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Antiplasmodial and Antipyretic Activity of the N-butanol Fraction of Methanol root Extract of Cissuscornifolia

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ABSTRACT

Cissuscornifolia has been used in traditional medicine to treat malaria and inflammatory diseases. The methanol root extract of the plant has been reported to possess antiplasmodial activity. The n-butanol fraction (NBF) of the extract has also been reported to have better in vitroantiplasmodial activity. The aim of the study was thus to evaluate the in vivoantiplasmodial and antipyretic activity of the NBF in murine models. The methanol root extract was fractionated by serial dilution using solvents of varying polarity while preliminary phytochemical screening and oral acute toxicity studies were conducted using standard protocols. The antiplasmodial activity was evaluated in mice intraperetonially infected with chloroquine sensitive plasmodium berghei-bergheiusing suppressive, prophylactic, and curative experimental models. Antipyretic activity was evaluated using the Brewer's yeast induced pyrexia model. Phytochemical constituents of the NBF revealed the presence of anthraquinones, flavonoids, saponins, steroids, terpenoids, tannins, cardiac glycosides, alkaloids and phenols. The LD_{50} was estimated to be 2154 mg/kg body weight. The n-butanol fraction at 150, 300 and 600 mg/kg exhibited significant ($p<0.001$) decrease in parasitaemia level in all the three in vivo models as compared with the control group. It also increases significant ($p<0.001$) mean survival times (Day) of the test animals. The fraction also exhibited significant ($p<0.05$) reduction in body temperature of rats compared to control group. These findings scientifically suggest that the NBF may be useful as antiplasmodial and antipyretic agent.

KEYWORDS: Antiplasmodial, Antipyretic, Cissuscornifolia, In vivo, N-butanol, Plasmodium berghei

I. INTRODUCTION

Medicinal plants provide a rich source of therapeutic agents in treatment of diseases such as malaria, hypertension, inflammation in Africa and other parts of the world. Notable examples include quinine from Cinchona pubescens, digoxin/digitoxin from the vinca alkaloids, morphine from Papaversomniferumetc [1]. Currently there is a surge in scientist interest in plants as source of drugs and isolation of novel molecules for use in the elucidation of physiological/biochemical phenomena. Scientist considers herbal remedies as safer due to their less damaging effect to the human body than synthetic drugs [1].

Cissuscornifolia Baker-Planch (Family - Vitaceae) is an annual, sub-erect herb found mainly in the rocky environment and Savannah regions of Ghana and Northern Nigeria. The herb is locally called Ewe Akoko in Yoruba, Ugolo in Igbo, Rigarbiri or "Duwawunbiri" among the Hausa speaking people of NorthernNigeria [2]. 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 [2].

Previous studies revealed that the methanol leaf and root extracts of Cissuscornifolia possess central nervous system depressant and sedative properties in mice [3], antidiarrheal activity [4], hypoglycemic effects [5], antinociceptive and anti-inflammatory activities of ethylacetate fraction [6], etc.

This study evaluated the in vivoantiplasmodial and antipyretic activities of the n-butanol fraction of this plant. Besides, the finding of this study might provide a clue about the possible mechanisms of antiplasmodial action and may serve as a lead compound for the development of new antimalarial drugs. Furthermore, it might

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serve as baseline information for scientific community to further investigate the plant by initiating advanced studies on molecular mechanisms with identification of the specific agent responsible for the antimalarial effect of the plant.

II. MATERIALS AND METHODS

Collection and identification of plant materials

The root of Cissuscornifolia was collected fromBasawa village, SabonGari 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

Fractionation of crude extract

The methanol crude extract of Cissuscornifolia was subjected to liquid-liquid partition to separate the extract into different fractions. Five hundred milliliters (500 ml) of the reconstituted extract was placed in a separator funnel and 500ml of ethyl acetate and n-butanol solvents were added sequentially as a 1:1 (v/v) solution with frequent shaking. The sample was left to stand for 30 minutes for each solvent on the separator funnel until a fine separation line appear clearly indicating the supernatant from the sediment before desorption. The process was repeated thrice in order to get enough quantity for each fraction. The ethylacetate, n-butanol as well as the aqueous residue fractions were concentrated over a water bath maintained at 50 degrees Celsius. The concentrated fractions were kept in sealed containers and refrigerated at 21degrees Celsius for further use [7].

Phytochemical screening

The phytochemical screening for the determination of the secondary metabolites in the crude methanol root extract of Cissuscornifolia was carried out as earlier described [7].

Acute toxicity tests

In the first phase of the acute toxicity testing, 9 mice were divided into three groups of three mice each and then treated with the n-butanol fraction of Cissuscornifolia root at doses of 10, 100 and 1000 mg/kg orally. The mice were observed for the first four hours and 24 hours after treatment for signs of toxicity including death. In the second phase, four groups of one mouse each were treated with the fraction at selected doses of 1600, 2900, and 5000 mg/kg orally based on the result of the first phase. The mice were observed for the first four hours and 24 hours for signs of toxicity including death. The median lethal dose (LD_{50}) was calculated as the geometric mean of the lowest dose that caused death and the highest dose at which all the animals survived [8].

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 $1x10^7$ infected red blood cells. Each mouse was administered with 0.2 ml of the aliquot intraperitoneally.

Antimalarial studies

Curative or Rane's test

Adult mice were inoculated with Plasmodium bergheibergheion 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 150, 300 and 600 mg/kg of the NBF of Cissuscornifolia 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 [9]. Blood was collected from the tail of each mouse and smear made.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 parasitaemiain infected control with those of treated mice [10].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 [9].

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MST= Sum of survival time (days) of all mice in a group /Total number of mice in that group

Suppressive test

The Peter`s 4 days' suppressive test against chloroquine sensitive P. bergheiberghei NK 65 infection in mice was employed [10]. Adult Swiss albino mice were infected by intraperitoneal (IP) injection with standard inoculums of P. bergheiberghei with 1×10^7 infected erythrocytes. The first group received distilled water (10 ml), and second group received (600 mg/kg), third group (300mg/kg), fourth group (150mg/kg) of NBF of Cissuscornifolia planch methanol 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 [9].

Evaluation of prophylactic activity (repository test)

Evaluation of the prophylactic potential of extract was carried out according to the method of Peters [10]. Adult mice were randomized into 5 groups of six mice each. First group received distilled water (10ml), second group (150mg/kg), third group (300mg/kg), fourth group (600mg/kg) graded doses of NBF 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 [10].

Antipyretic activity of n-butanol fraction of Cissuscornifollia root

Antipyretic activity was evaluated in rat using method as described by Somzeet[11]. The normal body temperature of each rat was checked by using digital thermometer at the beginning of the study. Pyrexia was induced in all rats by injection of 20% aqueous suspension of brewer's yeast at doses of 10mg/kg subcutaneously below the nape of each rat. Animals were fasted with free access to only water after injection for 24hrs. Rectal temperature of each rat was then recorded and pyrexia was determined by increases in temperature between 0.5 degree Celsius and 1 degree Celsius while animals showing less than that were excluded from the experiments. The selected rats were randomly divided in to 5 groups of 6 rats each. Group I received distilled water (10ml/kg), group II received aspirin (150 mg/kg), Group III received NBF (150 mg/kg), Group IV received NBF (300 mg/kg) and group V received NBF (600 mg/kg). The rectal temperature of the groups was recorded at 1h intervals for 4 hours.

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

III. RESULTS AND DISCUSSION

Percentage Yields Obtained from Cisssuscornifolia Planch Root

The macerated 500-gram powder of Cissuscornifolia root produced 192g of dried methanol extract. The yield of the ethyl acetate fraction 9.5g, n-butanol 75 g and residual aqueous fraction 85 g (Table: 1).

Table: 2 Percentage Yields of Methanol Extract and Fractions of CisssuscornifoliaRoot

Extract /Fractions	Yield (g)	Percentage yield ($^{w}/_{w}$)
Crude extract	192	38.4
Ethyl acetate	9.5	5
N-Butanol	75	39
Residual Aqueous	85	45

Qualitative phytochemical constituents of the crude extract and fractions of cissuscornifolia root

Preliminary phytochemical screening of the methanol root extract of Cissuscornifolia revealed the presence of alkaloids, flavonoids, steroids/terpenoids, cardiac glycosides,

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carbohydrates, phenols, anthraquinones, tanins and tannins (Table 2).

Table 2: Qualitative Phytochemical Constituents of Crude Extract and Fractions of CissuscornifoliaRoot

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

Quantitative analysis of secondary metabolites

The result indicated alkaloid (41.50 mg/g), Triterpenes (24.35 mg/g) and steroids (38.53 mg/g) in ethyl acetate fraction. N-butanol fraction was found to have highest weight of flavonoids (217.75 mg/g) (Table 3).

Table 3: Quantitative Phytochemical Constituents of Cissuscornifolia

Constituents	EAF (mg/g)	NBF (mg/g)	RAF C(mg/g)
Alkaloids	41.50±0.02	19.81±0.05	19.56±0.13
Flavonoids	42.08±0.08	217.75±0.02	32.54±0.34
Saponins	15.84±0.02	38.78±0.04	12.42±0.06
Phenols	36.04±0.06	135.52±0.07	25.65±0.14
Tannins	9.98±0.08	71.12±0.02	105.86±0.04
Carbohydrates	130.46±0.81	184.54±0.04	237.58±0.09
Steroids	38.53±0.01	21.35±0.17	18.38±0.04
Triterpenes	24.35±0.01	23.07±0.02	18.23±0.01
Cardiac glycosides	20.33±0.01	23.90±0.01	61.33±0.02

Key: - NBF: N-Butanol fraction EAF: Ethyl acetate fraction RAF: Residual aqueous fraction

Acute toxicity study of n- butanol fraction of Cissuscornifolia root

The oral median lethal dose of Cissuscornifolia fraction in both mice and rats was estimated to be 2154 mg/kg body weight.

In vivo antimalarial effects of n-butanol fraction of Cissuscornifolia n-butanol fraction

Curative effect n-butanol fraction of Cissuscornifolia on parasitemia

Effect of Cissuscornifolia n-butanl fraction on parasitemia at doses (150, 300 and 600mg/kg) showed statistical significant ($p<0.01$) reduction in mean parasitemia with percentage clearance of 70, 73 and 74% and standard drugs chloroquine and artesunate 79 and 85% respectively, when compared with non-treated mice. The n-butanol fraction significantly ($p<0.01$) prolonged survival time of mice that were infected with Plasmodium bergheberghei(Table 4).

Table 4: Curative Effect of N-Butanol Fraction of Cissuscornifolia

Treatment (mg/kg)	Mean parasitemia (%)	MST (Day)	% Clearance
DW (10ml)	22.30±0.58	15.17±1.22	-
NBF (150)	6.65±0.69*	21.67±1.09*	70.49

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NBF (300)	5.80±0.41*	22.50±0.76*	73.40
NBF (600)	5.50±0.53*	25.33±0.71*	74.88
CQ (5)	4.55±0.17*	25.17±0.65*	79.60
ART (10)	3.15±0.38*	25.00±0.58*	85.89

Values are Mean ± SEM. *=p<0.01 compared to distilled water control, one-way ANOVA fallowed by Bonferroni post hoc test; NBF= n-butanol fraction DW = Distilled water; CQ= Chloroquine; ART= Artesunate n=6.

Suppressive effect of n-butanol fraction of Cissuscornifoliaonparasitemia

The n-butanol fraction of Cissuscornifolia at doses (150, 300 and 600 mg/kg) showed statistical significant (p<0.01) reduction in mean parasitemia with percentage suppression of 20, 29 and 66% respectively when compared with distilled water group and standard drugs chloroquine and artesunate 85 and 91% (Table 5).

Table 5: Suppressive Effect of N-Butanol Fraction of CissuscornifoliaPlanch Root

Treatment (mg/kg)	Meanparasitemia (%)	% Suppression
DW (10ml)	19.13±0.77	-
NBF (150)	15.25±0.71*	20.20
NBF (300)	3.45±0.30*	29.70
NBF (600)	6.47±0.45*	66.18
CQ (5)	2.83±0.45*	85.20
ART (10)	1.60±0.17*	91.60

Values are Mean ± SEM. *=p<0.001 compared to distilled water control, one-way ANOVA fallowed by Bonferroni post hoc test; NBF= n-butanol fraction DW = Distilled water; CQ= Chloroquine; ART= Artesunate n=6.

Prophylactic effect of n-butanol fraction of Cissuscornifolia root onparasitemia

The n-butanol fraction of Cissuscornifolia at doses (150, 300 and 600 mg/kg) exhibited statistical significant (p<0.01) reduction in mean parasitemia in the prophylactic test with percentage clearance of 49, 49 and 64% respectively, while standard drug pyrimethamine had 91% when compared with the non-treated group (Table 6).

Table 6: Prophylactic Effect of N-Butanol Fraction of CissuscornifoliaPlanch Root

Treatment (mg/kg)	Meanparasitemia (%)	% Clearance
DW (10ml)	23.80±0.61	-
NBF (150)	12.02±0.90*	49.50
NBF (300)	11.98±0.59*	49.66
NBF (600)	8.40±0.33*	64.70
PYT (1.2)	2.12±0.13*	91.10

Values are Mean ± SEM. *=p<0.01 compared to distilled water control, one-way ANOVA fallowed by Bonferroni post hoc test; NBF= n-butanol fraction DW = Distilled water; PY= Pyrimethamine

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Anti-pyretic effect of n-butanol fraction of Cissuscornifoliaroot in rats

The rectal temperature was measured at 0 hour, 1 hour, 2 hours, 3 hours, and 4 hours after yeast administration. The fraction exhibited significant ($p>0.05$) reduction in body temperature at all doses 3 hours after yeast administration compared with control group (Figure 1).

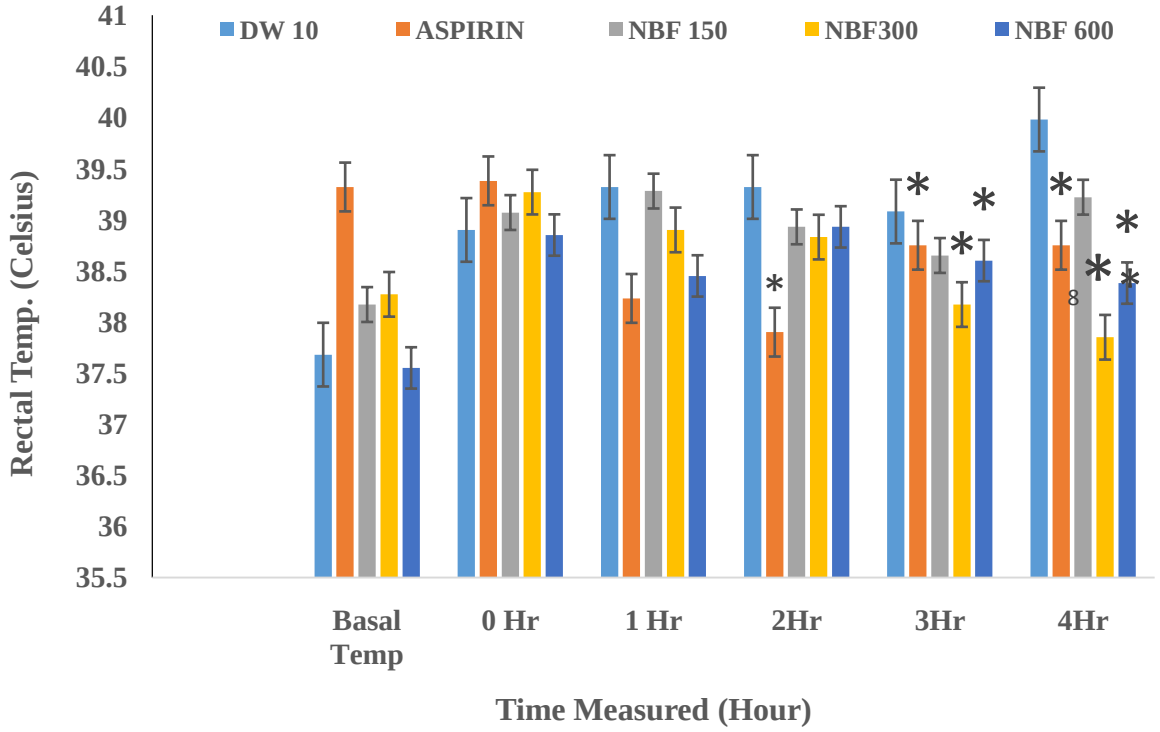

Figure 1: Anti-pyretic effect of N-Butanol Fraction of CissusCornifolia root in Rats

Values are mean ± S.E.M. * = $p<0.05$ as compared to DW group, = $p<0.05$ as compared to Basal rectal temperature – Repeated measure ANOVA followed by Bonferroni's post hoc test, n = 6, DW = Distilled water, NBF = N-butanol fraction

Discussion

The folkloric claim for the use of Cissuscornifolia root in the treatment of malaria has been largely based on empirical evidence passed down through generations. However, with the increasing reliance on herbal medicine and global threat of malaria, there is need to scientifically validate the antimalarial properties of traditionally used plant. The present study investigated in vivo antimalarial and antipyretic effect of n-butatnol fraction of Cissuscornifolia root.

The yield of the extract and fractions resulted into varying percentage. 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 [12].Methanol extract was higher in quantity because it is a more polar solvent which allowed effective extraction of wide range of compounds.

The qualitative screening provides preliminary information about different classes of secondary metabolites present in a plant which is a measure of its medicinal importance [13].The result of preliminary phytochemical screening of the methanol root extract of Cissuscrnifoliarevealed 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 [3][14]. The ethyl acetate fraction revealed the presence of alkaloids, terpenoids, steroids, flavonoids, cardiac glycosides and tannins which were largely supported of the study [14].N-butanol fraction revealed the presence of flavonoids, alkaloids, steroids, terpenoids, phenols, saponins and cardiac

glycosides and same secondary metabolites were reported[3].

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 [1].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 [1].

The Flavonoid compounds revealed in this extract have been reported to exhibit strong antimarial activity [15]. 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 [16].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 [17].Flavonoids also inhibit plasmodium parasites enzymes and metabolism e.gDihydrofolatereductase (DHFR) in folate metabolism for DNA synthesis, ATPases and protease for survival and replication, Glutathione reductase for survival and replication [18].

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 [19].Cardiac glycosides are also reported to disrupt parasite ion transport and Ph regulation preventing nutrient uptake [19]. 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 [20].

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 [21].It also acts by either generation of reactive oxygen species, inhibition of plasmodia enzyme, disruption of mitochondrial function and modulation of host immune response [22].Therefore, the reported availability of these secondary metabolites in Cissuscornifoliaroot 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 [1].These findings help determine safe dosage ranges and identify any early toxicological symptoms. Administration of Cisuscornifoliaroot 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 [3]. 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 Cissuscornfolia root extract and its fraction are relatively safe [23].

In vivo models on plant materials are important for understanding the biological effect and potential therapeutic administration of plant derived compounds [1].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 [24].Cissuscornifoliaroot 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. Artemesiaannua was reported to inhibit heme detoxification which causes heme accumulation to the parasite which results to its death [25].It may also act 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 [25].Saponins were reported to illicit their antimalarial effect by disrupting membrane integrity or digestive vacuole. This result is supported by a reported studywhere stem methanol extract cleared parasite by more than 70% in curative model [26].

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 [1].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 [26].

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 vivoantiplasmodial activity can be classified as moderate, good, and very good if an extract displayed percentage parasitaemia suppression equal to or greater than 50% [1].Cissuscornifolia n-butanol fraction exhibited parasite suppressive ability 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 Azadiracaindica was reported to disrupt parasite membranes leading to lysis[27].

The n-butanol fraction of Cissuscornifolia planch root exhibited good prophylactic activity 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 [28].During this important stage, parasite evades detection by immune system. Some plant compounds were reported to disrupt this process by preventing sporozoiteinvation inhibits hepatic schizogony or blocking the release of merozites, thereby stopping the infection from growing [28].The n-butanol fraction of Cissuscornifoliaroot was found to possess in vivo antimalarial which could be due to the presence of its secondary metabolites.

Injection of Brewer's yeast in mice through the subcutaneous route causes increase in prostaglandin synthesis thereby triggering a fever. This procedure serves as a useful model for testing the effects of natural or synthetic drugs for antipyretic activity [29][30].This type of fever, induced by yeast, is known as pathogenic fever, likely caused by prostaglandin production. Hence, the potential antipyretic action of drugs could involve inhibiting prostaglandin synthesis, achievable by blocking the cyclooxygenase enzyme [31].The decrease in temperature observed in the present study suggests that the n-butanol fraction of Cissuscornifolia root reduces fever similar to the standard drug aspirin. The mechanism behind its temperature-lowering effect might involve inhibiting prostaglandins through the blockade of cyclooxygenase enzyme activity.

IV. CONCLUSION

The n-butanol fraction of Cissuscornifoliaroot was found to possess in vivo antimalarial and antipyretic activity which could be due to the presence of its secondary metabolites. The findings of this study revealed that the extract possess antiplasmodial and anti-inflammatory activity thereby validating its uses in folkloric medicine in the treatment of malaria and pain.

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