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Ethnobotanical study of medicinal plants of the Ipassa-Makokou Biosphere Reserve, Gabon: Plants used for treating malaria

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Malaria remains a major cause of illness and death as well as a contributing factor to poverty in tropical and subtropical regions. Ethnobotanical surveys conducted in the periphery of the Ipassa - Biosphere Reserve (Gabon) allowed to identify 61 plant species used by the Baka pygmies, Fang, Kota and Kwélé ethnic groups for the treatment of malaria. These plants are distributed in 55 genera and 34 botanical families. Leaves are among the plant parts that are largely cited (62% of citations), followed by stem barks (17%) and fruits (13%) while decoction (58%) and maceration (35%) are the most cited pharmaceutical forms. These forms are often administered through the vaporation bath (41%), rectal (25%) and oral (23%) voices. Most of the recipes (73%) cited for treating malaria are made of combination of many plant species. Seven plant species that were largely cited by people living in the periphery of the Ipassa Biosphere Reserve are also known in other African countries for the same usages and are confirmed in the literature for their usage against malaria including Alstonia boonei, Carica papaya, Citrus limon, Cymbopogon citratus, Enantia chlorantha, Picralima nitida, Vernonia amygdalina. The fact that some plant species cited are well recognised for their activity against Plasmodium, is a credibility index which can be attributed to the pharmacopoeia of those people on one hand and illustrates the efficiency of the method used to identify medicinal plants of the Makokou Biosphere Reserve on the other hand. Future studies should be directed towards implementing strategies and programmes to identify active chemical substances of other plant species which have not yet been investigated for their chemical and antimalarial activities in the region.

Key words: Ethnobotanical surveys, medicinal plants, malaria, recipe, combination of plants, Ipassa-Makokou Biosphere Reserve.

INTRODUCTION

Malaria is a global disease that is predominant in the tropics and caused by blood parasites, *Plasmodium falciparum, Plasmodium ovale, Plasmodium malariae, and Plasmodium vivax*. The parasite is transmitted to its human hosts via various mosquito species of the genus *Anopheles*. The disease can cause high fever, enough to be fatal to human being. Malaria has a great morbidity than any other infectious diseases of the world (World

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Malarial Report, 2005; World Health Organization, 2000). Half of the world's population is at risk of malaria, with an estimated 247 million cases that caused 881,000 malaria deaths in 2006 (World Malaria Report, 2008). In tropical and subtropical regions such as sub-Saharan Africa, malaria remains a major cause of illness and death as well as a contributing factor to poverty. Each year, about 400 million people contract malaria, with 90% in Africa, and each year, the disease kills one million of them, mostly (85%) children under five years of age. Pregnant women are also among the highly vulnerable people (Saotoing et al., 2011; Tropical diseases Web Ring, 2000). Most of the current antimalarial drugs have been developed through synthesis or screening voices. These approaches have been revealed as non efficient and expensive. Due to the lack of vaccination, the chimiotherapy and chymioprophylaxy remain the best method in the struggle against malaria (Oketch-Rabah and Mwangi, 1998). *P. Falciparum*, the pathogenic most widespread human malaria, is becoming increasingly resistant to antimalarial drugs. This requires extra effort and continuous search for new drugs, especially with new mode of action (Saotoing et al., 2011; Oketch-Rabah and Mwangi, 1998). Ethnobotanical and ethnopharmaclogical studies are now recognized to be the most viable methods of identifying new medicinal plants (Balick, 1985, 1990, 1994; Cotton 1996; King and Tempesta, 1994).

In Gabon, malaria is predominantly caused by *P. falciparum* and malaria transmission is recurrent and considered as hyperendemic (Elissa et al., 1999). Past reports showed that infections with *P. falciparum* ranged from 30 to 50% on the children consulted with fever between 1980s and 1990s throughout the country (Richard-Lenoble et al., 1986; Richard-Lenoble et al., 1987). Adults and pregnant women are also among the most affected in the country (Bouyou**-**Akotet et al., 2003 and 2009). Although progress regarding modern treatment of malaria has improved in the country, however, many people still depend on traditional usages of medicinal plants, especially rural ones (Sassen and Wan, 2006). Despite this dependence, there is a paucity of ethnobotanical and ethnopharmaclogical studies on traditional uses of medicinal plants in the treatment of malaria on one hand and promoting local knowledge on traditional medicines on the other hand. Thus, this paper aims to document the traditional use of medicinal plants in the treatment of malaria in villages settled in the periphery of the Ipassa- Biosphere Reserve, in Makokou, the province of Ogoué-Ivindo for local knowledge promotion in the Republic of Gabon.

MATERIALS AND METHODS

Study site

The Ipassa Biosphere Reserve is located in North East of Gabon, in the Ogooué Ivingo province, and at 620 km from Libreville and at about 12 km to Makokou city. Makokou itself is the regional capital of the Ogooué-Ivindo province. The Ipassa reserve was listed as a Biosphere reserve since 30 June, 1983. And since then, it is the unique Biosphere Reserve in Gabon. The Ipassa Biosphere Reserve is composed of three main areas including: a central or core area of 10,000 hectare, a 2 km^2 buffer zone, and a 3.5 km^2 transition area. The average altitude is 520 m and with an average temperature is 23.9°C, while the annual rainfall varies between 1,600 and 1,800 mm.

Makokou belongs to the Guineo-congolian phytogeographical type (White, 1983). Primary forests contain many plant species of Caesalpiniaceae, Burseraceae, and Euphorbiaceae family groups. Secondary forests contain high light demand plant species such as *Pycnanthus angolensis* and *Scyphocephalium ochococoa*. Species such as *Scorodophleus zenkeri, Santiria trimera, Coula edulis, Anonidium mannii, Afrostyrax lepidophyllus,* and *Picralima nitida* are known as Non Timber Forest Products (NTFPs) in Gabon. They are listed among the most abundant tree species in the primary forests of the Ipassa Biosphere Reserve. The reserve hosts a large variety of Wildlife species including 129 mammals and 401 bird species (Dupuy, 2008). The major ethnic groups are the Bantus and the Baka Pygmies who live side by side outside the reserve. The Bantus include the Fang, Kwélé, and Kota. Baka Pygmies live mostly scattered in small settlements, mainly in the forest at some distance from the Bantu villages and roads. Bantus and Baka pygmies undertake many livelihoods activities such as slash and burn agriculture type, hunting, fishing, gathering in the buffer and transition zones of the reserve.

Ethnobotanical survey

The method used in this study called the “method for the popular pharmacopoeia”, consists of gathering data on the popular use of medicinal plants in a given area (ex. village). Data collected for this study were obtained from both semi-structured interviews and direct interviews, with the local people conducted from 5th May to 30th August, 2011 in villages settled in the periphery of the Makokou city. The survey aimed at identifying plants used in the popular pharmacopoeia among local people. The household was considered as the sample unit. In each household who accepted to answer to our questions, data were mostly recorded from adult women (mothers), because they usually knew the plants better than men and younger people. They provided useful and firsthand information on the popular use of medicinal plants. During the survey, enquiry was made to know “to what extent ailments were treated by which plant species” rather than asking “which plants were used to treat which ailments”. For each health problem cited, the name of the plants and the plant parts used were carefully recorded. The vernacular names of the plants were recorded as much as possible, and the plants specimen mentioned by the informants were collected and brought to the National Herbarium of the Institut de Pharmacopé et Medecine Traditionelle (IPHAMETRA), in Libreville (Gabon) for further identification. Voucher herbal specimens were kept at the Herbarium of IPHAMETRA. The therapeutic statements were made of a specific disease, a symptom or a physiological effect. Information on the diagnosis of ailments was provided through a semi-structured interview of nurses or local health officials.

RESULTS

Ethnic composition of the informants

A total of 60 informants based in 7 villages prescribed

Table 1. List of informants who cited plants for treating malaria in the Makokou region.

Cod_informant	Age	Gender	Village	Ethnic group
Bk1	23	F	Mekob	baka
Bk2	35	M	Mekob	baka
Bk3	60	M	Mekob	baka
Bk4	22	F	Mekob	baka
Bk5	42	M	Mekob	baka
Fg1	49	M	Minkwala	fang
Fg2	38	F	Minkwala	fang
Fg3	70	F	Minkwala	fang
Fg4	32	F	Minkwala	fang
Fg5	60	F	Minkwala	fang
Fg6	60	F	Minkwala	fang
Fg7	63	F	Minkwala	fang
Ko1	63	F	Lascierie	kota
Ko2	43	F	Lascierie	kota
Ko3	50	F	Lascierie	kota
Ko4	76	M	Lascierie	kota
Ko5	49	F	Lascierie	kota
Ko6	38	F	Lascierie	kota
Ko7	70	F	Lascierie	kota
Ko8	56	F	Mbondou	kota
Ko9	32	M	Mekob	kota
Ko10	-	M	Mekob	kota
Ko11	46	F	Messeb	kota
Ko12	46	F	Messeb	kota
Ko13	19	F	Minkwala	kota
Ko14	41	M	Ngazi	kota
Ko15	53	M	Ngazi	kota
Ko16	34	F	Ntsiété	kota
Ko17	59	F	Ntsiété	kota
Ko18	53	F	Ntsiété	kota
Ko19	50	F	Ntsiété	kota
Ko20	62	F	Ntsiété	kota
Ko21	74	F	Ntsiété	kota
Ko22	90	F	Ntsiété	kota
Ko23	73	M	Ntsiété	kota
Ko24	45	F	Ntsiété	kota
Ko25	69	M	Ntsiété	kota
Ko26	57	F	Ntsiété	kota
Ko27	43	F	Ntsiété	kota
Ko28	56	F	Ntsiété	kota
Ko29	35	F	Ntsiété	kota
Ko30	59	F	Ntsiété	kota
Ko31	36	F	Ntsiété	kota
Ko32	43	F	Ntsiété	kota
Ko33	46	F	Ntsiété	kota
Ko34	65	F	Ntsiété	kota
Ko35	36	M	Ntsiété	kota
Kw1	49	M	Mekob	kwélé
Kw2	39	F	Mekob	kwélé
Kw3	75	M	Messeb	kwélé
Kw4	66	F	Messeb	kwélé
Kw5	74	F	Messeb	kwélé
Kw6	60	F	Messeb	kwélé
Kw7	47	F	Messeb	kwélé
Kw8	40	M	Messeb	kwélé
Kw9	61	M	Messeb	kwélé
Kw10	52	F	Messeb	Kwélé
Kw11	44	F	Messeb	Kwélé
Kw12	41	M	Messeb	Kwélé
Kw13	38	F	Messeb	Kwélé

plants in the treatment of malaria. Table 1 shows the informants, their age, gender, and ethnic groups. The distribution of interviews in different ethnic groups is as follows: Fang (7 informants), Kota (35), Kwélé (13), and the Baka Pygmies (5). The Kota ethnic group forms the largest portion, with more than half of the total number of informants; this is because the Kota is the dominant ethnic group in the province.

List of anti-malarial plants and recipes

A total of 61 plant species were cited, for which a total of 374 citations were made on malaria (Appendix 1). The plant species cited are distributed in 55 genera and 34 families. The most represented families are Annonaceae and Zingiberaceae (5 plant species each), Asteraceae (4), Apocynaceae, Maranthaceae, Poaceae, Rutaceae (3 each). The most cited families are Caricaceae (43 citations), Lamiaceae (38), Solanaceae (35), Apocynaceae (34), Zingiberaceae (32), Rutaceae (29), Poaceae (26), Musaceae (25) and Asteraceae (21) (Table 2). To investigate if the collected plants were representative of the plants used for treating malaria by people living in the periphery of the Ipassa Biosphere Reserve in Makokou, we counted the cumulative number of plants cited by additional number of informants. The informants were chosen randomly without replacement in groups of 5. The change in the number of plant species to that of informants is illustrated in Figure 1.

The curve can best be approximated equation: $Y = 17.86 \ln(X) + 15.99$. Y is the number of plant species; X is the number of informants. The examination of the figure shows that an increasing number of informants do not contribute to increasing the number of anti-malarial plants beyond a certain point. But this may only be true for the new informants belonging to the same ethnic groups with the sample mainly composed of the Kota ethnic group.

The same analysis was made for what concerns

Table 2. List of plants cited against malaria by people living in the periphery of the Ipassa-Makokou Biosphere Reserve.

Latin name of the plant	Family	Baka	Fang	Kota	Kwélé	Total
Aframomum melegueta K. Schum.	Zingiberaceae	1	-	16	1	18
Aframomum pruinosum	Zingiberaceae	1	-	-	9	10
Aframomum renealmia	Zingiberaceae	-	-	1	-	1
Aframomum sulcathum	Zingiberaceae	1	-	-	-	1
Ageratum conyzoides L.	Asteraceae	-	-		1	1
Alchornea floribunda Müll. Arg.	Euphorbiaceae	2	-	2	-	4
Alstonia boonei De Wild.	Apocynaceae	6	5	13	7	31
Anchomanes difformis (Bl.) Engl.	Araceae	-	-	4	-	4
Annona muricata L.	Annonaceae	-	-	5	1	6
Antaenidia conferta (Benth.) K. Schum.	Maranthaceae	1	-	-	-	1
Baillonella toxisperma Pierre	Sapotaceae	1	-	1	-	2
Capsicum annum L.	Solanaceae	-	-	1	-	1
Capsicum frutescens L.	Solanaceae	2	-	14	16	32
Carica papaya L.	Caricaceae	3	2	25	13	43
Cassia alata L. (syn : *Senna alata* L.)	Caesalpiniaceae	-	-	7	-	7
Cacia sp.	Mimosaceae	-	-	1	-	1
Ceiba pentandra (L.) Gaertn.	Bombacaceae	4	-	-	1	5
Chromolaena odorata (L.) R. King & H. Robinson	Asteraceae	-	-	3	-	3
Chrysophylum africanum (*Gambea africana*)	Sapotaceae	2	-	-	-	2
Citrus limon L.	Rutaceae	1	3	18	4	26
Citrus reticulata L.	Rutaceae	-	-	1	-	1
Citrus sinensis L.	Rutaceae	-	-	1	1	2
Clerodendrum umbellatum Poir.	Verbenaceae	-	1	-	-	1
Costus lucanusianus J. Braun ou C, afer Ker Gawl	Zingiberaceae	-	-	-	2	2
Cymbopogon citratus DC. (Stapf)	Poaceae	-	1	18	5	24
Cyperus sp.	Cyperaceae	-	-	-	1	1
Dacryodes edulis (G. Don) H. J. Lam	Burseraceae	-	-	2	-	2
Dorstenia psilurus	Moraceae	-	-	4	-	4
Duboscia macrocarpa BOcq.	Tiliaceae	1	-	-	-	1
Elaeis guineensis Jacq.	Arecaceae	-	-	3	1	4
Enantia chlorantha Oliv.	Annonaceae	-	3	-	-	3
Guibourtia tessmannii (Harms) Léonard	Caesalpiniaceae	-	-	1	-	1
Harungana madagascariensis Lam. ex Poir.	Myristicaceae	1	-	2	-	3
Haumania danckelmaniana (Braun & K. Schum.) Milne-Redh.	Maranthaceae	1	-	-	-	1
Ipomoea involucrata Beauv.	Convolvulaceae	2	-	-	1	3
Lophira alata Banks ex Gaertn.	Ochnaceae	-	-	1	-	1
Mangifera indica L.	Anacardiaceae	-	-	3	-	3
Manihot esculenta Crantz	Euphorbiaceae	-	-	4	2	6
Microdesmis puberula Hook. f. ex Planch.	Pandaceae	1	-	-	-	1
Musa paradisiaca L.	Musaceae	1	1	14	9	25
Occimum gratissimum L.	Lamiaceae	-	1	25	12	38
Pachypodanthium staudtii (Engl. & Diels)	Annonaceae	1	-	-	-	1
Persea americana Miler	Lauraceae	-	-	1	-	1
Picralima nitida (Stapf) Th. Dur.	Apocynaceae	2	-	-	-	2
Piptadeniastrum africanum (Hook. f.) Bren.	Mimosaceae	-	-	-	1	1
Polyalthia suaveolens Engl. & Diels	Annonaceae	-	-	2	-	2
Psidium guajava L.	Myrtaceae	-	-	2	2	4
Pterocarpus soyauxii Taub.	Fabaceae	-	-	4	-	4
Saccarum officinarum L.	Poaceae	-	-	1	-	1
Sarcophylum schweinfurthii	Maranthaceae	-	-	3	-	3

Table 2. Contd.

Scorodophloeus zenkeri Harms	Huaceae	-	-	1	-	1
Solanum aethiopium L.	Solanaceae	-	-	1	1	2
Solenostemon monostachyus (P.Beauv.) Briq.	Labiateae	-	-	1	2	3
Staudtia gabonensis	Myristicaceae	-	-	1	-	1
Strophantus glauca	Apocynaceae	1	-	-	-	1
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	-	-	1	-	1
Trema orientalis (L.) Blume	Ulmaceae	-	-	-	1	1
Trichoscypha acuminata Engl. ou T. arborea	Anacardiaceae	1	-	-	-	1
Vernonia amygdalina Del.	Asteraceae	-	-	13	3	16
Xylopia aethiopica (Dun.) A. Rich.	Annonaceae	-	-	-	1	1
Zea mays L.	Poaceae	-	-	1	-	1
Total citations	-	37	17	222	98	374

Each plant species is represented with its number of citation in each ethnic group.

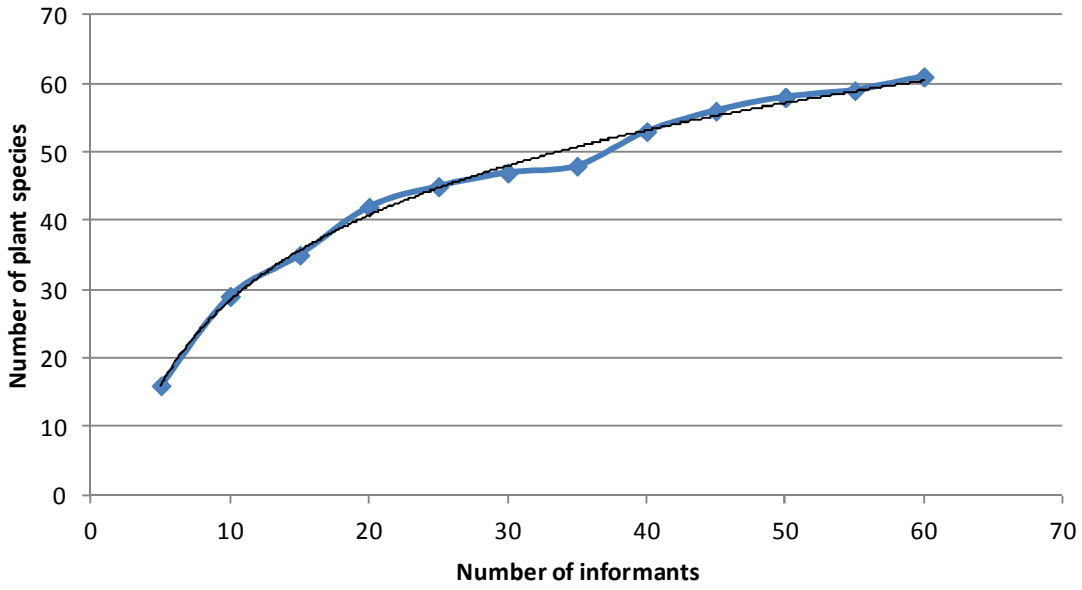

Figure 1. Cumulative number of anti-malarial plants to the number of informants interviewed.

recipes used. In this paper, a recipe consists of a combination of plant part - pharmaceutical form - mode of administration. For example, the recipe "le-de-vaba" means: using for a given plant species, leaves (le), in decoction (de), and through a vaporation bath (vaba). A total of 45 recipes were cited for treating malaria by people living in the periphery of the Ipassa Biosphere Reserve. Figure 2 illustrates the evolution of recipes cited with that of informants. As observed for plant species, increasing number of informants does not contribute to increasing the number of anti-malarial recipes beyond a certain point. The ten most cited plant species are: *Carica papaya* (43 citations, all or 4 ethnic groups), *Occimum gratissimum* (38, 3), *Capsicum frutescens* (32, 3), *Alstonia boonei* (31, 4), *Citrus limon* (26, 4), *Musa paradisiaca* (25, 4), *Cymbopogon citratus* (24, 3), *Aframomum melegueta* (18, 3), *Vernonia amygdalina* (16, 2), *Aframomum pruinosum* (10, 2).

Characterization of recipes

Recipes are characterized by the plant part, the pharmaceutical form, the mode of administration, and the degree of association of plant species. A total of seven plant parts were cited by people living in the periphery of the Ipassa Biosphere Reserve for treating malaria including fruits, leaves, roots, seeds, stems bark, tubers.

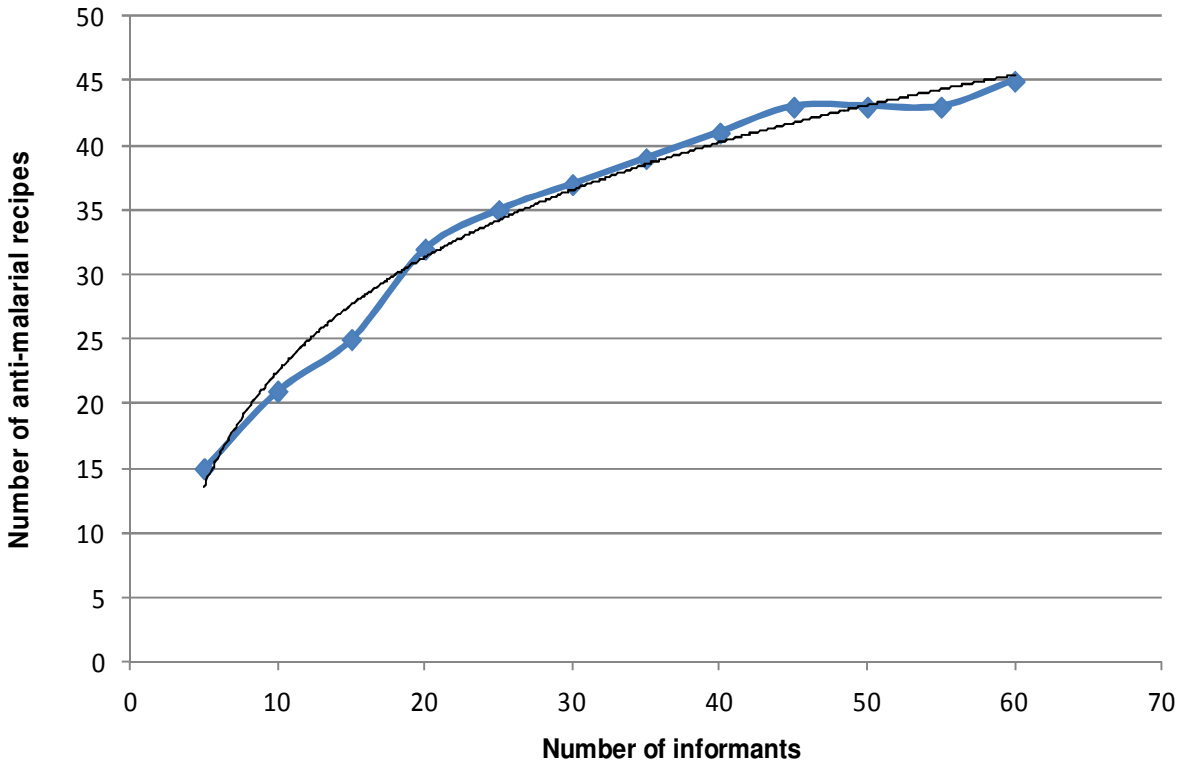

Figure 2. Cumulative number of anti-malarial recipes to the number of informants interviewed.

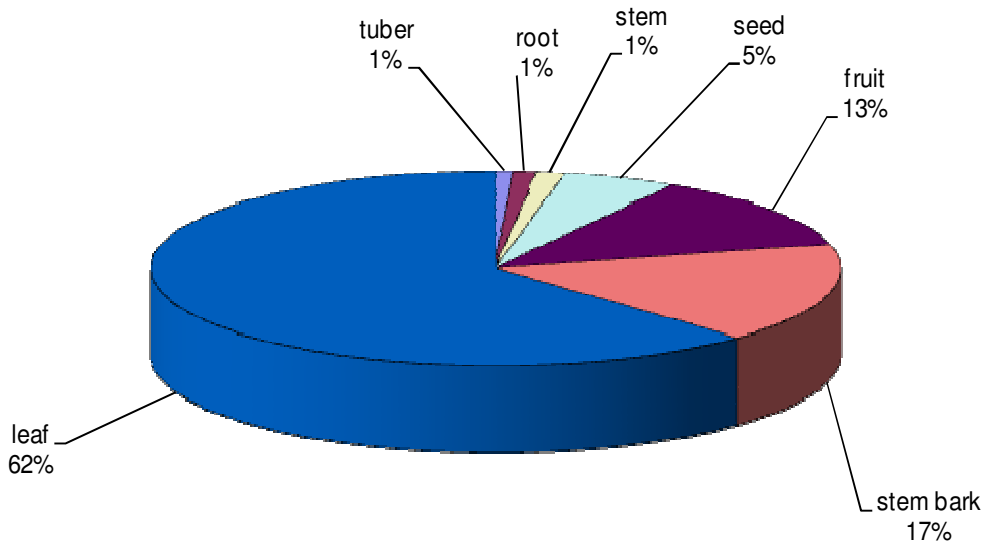

Figure 3. Plant parts cited for treating malaria in the Ipassa Biosphere Reserve, Makokou region.

Figure 3 illustrates the relative importance of those plant parts. Leaves are the plant parts that are largely cited (62%), followed by stem barks (17%) and fruits (13%). A total of seven different pharmaceutical forms were cited (Figure 4) that include decoction, juice, maceration, oil, pounding, rapure, and trituration. Decoction (58%) and

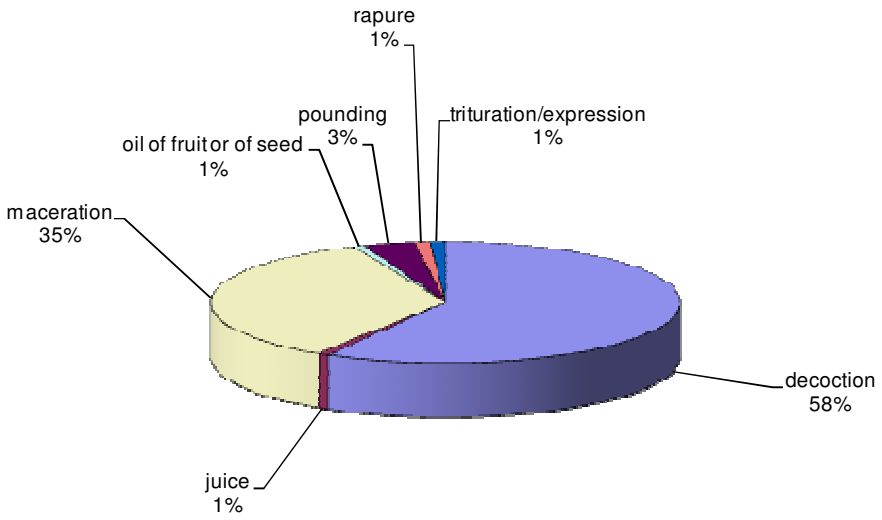

Figure 4. Pharmaceutical forms used for treating malaria in the Ipassa Biosphere Reserve, Makokou region.

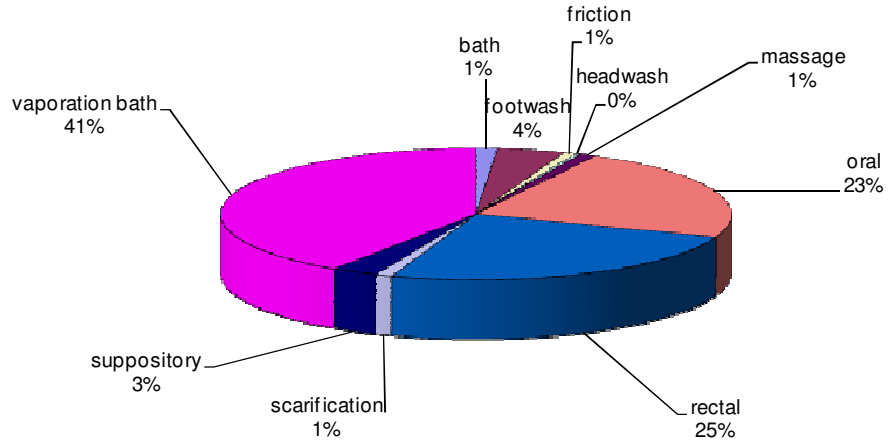

Figure 5. Mode of administration of recipes in the treatment of malaria in the Ipassa Biosphere Reserve, Makokou region.

maceration (35%) appear to be the most pharmaceutical forms used for treating malaria in the Makokou region. People living in the periphery of the Ipassa Biosphere Reserve have cited 10 different modes of administration of drugs used for treating malaria, which are bath, footwash, friction, headwash, massage, oral, rectal, scarification, suppository, and vaporation bath. Vaporation bath (41% of citations), rectal (25%) and oral voices (23%) appear to be the main modes of administration of plants used for treating malaria in the study (Figure 5).

About 73% of the citations are made of combination of two, three, four, five, six, or seven plant species. Only 13 plant species (21.3%) cited are used alone. Plants species such as *C. papaya, Capsicum frutescens, C. limon, Cymbopogon citratus* and *Manihot esculenta* are largely cited as associated plant species for treating malaria.

DISCUSSION

The samples collected for ethnobotanical survey are often very poor. The number of informants may not even reach one percent (1%) of the total number of persons found in the study site (Höft et al., 1999). This is partly because informants are often reluctant to provide information. This problem is more crucial in survey of medicinal plants. To examine the validity of the sample, we examined the representativeness of the samples

through a regression curve of the number of plant species by number of informants. Figures 1 and 2 show that the plants and the recipes samples recorded in this study are quite representatives of all that are used by people living in the periphery of the Ipassa Biosphere Reserve as anti-malarial. In fact, almost all the plants and recipes used for treating malaria by people living in the periphery of the Ipassa Biosphere Reserve were collected. The distribution of informants to different ethnic groups shows considerable imbalance. The Kota is the group that is largely represented (58.3% of informants), and aslo the most dominant ethnic group in the province. Baka pygmies are represented only with 08.3% of informants. The major consequence of such an imbalance in relative number of informants by ethnic group is that an intergroup comparison would not make sense. A comparison of the total sample collected with those in other African countries would be more fruitful.

Most of the citations (73%) cited for treating malaria by people living in the periphery of the Reserve are made of combination of many plant species. In traditional medicine whole plants or mixtures of plants are used rather than isolated compounds. There is evidence that crude plant extracts often have greater antiplasmodial activity than isolated constituents at an equivalent dose (Rasoanaivo et al., 2011). Leaves (62% of citations) are plant parts that are largely used. They are followed by stem barks (17%) and fruits (13%). Villagers have through experience observed that plant parts such as barks, leaves and roots are sites of bio-synthesis and sites of storage of secondary metabolites. These metabolites are responsible of biological properties of plants. The vulnerability of a plant species is linked to the rhythm of regeneration of plant parts used. The harvesting of stem barks or root barks, “always tend to kill the trees”, but the harvesting of latex, leaves, fruits and oleaginous seeds do not necessarily leads to the death of adult trees and do not modify radically the specific structure of the populations of trees (Peters, 1997, Ticktin, 2004). The sporadic harvesting of few fruits will have little impact on the long term stability of the populations of the exploited trees. But an intensive harvesting of seeds for example, can lead to the progressively elimination of the tree species (Peters, 1997, Ticktin, 2004).

Decoction (58%) and maceration (35%) are the two most pharmaceutical forms used for treating malaria by people living in the periphery of the Ipassa-Makokou Biosphere Reserve. The plant species for which the recipes allow a long conservation (ex. storage) will be less vulnerable compared to those which must be used immediately (Betti, 2002a). The oil can be stored and stay more long than aqueous forms such as decoctions and macerations or plant parts freshly used (ex. pulp). The Dja herbalists as those of the Congo Brazzaville (Diafouka, 1997) do not get aseptic methods to store and conserve aqueous medicines. Their length of conservation does not exceed five to seven days. After this length, the medicine becomes unfit for consumption, not effective and sometimes toxic, due to the proliferation of pathogen agents.

Some plants largely cited by people living in the periphery of the Ipassa Biosphere Reserve are also known in other African countries for the same usages. Other plant species, which are frequently mentioned by the informants as being used for treating malaria, are well known in the literature for their active compounds for the same usages. These plant species are presented hereby, with the countries where they are cited from and roles played for treating malaria and if possible, pharmacological inquiries related to that ailment:

Alstonia boonei **(Apocynaceae)**

This plant specie was cited 31 times by informants belonging to the all ethnic groups for treating malaria. The plant is known for the same usage in eight African countries including Cameroon, Congo-Brazzaville, Equatorial Guinea, Nigeria, Senegal, Togo, and the Democratic Republic of Congo (Betti, 2002b). The genus *Alstonia* in general, was considered to be not effective against Plasmodium (Wright et al., 1993). The anti-malarial tests conducted by Oliver-Bever (1986) with *A. boonei* were not positive. However, Zihiri Guede (2004) has revealed a good activity of *A. bonnei* (IC_{50} < 4 µg/ml) against *Plasmodium falciparum* FcB1/Colombia. *A. boonei’s* antimalarial activity is significant, while its toxicity is minimal (Idowu et al., 2010). This antimalarial activity can well explain the large use of that plant specie in the treatment of malaria in the Makokou region.

Carica papaya **(Caricaceae)**

This is the most cited plant species in the treatment of malaria by people living in the Makokou region (43 citations). The plant is largely cited for the same usage in many African countries such as Cameroon and Ghana (Saotoing et al., 2011), and Ngeria (Idowu et al., 2010). Its use against malaria is justified by the presence of high concentrations of active compounds in the seeds. For Titanji et al. (2008), there is no report on the phyto-chemistry of this plant with regards to its antiplasmodial activity. However, Idowu et al. (2010) reported that *C. papaya* has a minimal antimalarial activity and a minimal toxicity.

Citrus limon **(Rutaceae)**

This is cited 26 times for treating malaria. The fruits are often associated (23 citations/26) in decoction to other plant species. The fruits of *C. limon* contain anti-malarial

substances, and the studies conducted in Cameroon showed that the plant is effective against malaria (Titanji et al., 2008).

Cymbopogon citratus (Poaceae)

This plant was cited 24 times by informants for treating malaria. *C. citratus* is one of the most commonly used herbs in Cameroon to treat malaria and other fevers (Titanji et al., 2008). As observed in the far north region of Cameroon, *C. citratus* is generally used in combination with other plant species (21 citations/24) in decoction for treating malaria/fever. The same use is mentioned in Nigeria (Idowu et al., 2010). Although, the essential oil has analgesic and pyretic properties, however, that oil is not active against malaria (Robineau, 1991). *C. citratus* was reported to be slightly significant and not toxic (Idowu et al., 2010).

Enantia chlorantha (Annonaceae)

This plant specie was cited three times for treating malaria by the Fang ethnic group. The plant is known for the same usage in Cameroon, Congo Brazzaville and Equatorial Guinea (Betti, 2001). *E. chlorantha* is active against *Plasmodium yoelii nigeriensis* (Agomo et al., 1992).

Picralima nitida (Apocynaceae)

This plant is cited in two different recipes for treating malaria by one Baka healer. The usages against malaria are mentioned in Cameroon (Adjanohoun et al., 1996; Dijk, 1999; Betti, 2002a, 2004, 2010), Democratic Republic of Congo (Magilu et al., 1996; Terashima and Ichikawa, 2003), Nigeria (Iwu, 1993, 1994; Iwu et al., 1992). The main alkaloid found in the seeds of *P. nitida*, akuamine, has properties similar to morphine (Gbile, 1998). Some indol-alkaloids have been isolated from the seeds of *P. nitida* and have shown activity against the chloroquin-resistance type of malaria (Iwu, 1994). Extracts from seeds, fruits and those from stem barks of *P. nitida* are effective against *P. falciparum* (Iwu and Klayman, 1992). According to François et al. (1996), the extracts obtained from fruits are more effective than those obtained from stem barks. The anti-inflammatory, anti-pyretic and anti-malarial (mainly *P. falciparum*) activities were confirmed in fruits (Ezeamuzie et al., 1994).

Vernonia amygdalina (Asteraceae)

This is cited 16 citations for treating malaria by Kota and Kwélé farmers (The plant was recorded to be frequently used against malaria by the Baka pygmies living in the periphery of the Dja Biosphere Reserve, Cameroon. The extract from leaves has shown some anti-malarial property against *Plasmodium berghei* (Hakizamungu and Weri, 1988) and *Plasmodium falciparum* (Tona *et al*., 1999). The "ndolé" the popular name for *Vernonia* leaves is widely used as relish in Cameroon. The plant is non toxic, but the excessive ingestion of leaves can produce a purgative effect (Iwu, 1993). Idowu et al. (2010) reported that *V. amygdalina*'s toxicity is negligible.

The fact that some plant species cited by Makokou people are well recognized in literature for their anti-malarial property against *Plasmodium*, is a credibility index which can be attributed to local knowledge of those people on pharmacopoea. This also illustrates the efficiency of the method used to identify medicinal plants used by rural people around the Ipassa Biosphere Reserve in Makokou. Thus, local knowledge on medicinal plants used for treating malaria needs to be promoted throughout the country to secure pharmacopoeia as a whole. The glaring development challenge at the back-ground of what precedes is the pressing need to implement strategies and programmes to identify active chemical substances of other plant species which have not yet been investigated for their chemical and antimalarial activities.

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Appendix 1. Citations of plants in the treatment of malaria by people living in the periphery of the Ipassa-Makokou Biosphere Reserve, Gabon.

Latin name of the plant species	Associated plants	Recipe	Cod_informant
Occimum gratissimum	*Dorstenia psilurus + Aframomum melegueta*	le-ma-re	Ko26
Carica papaya	*Musa paradisiaca + Cymbopogon citratus + Cassia alata*	le-de-vaba	Ko33
Occimum gratissimum	*Psidium guajava + Citrus limon + Citrus reticulata + Citrus sinensis + Annona muricata + Dacryodes edulis + Musa paradisiaca*	le-de-vaba	Ko22
Cassia alata	*Cassis sp. + Manihot esculenta + Carica papaya + Citrus limon + Cymbopogon citratus*	le-de-vaba	Ko5
Occimum gratissimum	*Aframomum melegueta*	le-ma-re	Ko16
Carica papaya	*Aframomum pruinosum + Annona muricata*	le-de-vaba	Kw13
Carica papaya	*Aframomum sulcathum + Alchornea floribunda +Citrus limon*	le-de-vaba	Bk2
Occimum gratissimum	*Alchornea floribunda + Carica papaya + Musa paradisiaca + Aframomum pruinosum*	le-de-vaba	Kw4
Microdesmis puberula	*Alchornea floribunda + Haumania danckelmaniana*	le-de-vaba	Bk1
Dacryodes edulis	*Annona muricata*	le-de-vaba	Ko20
Alchornea floribunda	As. *Aframomum melegueta*	le-de-vaba	Ko7
Capsicum frutescens	As. *Aframomum melegueta*	fr-ma-re	Ko15
Capsicum frutescens	As. *Aframomum melegueta*	fr-ma-re	Kw2
Carica papaya	As. *Aframomum melegueta*	le-de-vaba	Ko7
Elaeis guineensis	As. *Aframomum melegueta*	se-oi-su	Ko13,16
Occimum gratissimum	As. *Aframomum melegueta*	le-ma-re	Ko15
Occimum gratissimum	As. *Aframomum melegueta*	le-ma-re	Kw2
Pterocarpus soyauxii	As. *Aframomum melegueta*	stb-ma-re	Ko4
Carica papaya	As. *Aframomum pruinosum*	le-de-vaba	Kw8
Alchornea floribunda	As. *Aframomum renealmia*	le-de-vaba	Ko6
Carica papaya	As. *Aframomum renealmia*	le-de-vaba	Ko6
Cymbopogon citratus	As. *Aframomum renealmia*	le-de-vaba	Ko6
Occimum gratissimum	As. *Aframomum renealmia*	le-de-vaba	Ko6
Enantia chlorantha	As. *Alstonia boonei*	stb-de-or	Fg4
Capsicum frutescens	As. *Alstonia boonei*	fr-ma-re	Kw7
Capsicum frutescens	As. *Alstonia boonei*	fr-ma-re	Bk2
Capsicum frutescens	As. *Alstonia boonei*	fr-ma-re	Kw2
Carica papaya	As. *Alstonia boonei*	le-de-or	Fg4
Citrus limon	As. *Alstonia boonei*	fr-de-or	Fg4
Pterocarpus soyauxii	As. *Anchomanes difformis*	stb-po-ma	Ko22
Pterocarpus soyauxii	As. *Anchomanes difformis*	stb-po-fr	Ko22
Solanum aethiopium	As. *Anchomanes difformis*	fr-ma-re	Ko1
Carica papaya	As. *Annona muricata*	le-de-vaba	Ko29
Cassia alata	As. *Annona muricata*	le-de-vaba	Ko29
Citrus limon	As. *Annona muricata*	le-de-vaba	Ko29
Cymbopogon citratus	As. *Annona muricata*	le-de-vaba	Ko29
Occimum gratissimum	As. *Annona muricata*	le-de-vaba	Ko29

Appendix 1. Contd.

Capsicum annum	As. *Baillonella toxisperma*	fr-de-re	Ko5
Solenostemon monostachyus	As. *Carica papaya*	le-de-vaba	Kw10
Aframomum pruinosum	As. *Carica papaya*	le-de-vaba	Kw12
Aframomum pruinosum	As. *Carica papaya*	le-de-vaba	Kw13
Aframomum pruinosum	As. *Carica papaya*	le-de-vaba	Kw10
Aframomum sulcathum	As. *Carica papaya*	le-de-vaba	Bk2
Ageratum conyzoides	As. *Carica papaya*	le-de-vaba	Kw10
Alchornea floribunda	As. *Carica papaya*	le-de-vaba	Bk2
Annona muricata	As. *Carica papaya*	le-de-vaba	Kw13
Cassia alata	As. *Carica papaya*	le-de-or	Ko35
Citrus limon	As. *Carica papaya*	fr-de-vaba	Ko8
Citrus limon	As. *Carica papaya*	le-de-vaba	Ko8
Citrus limon	As. *Carica papaya*	fr-de-vaba	Bk2
Costus lucanusianus	As. *Carica papaya*	st-de-vaba	Kw2
Cymbopogon citratus	As. *Carica papaya*	le-de-vaba	Ko33
Cymbopogon citratus	As. *Carica papaya*	le-de-vaba	Ko8
Ipomoea involucrata	As. *Carica papaya*	le-de-vaba	Kw10
Mangifera indica	As. *Carica papaya*	le-de-fowa	Ko28
Mangifera indica	As. *Carica papaya*	le-de-vaba	Ko8
Manihot esculenta	As. *Carica papaya*	le-de-vaba	Kw2
Musa paradisiaca	As. *Carica papaya*	le-de-vaba	Ko33
Musa paradisiaca	As. *Carica papaya*	le-de-vaba	Ko8
Musa paradisiaca	As. *Carica papaya*	le-de-vaba	Kw12
Musa paradisiaca	As. *Carica papaya*	le-de-vaba	Kw10
Musa paradisiaca	As. *Carica papaya*	le-de-vaba	Kw2
Occimum gratissimum	As. *Carica papaya*	le-de-vaba	Kw12
Cassia sp.	As. *Cassia alata*	le-de-vaba	Ko5
Carica papaya	As. *Cassia alata*	le-de-vaba	Ko5
Carica papaya	As. *Cassia alata*	le-de-or	Ko27
Citrus limon	As. *Cassia alata*	fr-de-vaba	Ko5
Citrus limon	As. *Cassia alata*	fr-de-or	Ko27
Cymbopogon citratus	As. *Cassia alata*	le-de-vaba	Ko5
Cymbopogon citratus	As. *Cassia alata*	le-de-or	Ko27
Manihot esculenta	As. *Cassia alata*	le-de-vaba	Ko5
Musa paradisiaca	As. *Cassia alata*	le-de-or	Ko27
Aframomum pruinosum	As. *Ceiba pentandra*	le-de-vaba	Bk4
Capsicum frutescens	As. *Ceiba pentandra*	fr-de-re	Kw1
Ipomoea involucrata	As. *Ceiba pentandra*	le-de-ba	Bk4
Ipomoea involucrata	As. *Ceiba pentandra*	st-de-vaba	Bk4
Musa paradisiaca	As. *Ceiba pentandra*	le-de-vaba	Bk4
Piptadeniastrum africanum	As. *Ceiba pentandra*	stb-de-re	Kw1
Carica papaya	As. *Citrus limon*	le-de-vaba	Fg1
Musa paradisiaca	As. *Citrus limon*	le-de-vaba	Fg1
Capsicum frutescens	As. *Costus lucanusianus*	fr-ma-or	Kw10
Annona muricata	As. *Cymbopogon citratus*	le-de-vaba	Ko2
Annona muricata	As. *Cymbopogon citratus*	le-de-or	Ko2
Carica papaya	As. *Cymbopogon citratus*	le-de-vaba	Ko2
Carica papaya	As. *Cymbopogon citratus*	le-de-or	Ko2

Appendix 1. Contd.

Carica papaya	As. *Cymbopogon citratus*	le-de-fowa	Kw7
Carica papaya	As. *Cymbopogon citratus*	le-de-vaba	Kw7
Citrus limon	As. *Cymbopogon citratus*	le-de-vaba	Ko34
Citrus limon	As. *Cymbopogon citratus*	fr-de-vaba	Ko2
Citrus limon	As. *Cymbopogon citratus*	fr-de-or	Ko2
Citrus limon	As. *Cymbopogon citratus*	le-de-fowa	Kw7
Citrus limon	As. *Cymbopogon citratus*	le-de-vaba	Kw7
Manihot esculenta	As. *Cymbopogon citratus*	le-de-vaba	Ko2
Manihot esculenta	As. *Cymbopogon citratus*	le-de-or	Ko2
Occimum gratissimum	As. *Cymbopogon citratus*	le-de-vaba	Ko2
Occimum gratissimum	As. *Cymbopogon citratus*	le-de-or	Ko2
Occimum gratissimum	As. *Cymbopogon citratus*	le-de-fowa	Kw7
Occimum gratissimum	As. *Cymbopogon citratus*	le-de-vaba	Kw7
Sarcophylum schweinfurthii	As. *Cymbopogon citratus*	le-de-vaba	Ko34
Sarcophylum schweinfurthii	As. *Cymbopogon citratus*	le-de-vaba	Ko2
Sarcophylum schweinfurthii	As. *Cymbopogon citratus*	le-de-or	Ko2
Vernonia amygadalina	As. *Cymbopogon citratus*	le-de-vaba	Ko34
Vernonia amygadalina	As. *Cymbopogon citratus*	le-de-vaba	Ko2
Vernonia amygadalina	As. *Cymbopogon citratus*	le-de-or	Ko2
Annona muricata	As. *Dacryodes edulis*	le-de-vaba	Ko20
Carica papaya	As. *Dacryodes edulis*	le-de-vaba	Ko20
Chromolaena odorata	As. *Dacryodes edulis*	le-de-vaba	Ko20
Citrus limon	As. *Dacryodes edulis*	fr-de-vaba	Ko20
Citrus limon	As. *Dacryodes edulis*	le-de-vaba	Ko20
Cymbopogon citratus	As. *Dacryodes edulis*	le-de-vaba	Ko20
Capsicum frutescens	As. *Dorstenia*	fr-ma-re	Ko11
Occimum gratissimum	As. *Dorstenia*	le-ma-re	Ko11
Baillonella toxisperma	As. *Harungana madagascariensis*	stb-ma-re	Bk1
Capsicum frutescens	As. *Harungana madagascariensis*	fr-ma-re	Bk1
Gambea africana	As. *Harungana madagascariensis*	stb-ma-re	Bk1
Musa paradisiaca	As. *Harungana madagascariensis*	fr-ma-or	Ko1
Capsicum frutescens	As. *Lophira alata*	fr-ma-or	Ko10
Alchornea floribunda	As. *Microdesmis puberula*	le-de-vaba	Bk1
Haumania danckelmaniana	As. *Microdesmis puberula*	le-de-vaba	Bk1
Aframomum pruinosum	As. *Musa paradisiaca*	le-de-vaba	Kw5
Carica papaya	As. *Musa paradisiaca*	le-de-vaba	Ko24
Carica papaya	As. *Musa paradisiaca*	le-de-vaba	Ko19
Carica papaya	As. *Musa paradisiaca*	le-de-vaba	Kw5
Carica papaya	As. *Musa paradisiaca*	le-de-vaba	Kw6
Carica papaya	As. *Musa paradisiaca*	le-de-vaba	Kw11
Carica papaya	As. *Musa paradisiaca*	le-de-vaba	Ko11
Carica papaya	As. *Musa paradisiaca*	le-de-fowa	Ko12
Carica papaya	As. *Musa paradisiaca*	le-de-vaba	Kw1
Cassia alata	As. *Musa paradisiaca*	le-de-vaba	Ko24
Chromolaena odorata	As. *Musa paradisiaca*	le-de-vaba	Ko19
Citrus limon	As. *Musa paradisiaca*	fr-de-vaba	Ko19
Citrus limon	As. *Musa paradisiaca*	le-de-vaba	Ko17
Citrus limon	As. *Musa paradisiaca*	le-de-vaba	Kw11

Appendix 1. Contd.

Citrus sinensis	As. *Musa paradisiaca*	le-de-vaba	Kw11
Cymbopogon citratus	As. *Musa paradisiaca*	le-de-vaba	Ko24
Cymbopogon citratus	As. *Musa paradisiaca*	le-de-vaba	Ko19
Cymbopogon citratus	As. *Musa paradisiaca*	le-de-vaba	Ko30
Cymbopogon citratus	As. *Musa paradisiaca*	le-de-vaba	Kw6
Cymbopogon citratus	As. *Musa paradisiaca*	le-de-vaba	Kw11
Cymbopogon citratus	As. *Musa paradisiaca*	le-de-vaba	Ko11
Cymbopogon citratus	As. *Musa paradisiaca*	le-de-fowa	Ko12
Elaeis guineensis	As. *Musa paradisiaca*	le-de-vaba	Kw1
Manihot esculenta	As. *Musa paradisiaca*	le-de-vaba	Kw6
Occimum gratissimum	As. *Musa paradisiaca*	le-de-vaba	Ko11
Occimum gratissimum	As. *Musa paradisiaca*	le-de-fowa	Ko12
Psidium guajava	As. *Musa paradisiaca*	le-de-vaba	Ko19
Aframomum melegueta	As. *Occimum gratissimum*	se-ma-re	Ko16
Aframomum melegueta	As. *Occimum gratissimum*	se-ma-re	Ko26
Aframomum pruinosum	As. *Occimum gratissimum*	le-de-vaba	Kw4
Alchornea floribunda	As. *Occimum gratissimum*	le-de-vaba	Kw4
Annona muricata	As. *Occimum gratissimum*	le-de-vaba	Ko22
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Kw9
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Ko13
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-or	Ko27
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Ko29
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Ko31
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Kw8
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Kw13
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Kw6
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Kw7
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Kw10
Capsicum frutescens	As. *Occimum gratissimum*	fr-ma-re	Kw4
Carica papaya	As. *Occimum gratissimum*	le-de-vaba	Ko16
Carica papaya	As. *Occimum gratissimum*	le-de-vaba	Ko26
Carica papaya	As. *Occimum gratissimum*	le-de-vaba	Ko31
Carica papaya	As. *Occimum gratissimum*	le-de-vaba	Kw4
Cassia alata	As. *Occimum gratissimum*	le-de-vaba	Ko3
Cassia alata	As. *Occimum gratissimum*	le-de-vaba	Ko26
Chromolaena odorata	As. *Occimum gratissimum*	le-de-vaba	Ko31
Citrus limon	As. *Occimum gratissimum*	fr-de-vaba	Ko16
Citrus limon	As. *Occimum gratissimum*	le-de-vaba	Ko22
Citrus limon	As. *Occimum gratissimum*	fr-ma-or	Ko27
Citrus sinensis	As. *Occimum gratissimum*	le-de-vaba	Ko22
Citrus reticulata	As. *Occimum gratissimum*	le-de-vaba	Ko22
Cymbopogon citratus	As. *Occimum gratissimum*	le-de-vaba	Ko16
Cymbopogon citratus	As. *Occimum gratissimum*	le-de-vaba	Ko3
Dacryodes edulis	As. *Occimum gratissimum*	le-de-vaba	Ko22
Dorstenia psilurus	As. *Occimum gratissimum*	ro-ma-re	Ko26
Dorstenia psilurus	As. *Occimum gratissimum*	ro-ma-re	Ko20
Mangifera indica	As. *Occimum gratissimum*	le-de-vaba	Ko22
Manihot esculenta	As. *Occimum gratissimum*	le-de-vaba	Ko26

Appendix 1. Contd.

Musa paradisiaca	As. *Occimum gratissimum*	le-de-vaba	Ko26
Musa paradisiaca	As. *Occimum gratissimum*	le-de-vaba	Ko22
Musa paradisiaca	As. *Occimum gratissimum*	le-de-vaba	Ko31
Musa paradisiaca	As. *Occimum gratissimum*	le-de-vaba	Kw4
Psidium guajava	As. *Occimum gratissimum*	le-de-vaba	Ko22
Vernonia amygadalina	As. *Occimum gratissimum*	le-ma-re	Ko29
Vernonia amygadalina	As. *Occimum gratissimum*	le-ma-re	Ko20
Carica papaya	As. *Persea americana*	le-de-fowa	Ko32
Citrus limon	As. *Persea americana*	fr-de-fowa	Ko32
Citrus limon	As. *Persea americana*	le-de-fowa	Ko32
Saccarum officinarum	As. *Staudtia gabonensis*	st-ju-or	Ko19
Capsicum frutescens	As. *Vernonia amygdalina*	fr-ma-re	Ko18
Capsicum frutescens	As. *Vernonia amygdalina*	fr-ma-re	Kw13
Carica papaya	As. *Vernonia amygdalina*	le-ma-re	Ko27
Capsicum frutescens	As. *Xylopia aethiopica*	fr-de-re	Kw12
Zea mays	As. *zea mays*	se-de-or	Ko14
Harungana madagascariensis	*Baillonella toxisperma + Gambea africana + Capsicum frutescens*	stb-ma-re	Bk1
Baillonella toxisperma	*Capsicum annum*	stb-de-re	Ko5
Alstonia boonei	*Capsicum frutescens*	stb-ma-re	Kw7
Alstonia boonei	*Capsicum frutescens*	stb-ma-re	Bk2
Alstonia boonei	*Capsicum frutescens*	stb-ma-re	Kw2
Costus lucanusianus	*Capsicum frutescens*	st-ma-or	Kw10
Lophira alata	*Capsicum frutescens*	stb-ma-or	Ko10
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Ko13
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Ko31
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Kw9
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Kw8
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Kw13
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Kw6
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Kw7
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Kw10
Occimum gratissimum	*Capsicum frutescens*	le-ma-re	Kw4
Vernonia amygadalina	*Capsicum frutescens*	le-ma-re	Ko18
Vernonia amygadalina	*Capsicum frutescens*	le-ma-re	Kw13
Xylopia aethiopica	*Capsicum frutescens*	stb-de-re	Kw12
Aframomum melegueta	*Capsicum frutescens + Occimum gratissimum*	se-ma-re	Ko15
Aframomum pruinosum	*Carica papaya*	le-de-vaba	Kw8
Musa paradisiaca	*Carica papaya + Aframomum pruinosum*	le-de-vaba	Kw9
Musa paradisiaca	*Carica papaya + Aframomum pruinosum*	le-de-vaba	Kw5
Musa paradisiaca	*carica papaya + Cassia alata + Cymbopogon citratus*	le-de-vaba	Ko24
Musa paradisiaca	*Carica papaya + Citrus limon + Citrus sinensis + Cymbopogon citratus*	le-de-vaba	Kw11
Persea americana	*Carica papaya + Citrus limon*	le-de-fowa	Ko32
Musa paradisiaca	*Carica papaya + Cymbopogon citratus + Occimum gratissimum*	le-de-vaba	Ko11

Appendix 1. Contd.

Musa paradisiaca	*Carica papaya + Elaeis guineensis*	le-de-vaba	Kw1
Musa paradisiaca	*Carica papaya + Manihot esculenta + Cymbopogon citratus*	le-de-vaba	Kw6
Citrus limon	*Carica papaya + Musa paradisiaca*	le-de-vaba	Fg1
Occimum gratissimum	*carica papaya + Musa paradisiaca + Chromolaena odorata*	le-de-vaba	Ko31
Musa paradisiaca	*Carica papaya + Psidium guajava + Chromolaena odorata + Cymbopogon citratus + Citrus limon*	le-de-vaba	Ko19
Cymbopogon citratus	*Carica papaya + Vernonia amygadalina + Occimum gratissimum + Annona muricata + Manihot esculenta + Citrus limon + Sarcophylum schweinfurthii*	le-de-vaba	Ko2
Cymbopogon citratus	*Carica papaya + Vernonia amygadalina + Occimum gratissimum + Annona muricata + Manihot esculenta + Citrus limon + Sarcophylum schweinfurthii*	le-de-or	Ko2
Aframomum melegueta	*Carica papaya+Alchornea floribunda*	le-de-vaba	Ko7
Carica papaya	*Cassia alata*	le-de-or	Ko35
Occimum gratissimum	*Cassia alata + Carica papaya + Musa paradisiaca + Manihot esculenta*	le-de-vaba	Ko26
Annona muricata	*Cassia alata + Citrus limon + Cymbopogon citratus + Carica papaya + Occimum gratissimum*	le-de-vaba	Ko29
Occimum gratissimum	*Citrus limon + Capsicum frutescens*	le-ma-or	Ko27
Alstonia boonei	*Citrus limon + Enantia chlorantha + Carica papaya*	stb-de-or	Fg4
Carica papaya	*Citrus limon + Mangifera indica + Cymbopogon citratus + Musa paradisiaca*	le-de-vaba	Ko8
Musa paradisiaca	*Citrus limon*	le-de-vaba	Ko30
Musa paradisiaca	*Citrus limon*	le-de-vaba	Ko17
Occimum gratissimum	*Cymbopogon citratus+ Cassia alata*	le-de-vaba	Ko3
Occimum gratissimum	*Cymbopogon citratus+ Citrus limon + carica papaya*	le-de-vaba	Ko16
Cassia alata	*Cymbopogon citratus+ Mus paradisiaca + Carica papaya + Citrus limon*	le-de-or	Ko27
Aframomum melegueta	*Elaeis guineensis*	se-po-su	Ko13, 16
Ceiba pentandra	*Ipomoea involucrata*	stb-de-ba	Bk4
Ceiba pentandra	*Ipomoea involucrata + Aframomum pruinosum + Musa paradisiaca*	stb-de-vaba	Bk4
Carica papaya	*Mangifera indica*	le-de-fowa	Ko28
Carica papaya	*Musa aethiopica + Occimum gratissimum+ etsia*	le-de-vaba	Kw12
Harungana madagascariensis	*Musa paradisiaca*	stb-ma-or	Ko1
Carica papaya	*Musa paradisiaca + Musa paradisiaca +Ipomoea involucrata + Aframomum pruinosum + Aelanthus lamborayi +Ageratum conyzoides*	le-de-vaba	Kw10
Carica papaya	*Musa paradisiaca + Costus lucanusianus+ Manihot esculenta*	le-de-vaba	Kw2

Appendix 1. Contd.

Aframomum melegueta	*Occimum gratissimum + Capsicum frutescens*	se-ma-re	Kw2
Dorstenia psilurus	*Occimum gratissimum + Capsicum frutescens*	ro-ma-re	Ko11
Cymbopogon citratus	*Occimum gratissimum + Citus limon + carica papaya*	le-de-fowa	Kw7
Cymbopogon citratus	*Occimum gratissimum + Citus limon + carica papaya*	le-de-vaba	Kw7
Aframomum renealmia	*Occimum gratissimum + Cymbopogon citratus + Carica papaya + Alchornea floribunda*	le-de-vaba	Ko6
Vernonia amygadalina	*Papayer*	le-ma-re	Ko27
Musa paradisiaca	*papayer + Cymbopogon citratus + Occimum gratissimum*	le-de-fowa	Ko12
Ceiba pentandra	*Piptadeniastrum africanum + Capsicum frutscens*	stb-de-re	Kw1
Aframomum melegueta	*Pterocarpus soyauxii*	se-ma-re	Ko4
Anchomanes difformis	*Pterocarpus soyauxii*	tu-po-ma	Ko22
Staudtia gabonensis	*Saccarum officinarum*	stb-ju-or	Ko19
Anchomanes difformis	*Solanum aethiopium*	tu-ma-re	Ko1
Occimum gratissimum	*Vernonia amygadalina + Dorstenia psilurus*	le-ma-re	Ko20
Occimum gratissimum	*Vernonia amygdalina + Capsicum frutescens*	le-ma-re	Ko29
Cymbopogon citratus	*Vernonia amygdalina+ Citrus limon + Sarcophylum schweinfurthii*	le-de-vaba	Ko34
Solenostemon monostachyus	-	le-ma-hewa	Ko22
Solenostemon monostachyus	-	le-tr-fr	Kw5
Aframomum melegueta	-	se-po-su	Ko10, 18, 20, 21, 22, 31
Aframomum melegueta	-	se-ma-or	Ko11
Aframomum melegueta	-	se-ma-re	Bk4, K10, 11
Aframomum pruinosum	-	le-de-ba	Kw3
Aframomum pruinosum	-	le-de-vaba	Kw9
Aframomum pruinosum	-	st-ma-or	Kw8
Alstonia boonei	-	stb-de-ba	Ko28
Alstonia boonei	-	stb-de-or	Fg7, Ko28
Alstonia boonei	-	stb-ma-or	Bk1, 2, 3, Fg3, 6, Ko9, 10, 12, 18, 19, 20, 21, 27, 33, Kw1, 2, 3, 8
Alstonia boonei	-	stb-ma-re	Bk1, 3, Fg6, Ko27, Kw1
Anchomanes difformis	-	tu-de-re	Ko23
Anchomanes difformis	-	le-de-or	Ko4
Enantia chlorantha	-	stb-de-or	Fg1, 6
Antaenidia conferta	-	le-ma-or	Bk5
Capsicum frutescens	-	le-ma-re	Ko1, 4
Capsicum frutescens	-	fr-ma-or	Ko4
Capsicum frutescens	-	le-tr-ma	Ko28
Capsicum frutescens	-	le-po-ma	Ko26
Capsicum frutescens	-	le-tr-sc	Ko20

Appendix 1. Contd.

Capsicum frutescens	-	fr-ma-re	Kw3, 5
Carica papaya	-	le-de-or	Ko13
Carica papaya	-	le-ma-or	Ko15
Carica papaya	-	le-ma-re	Bk2, Ko22, 34
Carica papaya	-	le-de-vaba	Kw9
Ceiba pentandra	-	stb-ma-or	Bk4
Ceiba pentandra	-	stb-ma-re	Bk4
Citrus limon	-	fr-po-or	Fg2
Citrus limon	-	le-ma-or	Ko25
Citrus limon	-	fr-ju-or	Kw13
Clerodendrum umbellatum	-	le-ma-re	Fg5
Cymbopogon citratus	-	le-de-fowa	Fg4, Kw4
Cymbopogon citratus	-	le-de-or	Ko17
Cyperus sp	-	ro-ma-or	Kw8
Dorstenia psilurus	-	le-de-or	Ko25
Duboscia macrocarpa	-	stb-de-ba	Bk1
Elaeis guineensis	-	se-oi-sc	Ko32
Gambea africana	-	stb-ma-re	Bk1
Guibourtia tessmannii	-	stb-de-or	Ko14
Harungana madagascariensis	-	stb-ma-or	Ko4
Musa paradisiaca	-	fr-ma-or	Ko25
Occimum gratissimum	-	le-tr-fr	Fg6
Occimum gratissimum	-	le-ma-re	Ko3
Occimum gratissimum	-	le-ma-or	Ko24
Occimum gratissimum	-	le-de-or	Ko17, 30, 31
Pachypodanthium staudtii	-	stb-ra-su	Bk1
Picralima nitida	-	stb-ma-or	Bk2
Picralima nitida	-	stb-ra-or	Bk2
Polyaltia suaveolens	-	stb-de-or	Ko25, 32
Psidium guajava	-	le-de-or	Kw3, 12
Pterocarpus soyauxii	-	stb-ra-sc	Ko25
Scorodophleus zenkerii	-	le-de-or	Ko17
Solanum aethiopium	-	fr-ma-or	Kw8
Strophantus glauca	-	le-ma-re	Bk2
Tithonia diversifolia	-	le-ma-re	Ko28
Trema orientalis	-	le-de-vaba	Kw13
Trichoscypha acuminata	-	stb-ra-sc	Bk5
Vernonia amygadalina	-	le-ma-or	Ko4, 22, Kw10
Vernonia amygadalina	-	le-ma-re	Ko3, 21, 22, 34, Kw11

Associated plants: As: associated with. These are plants which are prescribed together with other plant (s) for the same purpose. For exemples, *Dorstenia psilurus* and *Aframomum melegueta* are cited as associated plants to *Occimum gratissimum* for treating malaria. Recipe : the two or three first letters designate the plant part (le: leaf; ro: root; st: stem; stb: stem bark; fr: fruit; se: seed; tu: tuber), the two second letters designate the pharmaceutical form: de: decoction; ju: juice; ma: maceration; oi: oil; po: pounding; ra: rapure; tr:trituration;), the last letters designate the voice of administration (ba: bath; fr: friction; fowa: food wach; hewa: head wach; ma: massage; or: oral; re:rectal; su: suppository; vaba: vaporation bath). Code of informant: the letters designate the ethnic group (Ba: Baka; Fg: Fang; Ko: Kota; Kw: kwélé), the number designate the order number of each informant in his ethnic group.