shrub	Kpofin, Kpodèman (g, f)	Leaves	Decoction, oral	YH311/HNB	0.04	Not yet been assessed
Melastomataceae	*Dissotis rotundifolia* (Sm.) Triana	Shrub	Hèhèman (g, f); Ewé eti ékouté (y)	Leaves	Decoction, oral	YH313/HNB	0.55	Not yet been assessed
Meliaceae	*Azadirachta indica* A. Juss.	Tree	Quinininiman (g, f)	Leaves	Decoction, oral	YH314/HNB	0.24	Not yet been assessed
	Khaya senegalensis (Desr.) A. Juss.	Tree	Caïlcédra (g, f)	Leaves	Decoction, oral	YH315/HNB	0.24	Vulnerable A1cd ver 2.3
Moringaceae	*Moringa oleifera Lam.*	Shrub	Kpatiman (g, f)	Leaves	Maceration/decoction, oral	YH318/HNB	0.17	Not yet been assessed
Passifloraceae	*Passiflora foetida* L.	Shrub	Avounyinmitrui (g, f)	Leaves	Decoction, oral	YH322/HNB	0.02	Not yet been assessed
Poaceae	*Cymbopognon citratus* (DC.) Stapf	Herb	Timan/Tchaman (g, f)	Aerial part	Decoction, oral	YH326/HNB	0.04	Not yet been assessed
Rubiaceae	*Gardenia erubescens* Stapf & Hutch.	Tree	Adakplaman (g, f)	Leaves	Decoction, oral	YH331/HNB	0.14	Not yet been assessed
	Morinda lucida Benth.	Tree	Houensi (g, f)	Leaves	Decoction, oral	YH333/HNB	0.17	Not yet been assessed
	Pavetta corymbosa (DC.) F. N. Williams	Shrub	Lohou (g, f)	Leaves	Decoction, oral	YH334/HNB	0.08	Not yet been assessed
	Sarcocephalus latifolius (Sm.) E. A. Bruce	Shrub	Codô (g, f)	Roots	Decoction/infusion, oral	YH335/HNB	0.36	Not yet been assessed
Rutaceae	*Citrus aurantifolia* (Christm. & Panzer) Swingle	Tree	Clessiman (g, f)	Leaves	Decoction, oral	YH337/HNB	0.14	Not yet been assessed

Table 2. Cont'd

Sterculiaceae	*Cola millenii* K. Schum.	Shrub	Alovi aton (g, f)	Leaves	Decoction, oral	YH344/HNB	0.24	Not yet been assessed
Verbenaceae	*Lantana camara* L.	Herb	Hlachiayo (g, f)	Leaves	Decoction, oral	YH350/HNB	0.12	Not yet been assessed
Vitaceae	*Ampelocissus bombycina* (Baker) Planch.	Shrub	Têkplê (g, f)	Leaves	Decoction, oral	YH352/HNB	0.10	Not yet been assessed

f: fon, g: goun, y: yoruba, w: watchi, a: adja

and some of them are critically endangered according to the red list of International Union for Conservation of Nature and Natural resource.

Part used and mode of administration

The survey showed that leaves are the frequently used organs (73.50%), followed by roots and fruits (8.82%), aerial part (5.88%) and bark (2.94%) (Figure 4a). According to collected data, decoction (91.20%) is the most common method of preparation followed by maceration (5.90%) and infusion (2.90%) (Figure 4b). They are mostly administered orally with a dosage ranged between 1 and 3 doses per day. Preparation methods and doses are variable and often random. The only measurable dose is the use of small glass called "T*alokpémi*" corresponding to 40 ml. Regarding the availability of species, vendors have regular suppliers. Sometimes, the plants are domesticated by traditional healers. The healers also purchase plants in the markets.

Causes and symptoms of malaria according to informants

During the survey, all informants mentioned that malaria was caused by mosquito bite called "*Zanssoukpè* or *Gnam-gnamou*" which means "Night Fly" in local language *Fon*, *Goun* and *yoruba* (Table 3). This knowledge of malaria could be explained by the extensive education campaign conducted by the Ministry of Health and the Association of traditional healers. Thirty informants out of forty two reported that working in sun can also cause malaria. This was consistent with the common local name of malaria "*hwessivozon*" which means "sun disease". Consumption of avocado, peanuts or peanut oil were also mentioned (Table 3). The most important symptoms cited by informants were fever/pain (88.10%) and headaches (78.57%) (Table 3). Vomiting (52.38%) and appetite loss (47.62%) were also reported as malaria symptoms.

DISCUSSION

Malaria is the most devastating parasitic disease affecting all developing countries, causing severe emotional and economic disorders and thus delays the progress of nations. The fight against malaria is still difficult because there is no credible vaccine for malaria treatment or drug for which the resistance effect is not reported. To rectify this situation, many recipes of medicinal plants are generally used in the treatment of malaria. The species collected in this study are also involved in the treatment of several diseases in Benin and neighboring countries.

The majority of the species mentioned by the informants belongs to the family of Caesalpinioideae and Rubiaceae. In a survey conducted on plants traditionally used to treat malaria in the maritime region of Togo, it has been shown that Rubiaceae is the most cited family (Koudouvo et al., 2011). In the great diversity of plant species used in the management of malaria, Rubiaceae and Caesalpinioideae are generally the most represented (Adjanohoun et al., 1989; Asase et al., 2010; Kamagaté et al., 2014). This is consistent with our results. Among the recorded species, *C. rotundifolia* (RFC 0.88), *S. siamea* (RFC 0.79) and *D. guineense* (RFC 0.79) were frequently quoted by the informants and highlighted their importance in malaria management. The most cited species *C. rotundifolia* is found in Littoral, Ouémé, Zou Department in Benin (Akoègninou et al., 2006) and in the savannas of Ghana and Nigeria where the aqueous decoction of the whole plant is indicated for the treatment of jaundice and malaria (Adjanohoun et al., 1989). In Benin, decoction of *S. siamea* root, bark and leaves is indicated orally for the treatment of malaria (Adjanohoun et al., 1989). *S. siamea* is also used traditionally in the south-west Nigerian as an antimalarial remedy (Batista et al., 2009). The similarity of results could be justified by proximity between study area in Bénin and Nigeria. The leaves of *D. guin*eense were used alone or in combination with other plants by traditional healers and local populations as antimalarial in Bénin (Adjanohoun et al., 1989). The common vernacular names in the study area were *Assonswen* (Fon and Goun, southern region), *Anwin* (Yoruba, middle and southern region). *D. guin*eense can be found in West African countries

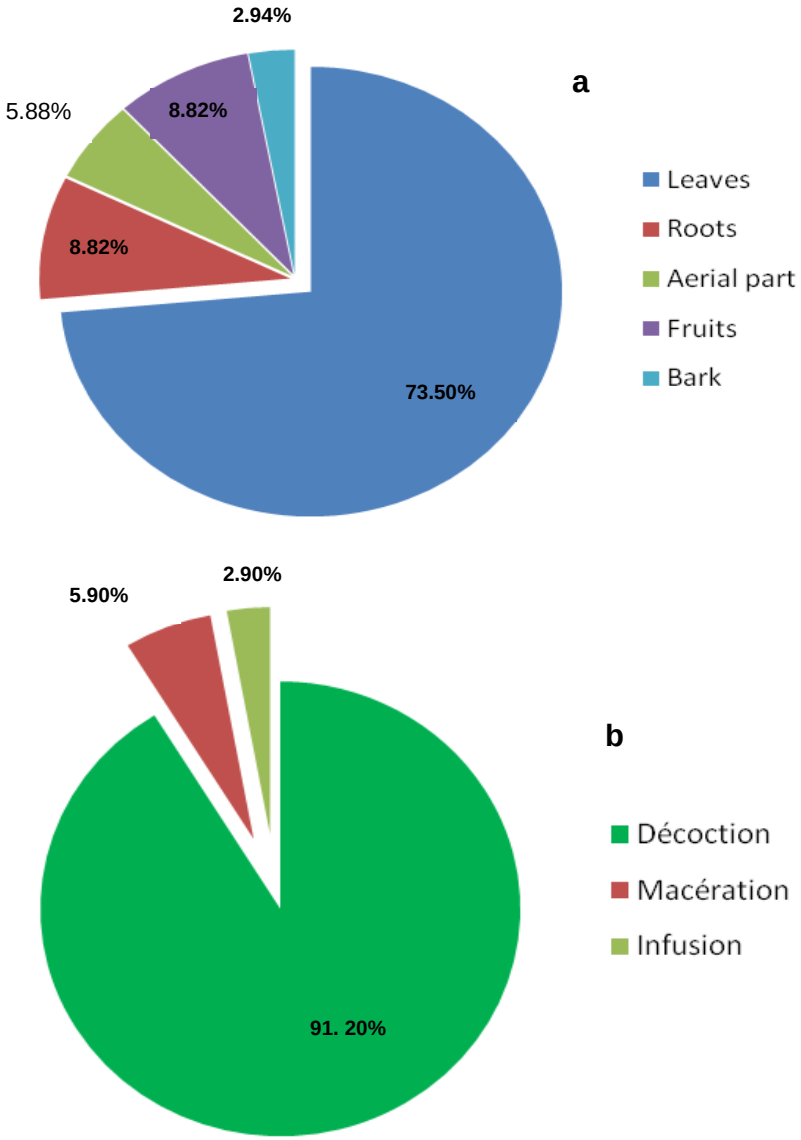

Figure 4. (a) Plants parts used in the management of malaria in the study area; (b) Preparation methods of collected plants in study area.

such as Ghana where it is known as Yoyi, Sierra Leone, Senegal, and Nigeria (Adumanya et al., 2013; Akinpelu et al., 2011; Nwosu, 2004). The stem bark and leaves of the same species are used traditionally to treat malaria fever in Nigeria (Balogun et al., 2013).

Among the recorded species in this study, 8 species were frequently quoted by the informants and highlighted their importance in malaria management. Other traditional uses and *in vitro* antiplasmodial activity of four species with highest citation frequency were also reported by previous studies (Adjobimey et al., 2004; Bero et al., 2009; Erhenhi and Obadoni, 2015; Fah et al., 2013; Kazhila, 2015).

The obtained data indicated that the traditional healers used various parts of the medicinal plants for preparation of antimalarial remedies. However, leaves were the major parts used. Similar reports had been already recorded in several studies (Koudouvo et al., 2011; Asase et al., 2010; Nguta et al., 2010; Balcha, 2014). Contrary to the devastating effect that the use of roots and bark can cause to plant biodiversity, the high frequency of use of leaves in recipes is a great advantage for the preservation of plant biodiversity. Then, the use of leaves is less dangerous than to the use of underground parts (roots, stem, bark), or the use of whole plants (Giday et al., 2003; Zheng and Xing, 2009). However, harvesting the leaves for therapeutic purposes is not without effect on the regeneration of biodiversity because it could limit the vegetative reproduction that leads to the development of flowers, fruits and natural regeneration of wild plants

Table 3. Causes and symptoms of malaria cited by informants.

Causes	Number of informants	Symptoms	Number of informants
Mosquito bite	42	Fever and pain	37
Working in the sun	30	Headache	33
Working or Walking in the rain	9	Vomiting/mouth sores	22
Consumption of oil	11	Nausea	08
Working in the rain	9	Body weakness	04
Avocado consumption	13	Vomiting, pale face	09
Peanut and oil consumption	4	Appetite loss	20
peanut consumption	5	Dizziness, Sweating	10

(Cunningham, 2001).

In this study, it was found that the main method of transmission of traditional knowledge of medicinal plants was parental inheritance. It was also noted that knowledge is transmitted orally. Analogous to this study, traditional knowledge on medicinal plants in most communities is often passed from one generation to another usually via word-of-mouth (Yetein et al., 2013). From this study, we notice that the use of medicinal plants differs from a department to another according to the source of information. This situation testifies the complexity of the medicine domain and the traditional pharmacopeia. People are greatly concerned about the efficacy and side effects of many synthetic drugs. Hence, they choose herbal medicines as a safe and natural alternative treatment for many health problems. The use of medicinal plants is growing, because herbs are always the source of alternative medicine for primary health care.

Conclusion

Our investigation allowed the registration of plants and recipes traditionally used in the treatment of malaria in four departments of southern Benin. These results show the importance of the use of plants in the treatment of human diseases. The information listed was recorded in a document in order to preserve the data collected and to avoid loss of information through the time. The results obtained for our study could also help to identify new research topics in connection with the implementation of traditional medicines.

Conflict of interests

The authors have not declared any conflict of interest.

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