

ETHNO-BOTANICAL STUDY OF PLANTS USED FOR TREATING MALARIA IN A FOREST: SAVANNA MARGIN AREA, EAST REGION, CAMEROON

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ABSTRACT

Ethno-botanical surveys were conducted in Andom, a village situated in a forest-savanna contact zone from December 2011 to April 2012 with the aim to gather plants that are used in traditional medicine. The method used is direct interviews conducted among adult people, mainly women. The 36 persons interviewed prescribed a total of 219 citations and 94 recipes of 59 plant species distributed in 49 genera and 27 families in the treatment of malaria or fever. About 51.6 % of the citations are made of combination of two, three; four, five, six, or seven plant species. Leaves are the plant parts that are largely used; decoctions are the pharmaceutical forms that are more cited; and recipes are essentially administered orally. A total of 29 plant species (57%) used by Andom people against malaria are also known in other regions of Cameroon and other African countries for the same use. Among these, eight plant species representing 27.6 % are well recognised in the literature for their real activity against malaria including: *Alstonia boonei*, *Carica papaya*, *Citrus limon*, *Cymbopogon citratus*, *Enantia chlorantha*, *Morinda lucida*, *Picralima nitida*, and *Vernonia amygdalina*. The fact that some plant species cited by Andom people are well recognized 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 Andom village 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 anti-malarial activities in the region.

KEY WORDS: Forest-savanna contact zone, Medicinal plants; Malaria; Recipe; Andom village.

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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*, and *Plasmodium vivax*. The parasite is transmitted to its human hosts via various mosquito species of the genus *Anopheles*. Malaria has a great morbidity than any other infectious diseases of the world as well as a contributing factor to poverty in tropical and subtropical regions such as sub-Saharan Africa (World Malarial Report, 2008). *Plasmodium falciparum*; the pathogenic most widespread human malaria is becoming increasingly resistant to anti-malarial drugs. The malaria parasite has gradually developed resistance to the most commonly used medicines. The resistance of *Plasmodium* spp. to drugs such as chloroquinone has become a serious problem in areas of endemic malaria such as Cameroon, and in malaria-free areas with occasional imported cases. This requires extra effort and continuous search for new drugs, especially with new mode of action (Muregi *et al.* cit. Saotoing *et al.*, 2011; Oketch-Rabah and Mwangi, 1998). Ethnobotanical survey is an important step in the identification, selection and development of the therapeutic agents from medicinal plants (Balick, 1985, 1990, 1994; Cotton, 1996; King and Tempesta, 1994). This paper aims to analyze the traditional use of medicinal plants in the treatment of malaria in Andom, a village situated in the forest-savannah contact zone, East region, Cameroon.

MATERIAL AND METHODS

The study site

Andom village is in the Eastern region, in the Lom and Djerem division, Diang subdivision or commune. The village was established in 1925 and is located at about 45 km from Bertoua, the regional capital of East Cameroon. Houses line both sides of National Route 1, which is 3.5 km, East to West. The population of Andom village is about 2,500. The *Bamvélé* people are classified within the Tuki, Bantou group, and along with the Baka and Bororo peoples, live in Andom

village. Among them, the *Bamvélé* people are the most prevalent ethnicity within Andom village. Andom is located at the forest-savanna transition zone, with the savanna being the main useful lands. Cassava, groundnuts, maize and cocoyams seem to be in this order, the most important crops cultivated in this savanna area. But some people are moving more and more in the forest zone in search of new and fertile soils for cultivation. The mixed cropping of cassava and groundnuts or maize under grass fallow is the most common cropping system used in Andom village. In this fallow, the wild plant species *Chromolaena odorata*, known locally as “*Bokassa*” abounds. Non-timber forest products including wild fruits (moabi, bush mango), caterpillar (*egbagéndong*), bushmeat (grass-cutter, rats, duikers) are used in the daily diet of the villagers as sources of complementary proteins. Andom village is rich in medicinal plants which are used for the daily healthcare.

Ethno-botanical survey

Data for this study were obtained from direct interviews with the local people conducted from December 2011 to April 2012 in Andom village. 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 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, we made enquiry “as to what 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.

For each health problem cited, details of prescriptions (plant part used, mode of preparation, etc.) were carefully recorded. The vernacular names of the plants were recorded as much as possible, and the plants mentioned by the informants were collected. The final

identification of plants was made at National Herbarium of Cameroon Yaounde (YA) with the help of Dr. Onana and Mr. Paul Mezili. Voucher herbal specimens, collected in three samples are kept at the YA.

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. In this paper, anti-malarial plants refer to the plants used for treating malaria or fever on a broader scale.

RESULTS

List of anti-malarial plants

A total of 36 persons (Table 1) provided information on the use of medicinal plants in treatment of malaria comprising 29 women and 7 men. The average age of the informant is 54 years old. A total of 51 plant species were cited for which a total of 219 citations were made on malaria (Table 2). The plant species cited are

distributed in 49 genera and 27 families. The most cited plant species are: *Alstonia boonei* (24 citations), *Enantia chlorantha* (22), *Rauvolfia vomitoria* (13), *Dichrocephala integrifolia* (12), *Carica papaya* (10), *Citrus limon* (10), *Schumanniohyton magnificum* (9), and *Capsicum frutescens* (9). The most represented families are Asteraceae (7 plant species) and Apocynaceae (5). The most cited families are Apocynaceae (52 citations), Asteraceae (31), Annonaceae (25), Rubiaceae (15), Rutaceae (11), Solanaceae and Caricaceae (10 citations each).

The list of the 219 citations of anti-malarial plants recorded in Andom village is presented in table 3. Each citation or line in the table presents for a given plant species, the scientific name, the associated plant (s), the plant part cited, the mode of preparation, the voice (way) of administration, and the code of informant(s) who indicated the recipe in brackets. The first letter of the code refers to the gender (M: male, F: female), the number indicates the order number of the informant in each gender.

Table 1: List of informants

Code_informant	Age	Code_informant	Age
F1	34	F19	36
F2	71	F20	55
F3	40	F21	62
F4	50	F22	49
F5	49	F23	76
F6	59	F24	80
F7	64	F25	60
F8	78	F26	39
F9	42	F27	60
F10	52	F28	50
F11	54	F29	51
F12	58	M1	43
F13	75	M2	40
F14	62	M3	35
F15	50	M4	60
F16	35	M5	47
F17	57	M6	74
F18	45	M7	57

Table 2: List of plant species cited as anti-malarials in Andom village

Scientific Name	Family
<i>Acmella caulirhiza</i> Del. (syn. : <i>Spilanthes filicaulis</i> , <i>S. africana</i>)	Asteraceae
<i>Ageratum conizoides</i> L.	Asteraceae
<i>Albizia adianthifolia</i> (Schum.) W.F.Wight	Mimosaceae
<i>Alchornea cordifolia</i> (Sch. & Thonn.) Müll. Arg.	Euphorbiaceae
<i>Alstonia boonei</i> De Wild.	Apocynaceae
<i>Annona muricata</i> L.	Annonaceae
<i>Anonidium mannii</i> (Oliv.) Engl. & Diels	Annonaceae
<i>Beilschmiedia</i> sp	Lauraceae
<i>Bidens pilosa</i> L.	Asteraceae
<i>Bridelia scleroneura</i>	Euphorbiaceae
<i>Capsicum frutescens</i> L.	Solonaceae
<i>Carica papaya</i> L.	Caricaceae
<i>Chenopodium ambrosioides</i> L.	Chenopodiaceae
<i>Chromolaena odorata</i> (L.) R. King & H. Robinson	Asteraceae
<i>Citrus limon</i> L.	Rutaceae
<i>Citrus reticulata</i> L.	Rutaceae
<i>Clerodendrum splendens</i> G. Don	Verbenaceae
<i>Coffea canephora</i> Froehn. (syn : <i>Coffea robusta</i> Linden)	Rubiaceae
<i>Cymbopogon citratus</i> (DC.) Stapf	Poaceae
<i>Dacryodes edulis</i> (G. Don) H. J. Lam	Burseraceae
<i>Dichrocephala integrifolia</i> (L. f.) O. ktze	Asteraceae
<i>Elaeis guineensis</i> Jacq.	Arecaceae
<i>Enantia chlorantha</i> Oliv.	Annonaceae
<i>Eucalyptus camaldulensis</i>	Myrtaceae
<i>Ipomoea involucrata</i> Beauv.	Convolvulaceae
<i>Khaya ivorensis</i>	Meliaceae
<i>Lippia</i> sp	Verbenaceae
<i>Mangifera indica</i> L.	Anacardiaceae
<i>Manihot esculenta</i> Crantz	Euphorbiaceae
<i>Morinda lucida</i> Benth.	Rubiaceae
<i>Musa paradisiaca</i> L.	Musaceae
<i>Musa sapientum</i> L.	Musaceae
<i>Ocimum gratissimum</i> L	Lamiaceae
<i>Persea americana</i> Mill.	Lauraceae
<i>Picralima nitida</i> (Stapf) Th & H. Dur.	Apocynaceae
<i>Psidium guajava</i> L.	Myrtaceae
<i>Pteridium aquilinum</i>	Dennstaediaceae
<i>Rauvolfia vomitoria</i> Afzel.	Apocynaceae
<i>Maranthocloa</i> Sp	Maranthaceae
<i>Schumanniphyton magnificum</i> (R. Good). N. Hallé	Loganiaceae

<i>Solanum melongena</i> L.	Solonaceae
<i>Spathodea campanulata</i> P. Beauv.	Bignoniaceae
<i>Tabernaemontana crassa</i> Benth.	Apocynaceae
<i>Tetrapleura tetraptera</i> (Schum. & Thonn.) Taub.	Mimosaceae
<i>Theobroma cacao</i> L.	Sterculiaceae
<i>Tithonia diversifolia</i> Gray	Asteraceae
<i>Vernonia amygdalina</i> Del.	Asteraceae
<i>Vitex doniana</i> Sweet	Verbenaceae
<i>Voacanga africana</i> Stapf incl.	Apocynaceae
<i>Zingiber officinale</i> Rosc.	Zingiberaceae

Table 3: Citations of anti-malarial plant species in Andom village

Scientific Name	Associated Plant	Plant Part	Mode of preparation	Administration	Code_ Informant
<i>Ageratum conyzoides</i>	associated with <i>Dichrocephala</i>	whole plant	decoction	bath	F2
<i>Ageratum conyzoides</i>	<i>Dichrocephala, Citrus limon</i>	fresh leaves	decoction	oral	F18
<i>Ageratum conyzoides</i>	<i>Elaeis guineensis</i>	fresh leaves	grind	rub on child	F24
<i>Ageratum conyzoides</i>		fresh leaves	maceration	oral	F25
<i>Ageratum conyzoides</i>		fresh leaves	trituration	friction	F3
<i>Ageratum conyzoides</i>		fresh leaves	trituration	press on painful side	F25
<i>Ageratum conyzoides</i>		fresh leaves	trituration	rub on body	F10, F19
<i>Albizia adiantifolia</i>	<i>Voacanga</i>	fresh leaves	pound	application on stomach	M6
<i>Alchornea cordifolia</i>	<i>Rauvolfia vomitoria</i>	fresh leaves	warm on fire-friction-squeeze	oral	F7
<i>Alchornea cordifolia</i>		fresh leaves	decoction	vaporation bath	F8
<i>Alstonia boonei</i>	associated with <i>Cymbopogon</i>	stem bark	decoction	oral	F16
<i>Alstonia boonei</i>	Associated with <i>Vernonia</i>	stem bark	decoction	oral	F20
<i>Alstonia boonei</i>	<i>Citrus limon</i>	stem bark	decoction	oral	F26
<i>Alstonia boonei</i>	<i>Enantia</i>	stem bark	decoction	oral	F29
<i>Alstonia boonei</i>		stem bark	decoction	oral	F1, F2, F4, F7, F9, F10, F12, F18, F19, F25, F28, M1, M2, M4
<i>Alstonia boonei</i>		stem bark	decoction	rectal	F4
<i>Alstonia boonei</i>		stem bark	infusion	oral	F2, M2
<i>Alstonia boonei</i>		stem bark	maceration	oral	F10, F14, F18
<i>Alstonia boonei</i>		stem bark	maceration	rectal	F4
<i>Annona muricata</i>	associated with <i>Carica</i>	fresh leaves	decoction	Vaporation bath	F16
<i>Annona muricata</i>	associated with <i>Coffea</i>	fresh leaves	decoction	oral	F30
<i>Annonidium mannii</i>		stem bark	decoction	oral	F1

<i>Beilschmiedia sp</i>	<i>Capsicum frutescens</i>	stem bark	decoction	nasal	F8
<i>Bidens pilosa</i>	associated with <i>Enantia</i>	fresh leaves	decoction	oral	F27
<i>Bridelia scleroneura</i>	associated with <i>Spathodea</i>	roots	decoction	auricular	F8
<i>Bridelia scleroneura</i>	associated with <i>Spathodea</i>	roots	decoction	nasal	F8
<i>Coffea robusta</i>	<i>Citrus limon, Theobroma</i>	fresh leaves	decoction	oral	F28
<i>Coffea robusta</i>	<i>Musa sapientum</i>	fresh leaves	decoction	Vaporation bath	F23
<i>Capsicum frutescens</i>	associated with <i>Beilschmiedia</i>	fruits	decoction	nasal	F8
<i>Capsicum frutescens</i>	associated with <i>Clerodendrum</i>	fruits	maceration	rectal	F17
<i>Capsicum frutescens</i>	associated with <i>Coffea</i>	fruits	decoction	oral	F30
<i>Capsicum frutescens</i>	associated with <i>Spathodea</i>	fresh leaves	warm on fire-friction-squeeze	nasal	F3
<i>Capsicum frutescens</i>	associated with <i>Spathodea</i>	fresh leaves	warm on fire-friction-squeeze	Oral instillation	F3
<i>Capsicum frutescens</i>	associated with <i>Spathodea</i>	fruits	decoction	auricular	F8
<i>Capsicum frutescens</i>	associated with <i>Spathodea</i>	fruits	decoction	nasal	F8
<i>Capsicum frutescens</i>	Associated with <i>Vernonia</i>	fresh leaves	trituration	rectal	F16
<i>Capsicum frutescens</i>		fruits	decoction	oral	F11
<i>Carica papaya</i>	associated with <i>Coffea</i>	fresh leaves	decoction	Vaporation bath	F27
<i>Carica papaya</i>	associated with <i>Lippia</i>	fresh leaves	decoction	Vaporation bath	F18
<i>Carica papaya</i>	Associated with <i>Persea</i>	fresh leaves	decoction	Vaporation bath	F20
<i>Carica papaya</i>	<i>Citrus limon, Cymbopogon, Musa paradisiaca, Annona, Voacanga</i>	fresh leaves	decoction	Vaporation bath	F16
<i>Carica papaya</i>	<i>Psidium, Coffea, Eucalyptus, Citrus limon</i>	fresh leaves	decoction	oral	F22
<i>Carica papaya</i>	<i>Psidium, Coffea, Eucalyptus, Citrus limon</i>	roots	decoction	oral	F22
<i>Carica papaya</i>		fresh leaves	decoction	oral	F4
<i>Carica papaya</i>		fresh leaves	maceration	oral	F4
<i>Carica papaya</i>		seeds	decoction	oral	F4
<i>Carica papaya</i>		seeds	maceration	oral	F4
<i>Chenopodium ambrosioides</i>	associated with <i>Dichrocephala</i>	whole plant	decoction	Bath	F2
<i>Chenopodium ambrosioides</i>		fresh leaves	decoction	oral	F4
<i>Chromolaena odorata</i>	associated with <i>Coffea</i>	fresh leaves	decoction	Vaporation bath	F3
<i>Chromolaena odorata</i>	<i>Musa sapientum, Thitonia diversifolia</i>	fresh leaves	decoction	Vaporation bath	F5
<i>Citrus limon</i>	associated with <i>Ageratum</i>	fruits	decoction	oral	F18
<i>Citrus limon</i>	associated with <i>Enantia chlorantha</i>	fruits	decoction	oral	M2
<i>Citrus limon</i>	Associated with <i>Alstonia</i>	fruits	decoction	oral	F26
<i>Citrus limon</i>	associated with <i>Carica</i>	fresh leaves	decoction	Vaporation bath	F16
<i>Citrus limon</i>	associated with <i>Carica's leaves</i>	fruits	decoction	oral	F22
<i>Citrus limon</i>	associated with <i>Carica's roots</i>	fruits	decoction	oral	F22
<i>Citrus limon</i>	associated with <i>Coffea</i>	fresh leaves	decoction	Vaporation bath	F27
<i>Coffea robusta</i>	<i>Citrus limon</i>	fresh leaves	decoction	oral	F28

<i>Citrus limon</i>	associated with <i>Coffea</i>	fruits	decoction	oral	F28
<i>Citrus limon</i>	associated with <i>Lippia</i>	fresh leaves	decoction	Vaporation bath	F18
<i>Citrus reticula</i>	Associated with <i>Persea</i>	fresh leaves	decoction	Vaporation bath	F20
<i>Clerodendrum splendens</i>	Associated with <i>Morinda</i>	fresh leaves	trituration	oral	M3
<i>Clerodendrum splendens</i>	Associated with <i>Vernonia</i>	fresh leaves	trituration	rectal	F16
<i>Clerodendrum splendens</i>	<i>Capsicum frutescens</i>	fresh leaves	maceration	rectal	F17
<i>Clerodendrum splendens</i>		fresh leaves	trituration	oral	F16
<i>Clerodendrum splendens</i>		fresh leaves	trituration	oral	F17
<i>Clerodendrum splendens</i>		fresh leaves	trituration	oral	F27
<i>Coffea canephora</i>	<i>Annona, Persea, Capsicum, Elaeis</i>	fresh leaves	decoction	oral	F30
<i>Coffea canephora</i>	associated with <i>Carica's</i> leaves	fresh leaves	decoction	oral	F22
<i>Coffea canephora</i>	associated with <i>Carica's</i> roots	fresh leaves	decoction	oral	F22
<i>Coffea canephora</i>	Associated with <i>Persea</i>	fresh leaves	decoction	Vaporation bath	F20
<i>Coffea canephora</i>	<i>Carica, Musa paradisiaca, Citrus limon</i>	fresh leaves	decoction	Vaporation bath	F27
<i>Coffea canephora</i>	<i>Chromolaena, Psidium</i>	fresh leaves	decoction	Vaporation bath	F3
<i>Coffea canephora</i>		fresh leaves	decoction	oral	F15, F29
<i>Cymbopogon citratus</i>	associated with <i>Carica</i>	fresh leaves	decoction	Vaporation bath	F16
<i>Cymbopogon citratus</i>	<i>Zingiber, Alstonia</i>	roots	decoction	oral	F16
<i>Dacryodes edulis</i>	associated with <i>Lippia</i>	stem bark	decoction	oral	F18
<i>Dichrocephala integrifolia</i>	<i>Ageratum, Musa paradisiaca, Chenopodium</i>	whole plant	decoction	Bath	F2
<i>Dichrocephala integrifolia</i>	associated with <i>Ageratum</i>	fresh leaves	decoction	oral	F18
<i>Dichrocephala integrifolia</i>	associated with <i>Acmela</i>	fresh leaves	pound	Scarification	F16
<i>Dichrocephala integrifolia</i>		fresh leaves	decoction	nasal	F26
<i>Dichrocephala integrifolia</i>		fresh leaves	pound	Application on stomach	F16
<i>Dichrocephala integrifolia</i>		fresh leaves	pound	nasal	F25
<i>Dichrocephala integrifolia</i>		fresh leaves	pound	Scarification	F3
<i>Dichrocephala integrifolia</i>		fresh leaves	trituration	nasal	F18
<i>Dichrocephala integrifolia</i>		fresh leaves	warm on fire-friction-squeeze	nasal	F3, F8, F10
<i>Dichrocephala integrifolia</i>		roots	pound	Scarification	F3
<i>Elaeis guineensis</i>	associated with <i>Ageratum</i>	seeds	oil	rub on child	F24
<i>Elaeis guineensis</i>	associated with <i>Coffea</i>	sap	palm wine	oral	F30
<i>Elaeis guineensis</i>	associated with <i>Tetrapleura</i>	fruits	oil	Massage	F6
<i>Enantia chlorantha</i>	Associated with <i>Alstonia</i>	stem bark	decoction	oral	F29
<i>Enantia chlorantha</i>	associated with <i>Schumanniphyton</i>	stem bark	decoction	oral	F3

<i>Enantia chlorantha</i>	<i>Citrus limon</i>	stem bark	decoction	oral	M2
<i>Enantia chlorantha</i>	<i>Schumanniohyton, Picralima, Bidens</i>	stem bark	decoction	oral	F27
<i>Enantia chlorantha</i>		stem bark	decoction	oral	F1, F2, F4, F7, F8, F9, F10, F14, F16, F18, F25, F28, M1, M4, M5
<i>Enantia chlorantha</i>		stem bark	maceration	oral	F10, F16, F18
<i>Eucalyptus camaldulensis</i>	associated with <i>Carica's</i> fresh leaves	fresh leaves	decoction	oral	F22
<i>Eucalyptus camaldulensis</i>	associated with <i>Carica's</i> roots	fresh leaves	decoction	oral	F22
<i>Ipomoea involucrata</i>	associated with <i>Lippia</i>	fresh leaves	decoction	Vaporation bath	F18
<i>Ipomoea involucrata</i>	associated with <i>Spathodea</i>	fresh leaves	warm on fire-friction-squeeze	nasal	F3
<i>Ipomoea involucrata</i>	associated with <i>Spathodea</i>	fresh leaves	warm on fire-friction-squeeze	Oral instillation	F3
<i>Khaya ivorensis</i>		stem bark	decoction	oral	F1, M2
<i>Lippia sp</i>	<i>Citrus limon, Ipomoea, Ocimum, Vitex, Carica, Dacryodes</i>	fresh leaves	decoction	Vaporation bath	F18
<i>Lippia sp</i>		fresh leaves	decoction	oral	F15
<i>Mangifera indica</i>	Associated with <i>Persea</i>	fresh leaves	decoction	Vaporation bath	F20
<i>Manihot esculenta</i>		Tuber	dry-squeeze	Scarification	M6
<i>Morinda lucida</i>	<i>Spathodea</i>	fresh leaves	warm on fire-friction-squeez	nasal	F16
<i>Morinda lucida</i>	<i>Vernonia</i>	fresh leaves	trituration	oral	M3
<i>Morinda lucida</i>		fresh leaves	ash	nasal	F23
<i>Morinda lucida</i>		fresh leaves	warm on fire-friction-squeeze	nostril	F14
<i>Morinda lucida</i>		stem bark	decoction	oral	F14
<i>Musa paradisiaca</i>	associated with <i>Carica</i>	fresh leaves	decoction	Vaporation bath	F16
<i>Musa paradisiaca</i>	associated with <i>Coffea</i>	fresh leaves	decoction	Vaporation bath	F27
<i>Musa paradisiaca</i>	associated with <i>Dichrocephala</i>	dead leaves	decoction	Bath	F2
<i>Musa sapientum</i>	associated with <i>Chromolaena</i>	dead leaves	decoction	Vaporation bath	F5
<i>Musa sapientum</i>	associated with <i>Coffea</i>	dead leaves	decoction	Vaporation bath	F23
<i>Ocimum gratissimum</i>	associated with <i>Lippia</i>	fresh leaves	decoction	Vaporation bath	F18
<i>Ocimum gratissimum</i>		fresh leaves	warm on fire-friction-squeeze	oral	F13
<i>Persea americana</i>	associated with <i>Coffea</i>	fresh leaves	decoction	oral	F30
<i>Persea americana</i>	<i>Mangifera, Coffea, Citrus reticula, carica</i>	fresh leaves	decoction	Vaporation bath	F20
<i>Picralima nitida</i>	associated with <i>Enantia</i>	stem bark	decoction	oral	F27
<i>Picralima nitida</i>		stem bark	decoction	oral	F4

<i>Psidium guajava</i>	associated with <i>Carica's</i> roots	fresh leaves	decoction	oral	F22
<i>Psidium guajava</i>	associated with <i>Carica's</i> leaves	fresh leaves	decoction	oral	F22
<i>Psidium guajava</i>	associated with <i>Coffea</i>	fresh leaves	decoction	Vaporation bath	F3
<i>Pteridium aquilinum</i>	<i>Sarcophrynium schweinfurthianum</i>	fresh leaves	decoction	Vaporation bath	F24
<i>Rauvolfia vomitoria</i>	associated with <i>Alchornea</i>	fresh leaves	decoction	oral	F7
<i>Rauvolfia vomitoria</i>		fresh leaves	decoction	Massage	F16, F27
<i>Rauvolfia vomitoria</i>		fresh leaves	decoction	oral	F15
<i>Rauvolfia vomitoria</i>		fresh leaves	warm on fire-friction-squeeze	Massage	F18
<i>Rauvolfia vomitoria</i>		fresh leaves	warm on fire-friction-squeeze	press on painful side	F25
<i>Rauvolfia vomitoria</i>		roots	decoction	oral	F3
<i>Rauvolfia vomitoria</i>		roots	pound	nasal	F18
<i>Rauvolfia vomitoria</i>		seeds		oral	F26
<i>Rauvolfia vomitoria</i>		stem bark	decoction	oral	F7, F18, F19, F25
<i>Sarcophrynium schweinfurthianum</i>	Associated with <i>Pteridium</i>	fresh leaves	decoction	Vaporation bath	F24
<i>Schumanniohyton magnificum</i>	associated with <i>Enantia</i>	stem bark	decoction	oral	F27
<i>Schumanniohyton magnificum</i>	<i>Enantia</i>	stem bark	decoction	oral	F3
<i>Schumanniohyton magnificum</i>	<i>Solanum aethiopicum</i>	fresh leaves	pound	Scarification	F27
<i>Schumanniohyton magnificum</i>		stem bark	decoction	oral	F3, F4, F6, F9, F16, M6
<i>Solanum aethiopicum</i>	associated with <i>Schumanniohyton</i>	fresh leaves	pound	Scarification	F27
<i>Spathodea campanulata</i>	Associated with <i>Morinda</i>	fresh leaves	warm on fire-friction-squeeze	oral	F16
<i>Spathodea campanulata</i>	<i>Bridelia scleroneura, Tabernaemontana, Capsicum</i>	stem bark	decoction	auricular	F8
<i>Spathodea campanulata</i>	<i>Bridelia scleroneura, Tabernaemontana, Capsicum</i>	stem bark	decoction	nasal	F8
<i>Spathodea campanulata</i>	<i>Ipomoea involucrata, Capsicum frutescens</i>	fresh leaves	warm on fire-friction-squeeze	nasal	F3
<i>Spathodea campanulata</i>	<i>Ipomoea involucrata, Capsicum frutescens</i>	fresh leaves	warm on fire-friction-squeeze	Oral instillation	F3
<i>Spathodea campanulata</i>		fresh leaves	warm on fire-friction-squeeze	nasal	F27
<i>Acmella caulirhiza</i>	<i>Dichrocephala</i>	fresh leaves	pound	Scarification	F16
<i>Tabernaemontana crassa</i>	associated with <i>Spathodea</i>	stem bark	decoction	auricular	F8
<i>Tabernaemontana crassa</i>	associated with <i>Spathodea</i>	stem bark	decoction	nasal	F8

<i>Tabernaemontana crassa</i>		fresh leaves	warm on fire-friction-squeeze	press on painful side	F21
<i>Tabernaemontana crassa</i>		stem bark	decoction	oral	F13, F21
<i>Tetrapleura tetraptera</i>	<i>Elaeis guineensis</i>	stem bark	rapure	Massage	F6
<i>Cofea robusta</i>	<i>Theobroma</i>	fresh leaves	decoction	oral	F28
<i>Theobroma cacao</i>	associated with <i>Coffea</i>	fresh leaves	decoction	oral	F28
<i>Thitonia diversifolia</i>	associated with <i>Chromolaena</i>	fresh leaves	decoction	Vaporation bath	F5
<i>Vernonia amygdalina</i>	<i>Alstonia</i>	fresh leaves	decoction	oral	F20
<i>Vernonia amygdalina</i>	<i>Clerodendrum, Capsicum frutescens</i>	fresh leaves	trituration	rectal	F16
<i>Vernonia amygdalina</i>		fresh leaves	trituration	oral	F15
<i>Vernonia amygdalina</i>		fresh leaves	trituration	oral	F26
<i>Vernonia amygdalina</i>		roots	pound	nasal	F16, F27
<i>Vitex doniana Sweet</i>	associated with <i>Lippia</i>	fresh leaves	decoction	Vaporation bath	F18
<i>Voacanga africana</i>	associated with <i>Albizia</i>	fresh leaves	pound	Application on stomach	M6
<i>Voacanga africana</i>	associated with <i>Carica</i>	fresh leaves	decoction	Vaporation bath	F16
<i>Voacanga africana</i>		fresh leaves	decoction	oral	F15, F28
<i>Voacanga africana</i>		roots	decoction	nasal	F6
<i>Voacanga africana</i>		roots	decoction	oral	F15
<i>Voacanga africana</i>		roots	maceration	nasal	F6
<i>Voacanga africana</i>		seeds		oral	F28
<i>Zingiber officinalis</i>	associated with <i>Cymbopogon</i>	roots	decoction	oral	F16

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 involved.

A total of nine plant parts were cited by Andom people for treating malaria, including: dead leaves, fresh leaves, roots, sap, seeds, stem barks, tubers, and fruits. Figure 1 illustrates the result. Fresh leaves (49% of citations) and stem barks (33%) are in this order the plant parts that are largely cited. Dead or dried leaves represent only 1.4% of citations. Sometimes, people of Andom village use the whole plant (1.4%).

A total of eleven different mode of preparation of plants (or pharmaceutical forms)

were cited (figure 2): ash, decoction, dry-squeeze, grind, infusion, maceration, oil, pounding, rapure, trituration, warm on fire-friction-squeeze, and wine. Decoction (68% of citations) is the most important mode of preparation of anti-malarial plants.

The relative importance of the modes of administration of recipes used as anti-malarial by Andom people is illustrated in figure 3. A total of 14 modes of administration are shown including: application on stomach, auricular, bath, friction, massage, nasal instillation, application on nostril, oral, pressing on painful side, rectal, rubbing on body, scarification, and vapour bath. Oral voice is largely cited (56%), followed by vapour bath (15%) and nasal instillation (11%). About 51.6% of the citations are made of combination of two, three, four, five, six, or seventh plant species.

Figure 1: Relative importance of plant parts cited for treating malaria in Andom village

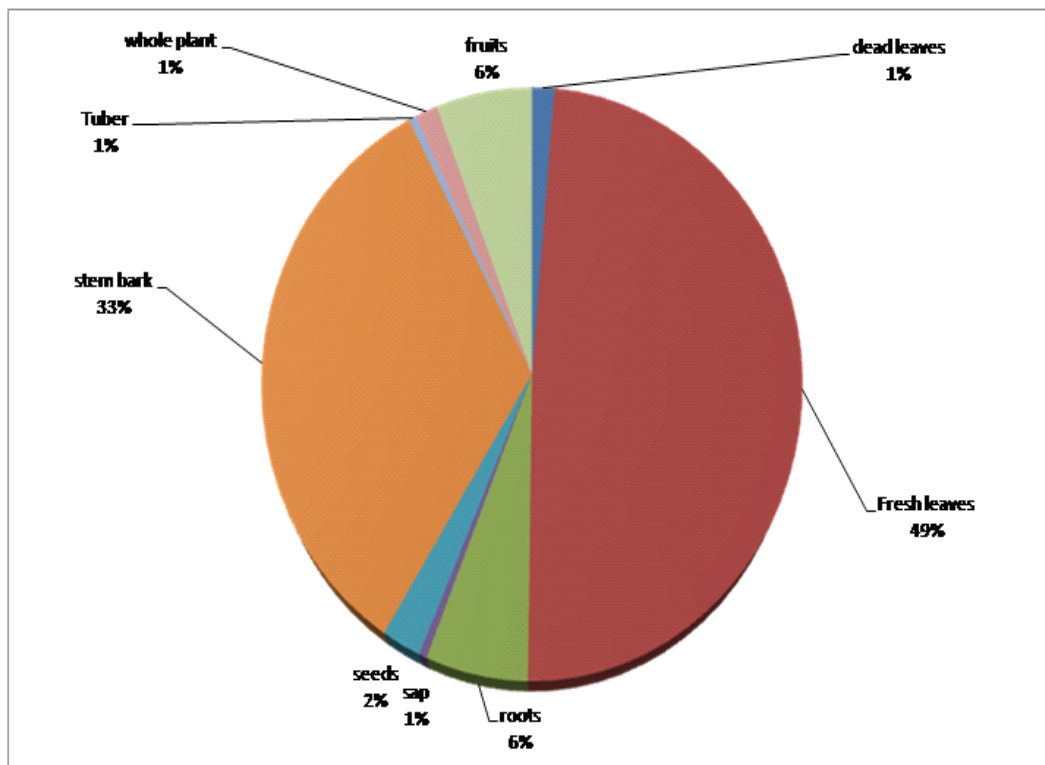


Figure 2: Relative importance of the modes of preparation of recipes in the treatment of malaria in Andom village.

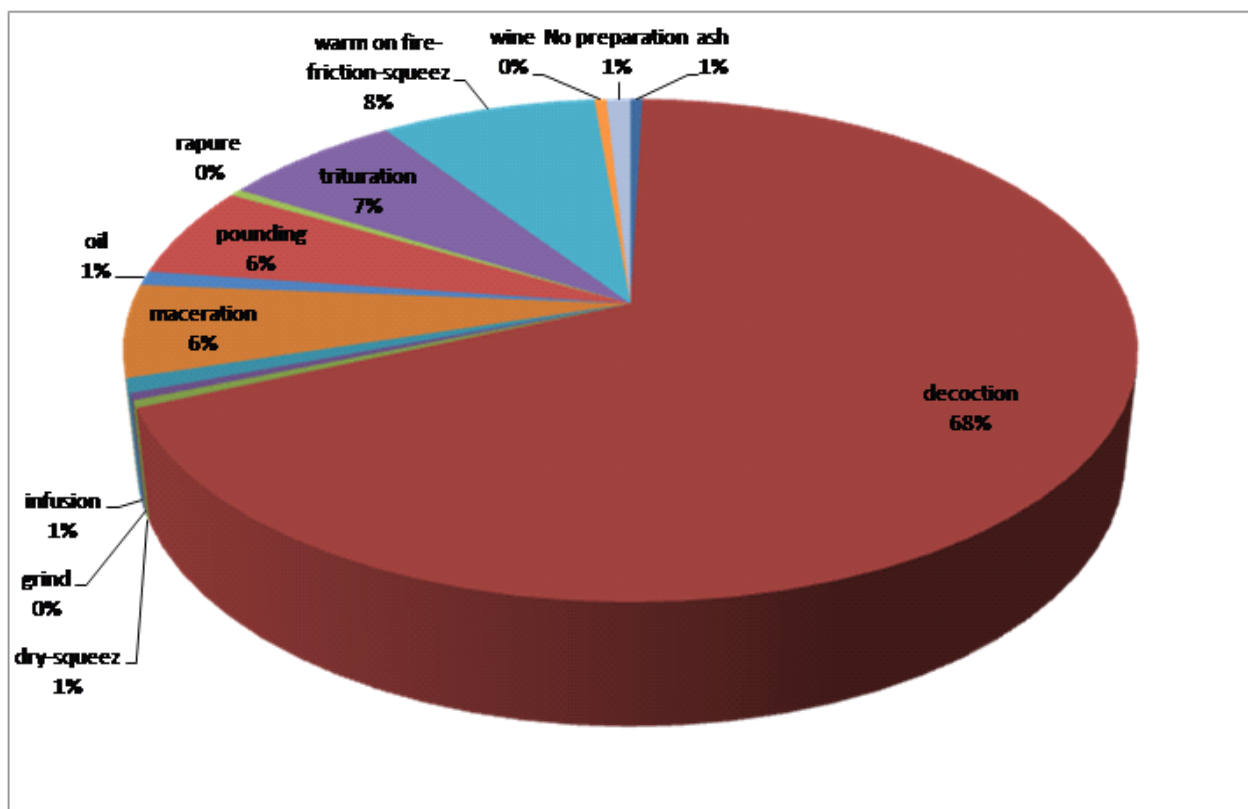
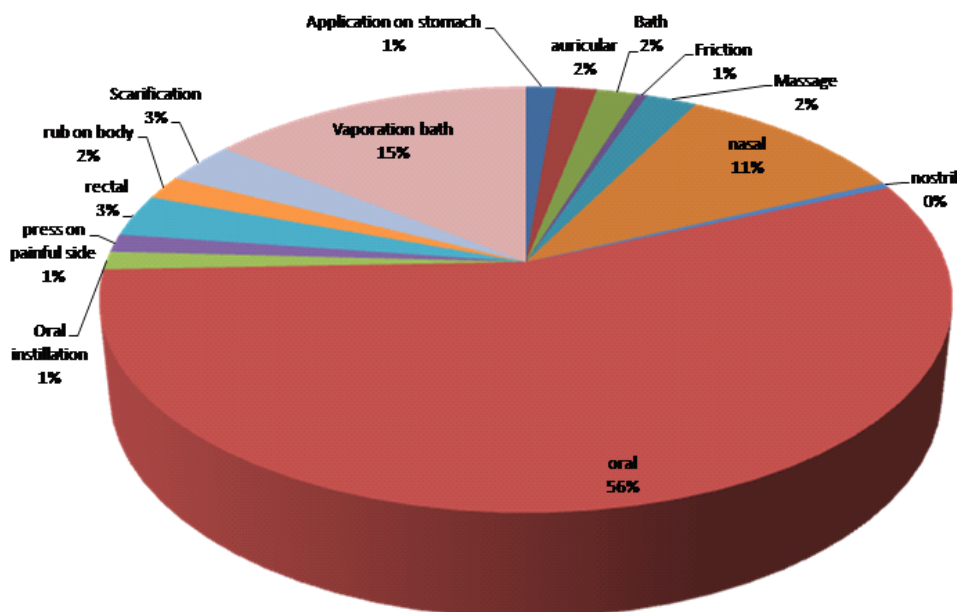


Figure 3: Relative importance of modes of administration of recipes in the treatment of malaria in Andom village.



DISCUSSION

Characteristics of recipes

Recipes gathered in Andom village on anti-malarial plants were compared to those obtained in the Dja Biosphere Reserve in the East Cameroon (Betti, 2001; 2003) and in the Ipassa-Makokou biosphere Reserve in Gabon (Betti *et al.*, 2013), using almost the same method. While leaves appear to be the most important plant parts used in Andom village and Ipassa-Makokou Biosphere Reserve (more than 50%), people living inside and in the periphery of the Dja Biosphere Reserve use mainly stem barks (60%) for treating malaria. Leaves arrive in the third position with only 11% of citations. Andom people have preferences in the use of freshly collected leaves (49%) than dried or dead leaves (1%). Studies had shown that there were quantitative and qualitative differences in the essential oil components of fresh and dry plant materials. Dry plant material might not be as potent as freshly collected materials (Idowu *et al.*, 2010). As observed in the Dja and Ipassa-Makokou Biosphere Reserves, decoction is the main mode of preparation of recipes in Andom village. While people living in Andom village and the Dja Biosphere Reserve use mainly oral

voices, those living in the Ipassa-Makokou Biosphere Reserve in Gabon, prefer vaporation baths as the way of administration of recipes in the treatment of malaria. About half of the recipes indicated for treating malaria by people living in Andom are made of combination of many plant species. In the Ipassa-Makokou Biosphere Reserve, 73% of recipes were made of combination of many plant species. According to Rasoanaivo *et al.* (2011), there is evidence that crude plant extracts often have greater anti-plasmodial activity than isolated constituents at an equivalent dose.

Use of medicinal plants out of Andom village

Citations of plants used in Andom village were compared to those mentioned in African countries. Table 4 presents each plant species cited in Andom, the countries where the same plants are indicated with the references in brackets. A total of 29 plants (57%) used by people living in Andom village as anti-malarial are also known in other region of Cameroon and other African countries for the same usage. The most cited plant species are: *Alstonia boonei* (8 countries), *Rauvolfia vomitoria* (7), *Carica papaya* (6), *Cymbopogon citratus* (5), *Morinda lucida* (5), and *Mangifera indica* (5), *Enantia chlorantha* (4), *Picralima nitida* (4).

Table 4: Use of anti-malarial plants out of the Andom village

Sources

1 : Adjanohoun *et al.* (1996) ; 2 : Bitsindou (1996) ; 3 : Diafouka (1997) ; 4 : Iwu *et al.* (1992) ; 5 : Magilu *et al.* (1996) ; Ngalamulume *et al.* (1995) ; 7 : Richel (1995) ; 8 : Cousteix (1961) ; 9 : Dijk (1999) ; 10 : Betti (2001) ; 11 : Iwu (1994) ; 12 : Betti (2003), 13 : Tchouamo and Njoukam (2000) ; 14 : Betti and Van Essche (2001); 15: Satoing *et al.* (2011); 16 : Betti (2002) ; 17: Idowu *et al.* (2010); 18: Betti *et al.* (2013) .

Plant species	Countries (reference)
<i>Acmella caulirhiza</i>	Cam (9, 10)
<i>Ageratum conizoides</i>	Gab (18)
<i>Alstonia boonei</i>	Cam (1, 8, 9, 10,12,14, 16) ; Cng (3) ; Ga (18); Geq (2) ; Nig (7, 17), Sén (7) ; DRC (5) ; Tog (7)
<i>Annona muricata</i>	Gab (18)
<i>Bidens pilosa</i>	Cam (1, 10, 12) ; DRC (2)
<i>Capsicum frutescens</i>	Cam (10, 12, 14, 15) ; DRC (2), Cng (3), Gab (18)
<i>Carica papaya</i>	Cam (1, 10, 12, 13, 14, 15) ; Cng (2, 3) ; Nig (7, 17), Gha (15), Tog (7); Gab (18)
<i>Citrus limon</i>	Cam (9, 10, 12, 14, 15) ; DRC (2, 5), Gab (18)
<i>Chromolaena odorata</i>	Gab (18)
<i>Clerodendrum splendens</i>	Geq (2) ; Cng (2) ; Gab (2, 18)
<i>Cymbopogon citratus</i>	Cam (1, 2, 9, 10, 12, 14, 15) ; Cng (2, 3) ; DRC (2); Ni (17); Gab (18)
<i>Dacryodes edulis</i>	Gab (18)
<i>Elaeis guineensis</i>	Cam (10, 12, 14) ; DRC (2); Gab (18)
<i>Enantia chlorantha</i>	Cam (8, 9, 10, 12, 14, 16) ; Geq (2) ; Cng (3); Gab (18)
<i>Ipomoea involucrata</i>	Gab (18)
<i>Mangifera indica</i>	Cam (10, 12, 14, 15); Gab (2, 18) ; DRC (2) ; Cg (3), Ni (17)
<i>Manihot esculenta</i>	Gab (18)
<i>Morinda lucida</i>	Cam (9, 10, 12, 14, 16) ; Cng (2) ; DRC (5) ; Nig (7, 11, 17), Tog (7)
<i>Musa paradisiaca</i>	Gab (18)
<i>Ocimum gratissimum</i>	Cam (10, 12, 14) ; Cng (3) ; Ni (17)
<i>Persea americana</i>	Gab (18)
<i>Picralima nitida</i>	Cam (1, 9, 10, 12, 14, 16) ; DRC (5), Nig (4, 11), Gab (18)
<i>Psidium guajava</i>	Cam (15), Ni (17), Gab (18)
<i>Rauvolfia vomitoria</i>	Cam (1, 9, 10, 12, 14) ; Gab, RCA (2) ; DRC (2, 5, 6) ; Nig (7, 17) ; Tog (7) ; Bén (7)
<i>Schumanniphyton magnificum</i>	Cam (10, 12, 14)
<i>Spathodea campanulata</i>	Cam (1, 9, 10, 12, 14) ; Cng (2)
<i>Tabernae montana crassa</i>	Cam (9)
<i>Tetrapleura tetraptera</i>	Cam (10, 12, 14)
<i>Vernonia amygdalina</i>	Cam (10, 15), Ni (17), Gab (18)

Countries: Ben. : Benin ; Cam : Cameroon ; Cng : Congo Brazzaville ; Gha : Ghana ; Geq : Equatorial Guinea ; Nig : Nigeria ; Sen : Senegal ; Gab : Gabon ; RCA : Central African Republic; DRC : Democratic Republic of Congo ; Tog : Togo.

Eight out of the twenty nine plant species (27.6%) also known for their anti-malarial usage out of Andom village are well recognized for their real activity against malaria including: *Alstonia boonei*, *Carica papaya*, *Citrus limon*, *Cymbopogon citratus*, *Enantia chlorantha*, *Morinda lucida*, *Picralima nitida*, and *Vernonia amygdalina*.

Alstonia boonei, *Carica papaya*, *Citrus limon*, *Cymbopogon citratus*, *Enantia chlorantha*, *Picralima nitida* and *Vernonia amygdalina* have been reported to be active against *Plasmodium spp* (Betti, 2001; 2003; Betti *et al.*, 2013). Clinical investigation of *Carica papaya*, *Cymbopogon citratus*, *Ocimum gratissimum*, and *Vernonia amygdalina*, used as traditional medicines in Kinshasa, the Democratic Republic of Congo, to treat malaria patients showed significant removal of parasites in the blood, as well as elimination of clinical detection of disease (Taba *et al.*, 2012). The anti-malarial activity of *Morinda lucida* (Rubiaceae) has been established on *Plasmodium berghei* (Makinde and Obih, 1985; Obih *et al.*, 1985), *P. yoelii nigeriensis* (Agomo *et al.*, 1992) and *P. falciparum* (Gbeassor *et al.*, 1988; Koumaglo *et al.*, 1992; Sittie *et al.*, 1999; Tona *et al.*, 1999). A prophylactic activity has also been established by Makinde and Salako (1991). According to Koumaglo *et al.* (1992), this activity is due to the presence of three compounds (anthraquinones) including digitolutein, rubiadin-1-methyl ether and damnacanthol isolated from the stem and root barks. Tona *et al.* (1999) having put in evidence *Morinda's* activity on leaves which

do not contain the above compounds, concluded that the leaves' activity may come from other type of compounds. The age of development of the plant part does not have any effect on the activity of *Morinda* (Tona *et al.* 1999). Iwu (1994) revealed that the anti-malarial activity of *M. lucida* is largely exploited in primary health centers in Nigeria. However studies have reported the toxicity of that plant species (Idowu *et al.*, 2010).

CONCLUSION

The fact that some plant species cited by Andom people be recognized for their activity against *Plasmodium*, is a credibility index which can be attributed to the pharmacopoeia of those people. This also illustrates the efficiency of the method used to identify medicinal plants of the Andom village. The glaring development challenge at the background of what precedes is the pressing need to implement strategies and programmes to identify active chemical substances of other plant species of this list, which have not yet been investigated for their chemical and anti-malarial activities.

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