

## 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), *Schumanniophyton 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>Picalima 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.

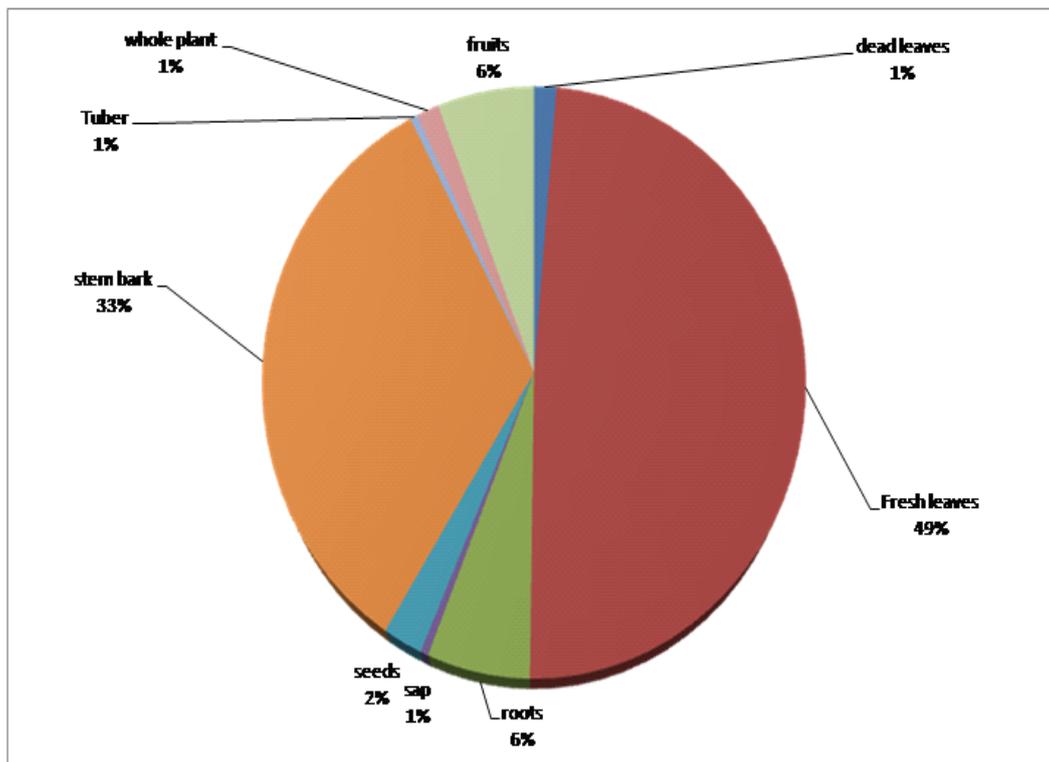
A total of nine plant parts were cited by Andom people for treating malaria, including: dead leaves, fresh leaves, roots, sap, seeds, stem barks, tubers, and fruits. Figure 1 illustrates the result. Fresh leaves (49% of citations) and stem barks (33%) are in this order the plant parts that are largely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

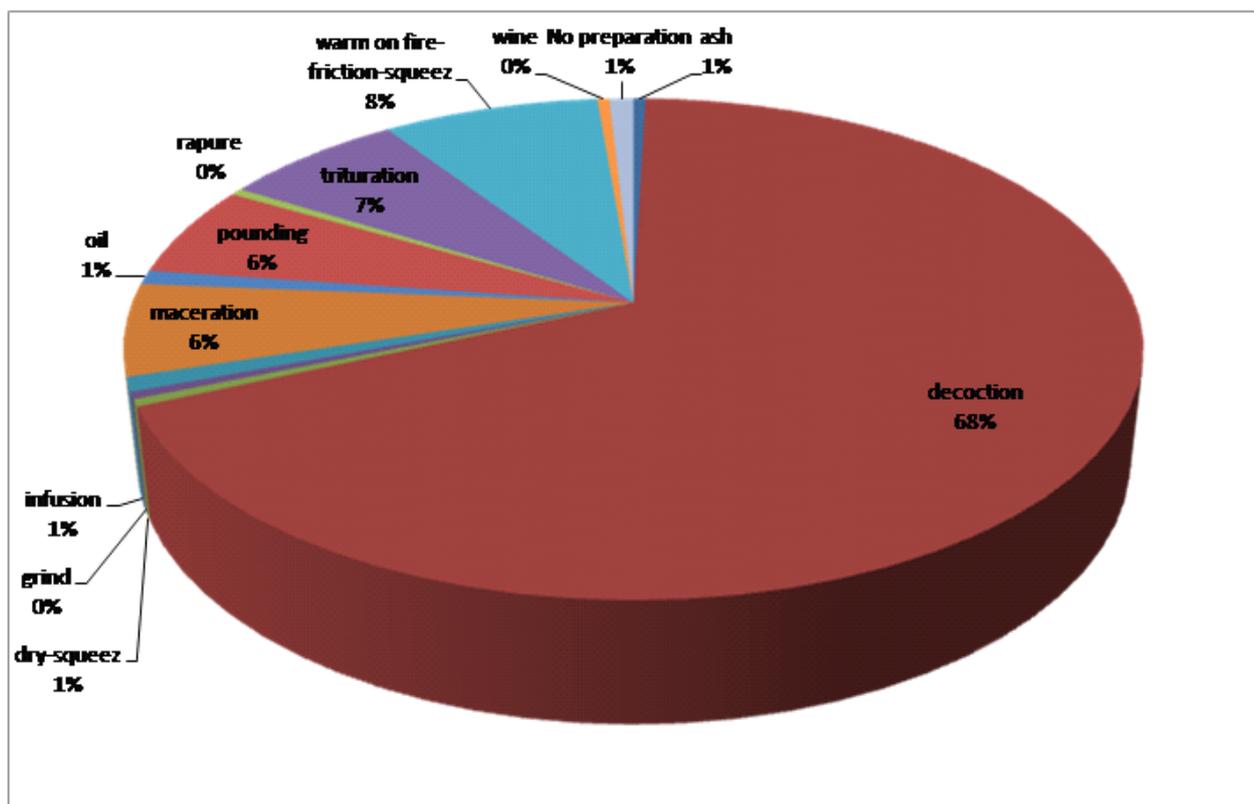
were cited (figure 2): ash, decoction, dry-squeeze, grind, infusion, maceration, oil, pounding, rapure, trituration, warm on fire-friction-squeeze, and wine. Decoction (68% of citations) is the most important mode of preparation of anti-malarial plants.

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.

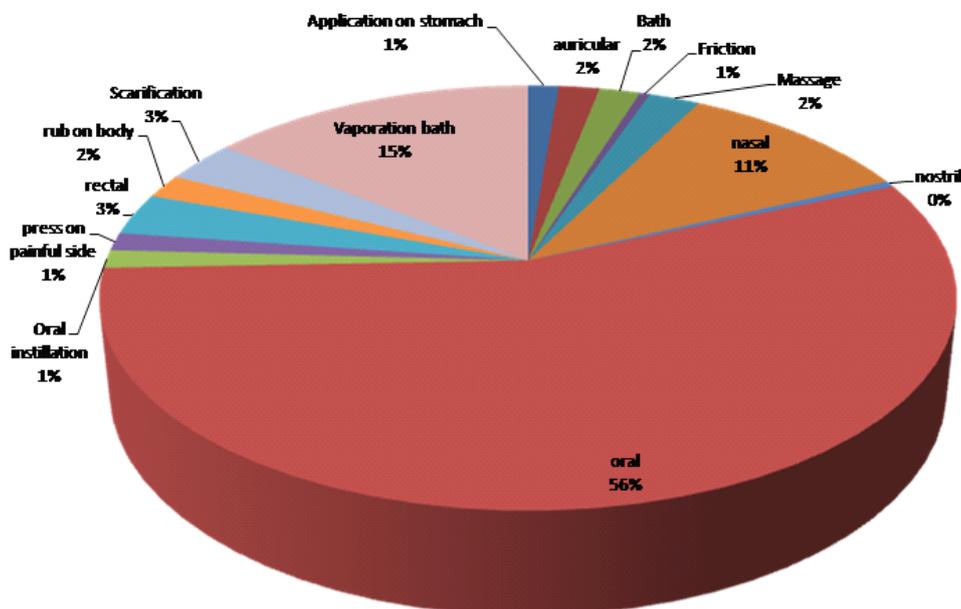
**Figure 1: Relative importance of plant parts cited for treating malaria in Andom village**



**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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