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West African medicinal plants: a review of their antimalarial activity

Abstract

Nowadays, the use of medicinal plants in the fight against malaria must be based on scientific results of safety and quality. However, reviews of the antiplasmodial activities of plants in West Africa in recent years are rare. This study analyzes scientific publications from 2010 to 2021 on plants traditionally used in antimalarial treatments in West Africa. A systematic search was carried out in the PubMed and google scholar databases using the following keywords: Malaria, Antiplasmodial activity, extract, medicinal plant, West Africa; for articles published from 2010 to 2021. These articles concern ethnobotanical studies, antiplasmodial tests, isolated molecules and toxicity tests. A total of 8 West African countries were explored and 54 papers from 2010 to 2021 were selected with 78 plants studied. Nigeria and Burkina Faso recorded more work with 28 and 7 papers respectively and studied more plants with 31, and 16 respectively. The most active extracts for in vitro tests are found in Nigeria with ethanolic extracts of *Phyllanthus amarus* and *Ipomoea purpurea* with respectively an Inhibitory Concentratin of 0.05 µg /mL and 0.06 µg / mL. The most active extract *in vivo* is found in Nigeria with the methanolic fraction of *Parkia biglobosa* with a 100% suppression rate at a dose of 100 mg/kg/Day. It is clear that the traditional West African pharmacopoeia is a potential source of effective phytomedicines for the management of malaria.

Keywords: malaria, antiplasmodial activity, extract, medicinal plant, West Africa

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Abbreviations: IC_{50}, concentration which inhibits 50% of the parasitaemia; *Pb: Plasmodium berghei*; *Py*, *Plasmodium yoeli*

Introduction

Malaria caused by parasites of the *Plasmodium species* is a public health burden.[1] In 2020, the World Health Organization reported 241 million cases of malaria and 627,000 deaths worldwide, with a predominance in sub-Saharan Africa.[2] The West African sub-region accounts for 45% of the continent's population and malaria is endemic in 15 of the 17 countries covered by WHO. In Togo, in 2020 according to the report of the National Malaria Control Program (PNLP), 1,737,469 cases were recorded with 929 deaths, 69% of which were children under the age of 5.[3] One of the best malaria control strategies recommended by the WHO is the early diagnosis of malaria cases followed by rapid and effective treatment, with Artemisinin-based Combination Therapies (ACTs) as the first line for cases. uncomplicated malaria and injectable artesunate for the treatment of severe malaria.[4] Despite the beneficial impact of this strategy, the resistance of *Plasmodium* to these conventional antimalarials currently constitutes an obstacle to the elimination of malaria. Drug pressure has been identified as a key factor in the emergence of this resistance.[5]

This resistance has led to the replacement of chloroquine (CQ) with Artemisinin-based Combination Therapeutics.[1] Chloroquine introduced into the treatment of malaria, more than 50 years ago, was effective and the number of deaths has rapidly halved.[6] In addition, it was available, easy to indicate because of low cost, and low toxic.[6] However, it took only a few years to see the development of resistance, which appeared between 1957 and 1970 in Southeast Asia and Latin America, before spreading to Africa (where the greatest number of lethal forms are currently rife) and is now almost universally widespread.[6] ACTs are likely to become ineffective in the coming years due to the uncontrolled use of *Artemisia annua in the* sub-Saharan African region for prevention of malaria.[1] The use of *Artemisia annua* for the prevention of malaria could be an important factor for the emergence of resistance to artemisinin-based therapies.[1]

Faced with this phenomenon, the search for new antimalarials is urgently needed. The isolation of quinine and artemisinin from *Cinchona species ledgeriana and Artemisia annua* respectively and several other secondary metabolites with antiplasmodial properties validates medicinal plants as a potential source of drugs.[7] Wouldn't there be endogenous resources capable of caring for malaria? Traditional African medicine uses many plants that can be a source of new drugs. It is therefore necessary to carry out scientific research to validate the use of these medicinal plants in the fight against malaria. Thus, in the West African region, many scientific researches are carried out on the medicinal plants listed among the populations and traditional health practitioners.[8] Several recent reviews have focused on studies of plants used in Africa for the treatment of malaria.[8] Others have shown the antiplasmodial activities of plants both *in vitro* and *in vivo* as well as their toxicities in Africa or in some of its countries or regions.[8,10,11] However, reviews analyzing work on the antiplasmodial activities of plants in West Africa over recent years are rare. Thus, the present study is an analysis of the various scientific publications from 2010 to 2021 on medicinal plants used in the treatment of malaria in West Africa.

Material and methods

A systematic search was carried out in the PubMed and google scholar databases using the following keywords: malaria; West Africa; antiplasmodial activity; medicinal plant; plant extract; for articles published from 2010 to 2021 and certain references of these articles. The articles selected relate to ethnobotanical studies, *in vitro* and/or *in vivo* antiplasmodial tests, molecules isolated from these plants and toxicity tests. Articles that did not specify extraction solvents, IC_{50} for *in vitro* tests, and those that did not provide information on doses used and parasitemia suppression rates for *in vivo* tests are excluded from selection. Following WHO recommendations and previous scientific data in several antiplasmodial studies on plant extracts and pure compounds,[12] the antiplasmodial activity of extracts and pure compounds is classified as follows Table 1:

For *in vivo* testing the antimalarial activity of the extract East considered as very good when suppression of parasitaemia is ≥ 50% at 100 mg / kg body weight /day, good if reduction in parasitaemia is ≥ 50% at 250 mg/kg body weight /day, moderate if the reduction in parasitaemia is ≥ 50% at 500 mg/kg body weight/day Table 2.[13]

Table 1 Classification of antiplasmodial activity of plant extracts and isolated pure compounds

Extract	IC_{50} (µg/ mL or µM)	Classification
Raw (µg/ mL)	≥ 50	Idle
	15≤ CI_{50} <50	Moderate activity
	5≤CI_{50} <15	Asset
	<5	Very active
Pure compounds (µM)	>50	Idle
	11<CI_{50} <50	Inactive compound
	2<CI_{50} <11	Active compound
	<1	Very active compound

Table 2 Classification of *in vivo* antiplasmodial activity of plant extracts

Extract dose	Percent reduction in parasitaemia	Classification
100 mg/kg body weight/ day	≥ 50%	**Very good**
at 250 mg/kg body weight/day	≥ 50%	**Good**
at 500 mg/kg body weight/day	≥ 50%	**Moderate**

Statistical analyses

The data was analyzed with Graph Pad Prism software version 8.02 and Excel 2016 spreadsheet.

Results

A total of 8 West African countries were explored and 54 articles from 2010 to 2021 were selected with 78 plants studied. These are Benign, Burkina Faso, Ivory Coast, Ghana, Niger, Nigeria, Senegal and Togo. Articles from other countries meeting our selection criteria in the searched databases were not found. Only 13 of the selected papers were published between 2017 and 2021.

Nigeria and Burkina Faso have carried out more work with 28 and 7 articles respectively and studied more plants with 31 and 16 respectively. Extracts from 37 plants out of 78 studied show good activity *in vitro* activity on Plasmodium strains in the laboratory with IC_{50} of crude extracts < 5µg/mL (Table 3). Work from Nigeria, Burkina Faso and Ghana recorded the largest numbers of these plants with 10, 10 and 7 respectively. Ethanol extracts recorded the highest number of very active plants *in vitro* with 14 plants with IC_{50} < 5 µg/ mL Table 4.

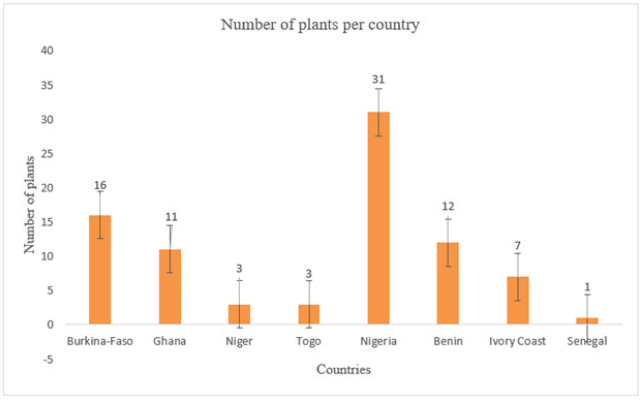

Figure 1 Number of plants per countryThis figure shows the number of plants studied by country.

The most active extracts are found in Nigeria with the ethanolic extract of *Phyllanthus amarus* with an IC_{50} = 0.05 µg / mL and the ethanolic extract of *Ipomoea purpurea* with an IC_{50} = 0.06 µg / mL.[18] These extracts have a similar activity to that of *Artemisia annua* which has an IC_{50} = 0.74 µg/mL.[19] *In vivo* studies on laboratory animals were few: 26 out of 78 (Table 5). The extracts are in general administered by way oral or intraperitoneal on a murine model. The extracts have no show none toxicity *in vivo*. Plasmodium *berghei* strain was used *in 25* studies while *Plasmodium yoeli* was reported that in a single study. Sixteen (16) of the 26 extracts tested present a good activity *in vivo* i.e. 61.54% of plants studied and among them, those from methanol and water distilled respectively have recorded more active plants *with* 5 plants each. The most active extract for *in vivo* testing is found in Nigeria with the methanolic fraction of *Parkia biglobosa* with a parasitaemia suppression rate of 100% at a dose of 100 mg/kg/day.[34]

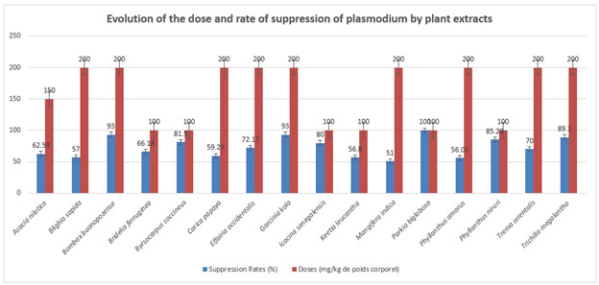

Figure 2 Plants with good activity *in vivo*

These plants have permit to isolate many active molecules and most of these most active compounds are alkaloids. In fact the alkaloids contain an atom nitrogen in the structure which makes them pharmacologically very active Table 4,5,6.[35,36]

Discussion

After investigation with of populations and traditional healers, the medicinal plants are then harvested and subjected to scientific evaluations *in vitro* or *in vivo*. The methods used for antiplasmodial tests are conventional methodologies such as continuous culture methods on *Plasmodium falciparum* bloodlines,[69] activity *in vitro* using radioisotopes methods[70] or microscopic methods and *in vivo* tests of plant extracts.[71] Few articles concerning the antiplasmodial

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activities of medicinal plants in West Africa were published between 2017 and 2021. This would explain the scarcity of recent reviews, highlighting the antiplasmodial activities of medicinal plants in this sub-region. In this review the excerpts are considered very active *in vitro* for a value of IC_{50} < 5µg / mL and *in vivo* when parasitemia is scaled down of 50% depending on the dose of the extract.

Table 3 Plants with strong antiplasmodial activity (IC_{50} <5 µg/ml)

Seedlings	Solvent extraction: IC_{50} (µg/mL) of the plants (Plasmodium falciparum lineage)	Countries	References
Acanthosermum hispidum DC	Lactone: 2.33 (3D7)	Benign	14
alafa barteri	Water distilled: 1.5	Nigeria	15
Alchornea cordifolia	Water distilled: 2.71 (NF54)	Ghana	16
Anogeissus leiocarpus	Methanol / Water: 4.9 (W2)	Burkina Faso	17
Azadirachta indica	Ethanol: 0.08 (3D7)	Nigeria	18
Cassia nigricans	Ethanol: 2.8 (W2)	Niger	19
Celtis integrifolia	Dichloromethane: 3.7(K1)	Burkina Faso	20
cochlospermum planchonii	Methanol - Dichloromethane: 2.4 (3D7)	Burkina Faso	21
Combretum collinum	Dichloromethane: 0.2 (K1) Ethanol- water: 2.1 (K1)	Burkina Faso	22
Diospyros monbuttensis	Methanol: 3, 2	Nigeria	23
Elaeis guineensis	Ethanol: 1.195 (3D7)	Ghana	24
Euphorbia hirta	Ethanol: 3.7 (W2	Niger	19
Ficus capraefolia	Dichloromethane: 1.8(K1)	Burkina Faso	25
Funtumia elastica	Ethanol: 3.6 (FCB1)	Ivory Coast	25
Hunteria eburnea	Ethanol: 2.2 (FCB1)	Ivory Coast	25
Icacina senegalensis	Methanol: 4.7 Pentane: 0.9	Senegal	26
Ipomoea purpurea	Ethanol: 0.06 (L292)	Nigeria	18
Lophira lanceolata	Dichloromethane: 4.7(K1)	Burkina Faso	20
Nauclea latifolia	Ethanol: 0.10 (3D7)	Nigeria	18
ocimum free	Acetate ethyl: 1.8 (K1)	Nigeria	27
Opilia celtidifolia	Dichloromethane: 2.8(K1)	Burkina Faso	20
Pavetta corymbosa	Methanol: 2.042	Togo	28
Phyllanthus amarus	Ethanol: 0.05 (3D7) Alkaloids: 0.27 (3D7)	Nigeria Nigeria	18 18
Phyllanthus fraternus	Methanol: 0.44 (3D7,W2)	Ghana	29
Polyalthia longifolia	Ethanol, N-Hexane, Dichloromethane, Acetate, Methanol - Ethyl acetate: 3–6(K1) Methanol, Chloroform, Cyclohexane, Ethyl acetate: 4.53–10.17 (3D8) Ethanol: 0.28(3D7)	Ghana Ghana Nigeria	30 31 18
Rauvolfa vomitoria	Ethanol: 2.5 (FCB1)	Ivory Coast	25
Sebastiani chamaelea	Ethanol: 3.3 (W2)	Niger	19
Securidaca longepedunculata	Methanol: 2.2(K1, 3D7) Chloroform: 2.6 (K1, 3D7)	Burkina Faso	32
Senna alata	Ethanol: 0.14 (3D7)	Nigeria	18
Sida acuta	Ethanol: 0.25 (3D7)	Nigeria	18
Tamarindus indica	Water distilled: 4.786	Togo	28
Tectona grandis	Methanol: 0.92 (3D7,W2)	Ghana	29
Terminalia avicennioides	Methanol: 1.9 (K1)	Burkina Faso	20
Terminalia ivorensis	Ethanol: 6.949 (3D7)	Ghana	31
Trema orientalis	Hexane: 1.93 (K1)	Nigeria	27
Tridax procumbens	Ethanol: 0.07 (3D7)	Nigeria	18
Zea mays	Acetate ethyl: 3.69 (INDO)	Nigeria	33

IC_{50}: Concentration which inhibits 50% of the parasitaemia; 3D7, NF54, FCB1, W2, K1, L292,3D8, INDO are laboratory strains used.

Table 4 *In vitro* antiplasmodial activity of West African plants

Seedlings	Solvent extraction: IC_{50} (µg/mL) of the plants (Plasmodium falciparum lineage)	Countries	References
Acanthosermum hispidum DC	Lactone: 2.33 (3D7)	Benign	14
Adenia cissampeoides	Ethanol: 8.5 (3D7)	Ghana	24
alafa barteri	Water distilled: 1.5	Nigeria	15
Alchornea cordifolia	Water distilled: 2.71 (NF54)	Ghana	16
Anogeissus leiocarpus	Methanol- water: 4.9 (W2)	Burkina Faso	17
Anthocleista nobilis	Ethanol- water: 20.7 (K1)	Burkina Faso	20
Azadirachta indica	Ethanol: 0.08 (3D7)	Nigeria	18
	Alkaloids: 0.36 (3D7)	Nigeria	18
Baillonella toxisperma	Ethanol < 9.6 (K1)	Benign	37
Boswellia dalzielii	Ethanol < 9.6 (K1)	Benign	37
cajanus cajan	Acetate ethyl: 15.6 (K1)	Nigeria	38
Cassia nigricans	Ethanol: 2.8 (W2)	Niger	19
Celtis integrifolia	Dichloromethane: 3.7(K1)	Burkina Faso	20
cochlospermum planchonii	Methanol- Dichloromethane: 2.4 (3D7)	Burkina Faso	21
Cola millenii	Ethanol: >100 (3D7)	Benign	39
Combretum collinum	Dichloromethane: 0.2 (K1) Ethanol- water: 2.1 (K1)	Burkina Faso	20
Combretum fragrans	Alkaloid: 3 (K1) Chloromethylene: 5 (K1)	Burkina Faso	22
Cordia myxa	Dichloromethane: 6.2	Burkina Faso	20
Crataeva religiosa	Acetate ethyl: 9.6 (K1)	Benign	37
Cymbopogon citratus	Essential oil: 47.92 (3D7)	Benign	40
Cymbopogon giganteus	Essential oils: 11.22 (3D7)	Benign	40
Cymbopogon nardus	Essential oil 52.61 (3D7)	Benign	40
Cymbopogon schoenantus	Essential oil 43.15 (3D7)	Benign	40
Dicoma tomentosa	Dichloromethane, Methanol: 7.04–7.90 (3D7 and W2)	Burkina Faso	41
Diospyros monbuttensis	Methanol: 3.2	Nigeria	23
Dissotis rotundifolia	Ethanol: 6.81 (3D7)	Benign	42
Elaeis guineensis	Ethanol: 1.195 (3D7)	Ghana	24
Euphorbia hirta	Ethanol: 3.7 (W2	Niger	19
Ficus capraefolia	Dichloromethane: 1.8(K1)	Burkina Faso	20
Funtumia elastica	Ethanol: 3.6 (FCB1)	Ivory Coast	25
Hunteria eburnea	Ethanol: 2.2 (FCB1)	Ivory Coast	25
Icacina senegalensis	Methanol: 4.7 Pentane: 0.9	Senegal	26
Ipomoea purpurea	Ethanol: 0.06 (L292)	Nigeria	18
	Alkaloids: 0.37 (L292)	Nigeria	18
Keetia leucantha	Dichloromethane 11.3 (3D7); 15.8 (W2) Methanol >100 (3D7) >100 Water >100 (3D7)	Benign	43
Khaya senegalensis	Cyclohexane, Methylene chloride, Chloroform, Diethyl ether < 9.6 (K1) Acetate ethyl 9.6 (K1)	Benign	37
Lophira lanceolata	Dichloromethane: 4.7(K1)	Burkina Faso	20
Mangifera indica	Water distilled: 18.11	Ghana	16
Morinda lucida	Ethanol: <10 (3D7 and Dd2)	Nigeria	23
morinda morindoids	Ethanol: 9.8 (FCB1)	Ivory Coast	25
Nauclea latifolia	Ethanol: 7.3 (FCB1) Ethanol: 0.10 (3D7)	Ivory Coast Nigeria	25 18
ocimum free	Acetate of ethyl: 1.8 (K1)	Nigeria	27
Olax gambecola	Ethanol: 5.2 (FCB1)	Ivory Coast	25
Opilia celtidifolia	Dichloromethane: 2.8(K1)	Burkina Faso	20

Table 4 continued...

Seedlings	Solvent extraction: IC_{50} (µg/mL) of the plants (Plasmodium falciparum lineage)	Countries	References
Pavetta corymbosa	Methanol: 2.042	Togo	[28]
Pavetta crassipes	Water distilled: <7	Togo	[44]
Phyllanthus amarus	Ethanol: 0.05 (3D7)	Nigeria	[18]
	Alkaloids: 0.27 (3D7)	Nigeria	[18]
	Ethanol: 34.9 (Dd2)	Ghana	[45]
	Ethanol: 5.80	Nigeria	[46]
Phyllanthus fraternus	Methanol: 0.44 (3D7,W2)	Ghana	[29]
Physalis angulata	Ethanol: 7.9 (FCB1)	Ivory Coast	[25]
Polyalthia longifolia	Ethanol, N-Hexane, Dichloromethane, Acetate, Methanol - Ethyl acetate: 3–6(K1)	Ghana	[30]
	Methanol, Chloroform, Cyclohexane, Ethyl acetate: 4.53–10.17 (3D8)	Ghana	[31]
	Ethanol: 0.28(3D7)	Nigeria	[18]
Rauvolfa vomitoria	Ethanol: 2.5 (FCB1)	Ivory Coast	[25]
Sebastiani Chamaelea	Ethanol: 3.3 (W2)	Niger	[19]
Securidaca longepedunculata	Methanol: 2.2(K1, 3D7) Chloroform: 2.6 (K1, 3D7)	Burkina Faso	[32]
Securinega viral	Dichloromethane: 7.1(K1)	Burkina Faso	[20]
Senna alata	Ethanol: 0.14 (3D7)	Nigeria	[18]
acute AIDS	Ethanol: 0.25 (3D7)	Nigeria	[18]
Tamarindus indica	Water distilled: 4.786	Togo	[28]
Tapinanthus dodoneifolius	Methanol: 5.2	Burkina Faso	[20]
Tectona grandis	Methanol: 0.92 (3D7,W2)	Ghana	[29]
Terminalia avicennioides	Methanol: 1.9 (K1)	Burkina Faso	[20]
Terminalia ivorensis	Ethanol: 6.949 (3D7)	Ghana	[31]
	Methanol: 5.70 (3D7,W2)	Ghana	[29]
Trema orientalis	Hexane: 1.93 (K1)	Nigeria	[27]
Tridax procumbens	Ethanol: 0.07 (3D7)	Nigeria	[18]
	Ethanol: 121.3 (Dd2)	Ghana	[45]
Vernonia amygdalina	Ethanol: 9.83 (3D7, NF54)	Nigeria	[47]
Zea mays	Ethanol 3.69 (INDO)	Nigeria	[33]

IC_{50}: Concentration which inhibits 50% of the parasitaemia; 3D7, NF54, *FCB1, W2, K1, L292, INDO are laboratory strains used.*

Table 5 *In vivo* antiplasmodial activity and toxicity of West African medicinal plants

Seedlings	Solvent extraction	Plasmodial species	Dose and route of administration	Parasite suppression spleen	Toxicity in Long live	Countries	References
Acacia nilotica	Methanol	*Pb* (NK65)	150mg/kg/day (intraperitoneal)	62.59%	Non-toxic	Nigeria	[48]
Acanthosermum hispidum DC	Water-acid	*Pb*	2000 mg/kg/day (oral)	50%	Non-toxic	Benin	[14]
Blighia tasted	Ethanol	*Pb* (ANKA)	200 mg/kg/day (intraperitoneal)	57%	Non-toxic	Nigeria	[49]
Bombax buonopozense	Water	Pb (NK65)	200 mg/kg/day (oral)	93%	Not available	Nigeria	[50]
Bridelia ferruginea	Water	*Pb*	100 mg/kg/day (intraperitoneal)	66.18%	Non-toxic	Nigeria	[51]
Byrsocarpus coccineus	Ethanol	*Pb*	100 mg/kg/day (intraperitoneal)	81.50%	Non-toxic	Nigeria	[52]
Carica papaya	Ethanol	*Pb* (NK65)	200 mg/kg/day (oral)	59.29%	Not available	Nigeria	[53]
Cassia alata	dichloromethane / methane (1:1, v/v)	*Pb*	400mg/Kg/day (oral)	45.20%	Non-toxic	Bukina -Faso	[54]
Cassia sieberiana	Ethanol	*Pb*	300 g/kg/day (oral)	63.90%	>2000mg/kg	Nigeria	[55]
Elfairia occidentalis	Water	*Pb* (ANKA)	200 mg/kg/day (intraperitoneal)	72.17%	Not available	Nigeria	[56]

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Table 5 continued....

Seedlings	Solvent extraction	Plasmodial species	Dose and route of administration	Parasite suppression spleen	Toxicity in Long live	Countries	References
Garcinia kola	petroleum ether	*Pb*	200 mg/kg/day (intraperitoneal)	93%	Not available	Nigeria	57
Icacina senegalensis	Methanol	*Pb*	100mg/kg/day (oral)	80%	(LD50>2000mg/kg	Nigeria	58
Keetia leucantha	Dichloromethane, Water	*Pb* *Pb*	200 mg/kg/day (intraperitoneal) 200 mg/kg/day (Oral)	56.80% 53%	Not available	Benin Benin	43
Mangifera indica	Ethyl acetate	*Pb*	200 mg/kg/day (oral)	>50%	Not available	Nigeria	59
Markhamia tomentosa	Water	*Pb* (ANKA)	250 mg/kg/day (oral)	46%	Not available	Nigeria	60
Murraya exotica (L.)	Methanol	*Pb*	600mg/Kg/day (intraperitoneal)	76.02%	Non-toxic	Ghana	61
Parkia biglobosa	Methanol Fraction	Pb	100mg/Kg/day (intraperitoneal)	100%	Non-toxic	Nigeria	34
Phyllanthus amarus	Water Ethanol	Py	200 mg/kg/day (intraperitoneal) 200 mg/kg/day (intraperitoneal)	56.07% 51.72%	Non-toxic Non-toxic	Nigeria	62
Phyllanthus niruri	Methanol (Chloroform Fraction)	*Pb*	100mg/Kg/day (intraperitoneal)	85.29%	Not available	Nigeria	63
Polyalthia longifolia	Water	*Pb* (ANKA)	800 mg/kg/day (oral)	53	Not available	Nigeria	60
Sida acuta	Alkaloids	*Pb*	300 mg/kg/day (oral)	58.56%	Non-toxic	Nigeria	64
Trema orientalis	Methanol	*Pb*	200 mg/kg/day (oral)	70%	Not available	Nigeria	65
Trichilia heudelotii	Water	*Pb* (ANKA)	500 mg/kg/day (oral)	21%	Not available	Nigeria	60
Trichilia megalantha	Methanol Chloroform	*Pb* (ANKA)	200 mg/kg/day (oral)	89.1–100%	Not available	Nigeria	66
Zea mays	Ethanol	*Pb*	374 mg/kg/day (Oral)	53.39	Not available	Nigeria	33

Pb: Plasmodium berghei, Py: Plasmodium yoeli ; ANKA and NK65 are laboratory strains used

Table 6 Molecules isolated from plants with antimalarial activity

Seedlings	Molecules insulated: IC 50 (µg/ml) of the plants; P. falciparum lineage	IC50 of cytotoxicity test (µg/ml): Line cellular	Countries	References
Azadirachta indica	Alkaloids: 0.36 (3D7)	95, 5: Fibroblast cells animals L292	Nigeria	18
cajanus cajan	Cajachalcone: 2 (K1)	Not available	Nigeria	38
Combretum collinum	Alkaloids: 0.4(K1)	HepG2	Burkina Faso	20
Combretum fragrans	Alkaloid: 3 (K1)	HepG2	Burkina Faso	22
Ipomoea purpurea	Alkaloids: 0.37 (3D7)	45, 71: Fibroblast cells animals (L292)	Nigeria	18
Jatropha gossypifolia	Jatrophone: 0.55(D6): 0.52(W2)	0, 43:VERO	Nigeria	67
Phyllanthus fraternus	Entnorsecurin: 0.31 (W2)	Not available	Ghana	68
Senna alata	Alkaloids: 0.14 (3D7)	204.17: Fibroblast cells animals (L292)	Nigeria	18

IC_{50}: Concentration which inhibits 50% of the parasitaemia; 3D7, K1, D6 are laboratory strains used; L292, HepG2, VERO are lineages cellular used.

Work from Nigeria, Burkina Faso and Ghana recorded the highest numbers of active plants *in vitro*. These results reflect the existence of malaria research centers with an adequate technical platform in these countries, unlike other countries in the West African sub-region where financial resources allocated to research are limited.[8] Most strains used are laboratory strains, conditions.which demonstrates the difficulty adaptation of field isolates to proliferation conditions *in vitro* . Polar solvents have been the most used although some nonpolar solvents have been used for the extraction of these plants. Since ethanol extracts have recorded the largest number of active plants *in vitro*, the choice of extraction solvent would therefore have an effect on the effectiveness of the extracts. So 47.44% of the plants present a good activity *in vitro*. Similar studies carried out between 1997 And 2007 by Soh et *al.* (2007) and between 2003 and 2015 by Agbodeka

et *al*. (2017) show respectively 15 % and 28% of plants efficient.[72,8] According these authors, many reasons can be mentioned: Issue of reproducibility of there method traditional in laboratory , degradation possible of Or of the principles assets At course of extraction , efficiency dependent of the associations of plants , not action direct on THE parasite.[8] The results obtained in this present study show an improvement in antiplasmodial tests during these latest years.

The most active extracts found in Nigeria have an activity similar to that of *Artemisia annua* which is a reference plant for the treatment of malaria.[19] This confirms the attention in the research of new antimalarial molecules.

In vivo studies in laboratory animals have been few. *In vivo* tests are usually performed when *in vitro* tests show interesting results. It should be noted that some of the extracts have significant *in vitro* activity but there *in vivo* activity is low and vice versa.[8] Similar studies carried out by Agbodeka et al. between 2003 and 2015 showed 7.53% of plants effective.[8] *In vivo* tests on humans have summer rare due to problems ethics .

Conclusion

The present study is a synthesis of the effectiveness of medicinal plants used in the West African region for the treatment of malaria. These results confirm and reinforce the use of these plants in traditional medicine for the treatment of malaria. However, they are only data preliminaries which deserve further study for a better valuation of these plants. The combination of two or more of these plants could be an interesting avenue for the discovery of new, more efficient molecules. Medicinal plants are therefore a very serious alternative in the management of malaria, especially to solve the problem of resistance of Plasmodium to antimalarials.

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Conflicts of interest

The authors state does not have none conflict of interest.

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