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The Potential of Nigerian Medicinal Plants as Antimalarial Agent: A Review

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ABSTRACT

Malaria is an infectious disease that arises from the presence of parasitic protozoa of the genus plasmodium within the RBC. The disease is confined to tropical and sub-tropical regions of the world and is transmitted by the female anopheles mosquito. The bites of a mosquito inject the parasite into the bloodstream and this migrates to the liver and other organs where they multiply. With varying degrees of incubation period of 12 days to 10 months, the parasite returns to the bloodstream and invade the RBC. Consequential multiplication of the parasite result in the destruction of RBC and this causes a bout of shivering, fever, sweating and ultimately the loss of healthy RBC results in haemolytic anaemia. Several epidemiological evidences from literatures have shown the potential of Nigerian medicinal plant to possess schizonticidal, chemo-suppressive, chemotherapeutic, chemo-preventive and antipyretic properties similar to the synthetic antimalarial agents. However, with advent of resistance to various antimalarial drugs by the parasite, there is need to intensify effort and interest in research for natural antimalarial from Nigerian medicinal plants. This paper reviews the reports on the potencies of Nigerian grown medicinal plants as a good source for novel antimalarial drugs covered from 1999 to 2011.

Keywords: *Medicinal plants, antimalarial, traditional medicine and Nigeria*

I. INTRODUCTION

Malaria is today a disease of poverty and underdeveloped countries, but it remains an important health problem globally. In the last decade, the prevalence of malaria has been escalating at an alarming rate, especially in Africa. An estimated 300 to 500 million cases each year cause 1.5 to 2.7 million deaths, more than 90% in children under 5 years of age in Africa [1], [2].Medicinal plants, since times immemorial, have been used in virtually all cultures as a source of medicine [3]. Traditional plants play an important role in medical system in Nigeria and plant materials remain an important resource to combat serious diseases in the world. Pharmacognostic investigations of plants are carried out to find novel drugs or templates for the development of new therapeutic agents. Since many drugs, e.g quinine and artemisinin were isolated from plants and because of the increased resistance of many pathogens, e.g malaria parasites, towards established drugs, investigation of the chemical compounds within traditional plants is necessary [4]. It is believed strongly that if the herbs used to treat malaria by our ancestors in Africa hundreds of years ago were not effective, malaria would have destroyed Africa. More so, Missionaries that came to Africa would not have met a single person on the continent of Africa [5]. In view of the problems associated with antimalarial drug resistance, new drugs or drug combinations are urgently required today for treatment of malaria. Preferably, the new drugs should have novel modes of action or be chemically different from the drugs in current use [6]. Plants have always been considered to be a possible alternative and rich source of new drugs and most of the antimalarial drugs in use today such as quinine and artemisinin were either obtained directly from plants or developed using chemical structures of plant-derived compounds as templates [7]. Due to limited availability and/or affordability of pharmaceutical medicines in many tropical countries, the majority of the populations depend on traditional medical remedies [8], [9], mainly from plants. In ethnomedicine, same plants and/or related species are used for the treatment of related ailments within the same region, or across different regions of the world. For instance, whereas *Maytenus senegalensis* is used in many African regions for the treatment of various ailments including chest pains, rheumatism, snakebites and malaria, plants of the genus *Maytenus* are used to prepare decoctions in south America as anti-inflammatory and analgesic remedies [10], [11]. This is however not surprising since malaria manifests itself with symptoms including fever, pains and immunosuppression and some plants may lack direct antiplasmodial activity but may possess antipyretic, analgesic and immune stimulatory effects [12]. New antimalarial drugs and approaches to overcome parasite resistance are needed to deal with the expanding problem of drug resistance which continues to challenge malaria control efforts based on early diagnosis and treatments. Only a limited number of antimalarial drugs are currently at an advanced stage of clinical development. In line with this, there is a renewed interest in plant products since the identification of sesquiterpene lactone artemisinin (quighaosu). An attractive option for poor countries is the exploitation of the possible therapeutic effects of their local herbs. The objective of the present study was to report the review and documentation of Nigerian medicinal plants as potential antimalarial drugs.

II. METHODOLOGY

The literature search was mainly through the internet search engines on Nigerian grown medicinal plants reported for

either *in vitro* or *in vivo* antimalarial activity covered from 1999 to 2011. The search strategies adopted includes: Nigerian medicinal plants, Nigerian medicinal plants with antimalarial activity.

Table 1: List of Nigerian Medicinal Plants Reported for Antimalarial Activity

s/n	Name of plant (family)	Local name (Hausa)	Part(s) used	Type of assay	Antimalarial activity	Active compounds	References
1	*Kaya grandifolia* (Meliaceae)	Madaci	Stem bark	In vitro	Good	N A	[13]
2	*Lowsonia inermis* (Lythraceae)	Lalle	Leaf	In vitro	Fair	N A	[13]
3	*Azadirchta indica* (meliaceae)	Dogon yaro	Stem/leaf	In vitro	Good	N A	[13], [14]
4	*Zingiber officinale* (Zingiberaceae)	Citta mai yatsu	Root	In vitro	Fair	N.A	[13]
5	*Striga hermonthica*(Scrophuloriaceae)	Kuduji/wuta-wuta	Whole plant	In vitro	Very good	Saponins, tannins	[15]
6	*Tapinanathus sessillifolia*(loranthaceae)	Kauci	Leaf	In vitro	Good	Saponins, flavonoids	[15]
7	*Quassia amara* (simaroubaceae)	Raken giwa	Leaf	In vivo	Good	N A	[16]
8	*Quassia undulata*(simaroubaceae)	Takandar giwa		In vivo	Good	N A	[16]
9	*Annona senegalensis* (Annonacaea)	Gwandar daji	Leaf	In vivo	Good	Alkaloids, tannins,cardiac glycosides	[17]
10	*Cymbogon giganteus* (Poaceae)	Zana	Leaf	In vitro	Good/very good	N A	[14], [18]
11	*Enantia chlorantha*	?	Leaf	In vitro	Very good	N A	[14], [18]
12	*Morinda lucida* (Rubiaceae)	?	Stem bark/leaf	In vitro	Good	N A	[13], [14]
13	*Citrus medica* (Rutaceae)	Lemun tsami	Leaf/flower	In vitro	Good	N A	[13]
14	*Sarcocephalus latifolius* (Rubiaceae)	tafashiya	Stem bark/leaf		Good	N A	[13]
15	*Morinda morindiodes* (Rubiaceae)	?	Aerial parts/rootbark		Good	N A	[13]
16	*Phyllanthus amara* (Euphorbiaceae)	Baba	Leaf/ stem	In vitro	Very good	N A	[19]
17	*Petivera alliaceae*	?	Stembark/ leaf		Good	N A	[13]
18	*Mangifera indica* (Anacardiaceae)	Mangwaro	Stem bark/leaf	In vitro	Good	Tannins, terpenoids	[20], [21]
19	*Cajanus cajan* (Fabaceae)	Waken suya	Leaf	In vitro	Good	N A	[20]
20	*Vernonia amygdalina* (Asteraceae)	Shuwaka	Leaf	In vivro	Good	N A	[20], [21]
21	*Rowalfia vomitoria* (Apocynaceae)	Wadda	Leaf	In vitro	Fair	N A	[20]
22	*Cassia fistulosa* (Caesalpniaceae)	?	Stem bark	In vitro	Fair	N A	[20]
23	*Garcina kola* (Guttiferae)	Namijin goro	Stem bark	In vitro	Fair	N A	[20]
24	*Chromoleana odorata* (Asteraceae)	?	Aerial parts	In vitro	Fair	N A	[20]

25	*Cymbogon citratus* (Poaceae)	Ciyawa mai kamshin lemu	Leaf	In vitro	Fair	N A	[20]
26	*Anacardium occidentale* (Anacardiaceae)	Kashu	Stem bark	In vitro	Good	Tannins	[20]
27	*Sclerocarya birrea* (Anacardiaceae)	Danya	Stem bark	In vitro	Good	N A	[20]
28	*Balanites aegytiaca* (Balanitaceae)	Aduwa	Bark/seeds	In vitro	Good	N A	[20]
29	*Newboldia laevis* (Bignoniaceae)	Aduruku	Leaf/root vark	In vitro	Good	N A	[20]
30	*Acacia nilotica* (Fabaceae)	Bagaruwa	Roots	In vivo	Good	Saponins,tannins	[22]
31	*Vernonia ambigua* (Asteraceae)	Shuwakar gona	Whole plant	In vitro and in vivo	Good	Saponins,flavonoids, sterols, tannins	[23]
32	*Carica papaya* (Caricaceae)	Gwanda	Leaf	In vitro	Fair	Terpenoids, flavonoids. Saponins	[21]
33	*Psidium guajava* (Myrtaceae)	Gwaba	Leaf	In vitro	Fair	Flavonoids,cardiac glycosides	[21]
34	*Argemone mexicana* Linn (Papaveraceae)	Karanko	Leaf	In vitro	good	Alkaloid	[13]
35	*Alstonia Alstonia* De Wild. (Apocyanaceae)		Stem bark/leaf	In vitro	good	N A	[13]

N A = Not Available

The Potential of Nigerian Medicinal plants as Antimalarials

Several Nigerian medicinal plants have been found to demonstrate an interesting antimalarial potential in the search for a cure against various species of resistant antimalarial agents. In the conventional method of treatment the pathogen (*Plasmodium* species) tends to be resistant to one or more of the several prescribed antimalarial drugs. A report on the *in vivo* antimalarial and cytotoxic properties of *Annona senegalensis* extract, a plant commonly used in Nigerian folk medicine against malaria was observed to show some intrinsic antimalarial activity judging by its percentage chemosuppression in comparison with that of chloroquine in the 4 - day suppressive test [24]. Treatment of mice infected with *P. berghei* with methanolic extracts of *A. senegalensis* showed a dose-dependent chemosuppression in comparison with chloroquine treated controls with the 800mg/kg treated group of mice showing the highest percent chemosuppression. The activity might be attributed to the presence of alkaloids that have been shown to be the major constituents identified in *Annona* species [25], [26]. In another study carried out on four crude organic extracts obtained from medicinal plants used in Nigerian folk medicine for the treatment of fever and malaria was tested *in vitro* against *P. falciparum*. The most active extract was obtained from *E. chlorantha* that showed appreciable inhibition of the parasites at all the concentrations used in the study. *Enantia chlorantha* (bark and leaf) which is used for sore treatment, fevers, coughs, vulnerary ulcer, haemostatic and febrifuge by traditional healers contains alkaloids, lignin, saponins and tannins [27]. For *M. lucida*, dose-dependent inhibitory outcomes were marked. [28], reported the dose-dependent and seasonal variation in the activity of *M. lucida* using both *in vitro* and *in vivo* techniques. *M. lucida* was reported to contain anthraquinones which showed *in vitro* activity against *P. falciparum* and also possess antifungal properties. *Morinda lucida* is used locally in the treatment of yellow fever and jaundice [29]. The inhibition shown by *C. giganteus* can be said to be remarkable because the plants is usually boiled with a mixture of certain other plants in Nigeria for prophylaxis or traditional chemotherapy of malaria. Occasionally, a few people take it alone. The relatively lower inhibition observed for the organic extract of *Azadirachta indica* in this study may correlates earlier findings that *A. indica* functions more as an antipyretic than as a schizonticidal agent in malaria therapy [30].

The antimalarial activity of boiled water extracts of two medicinal plants (*Cymbopogon giganteus* and *Enantia*

chlorantha) against chloroquine resistant *Plasmodium yoelii nigeriensis* in albino mice was assessed. The two extracts cleared the infection in a dose-dependent manner [17] and two years later another studies on four Nigerian medicinal plants against chloroquine-resistant *P.yoelii nigeriensis* in mice were reported in which a remarkable chemosuppressive and prophylactic activities were noted [31]. Their results showed that the boiled water extracts of *C.giganteus* and *E.chlorantha* have good potentials against chloroquine-resistant *P.yoeli nigeriensis* both as schizonticidal and prophylactic agents when compared to artemether. Also, in their study, very little antimalarial activity was reported for *A .indica* and *M. lucida* in the mice. However, [32] reported that the boiled water extract of *A.indica* showed schizonticidal activity against chloroquine-sensitive *P.berghei.* It is therefore possible that the strain of the parasites or the species accounted for the differences observed. In addition it is not uncommon that some plants which are popularly used to treat fever or malaria in some areas may be found to be inactive or toxic in mice [31], [33]. One plausible explanation is the unsuitability of the *in vivo* rodent malaria models to demonstrate the expected activity. Truly, no *in vitro* drug sensitivity test can entirely mimic the *in vivo* situation, but these *in vitro* methods should ideally utilize both uniform drug exposure and a test medium that approximates the *in vivo* milieu [34]. Additional *in vivo* models may be needed to adequately evaluate these antimalarial plants [35].

An ethnobotanical survey of herbal medicine used for the treatment of malaria fever in 17 communities in Ogun State, Southwest Nigeria carried out indicated that *Lowsonia inermis* is used as blood tonic, thus believing that it has a dual effect as antimalarial and blood purifier and in the same vain studies also confirmed that *S. latifolius*, *Alstonia boonei*, *Petivera alliacea*, *Mangifera indica* and *Khaya grandifolia* have significant antimalarial properties [36], [37], [38].

The work of Muregi and Co-workers [12], [39] on the antimalarial activity of methanolic extracts from plants used in Kenyan ethnomedicine and their interactions with chloroquine (CQ) against a CQ-tolerant rodent parasite in mice provide good blue print on the *in vivo* chemo-suppression from six (6) Kenyan medicinal plants *Vernonia lasiopus*, *Ficus sur*, *Clerodendru myricoides*, *Rhamnus prinoides* and *Rhamnus staddo* which showed moderate to significant *in vitro* antiplasmodial activities against both CQ-sensitive and -resistant *P. falciparum* isolates in their water and/or organic fractions. The organic leaf extract of *V. lasiopus* had shown the highest *in vitro* inhibition of parasite growth, with IC50 values as low as 1.0 µg/ml. The presence and/or quantities of bioactive compounds in plants are influenced by several factors including seasons, environment, plant-part used, intra-species variations and plant age [40], and this may explain the discrepancies observed in *in vitro* and *in vivo* activities of plant parts used. Many *Vernonia* species have been investigated chemically and found to contain several metabolites including triterpenes and oxygenated sesquiterpenes, flavones and vernolic acid [41].

III. CONCLUSION

Nigerian medicinal plants possess tremendous therapeutic potential as indicated in the various citation as promising antimalarial agents. Drug resistance to malaria has become one of the most significant threats to human health and the search for new and effective drugs is urgent [42]. One of the key challenges in the fight against malaria is not just to develop effective and safe treatments, but also to make sure they are available to local people at a price that will allow widespread use. New antimalarials are also needed because resistance has rapidly been building up against existing treatments. In addition the dilemma that now faces malaria control authorities arise as a result of the global resistance prevailing against the two most commonly used antimalarial drugs, chloroquine and the antifolate sulphadoxine/pyrimethamine. The challenge ahead lies in determining the best alternative therapies for use now, the best prospect for drug development, regulatory approval and use in short term and the establishment of mechanisms and projects to ensure that improved drugs are sustainably discovered and developed into the future. Continued and sustainable improvements in antimalarial medicines research and development are essential for the world's future ability to treat and control malaria [43]. The results in this study lend some credence to the use of the numerous active species in traditional medicine in the treatment of fever and malaria although the potencies of these active extracts would have to be tested and compared to those of the standard drug test. The different secondary metabolites responsible for this action range from alkaloids, tannins, saponins, terpenes, anthraquinones and so on. More works is needed in this area in order to isolate and characterize the compounds responsible for such action(s).

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