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IN VIVO ANTIPLASMODIAL ACTIVITY OF METHANOL ROOT EXTRACT OF *CISSUS CORNIFOLIA* (BAKER) PLANCH

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ABSTRACT

The plant Cissus cornifolia belongs to the family vitacea. It is traditionally employed in the treatment of many ailments including malaria. The root was cold macerated using 70% methanol while phytochemical analysis was carried out to determine the secondary metabolites using standard protocol. The median lethal dose was then determined by exploiting the OECD protocol. The antiplasmodial activity was evaluated in mice intraperetonially infected with chloroquine sensitive plasmodium berghei-berghei using suppressive, prophylactic, and curative experimental models. Cissus cornifolia root extract revealed the presence of alkaloids, flavonoids, steroids/terpenoids, cardiac glycosides, carbohydrates, phenols, anthraquinones, and tannins. The oral LD50 of crude extract in mice was estimated to be greater than 5000 mg/kg per body weight. Curative effect of crude extract at doses of 250 mg/kg, 500 mg/kg and 1000 mg/kg showed statistical dose dependent significant reduction in mean parasitemia with a p value of 0.001. The standard drugs artesunate and chloroquine offered 85% and 90% respectively, when compared with non-treated mice. The extract, significantly prolonged mean survival time of mice infected with the parasites when compared with the distilled water administered group (Negative). Chemosuppresive effect showed reduction in mean parasitemia with suppression in the extract, chloroquine and artesunates administered groups as compared with the distilled water group. Prophylactic activity showed percentage parasite clearance of 62%, 73% and 65% with the different doses of the extract and 84% clearance for pyrimethamine when compared with negative group. The findings revealed that the extract possess antiplasmodial activity thereby validating its uses in folkloric medicine.

Keywords: Antiplasmodial, *Cissus cornifolia*, *In vivo*, Methanol, *Plasmodium berghei*

INTRODUCTION

Malaria is one of the major diseases affecting poor people in developing countries due to poor sanitation, overcrowding among others. It is one of the leading causes of avoidable death, especially in children and pregnant women. In 2022 WHO estimated that 233 million cases of malaria occurred worldwide with 580,000 recorded deaths. Despite health intervention by the affected countries and organization, there is high prevalence of the disease in South-East Asia (7%) and Africa (233 million cases and 580,000 deaths) (WHO, 2023). The first line treatment for uncomplicated malaria is Artemisinin Combination Therapy (ACT). However, emerging challenges with ACTs, such as delayed hemolysis following Artesunate and oral ACTs (Kurth et al., 2016), raise concerns about their future in malaria chemotherapy. The side effect profile of some antimalarial drugs limits their clinical use. For example, cardiotoxicity is associated with quinine, halofantrine, and mefloquine; hemolytic anemia with primaquine; and kidney damage with quinine (Atsushi et al., 2010). Remedies from natural origins are believed to be harmless and pose low risk; however, some plants are inherently toxic, leading to adverse effects (Doma and Yaro, 2024).

Traditional medicine is the sum total of the knowledge, skill, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness (WHO, 2018). In developing countries traditional medicine still plays an important role in local health care systems. WHO in 2008 estimated that 80% of African population relied on herbal medication for their health care remedy and rose up to 88% in 2018 (Hawa et al. 2021). In Nigeria, 76.65% of the population still relies on traditional medicine (Afisulahi et al. 2022). For example, in Kano and Jigawa States of northern Nigeria, the majority of the population relies on traditional plant medicine to meet their primary health care obligation (Adoum, 2016).

Cissus cornifolia Baker-Planch (Family -Vitaceae) is an annual, sub-erect herb found mainly in the rocky environment and Savannah regions of Ghana and Northern Nigeria.

In Nigeria, more especially in the northern part of the country *Cissus cornifolia planch* root has been used for years as a remedy of malaria and other illnesses (Burkill, 2000). The herb is locally called *Ewe Akoko* in Yoruba, *Ugolo* in Igbo, *Rigarbiri* or "*Duwawun biri*" among the Hausa speaking people of Northern Nigeria (Burkill, 2000). The plant parts are used in African ethno medicine for wide variety of illness such as a remedy for gonorrhoea, malaria, pharyngitis and as a sedative in cases of mental derangement (Burkill, 2000).

MATERIALS AND METHODS

Collection and Identification of Plant Materials

The root of *Cissus cornifolia* was collected from Basawa village, Sabon Gari L.G.A Kaduna State, Nigeria in Febuary 2022. The authenticity of the plant material was confirmed by Botanist in the herbarium section of Plant Biology Department, Bayero University, Kano with a voucher specimen number (BUKHAN 0491) assigned.

Ethical Clearance

Ethical clearance was obtained from Animal Care and Use Research Ethics Committee, BUK. Animals use protocol (AUP) Number: BUK/ACCUREC/CAP/PG10

Preparation of Crude Extract

The plant root was washed with distilled water to remove dirt and dried at a place not above room temperature (to avoid denaturing heat sensitive constituents) until it attained constant weight and ground into fine powder by using mortar

and pestle. A portion of 2 kilogram of the pounded plant root was extracted using cold maceration with 10 litters of 70% methanol for 7 days with stirring. At the end of the extraction, the crude methanol extract was filtered using Whatman No. 1 filter paper (1mm mesh size) and then concentrated in water bath maintained at 500C until greenish black residues was obtained. A portion of the crude extract was subjected to phytochemical analysis (as carried out by Trease and Evans in 2002) using appropriate measures and the portion was reconstituted for further fractionation and the fractions were kept in conserved containers and refrigerated at 21oC for future use. The percentages yield of both the crude methanol and fractions was determined as percentage of the weight (g) of the extract to the original weight (g) of the dried sample used, using the formula below;

$$\text{Percentage yield of crude extract} = \frac{\text{Weight of extract}}{\text{Weight of sample}} \times 100$$

Phytochemical Screening

The phytochemical screening for the determination of the secondary metabolites in the crude methanol root extract of Cissus cornifolia was carried out as described by Trease and Evans 2002.

Acute Toxicity Tests

The oral median lethal dose (LD50) was determined using the Organization for Economic Co-operation and Development (OECD) guidelines in mice. Three mice were fasted for 3hours prior to dosing in the experiment and doses calculated according to the fasted body weight. Food was further withheld for 1-2h after which the methanol crude extract of Cissus cornifolia planch root was administered orally. The limit test was conducted in two stages. In the first stage, 5000 mg/kg of methanol crude extract was used for rat and mouse and observed for 48h. On survival, the second stage was carried out with two additional rats and mice. Both mice and rats were observed during first 30 minutes after treatment and then occasionally within 24h and finally daily for 14 days. Animals were monitored for tremors, convulsion, salivation, diarrhea, sleep, behavioral changes and coma.

Source of Malaria Parasite

The in vivo Plasmodium specie used was Plasmodium berghei NK65 chloroquine sensitive strain obtained from Medical Laboratory Complex of the Nigerian Institute of Medical Research, Yaba Lagos, Nigeria.

Inoculation of Mice

An infected donor mouse was used for infecting the mice in the curative and suppressive and prophylactic test procedures, respectively. The Blood was collected through retro- orbital sinus using heparinized capillary tube. Then the blood was diluted in normal saline treated with trisodium citrate so that each 0.2 ml of the aliquot could contain about 1x107 infected red blood cells. Each mouse was administered with 0.2 ml of the aliquot intraperitoneally.

Antimalarial Studies

Curative or Rane Test

Adult mice were inoculated with Plasmodium berghei berghei on the first day (D0). 72 hours later (D3), the mice were divided randomly into 6 groups of 6 mice each. Group I received 10 ml/kg of distilled water (negative control), Group II, III and IV received 250, 500 and 1000 mg/kg of the root extract of Cissus cornifolia planch respectively. The fifth group received Chloroquine (5 mg/kg) and sixth group was given Artesunate (10 mg/kg). The treatment was carried out once daily for 5 days (Ryley and Peters, 1970). Blood was collected from the tail of each mouse and smear made (Khan et al. 2015). Blood films were then fixed with methanol, stained with 10% Giemsa at pH 7.2 for 10 min and parasitaemia determined microscopically. The percentage parasitaemia was calculated for each dose level by comparing the parasitaemia in infected control with those of treated mice (Peter et al. 1967).

$$\% \text{ Parasitemia} = \frac{\text{number of infected RBC}}{\text{total number of RBCs}} \times 100$$

The average % suppression was calculated as:

$$\text{Average \% suppression} = \frac{\text{A}-\text{B}}{\text{A X}} \times 100$$

Where A = Average percentage parasitaemia in negative control group, and B = Average percentage parasitaemia in test group

Mortality was monitored daily and the number of days from the time of inoculation of the parasite up to death was recorded for each mouse for 28 days. The mean survival time (MST) for each group was calculated as in (Ryley and Peters 1970).

$$\text{MST} = \frac{\text{Sum of survival time (days) of all mice in a group}}{\text{Total number of mice in that group}}$$

Suppressive Test

The Peter`s 4 days' suppressive test against chloroquine sensitive P. berghei berghei NK 65 infection in mice was employed (Peter, 1967). Adult Swiss albino mice were infected by intraperitoneal (IP) injection with standard inoculums of P. berghei berghei with 1 × 107 infected erythrocytes. The first group received distilled water (10 ml), and second group received (1000 mg/kg), third gro up (500mg/kg), fourth group (250mg/kg) of Cissus cornifolia planch root extract, fifth group Chloroquine (5mg) and sixth group Artsunate (10 mg/kg). The grouping was done as described in curative test. On day 5 of the experiment, blood was collected from the tail of each mouse and made smear as mentioned above (Ryley and Peters 1970).

Evaluation of Prophylactic Activity (Repository test)

Evaluation of the prophylactic potential of extract was carried out according to the method of Peters (1967). Adult mice were randomized into 5 groups of six mice each. First group received distilled water (10ml), second group (250mg/kg), third group (500mg/kg), fourth group (1000mg/kg), and fifth group received Pyrimethamine (1.2 mg/kg). Treatments were initiated on day 0 and continued till day 4; mice were all infected with the parasite. After 72hr, thin blood films stained with Giemsa was prepared from tail blood of each mouse on day 8 to monitor the parasitaemia level (Peters, 1967).

Data Presentation and Analysis

Data were evaluated using SPSS version 2020 and results were presented as tables and charts where applicable and expressed as Mean±SEM. Statistical significance testing was done using the one-way analysis of variance (ANOVA) followed by post-hoc analysis-Values of less than or equal to 0.05 were considered statistically significant

RESULTS AND DISCUSSION

Percentage Yields Obtained from Cisssus Cornifolia Planch Root

The macerated 500-gram powder of Cissus cornifolia root produced 192g % of dried methanol extract with less than 50% yields (Table 1).

Table 1: Percentage Yields of Methanol Extract and Fractions of Cisssus Cornifolia Root

Extract	Yield (g)	Percentage Yield (w/w)
Crude extract	192	38.4

Qualitative Phytochemical Constituents of the Crude Extract and Fractions of Cissus Cornifolia Root

Preliminary phytochemical screening of the methanol leaf extract of Cissus cornifolia root revealed the presence of alkaloids, flavonoids, steroids/terpenoids, cardiac glycosides, carbohydrates, phenols, anthraquinones, tanins and tannins. Ethyl acetate revealed the presence of steroids, alkaloids, flavonoids, cardiac glycosides, phenols, saponins and anthraquinones. N-butanol fraction revealed alkaloids, terpenoids, carbohydrate, saponins, steroids, tannins, anthraquinones, saponins and flavonoid and finally residual aqueous fractions revealed cardiac glycoside, alkaloids, flavonoids, tanins, saponins, anthraquinones, phenols, and carbohydrate (Table 2).

Table 2: Qualitative Phytochemical Constituents of Crude Extract and Fractions of Cissus cornifolia Root

Constituents	Test	MRE	EAF	NBF	RAF
Anthraquinones	Bontragers test	+	+	+	+
Flavonoids	Shinodas test	+	+	+	+
Saponins	Frothing test	+	+	+	+
Steroids	Salkowiski test	+	+	+	+
Terpenoids	Burchard test	+	+	+	+
Tannins	Ferric Chloride test	+	+	+	+
Cardiac glycosides	Keller- Killiani test	+	+	+	+
Alkaloids	Dragendroffs test	+	+	+	+
Phenols	Lead acetate test	+	+	+	+

Key: + = Present, MRE=Methanol extract NBF=N-butanol fraction EAF=Ethyl acetate fraction RAF= Residual aqueous fraction

Acute Toxicity Study of Methanol Crude Extract of Cissus cornifolia Planch Root

The oral median lethal dose of methanol crude extract of Cissus cornifolia in mice and rat was estimated to be greater than 5000 mg/kg body weight. The oral administration of 5000mg/kg body weight to both mice and rats did not result in the death of any of the animals after 14 days

Antimalarial studies

Curative Effect of Methanol Root Extract of Cissus cornifolia Planch on Parasitemia

Effect of Cissus cornifolia methanol extract on parasitemia at doses (250, 500 and 1000mg/kg) showed statistical significant ($p<0.01$) reduction in mean parasitemia with % clearance (65%, 69% and 71%) respectively. The standard drugs Chloroquine and Artesunate offered 90% and 85% when compared with non-treated mice. The extract also significantly ($p<0.01$) prolonged survival time of parasites infected mice when compared with the distilled water administered group (Table 3).

Table 3: Curative Effect of Methanol Root Extract Cissus cornifolia on Parasitemia

Treatment (mg/kg)	Mean parasitemia	MST (Day)	% Clearance
DW (10ml)	19.03±0.96	11.50±1.36*	-
MRE (250)	6.65±0.069*	20.83±0.60*	65.0
MRE (500)	5.80±0.41*	23.00±1.59*	69.5
MRE (1000)	5.50±0.53*	20.33±0.92*	71.2
CQ (5)	1.84±0.27*	20.33±1.14*	90.5
ART (10)	2.73±0.33*	19.83±0.95*	85.6

Values are Mean ± S.E.M. *=$p<0.01$ compared to distilled water control, one-way ANOVA followed by Bonferroni's post hoc test. MRE= Methanol root extract; DW = Distilled water; CQ= Chloroquine; n=6. MST=mean survival time ART= Artesunate

Suppressive Effect of Methanol Extract of Cissus Cornifolia Planch Root on Parasitemia

Methanol extract of Cissus cornifolia at doses (250, 500 and 1000 mg/kg) showed statistical significant ($p<0.01$) reduction in mean parasitemia with % suppression of 79%, 77% and 88% respectively when compared with distilled water group and standard drugs chloroquine and artesunate 93% and 92% (Table 4)

Table 4: Suppressive Effect of Methanol Root Extract of Cissus cornifolia on Parasitemia

Treatment (mg/kg)	Mean parasitemia (%)	% Suppression
DW (10ml)	30.20±1.88	-
MRE (250)	6.12±0.38*	79.7
MRE (500)	6.80±0.31*	77.3
MRE (1000)	3.52±0.34*	88.3
CQ (5)	1.92±0.32*	93.7
ART (10)	2.35±0.24*	92.3

Values are Mean ± S.E.M. *=$p<0.01$ compared to distilled water control, one-way ANOVA followed by Bonferroni's post hoc test. MRE= Methanol root extract; DW = Distilled water; CQ= Chloroquine; n=6 ART= Artesunate

Prophylactic Effect of Methanol Extract of Cissus Cornifolia Planch Root on Parasitemia

The extract of Cissus cornifolia at doses (250, 500 and 1000 mg/kg) exhibited statistical significant ($p<0.01$) reduction in mean parasitemia in the prophylactic test with % clearance 62%,73% and 65% and standard drugs Pyrimethamine (84%) when compared with non-treated mice (Table 5).

Table 5: Prophylactic Effect of Methanol Root Extract Cissus Cornifolia on Parasitemia

Treatment (mg/kg)	Mean parasitemia (%)	% Clearance
DW (10ml)	17.25±1.75	-
MRE (250)	6.40±0.60*	62.9
MRE (500)	4.58±0.26*	73.8
MRE (1000)	5.88±0.22*	65.8
PYT (10)	2.62±0.17*	84.8

Values are Mean ± S.E.M. *=$p<0.01$ compared to distilled water control, one-way ANOVA followed by Bonferroni's post hoc test. MRE= Methanol root extract; DW = Distilled water; PYT= Pyrimethamine; n=6.

Discussion

The traditional use of this root for the treatment of malaria has been largely based on empirical evidence, with its efficacy passed down through generation of traditional healers. However, with the increasing global threat of malaria, there is need to scientifically validate the antimalarial properties of traditionally used plants such as Cissus cornifolia. The present study attempted to investigate in vivo and in vitro antimalarial effect of this plant root and provide scientific evidence to validate its traditional claim and also highlight its potential as a source of novel antimalarial compounds.

The percentage yield of the extract and fractions resulted into varying yield. The differences in the yield of the extract and fractions might be due to differences in solvents polarities which plays crucial role in increasing the solubility of phytochemicals compound (Felhi et al. 2017). Methanol extract was higher in quantity because it is a polar solvent which allowed effective extraction of wide range of compounds.

The qualitative phytochemical screening provides preliminary information about different classes of secondary metabolites present in a plant and the medicinal importance of such plant which may lead to drug discovery and development (Shabbir et al. 2013; Karande et al. 2016). The result of preliminary phytochemical screening of the methanol root extract of Cissus crnifolia revealed the presence of alkaloids, flavonoids, tannins, steroids, phenols, terpenoids, saponins and cardiac glycosides. These metabolites have also been reported in the same plant by other authors (Musa et al 2008 and Yaro et al. 2009). (Fulata et al. 2017). Ethyl acetate fraction revealed the presence of alkaloids, terpenoids, steroids, flavonoids, cardiac glycosides and tannins which were largely supported of the study (Aliyu et al. 2017 Fulata et al. 2017). N-butanol fraction revealed the presence of flavonoids, alkaloids, steroids, terpenoids, phenols, saponins and cardiac glycosides and same secondary metabolites were reported by (Yaro et al. 2015).

Phytochemicals are bioactive compounds produced by plants, and they play a vital role in the medicinal properties of plants. These compounds are responsible for the therapeutic effect, and they have been used for many years. Alkaloids are diverse group of naturally occurring nitrogen containing compounds that exhibit antimalarial properties. Many alkaloids have been isolated from medicinal plants and found to possess efficacy against plasmodium by targeting different stages of parasite life cycle leading to its deaths e.g inhibition of heme polymerization, interference with DNA or RNA synthesis, inhibition of enzymes, inhibition of mitochondria function and energy production (Abdullahi et al. 2024).

The Flavonoid compounds revealed in this extract have been reported to exhibit strong antimarial activity (Kwambe et al. 2019). Flavonoids act by increasing bioavalability and efficacy of artemesinins or help in the conversion of artemesinins into its active form by modulating oxidative stress and iron metabolism within the parasite (Lieu et al. 2018). Flavonoids act as pro- oxidants inside plasmodium infected red blood cells thereby generating reactive oxygen spicies which increase oxidative stress and damage the parasite proteins, DNA and membrane leading to apoptosis like cells death (Ferreira, 2019). Flavonoids also inhibit plasmodium parasites enzymes and metabolism e.g Dihydrofolate reductase (DHFR) in folate metabolism for DNA synthesis, ATPases and protease for survival and replication, Glutathione reductase for survival and replication (Bhattacharya, 2021).

Cardiac glycosides are naturally occurring steroidal compounds found in various medicinal plant which are shown to exhibit antimalarial activity by inhibition of Na+/ K+-ATPase in infected red blood cells which is essential for maintaining ion balance in host red blood cells resulting osmotic imbalance and parasite death (Chinappi, 2020). Cardiac glycosides are also reported to disrupt parasite ion transport and Ph regulation preventing nutrient uptake (Mehlhorn, 2018). It also induces oxidative stress and apoptosis-like cell death or inhibits synthesis of protein by binding to ribosomal sub unit thereby preventing parasite growth (Noulin. 2019).

Furthermore, Phenolic compounds exhibit their antimalarial activity by inhibition of heme polymerization which result to heme accumulation and subsequently becomes toxic to the parasite that leads to its death (Bonday et al. 2000). It also acts by either generation of reactive oxygen species, inhibition of plasmodia enzyme, disruption of mitochondrial function and modulation of host immune response (Mamede et al. 2020). Therefore, the reported availability of these secondary metabolites in Cissus cornifolia planch root extracts and its fraction could be responsible for its antimalarial properties.

Acute toxicity studies are essential for evaluating the safety of plant derived substances, especially those intended for medicinal use (Abdullahi et al. 2024). This study involves administering a single, high dose of a substance to test animals like mice and rats to observe potential adverse effect within short period. These findings help determine safe dosage ranges and identify any early toxicological symptoms. Administration of Cisus cornifolia planch root and its fractions did not exhibit any sign of toxicity throughout the study. These results indicated that the extract is safe at doses up to 5000mg/kg body weight and n-butanol fraction was safe up to above 2015mg/kg body weight, with no adverse effect or mortality observed in both mice and rats. These findings corroborate with that of (Yaro et al. 2015). The Organization for Economic cooperation and Development (OECD), has

recommended chemical labelling and classification of acute systemic toxicity based on oral median lethal dose values. Based on these classifications the Cissus cornfolia planch roots extracts and its fraction are relatively safe (Walum, 1998).

In vivo models on plant materials are important for understanding the biological effect and potential therapeutic administration of plant derived compounds. It allows researcher to assess the biological activity of plant extract and isolated compounds in a complex system. This is essential for understanding how plant derived compounds interacts with living organisms and exerts their biological activity (Zhang et al. 2014).

Malaria is a hematologic disease associated with inflammatory responses that may improve cell-to cell interaction (cytoadherence), cell stimulation involving malaria-derived antigens/toxins and host-derived factors such as cytokines (Depinay et al. 2011). Cissus cornifolia planch root extract was found to exhibit parasite clearance ability above 70% at highest doses of 1000 mg/kg body. The plant may probably act due to its ability to inhibit the production or release of inflammatory mediators associated with malaria or via cytotoxic effect on the parasites. Artemesia annua was reported to inhibit heme detoxification which causes heme accumulation to the parasite which results to its death. It also acts by either induction of stress by producing reactive oxygen species or by targeting parasite metabolism. Some secondary metabolites present in this extract such as alkaloids and flavonoids were reported to exhibit their antimalarial effect by inhibition of protein synthesis in the parasite by targeting ribosomes (Jude, 2017). Saponins were reported to illicit their antimalarial effect by disrupting membrane integrity or digestive vacuole. This result is supported with the study of (Doma et al. 2024) where stem methanol extract reported to cleared parasite by more than 70% in curative model.

The study showed significant increase in mean survival time (MST) days across treated groups which may suggest efficacy of the plant for the treatment of malaria (Udobre et al. 2013). The extended survival days were found to be more at higher doses of extract and also standard drugs Chloroquine and Artesunates. This survival could be due to the presence of its secondary metabolites that cleared the parasites or serves as anti-inflammatory or antioxidants that supported the wellbeing of the mice (Doma and Yaro, 2024).

The chemosuppresive or suppressive effect of plant materials on antimalarial activity refers to the ability of a certain plant extract or compounds to inhibit the growth of malaria parasites. In vivo antiplasmodial activity can be classified as moderate, good, and very good if an extract displayed percentage parasitaemia suppression equal to or greater than 50% (Hansen, 2012). Cissus cornifolia planch root extracts was found to exhibit parasite suppressive ability above 80% at highest doses of 1000mg/kg body which may be probably due to its ability to disrupt parasite membrane or interfere with lipid synthesis which is crucial for parasite survival. Limonoids from Azadiraca indica was reported to disrupt parasite membranes leading to lysis (Gogoi, 2021).

The prophylactic effect of a compound or treatment refers to its ability to prevent infection before the pathogen establishes itself in the host. In case of malaria parasites, prophylactic compounds act by inhibiting the initial stage of parasites developments, disrupting its life cycle,or enhancing host immunity. Several plant derived compounds have demonstrated this protective effect via various mechanisms of action such as immune modulation, oxidative stress induction, and interference with parasite metabolism.

Cissus cornifolia planch root crude extract in this prophylactic study exhibited more than 70% parasite clearances at 500mg/kg body weight which may suggest it acts probably by inhibition of parasite growth in the liver. When malaria parasites enter human blood stream it migrates to the liver where they undergo the exoeythrocytic stage of their development. During this important stage, parasite evades detection by immune system. Some plant compounds were reported to disrupt this process by preventing sporozoite invation inhibits hepatic schizogony or blocking the release of merozites, thereby stopping the infection from growing (Hill et al. 2006). Artemesinin from Artemesia annua reported to disrupt parasite growth by generating reactive oxygen species that causes oxidative stress and damage parasite (Tu, 2016). Cissus cornifolia planch root methanol extract was found to possess in vivo antimalarial which could be due to the presence of its secondary metabolites.

CONCLUSION

Cissus cornifolia planch root methanol extract was found to possess in vivo antimalarial activity which could be due to the presence of its secondary metabolites. The findings of this study revealed that the extract possess antiplasmodial activity thereby validating its uses in folkloric medicine in the treatment of malaria.

RECOMMENDATIONS

Based on this study, the following studies are recommended to be undertaken:

i. Micro-fluorimetric DNA- based assay should be carried out to monitor Plasmodium falciparum growth inhibition at different concentration of the active ingredient.
ii. Morphological study to evaluate the presentation of the plasmodium falciparum cultures after treatment with active ingredient.

REFERENCES

Abdullahi, Ibrahim Doma, Mustapha Ibrahim Gudaji and Abdullahi Hamza Yaro (2024) B-Hematin Inhibition activity of the Methanol Leaf Extracts and Residual Aqueous Fraction of *Ficus Asperifolia*. *FUDMA Journal of Science*. Volume 8 (15-22).

Adebayo, J.O. And Krettlia, A.U. (2010). Potential Antimalarials from Nigerian Plants: A Review. *Journal of Ethnopharmacology*, 133: 289–302.

Adefolaju, Toyin (2011). The Dyanamic and Changing Structure of Traditional Healing System in Nigeria. *International Journal of Health Research*: 4(2). 99-106.

Adesina, K. (2008). Traditional Medicine in Nigeria. Accessed July, 2018. http://www.OnlineNigeria.com/health

Adoum, O.A (2016). Screening of Medicinal Plant Native to Kano and Jigawa States of Northern Nigeria using Artem Cyst (Brine Shrimp Test). *American Journal of Pharmacological Science,*4: 3273-2344

Afisulahi, Abiodun, Yakubu Babatunde, Attahiru Al-Hajj Muhhamd, and Mark Devine (2022). Prevalence and Determinant of Herbal Medicine use among Adult Attending the National Health Insurance Clinic of Abubakar Tafawa Balewa University Teaching Hospital, Bauchi, Nigeria. *Nigerian Journal of Medicine*. Volume 31, 399-418.

Aminake, N., Makoah and Pradel Gabriele (2013). *Antimalarial Drugs Resistance in Plasmodium Falciparum and the Current Strategies to Overcome Them*. Institute of Molecular Biotechnology, RWTH Aachen University, 269-282.

Amorosa, L.F., Corballinic, G. And Coluzzib, M. (2005). Lessons Learned from Malaria Italy' Past and Sub-Sahara's Future. *Health and Place*, 11:65-73.

Anthony Ashmi and Parija Subhash Chandra (2016). Review of Antimalarial Resistance. T*ropical Parasitology*,6 (1): 30-41.

Baelmans, R., Deharo E., Munaz V., Sauvain and Ginsburg H (2000). Experimental conditions for testing the inhibitory activity of chloroquine on the formation of βhematin. *Experimental Parasitology*; 96:243-248.

Balli, S. (2023). Pyrexia: A review of its Pathophysilogy, Diagnosis and Management>*Journal of medical Science*.43(2).53-6.

Bannister, L. And Mitchell, G (2003). The in, Outs and Roundabouts of Malaria. *Trends in Parasitology*, 19: 209-213.

Basima, A. and B. H., Albadarani,(2021). A Preliminary Study of Malaria Infection (Plasmodium Spp) In Iraq Live Stock. *Egyptian Journal of Veterinary Science*. Volume 52, 97-111.

Berhan Mengiste (2008). *Antiplasmodial* Activity of Extracts from *Dodonaea Angustifolia L.F. and Bersama Abyssinica Fresen Against Plasmodium Berghei iin Mice Model*. Addis Ababa University Press, Ethopia, 20-44.

Berkowitz, B.A. (2004). B.G. Katzung. *Basic and Clinical Evaluation of New Drugs*. Lange Medical Books, *Mc Graw-Hill Medical Publishing Division New York Chicago,67*.

Bhattacharya, S., (2021). Flavonoids as potential antimalarial agents.: A review of their mechanism of action and efficacy. *Phytomedicine*, 85, 153-1551.

Boham AB, Kocipal AC. 1994. Flavonoid and condensed tannins from leaves of Hawaiian vaccininum vaticulum and vicalycinium. *Pacific Sciences*., 48: 458-463.

Bonday ZQ, Dhanasekaran S, Rangarajan PN, Padmanaban G (2000). Import of Host Delta-aminolevulinate dehydratase into the Malarial Parasite: Identification of a New Drug Target. *Natural Medicines*; 6:898–903.

Borquaye, Lawrence, Macheal Konney, Edward Ntim Gasu, and Glora Doh (2020) Anti-inflammator and antioxidant activities of extract of *Ressantia Indica, Cissus cornifolia* and *Grossseria Vinei. Cognet Biology Journal.*6;178-187.

Bragga Cssio, Martins Antonio Camarga, Klein Wganer, Wilson Brano and Silva Monaco (2015). Side Effect of Chlroquine and Symptomsreduction in Malaria Endemic Area (Mancio Lima, Acre and Brazil. Interdisplinary *Perspective on Infectious*

Burkill, H.M., (2000). *The Useful Plants of West Tropical Africa*. 2nd Edition. 4, Families M-R. Royal Botanic Gardens, Kew, Richmond, United Kingdom. 969.

Carlton, J.M., Das, A. And Escalante A.A (2013). Genomics Population Genetics and Evolutionary History of Plasmodium Vivax. *Advanced Journal of Parasitology*. 81: 203-222.

Chinappi, M. (2020). Cardiac glycoside from calotropis procera disrupt osmotic balance of fasciola gigantica. *Journal of Ethopharmacoloy*, 247,112-341.

Clark, I.A., And Cowden, W. B (2003). The Pathophysiology of Falciparum Malaria. *Journal of Pharmacology and Therapeutics*. 99(2): 221-260.

Das, D.K., Mukhereje, R., Chakraborty, C (2015). Computational Microscopic Imaging for Malaria Parasite Detection: A Systemic Review. *Journal of Microscopy*. https://doi.org/10.1111/jmi.12270 Accessed December 2021).

Depinay, J. F. Franetich, A. C. And Gr¨ Uner (2011). Inhibitory Effect of TNF-αon Malaria Pre Erythrocytic Stage Development: Influence of Host Hepatocyte/Parasite Combinations, *PloS One*, 6, (3), Article ID E17464.

Doma A. I and Yaro A. H (2024) In Vivo Antiplasmodial and Schizont Inhibition Activity of Methanol Stem Bark Extract of *Ficus vallis-Choude*. *Dutse Journal of Pure and Applied Sciences DUJOPAS* 10 (3c): 21-38, 2024

Dorsey, G., Vlahos, J., Kamya, M. R., Staedke, S. G. And Rosenthal, P. J. (2003). Prevention of Increasing Rates of Treatment Failure by Combining Sulfadoxine-Pyrimethamine with Artesunate or Amodiaquine for The Sequential Treatment of Malaria. *Journal of Infection*, 188: 1231–1238.

Dwivedi, A., (2021). Flavonoids and Phenolic acid: A comprehensive Review on their antioxidant, anti-inflammatory and antimicrobial properties. *Journal of Food Science. 86(5).* S 1448-1463.

Evans, W.C., (2002). *Trease and Evans Pharmacognosy*, 15th edition. W.R., Saunders Company Ltd, London, 15-77.

Felhi Samir, Daouda Amal Hajloui Hafedh, Gharsallah Neji,And Khadri Adel (2017). Solvent Extraction Effect On Phytochemical Constituent Profiles, Antioxidant And Antimicrobial Activities And Functional Group Analysis Of *Ecballium Elatrium* Seed And Peels Fruits. *Journal of Food Science Technology, Campinas*. 37(3), 483-492.

Ferreira, L. S., (2019). Flavonoids: A Review of their bioavailability, Metabolism and Health benefit. *Nutrients*, 11(22). 5218.

Francis, E.G. Cox (2010). *History of the Discovery of the Malaria Parasites and their Vectors*. Department of Infectious and Tropical Diseases. *London School of Hygiene and Tropical Medicine, London WC1E 7HT UK*. 230-245.

Fulata, M., Ali Hamidu, Usman, Arastud William, Sule, Ibrahim and Adamu I., Zadva (2017). Phytochemical, Analgesic and Anti-Imflammatory Evaluation of the Crude Ethanol and N. Hexaneextract of The Aerial Part of *Laggera Aurita Linn*. *Chemistry Research Journal*, 2(6) :22-28.

Gogoi, P. (2021). Limonoids. A comprehensive review on their chemistry, biosynthesis and Pharmacological activities. *Phytochemistry Review*, 20(2), 257-278.

Goldberg DE. (1993). Hemoglobin degradation in *Plasmodium*-infected red blood cells. *Semin Cell Biology*; 4:355–61.

Greenwood, B.M. (2008). Control to Elimination: Implications for Malaria Research. T*rends in Parasitology.* 24: 450-454.

Hansen D.S (2012). Inflammatory Responses Associated with The Induction of Malaria: Lessons from Experimental Murine Models. *PloS Pathogens*, 8: E1003045.

Harbone J.B (1973). Phytochemical methods. London. Chapman and Hall, Ltd., 49-188.

Hawa Mbali, Jessie JaneKhaki, and Alinane, Linda (2021). Prevelence and Correlate of Herbal Medicine use among Anti- Retro Viral Therapy (ART) Client at Queen Elizabeth Central Hospital (QECH), Blantyre Malawi: Cross-Sectional Study. *Malawi Medical Journal*. 33(3).153-158

Hill, R.D., J.K. Baird, M.E. Parise, L.S. Lewis, E.T. Ryan, And A. J. Magill (2006). Primaquine: Report from CDC Expert Meeting Onmalaria Chemoprophylaxis, *The American Journal of Tropica lmedicine and Hygiene*, 75 (3): 402–415.

Hyde, J. E. (2007). Drug-Resistant Malaria an Insight. *FEBS Journal*. 274(18), 4688-4698.

Idris, M.l., nkkafamiya, I.I., Akinterinwa,A., and Japari, J.I (2015). Preliminary studies of some medicinal plants in Girei, Adamawa state of Nigeria. *British Journal of Pharmaceutical research*. 6(3).203-213.

Idro, R., Jenkins, N. E., And Newton, C. R. (2005). Pathogenesis, Clinical Features, And NeurologicalOutcome of Cerebral Malaria. *The Lancet Neurolog,*. 4(12), 827-840.

Jimoh A, Tanko Y, Mohammed A (2013). Modulatory role of methanolic leaf extract of *Cissus cornifolia* on blood glucose levels of normoglycemic wistar rats. *European Journal of Experimental Biology*, 3:; 22–7.

Jude, O.K (2017). Secondary Metabolites from Plant.: A Review of their Antimicrobial, antoxidants, anticancer Properties. *Journal of Pharmacy and Pharmacology*, 74(1),11-34.

Karande AM, Kamble HV., Kumbhar VH., Kane SR., Maghdum CS. (2016), Preliminary Phytochemicals Profile and Antibacterial screening of Glochidion elliptecium. *European journal of Experimental Pharmacology. ;6(4).41-45*

Katerikul Surasak, Buranapong Jirayut, Sriturvanich Wareyut and Kaewthamsorn (2016). The Development of Malaria Diagnostic Techniques: A Review of the Approaches with Focus on Dieelectricphoretic and Magnophoretic Methods. *Malaria Journal*. 15: 358-369.

Katzung, B.G., Masters, S.B., And Trevor, A.J. (2012). *Basic And Clinical Pharmacology.* New York: Mcgraw-Hill Medical.12th Edition.

Kwambe, B. A., Okoro, E. U and Okoro CS (2019). Antiplasmodial activity of Artemesia annua aqueous extracts in plasmodium berghei berghei infected mice. *Journal of Ethnopharmacology*, 231, 145-153.

Liu Ying, Zhou Rui-Min, Zhang Ya-Lan, Wang DUO-Quan, Li SU-Hua, Yang Cheng-Yun, Qlan Dan, Zhoa Yu-Lin, Zhang Hong-Wei and Xu Bian (2018). Analysis *Polymorphisms* in The *Circumsprozoite* Protein Gene of *Plasmodium vivax* Isolate from Henan Province, China. *Malaria Journal*,17(103): 234-242.

Lorke D. A new approach to practical acute toxicity testing. *Archives of Toxicology*, 54: 1983; 275-87

Maigemu Ahmad Yahaya and Kalthum Haji Hassan (2015). Malaria as a Cause of Mortality and Morbidity: Socioeconomic Overview. *Journal on Humanities and Social Science*:5(8) 18-28.

Mehlhorn, H (2018). Cardiac glycosides disrupt integrity of membranes and the contractility of muscles in parasites. *Parasitology Research*, 117(10), 2931-2938.

Memede, O., W., Gwadhri, and P., Lars (2020). Phenolic compounds: A review of structural diversity, biosynthesis and Biological activities. *Journal of food sciences*, 85(5).

Musa, A.M., Yaro, A.H., Usman, H., Magaji, M.G. and Habu, M. (2008). Phytochemical and someneuropharmacological studies on the methanolic leaf extracts of *Cissus cornifolia* (Vitaceae) in mice. *International Journal of Pharmacology*; 4:145-148

Nayyar, G.M., Breman, J.G., and Newton, P. N. (2012). Poor Quality Antimalarial Drugs in Southeast Asia and Sub Saharan Africa. *Journal of Infectious Disease*. Volume 12(7).506-520.

Noulin F (2019). Oxidative stress in malaria: Double edge sword. *Online journal accessed* 20 th November, 2024. Doi 10.1002/1873.1352.

Obadoni BO, Ochuko PO. 2001. Phytochemical studies and Comparative efficacy of the crude extracts of some homeostatic plants in Edo and Delta States of Nigeria. *Global Journal of Pure and Applied Sciences*. 8: 203-208.

Olliaro P. L and Goldberg D. E. (1995). The plasmodium digestive vacuole: metabolic headquarters and choice drug target. *Parasitology Today*; 11:294–7

Olurokoba, A., O., (2018). Toxoplasmosis: A review on toxogenesis, Diagnosis and Control. *Journal of Parasitic diseases*. 42(3).537-547.

Olusegun, L., Thomas, R., And Micheal, I., M (2012). Curbing Aternal and Child Mortality. *The Nigerian Experience*: Doi:10:5897?INJM

Onaku, Linda O (2010). Evaluation of Combinations *of Artesunic* Acid and *Aqueous* Extract of *Azadirachta Indica or Carica Papaya* on the Reduction of Parasitemia in Mice

Infected with *Plasmodium berghe*. University of Nigeria Nsukka Press, 5-126

Peters W (1967). Rational Methods in the Search for Anti-Malaria Drugs. *Transient Research in Social Tropical Medecine*. 61: 400-410.

Peters, W (1998). Drug Resistance in Malaria Parasites of Animals and Man. *Advances in Parasitology*, 41, 1-62.

Peters, W. & Robinson, B. L. (1999). *Handbook of Animal Models of Infection*, London. Academic Press. Pharmacology, 74(1),11-34.

R. A. Turner, *Screening Methods in Pharmacology,* Academic Press, New York, NY, USA, 1965

Rayner C., Julian (2015). Plasmodium Malaria Malaria. *EBIO Medicine*. 2: 1023-1029.

Ruqayyah, I. H. Nock, I., Nadams and B.D.J George (2017). Investigating Prevalence and Intensity of *Plasmodium falciparum* Infection and Two Method of Malaria Diagnosis in North Western Nigeria. *International Journal of Tropical Disease.* 23(2): 1-8.

Russo, Gianluca, Giovanni Faggioni, Giacomo Maria Paganotti, Ghysaline Bruna Djeunang Dongho, Allce Pompanni, Ricardo Desentis, Gianpero Tebano, Mpoame Mbida, Martin Sanou Sobze, Vincenzo Vullo, Glovenni Rezza and Florig Romano Lista (2017). Molecular Evidence of *Plasmodium vivax* Infection in Duffy Negative Symptomatic Individuals from Dschang, West Cameroon. *Malaria Jounal*.16:74-87.

Ryley JF, Peters W (1970). The Anti-Malaria Activity of Some Quinolone Esters. *American Tropical Medical Parasitology*. 84: 209-222.

Safil Muheet Alam, Beg Tanveer, Harath Abdul Halim, Altayalan Fahad Suleman and Alquaish Saleh (2013). Antimalarial Drugs: Mode of Action and Status of Resistance. *African Journal of Pharmacy and Pharmacology*: 7(5), 148-156

Shabbir, M., Muhammad, R. K. And Naima, S. (2013). Assessment of Phytochemicals, Antioxidant, Anti-Lipid Peroxidation and Antihemolytic Activity of Extract and Various Fractions of Mytenus Royleanus. *BMC Complementary and Alternative Medicine*. 13:143-145.

Shen, Hai-Mo Shen-Bio Chen and Jun-Nhu (2015). Whole Genome Sequencing of a *Plasmodium vivax* Isolated from the China–Myanamar Border Area. *Rio De Janeiro*.110(6): 814-816.

Sigala P. A and Goldberg D. E (2014). The Peculiarities and Paradoxes of Plasmodium Heme Metabolism. *Annual Revision Microbiology*; 68:259–78.

Sinka Marianne E., Rubio-Palis Yasmin, Manguin Sylvie, Patil Anand P., Temperley Will H, Petter W Gettting, Thomas Van Boeckel, Kbaria W., Caroline, Harback E., Raph and Simon I Hay (2010). The Dominant Anopheles Vectors of Human Malaria in the Americas: Occurrence Data, Distribution Map and Bionomic Precis. *Parasite and Vectors.* 3 (72): 1-26.

Sofowora, A. (2008). *Medicinal Plants and Traditional Medicine in Africa*. Spectrum Books Limited, Ibadan, Nigeria, 3rd Edition. Pp. 200-202.

Somzeet P, Chouldry, NSK, Jagannath PV, Dippiti KP, (2009). Analgesics, Antipyretic and Antiimflammatory effect of the whole plant extract of *Desmotachya bipinnata stapf (Poaceac*) in Albino rats. Drug Invent. 1(2).150-153.

Sundus Shafat Ahmad, Mnju Rahi, Vikash Ranjan and Amit Sharma (2021). Mefloquine as A Prophylaxis for Malaria Need to Be Revisited. *International Journal of Parasitology. Dug and Resistance.* Volume 17, 23-26.

Talent Chipiti, Muhammad Auwal Ibrahim, and Shahidul Islam (2017). In Vitro A-Amylase and A-Glucosidase Inhibitory and Cytotoxic Activities of Extract from *Cissus Cornifolia* Planch Parts. *Journal of Pharmacognosy and Natural Products*. Volume 13(50). 330-333

Tanko, Y., Kadiri, O.T., Mohammed, A., Mahdi, M.A. and Musa, K.Y. (2011). Preliminary anti-diarrhoeal activity of methanol extract of *Cissus cornifolia* (bak) planch on experimental animals. *Annals of Biological Research*; 2(4): 229-237.

Temesgen Bekele (2015). *Invivo Anti-Malarial Evaluation of Leaf Extract of Vernonia amygdalina Del. (Asteraceae)* Against *Plasmodium berghei*. Addis Ababa University Press, Ethiopia. 110-221

Trager W and Jansen JB. (1976). Human Malaria Parasites un continuous Culture. *Science*; 193 (4254): 673-5

Trease, G.E. and Evans, M.C. (1983). *Textbook of Pharmacognosy*. Thirteenth Edition, Bailier Tindal, London, 247-762.

Tripathi, K. D (2003). *Essential of Medical Pharmacology*, 5th Edition, Jaypee Brothers Medical Publication (P) Ltd., New Delhi, 683-693.

Udobre A. S et al. (2013). Effect of Methanol Leaf Extract of *Nauclea latifolia* on Albino Mice Infected with Plasmodium berghei berghei. *African Journal of Pharmacology and Therapeutics*; 2 (3): 83 – 87

Walum, E (1998). Acute Toxicity of some naturally occurring compounds. *Toxicology in vitro*, 12 (2), 123-128.

WHO (2010). *Traditionalmedicine Strategy. Geneva*: Http://Apps.Who.Int/Iris/Handle/Accessed *20 November 2017.*

WHO (2018). *The Biology of Malaria Parasites: Report of WHO Scientific Group.* WHO Technical Report Series 2. (Accessed On April, 2019)

Winter, R.W., Kelly, J.X., Smiikstein, M.J., Dodean, R., Bagby, G.C., Rathbun, R.K., Levin, J.I., Hinrichs, D. and Riscoe M.K (2006). Evaluation and Lead Optimization of Antimalarial Acridones. *Journal of Pharmacology*. 114:47-56.

World Health Organization (2022) *Guidelines for the treatment of malaria*. 2nd edition Geneva, Switzerland: WHO Press.
World Health Organization (WHO, 2020). *Malaria Report*.

World Health Organization (2017). *World Malaria Report*. Geneva. (Http://Creativecommons. Org/Licenses/By-Nc-Sa/3.0/Igo)

Yaro, A.H., Anuka, J.A., Salawu, O.A., Hussaini, I.M, Usman, H. and Musa, A.M. (2009). Comparative Neuropharmacological Activities Methanolic Extracts of Leaves and Roots of *Cissus cornifolia* in Mice. *African Journal of Biomedical Research*; 12(3): 219-223.

Zheinji, L. And Xu Chunbo (2011). The Fundamental Theory of Traditional Chinese Medicine and The Consideration in its Research Strategy. *Journal of Frontiers of Medicine*. 5(2): 208-211.