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In Vivo Study of *Hyptis suaveolens* (Bush Mint) Ethanolic Leaf Extract Antiplasmodial Activity in Swiss Albino Mice Infected with *Plasmodium berghei*

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Abstract

Malaria is a disease caused by protozoans from the genus Plasmodium, it is endemic in the tropics and also of global concern. The emergence of resistant strains of the parasites necessitates the development of novel drugs against them. This study aimed at determining the in vivo antiplasmodial activities of the ethanolic leaf extract of *H. suaveolens* in *P. berghei* infected Swiss albino mice. Phytochemical analysis, GC/MS and Oral toxicity of the plant extract were carried out. The antiplasmodial activities of the plant extract were evaluated via curative test. The mean change in haematological parameters and body weight were determined after the curative test. The result of the curative test showed a dose-dependent efficacy of the plant extract, the group treated with ACT had the least parasitemia and the negative control recorded the highest parasitemia. Thus, the mean parasitemia in relation to the various treatments varied significantly ($P<0.05$). Haematological parameters analysis revealed that the mean change in Hb and RBC did not vary significantly ($P>0.05$), while that of PCV showed a high significant difference ($P<0.05$). The mean change in body weight showed no significant difference ($P>0.05$). This bioassay has demonstrated that *H. suaveolens* leaf ethanolic extract possess a dose-dependent curative antiplasmodial potency. Hence, with further research and development, the plant product may be used for the treatment of malaria in man.

Keywords: *Hyptis suaveolens*; ethanolic extract; phytochemical; GC/MS; antiplasmodial activities; *Plasmodium berghei;* swiss albino mice

Introduction

Protozoans from the genus *Plasmodium* are known to cause malaria disease. Different species of the plasmodium parasites infect humans, of which *Plasmodium falciparum* is the most virulent [1]. In several tropical countries, malaria disease remains a major public health problem, causing high morbidity and mortality most especially in sub-Saharan Africa [1]. Therefore, there is an urgent need to increase the discovery and development of novel, safe and affordable antiplamodial drugs to help prevent further spread of the parasite causing the disease [2]. In addition, the emergence of resistant strains of these parasites also requires the development of new drugs against the parasites. Possibly, the new drugs should have novel modes of action [3], in order to help combat the parasites efficiently.

Plants that are of medicinal importance and their phytochemical constituents are known to play vital roles in treating human malaria. Quinine and artemisinin used worldwide for treating malaria were all discovered from various plants [4]. Thus, medicinal plants possess great potential for new source of novel antiplasmodial drugs [4]. *Hyptis suaveolens* popularly known as Bush Mint is also widely used traditionally for treatment of malaria [5].

The development of resistance, burden and death caused by Plasmodium species and are the major drive for this study. This study therefore evaluated the antiplasmodial activities of the ethanolic leaf

extract of *Hyptis suaveolens* with the hope that a novel, affordable and more effective product may be developed for the treatment of malaria globally.

Materials and Methods

Plant Collection

Hyptis suaveolens leaves were collected from farmlands within Federal University of Lafia permanent site Nasarawa state, Nigeria. The plant was identified in the department of Botany, Federal university of Lafia.

Plant Preparation and Extraction

The plant extraction was achieved via cold organic maceration method as described by Harborne [6] with little modifications. The leaves of the test plant were rinsed with water to remove dirt. Then spread out on a clean surface and allowed to air-dry under shade at room temperature. The dried leaves were pounded using mortar and pestle, there after it was sieved to help obtain fine powder using 0.9mm mesh which was used for the extraction.

The 70% ethanol extract obtained was evaporated to dryness using water bath and the yield was stored in a refrigerator until it was used to carry out the test.

Qualitative Phytochemical Screening

Phytochemical screening of *H. suaveolens* leaves crude ethanolic extract was carried out employing standard procedures and tests [7-9]. The qualitative phytochemical screening was carried out in the Laboratory Unit, Department of Chemistry Federal University of Lafia, to reveal the presence of the phytochemical constituents of the plant.

Evaluation of the Bioactive Compounds Present in the Plant Extract Using Gas Chromatography/Mass spectrometry (GC/MS)

This was carried out at the Spectral Laboratory and Services, Tudunwada Kaduna South, Kaduna State, Nigeria. The plant Sample was analyzed by gas chromatography/mass spectrometry (GC/MS), using Agilent-Technologies (Little Falls, CA, USA) 6890N Network GC system, equipped with an Agilent-Technologies 5975 inert XL Mass selective detector and Agilent-Technologies 7683B series auto injector. The separation was performed on Agilent Technologies capillary column HP-5MS (30 m × 0.25 mm; film thickness 0.25 µm). The sample was identified on the basis of matching of their relative retention times with those of standards (Sigma Chemical Co., St Louis, MO, USA). Sample was further identified and authenticated using their MS spectra compared to those from the National Institute Standard and Technology (NIST) mass spectral library of the GC/MS system.

Ethical Permit

The Ethical permit for this research was obtained from the Ethical Committee of the Department of Zoology, Faculty of Science, Federal University of Lafia, Nasarawa State. The Ethical permit Project Identification Code for this study is (PIC)- FUL/FS/ZLY/2020/001.

Acute Oral Toxicity Test

The acute toxicity test was carried out by determining its LD_{50} using method described by Lorke [10]. This method involves two phases.

Phase 1, nine Swiss Albino mice were used. The nine animals were divided into three groups with three animals each. Group 1, 2 and 3 were administered different doses (10, 100 and 1000 mg/kg) of the crude extract respectively. The animals were placed under observation for 24 hours to monitor change in behavior and mortality.

Phase 2, three animals were distributed into three groups of one animal per group. The animal in group 1, 2 and 3 were administered higher doses (1600, 2900 and 5000 mg/kg) of the crude extract respectively and then observed for 24 hours for behavior changes as well as mortality.

Preparation of Bioassay

Experimental Animals

A total of 37 Swiss Albino mice ranging from 15–25g of both sexes were obtained from National Veterinary Research Institute (NVRI) Vom, Plateau State. The animals were housed in standard cages and maintained standard pelleted diet and water for 7 days to acclimatize before carrying out the bioassay.

Weighing and Coding of the Animals

The weighing, using digital analytical balance (aeAdam, version 3.40) and marking of the individual animal with picric acid on different anatomical parts of the body namely the head (HD), back (BK), tail (TL), right leg (RL) and left leg (LL) were carried out simultaneously.

Test Parasite

The chloroquine-sensitive *Plasmodium berghei* strain was purchased from the in vivo laboratory of National Institute for Pharmaceutical Research and Development (NIPRID), Federal Capital Territory, Abuja, Nigeria.

Parasite Inoculation of Mice

Percentage parasitemia and the erythrocytes count of the donor mouse was determined and diluting the blood with normal saline before infecting the mice [11]. The Parasites were maintained in the donor mice through serial blood passage, the donor mice infected with the *Plasmodium berghei* after establishment of infection and developing high parasitemia level were used as the donor. Blood samples were taken from the donor and diluted with normal saline in a way that every 0.2 ml injected intraperitoneally into the experimental animals contained 1×10^7 infected erythrocytes. The bloods of the mice used for the study were screened for pre-existing infections before inoculating with the test parasite.

Drug and mode of administration

The drug (positive control) Artemisinin Combination Therapy (Arthemeter-lumerfantrin) tablet, the crude extract and the negative control i.e., distilled water used in this study were orally administered with the aid of a feeding cannula [12].

Determinaton of Parasitemia

This was achieved by bleeding the mice through the tail vein and the blood collected. The blood collected was used to prepare a thin blood smear on a clean grease free microscope slide. The slides were allowed to air dry after which they were fixed with methanol and stained with 10% Giemsa stain after allowing to air dry for 20 minutes it was rinsed with water and finally viewed under the microscope using ×100 (oil immersion). The percentage parasitemia for each mouse was determined by counting the number of parasitized red blood cells for at least six different fields.

Percentage Parasitemia = (No. of infected RBCs ÷ Total No. of RBCs) x100

In vivo Antiplasmodial Curative Activity of the Extract

This was achieved following the method described by Ryley and Peters [13]. Twenty five Swiss albino mice were infected with *P. berghei* on the first day (D_0). After 72 hours, the mice were randomly

divided into five groups of five mice each after confirmation of parasitemia in the mice. Different doses of the extract 100, 200 and 400 mg/kg/day were administered to group 1, 2 and 3 respectively. To group 4 (Positive control) 8mg/kg/day of Artemisinin Combination Therapy (Arthemeter-lumerfantrin) tablet was administered and Group 5 were infected and received 10mg/kg/day of distilled water (Negative control). The treatment was carried out for four days (D_2-D_5). Blood samples were collected from the tail vein from (D_2-D_6) and thin smears were prepared to monitor parasitaemia.

Determination of the Effect of the Plant Extract on the Haematological Parameters of the Swiss Albino Mice

The haematological parameters determined are Packed Cell Volume (PCV), haemoglobin (Hb) and erythrocyte (RBC) counts using the methods described by Cheesbrough [14]. The parameters were determined for each mouse before infection and after treatment.

Statistical Analysis

Data obtained were analyzed using R. console software (Version 4.0.3). One sample Kologorov Smirnoff test was used to test for normality of the data. One-way Analysis of variance (ANOVA) was used to compare the mean parasitemia in albino mice in relation to the concentrations of *H. suaveolens* crude extract and ACT treatments. Also, mean change in body weight as well as haematological parameters were compared using one-way ANOVA. ANOVA test was followed by a post-hoc test using LSD test where there was a significant difference between the treatments. P value < 0.05 was considered statistically significant.

Results

Qualitative Phytochemical Constituents of the Plant Leaf Extract

The qualitative phytochemical result, (Table 1) reveals the presence of alkaloids, flavonoid, phenol, saponins, tannins, steroids, reducing sugar, amides and anthraqinones in the 70% ethanolic crude extract of *H. suaveolens* while Glycosides was not detected in the plant extract.

Table 1: Qualitative Phytochemical Constituents of Crude Extract of *H. suaveolens leaves*

S/No	Phytochemicals	Status
1	Alkaloids	+
2	Flavonoid	+
3	Phenol	+
4	Saponins	+
5	Tannins	+
6	Steroids	+
7	Reducing Sugar	+
8	Glycosides	-
9	Amides	+
10	Anthraqinones	+

Key: + = Present
- = Not detected

Bioactive Compounds Present in *H. suaveolens* leaves 70% Ethanol Crude Extract Using Gas Chromatography Mass Spectrometry (GC/MS)

The Gas Chromatography Mass Spectrometry (GC/MS) analysis of the *H. suaveolens* 70% Ethanolic crude extract revealed the presence of 29 peaks of bioactive compounds as seen in (Table 2). The compound with the highest peak area 13.1% is 2-Methyl-7-phenylindole at peak 28 with 36.634 minutes as retention time (RT) while Z-6-Pentadecen-1-ol acetate had the lowest peak area -0.09% and 34.977 minutes as retention time at peak 25. The chromatogram from the *H. suaveolens* 70% Ethanol crude extract is shown in Figure 1. GC/MS revealed various spectrums, each having several long chains of hydrocarbons.

Table 2: Bioactive Compounds Present *in H. suaveolens* Leaf 70% Ethanolic Crude Extract Using Gas Chromatography Mass Spectrometry (GC/MS)

Peak	RT	Compounds	Area (%)	Molecular Formula	Molecular Weight (g/mol)
1	5.334	Diacetamide	0.41	$C_4H_7NO_2$	101.10
2	5.42	2-Pentanone, 4-hydroxy-4-methyl-	10.9	$C_6H_{12}O_2$	116.15
3	5.458	2-Pentanone, 4-hydroxy-4-methyl-	7.14	$C_6H_{12}O_2$	116.15
4	10.994	1-Octanol	1.39	$CH_3(CH_2)_7OH$	130.23
5	11.474	1-Octanol	1.46	$CH_3(CH_2)_7OH$	130.23
6	11.474	Linalool	1.74	$C_{10}H_{18}O$	154.25
7	12.372	Linalool	1.81	$C_{10}H_{18}O$	154.25
8	28.722	Benzene, (3-nitropropyl)-	1.38	$C_9H_{11}NO_2$	165.19
9	29.206	Benzene, 1,1'-(1,2-cyclobutanediyl) bis-, trans	3.31	$C_{16}H_{16}$	208.29
10	29.206	Pentafluoropropionic acid, tetradecyl ester	0.73	$C_{17}H_{29}F_5O_2$	360.4
11	30.178	1-Docosene	1.58	$C_{22}H_{44}$	308.6
12	31.247	Heptadecylheptafluorobutyrate	1.71	$C_{21}H_{35}F_7O_2$	452.49

13	31.435	Hexadecanoic acid, methyl ester	1.26	$C_{17}H_{34}O$	270.45
14	31.739	Heptacosane	0.78	$C_{27}H_{56}$	380.7
15	31.803	n-Hexadecanoic acid	8.45	$C_{16}H_{32}O_2$	256.4
16	32.018	Hexadecanoic acid, ethyl ester	1.23	$C_{18}H_{36}O$	284.47
17	32.116	Oleic Acid	0.62	$C_{18}H_{34}O_2$	282.47
18	32.495	Oleic Acid	0.95	$C_{18}H_{34}O_2$	282.47
19	32.626	Pentadecanoic acid	1.15	$C_{15}H_{30}O_2$	242.39
20	32.941	Phytol	8.09	$C_{20}H_{40}O$	296.53
21	33.153	Linoelaidic acid	5.3	$C_{18}H_{32}O_2$	280.45
22	33.277	Cyclopropaneoctanal, 2-octyl-	1.12	$C_{19}H_{36}O$	280.5
23	33.313	Oleic Acid	2.06	$C_{18}H_{34}O_2$	282.47
24	33.99	Pyridine-3-carboxamide, oxime, N-(2-trifluoromethylphenyl)-	1.96	$C_{13}H_{10}F_3N_3O$	281.23
25	34.977	Z-6-Pentadecen-1-ol acetate	-0.09	$C_{17}H_{32}O_2$	268.4
26	35.527	1,2-Propanediol, 3-benzyloxy-1,2-diacetyl-	11	$C_{14}H_{18}O_5$	266.29
27	36.475	Pyrrolidin-2-one,	5.99	C_4H_7NO	85.10
28	36.634	2-Methyl-7-phenylindole	13.1	$C_{15}H_{13}N$	207.27
29	36.809	1-methyl-2-phenyl-	3.44	$C_{15}H_{13}N$	207.27

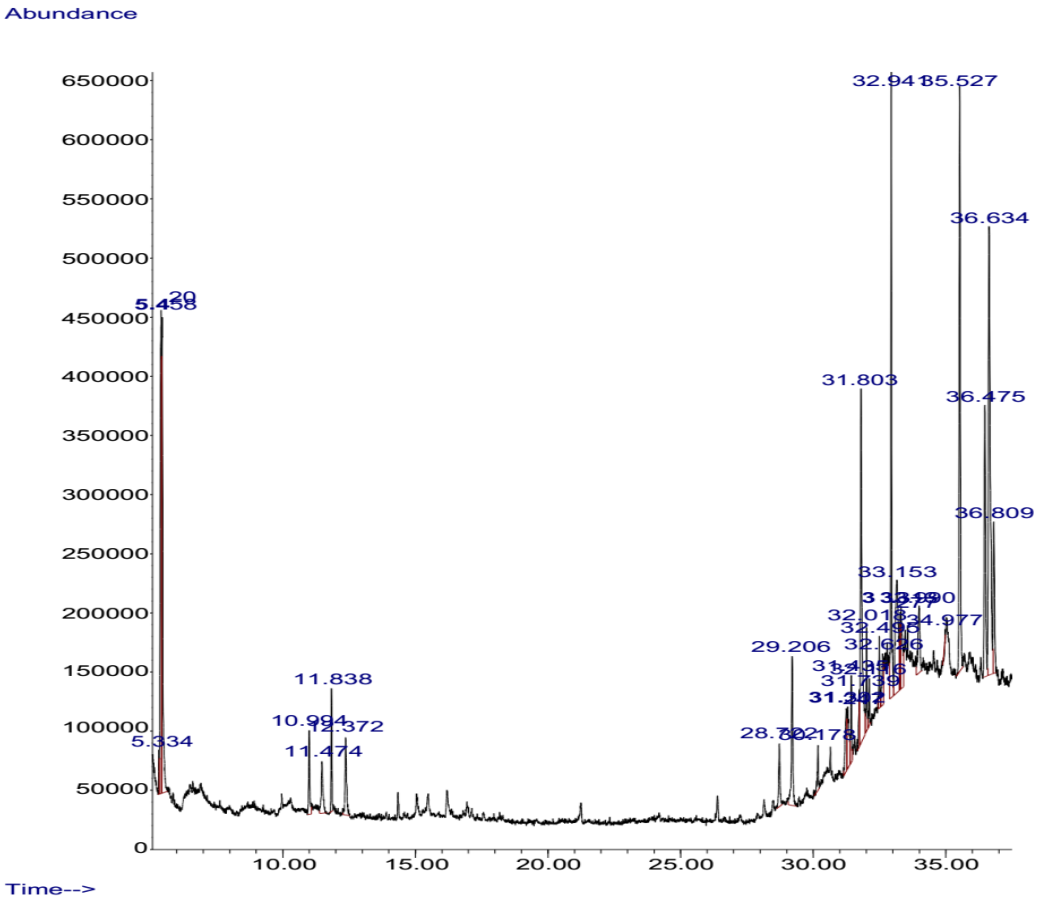

Figure 1: *GC/MS Chromatogram of H. suaveolens Leaf Ethanolic Crude Extract*

Acute Oral Toxicity of *H. suaveolens* Leaves Ethanolic Crude Extract (LD_{50})

After the administration of the various doses in both phase 1 (10, 100 and 1000mg/kg) and phase 2 (1600, 2900 and 5000mg/kg) of the Lorke's toxicity test method, no mortality was recorded in any of the groups after the 24 hours of observation. During the period of observation, the group administered 5000mg/kg showed hair erection, loss of appetite, reduction in locomotion and rigidity. The rest of the doses 10, 100, 1000, 1600 and 2900mg/kg did not show any significant physical and behavioural change. However, there was an immediate reduction in feeding activities and locomotion within few minutes of administration after which they bounced back to their regular activities (feeding, locomotion etc.). Therefore, from this experiment the LD_{50} of *H. suaveolens* is projected to be above 5000mg/kg.

Curative Activity of *H. suaveolens* Ethanolic Crude Extract

Mean Parasitemia in Swiss Albino Mice Treated with *H. suaveolens* Ethanolic Crude Extract and ACT (Curative Test)

The result of the *H. suaveolens* leaves ethanolic crude extract antiplasmodial curative activity showed a dose-dependent reduction in mean parasitemia in Swiss albino mice, with the group treated with ACT having the least parasitemia while the negative control group showed a daily increase in parasitemia. The mean parasitemia in relation to treatments showed a very high significant difference (F_{120} = 14.54, P < 0.0001, Figure 2). Pairwise multiple comparisons of means of parasitemia showed that there was no significant difference in relation to group treated with 8mg/kg/day of ACT versus group treated with 100mg/kg/day of *H. suaveolens*, group treated with 8mg/kg/day of ACT versus group treated with 400mg/kg *H. suaveolens* as shown in (Table 3).

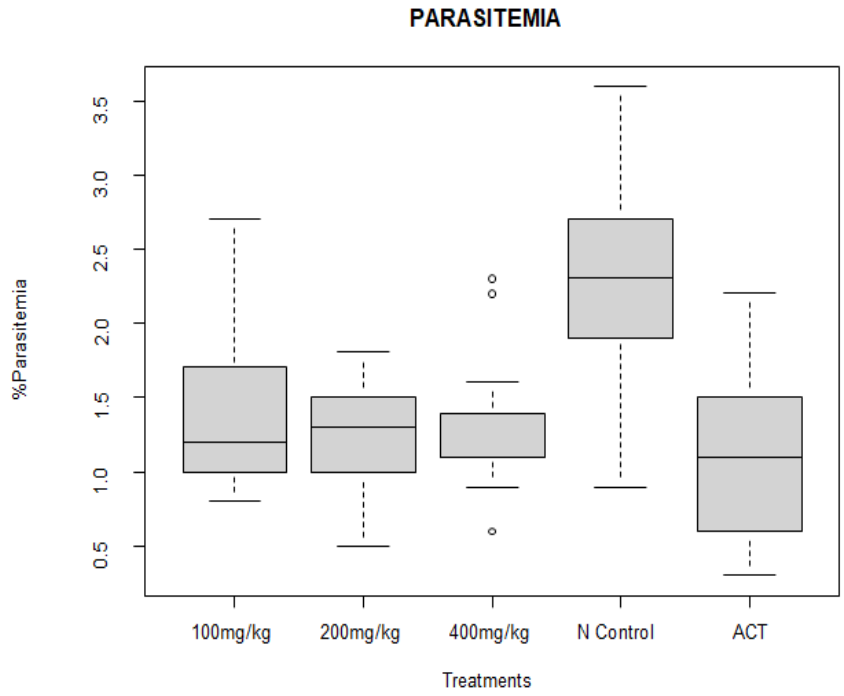

Figure 2: *Mean Parasitemia in Swiss Albino Mice in Relation to Treatments with H. suaveolens and ACT*

Table 3: *Post-hoc test for Overall Curative Test Mean Parasitemia in Swiss Albino Mice Treated with H. suaveolens Crude Extract and ACT*

Treatments	Dose (mg/kg)	Parasitemia Mean±SEM
P. Control (ACT)	8	1.12 ± 0.52^{b}
N. Control (DW)	10	2.16 ± 0.77^{a}
Hyptis suaveolens	100	1.42 ± 0.57^{b}
Hyptis suaveolens	200	1.29 ± 0.33^{b}
Hyptis suaveolens	400	1.24 ± 0.37^{b}

Key: a, b = Mean values on the same column having the same letter do not differ significantly (p > 0.05)

P. Control (ACT) = Artemisinin Combinaton Therapy (Arthemeter-lumerfantrin)

N. Control (DW) = Distilled Water.

Effect of the Extract on the Haematological Parameters of the Swiss Albino Mice

Mean Change in Haemoglobin (Hb) Level

The group treated with 200mg/kg/day of *H. suaveolens* had the highest Hb level while the group treated 400mg/kg/day of *H. suaveolens* had the least Hb level. However, the mean change in Hb level of the Swiss albino mice after four days curative parasitemia treatment in relation to treatments with *H. suaveolens* crude extract and ACT showed no significant difference (F_{20} = 0.689, P = 0.608, Figure 3).

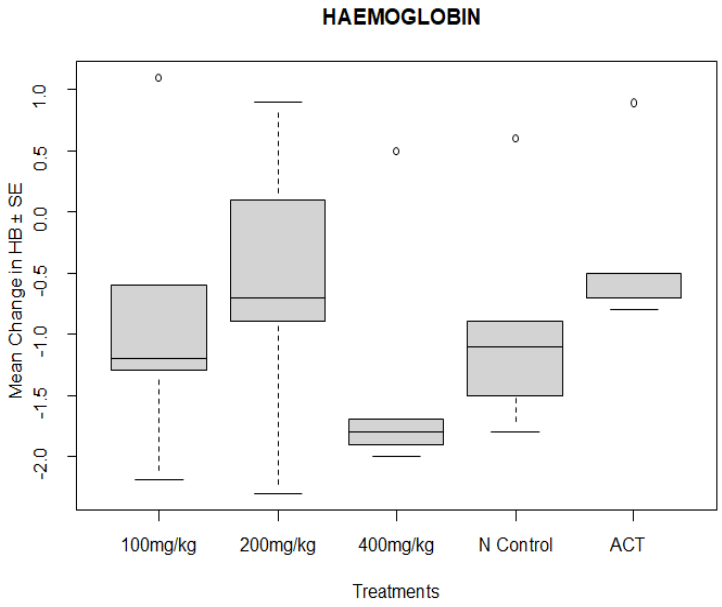

Figure 3: *Mean Change in Haemoglobin Level in Swiss Albino Mice in Relation to Treatment with H. suaveolens and ACT*

Mean Change in Red Blood Cell (RBC) Level

The group treated with 8mg/kg/day of ACT had the highest RBC level while the group treated with 10mg/kg/day of distilled water had the least RBC level. However, the mean change in RBC level in Swiss albino mice after four days curative parasitemia treatment in relation to treatments with *H. suaveolens* crude extract and ACT showed no significant difference (F_{20} = 1.445, P = 0.256, Figure 4).

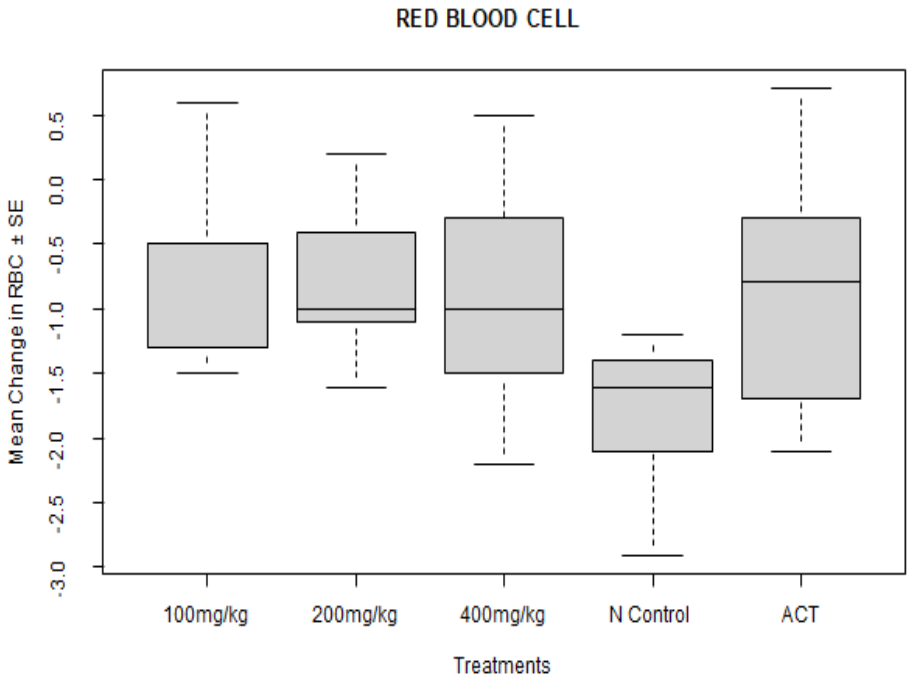

Figure 4: *Mean Change in Red Blood Cell Level in Swiss Albino Mice in Relation to Treatment with H. suaveolens and ACT*

Mean Change in the Packed Cell Volume (PCV) Level

The group treated with 400mg/kg/day of *H. suaveolens* had the highest PCV level while the group treated with 10mg/kg/day of distilled water had the least PCV level. However, the mean change in PCV level in Swiss albino mice after four days of curative parasitemia treatment in relation to treatments with *H. suaveolens* crude extract and ACT showed a significant difference (F_{20} = 7.417, P < 0.000781, Figure 5).

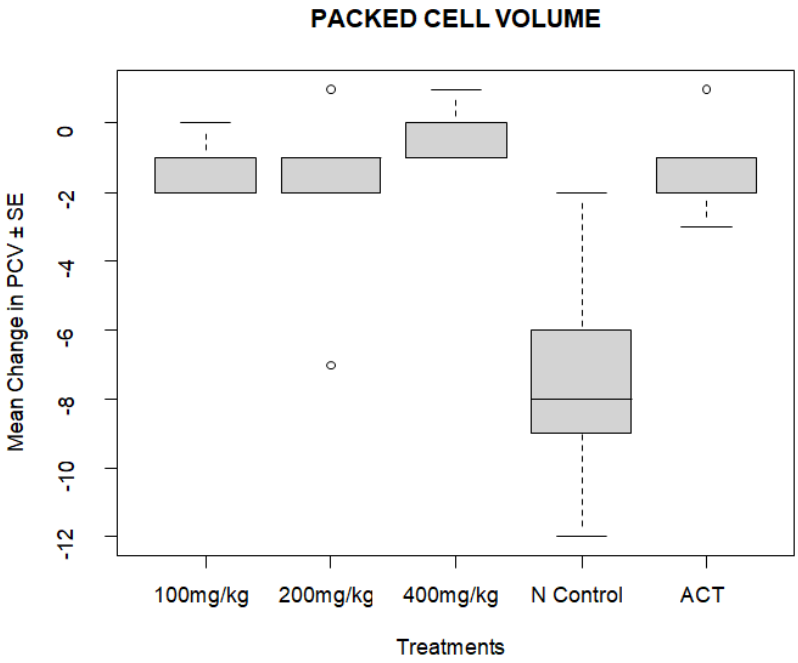

Figure 5: *Mean change in Packed Cell Volume Level in Swiss Albino Mice in Relation to Treatment with H. suaveolens and ACT*

Mean Change in Body Weight of Albino Mice Level

The group treated with 400mg/kg/day of *H. suaveolens* had the least body weight while the group treated with 8mg/kg/day of ACT had the highest body weight. However, the mean change in body weight of the Swiss albino mice after curative test in relation to treatments with *H. suaveolens* crude extract and ACT showed no significant difference (F_{20} = 0.381, P = 0.819, Figure 6).

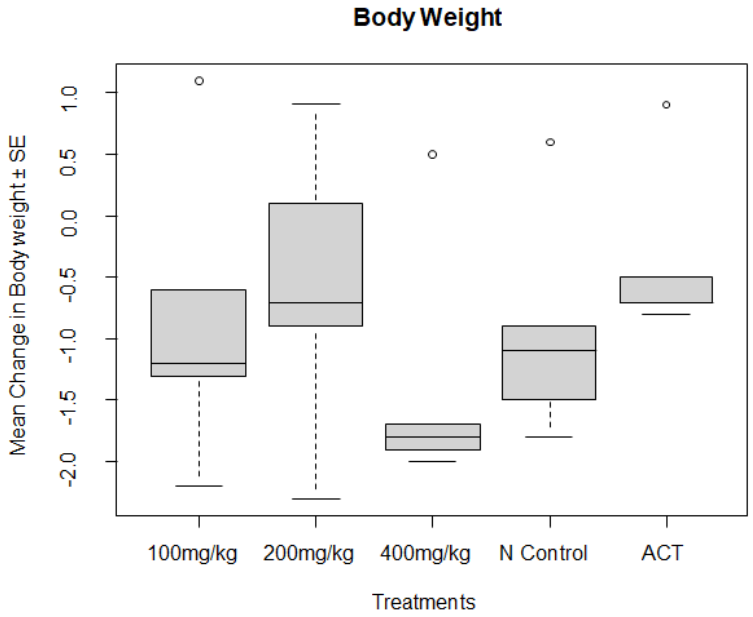

Figure 6: *Mean Change in Body Weight of Swiss Albino Mice in Relation to Treatment with H. suaveolens and ACT*

Discussion

H. suaveolens is traditionally used for repelling mosquitoes and treatment of malaria. The plant antiplasmodial activities were studied in vivo, Phytochemical, GC/MS and toxicity of the plant were investigated.

Qualitative Phytochemical Study of *H. suaveolens* Plant Leaves Ethanolic Crude Extract

The result obtained from the qualitative phytochemical screening (Table 1) revealed the presence of secondary metabolites in the 70% ethanolic crude extract of *H. suaveolens.* Alkaloids, flavonoid, phenol, saponins, tannins, steroids, reducing sugar, amides and anthraqinones were present while glycosides were not detected in the plant extract. The absence of glycosides is not in agreement with the findings of Dakum *et al.* [15] who documented its presence in the phytochemical analysis of *H. suaveolens* methanolic and aqueous

extracts. This might be as a result of the difference in the type solvent used for the extraction which is in agreement with the findings of Doughari *et al.* [16] who recorded that different solvents have different capacities for different phytochemical constituents. However, Osuagwu *et al.* [17] reported the presence of Glycosides in their mango leaves and neem leaves ethanol and aqueous extracts used to study the plants antibacterial activities and phytochemical constituents.

Bioactive Compounds Present in the Crude Extract Using Gas Chromatography Mass Spectrometry (GC/MS)

The GC-MS analysis of *H. suaveolens* leaves ethanolic crude extract revealed 29 peaks of bioactive compounds as seen in (Table 2). 2-Methyl-7-phenylindole was having the highest peak area 28, having 13.1% area with 36.634 minutes as retention time (RT). The findings disagree with that of Dakum *et al.* [15] who reported peak seven as the highest peak area having 33.33% with 21.378 seconds retention time (RT) and oleic acid as the compound present on the peak in their GC/MS analysis of *H. suaveolens* methanolic extract. Ankita *et al.* [18] reported the antimicrobial activity of 2-Methyl-7-phenylindole identified in ethanolic root extract of *Plumbago zeylanica* similarly Husein *et al.* [19] reported the *In Vitro* Antimicrobial Activity of the compound contained in Crude Aqueous Methanolic extract of *Eucalyptus* species leaves.

Acute Oral Toxicity of *H. suaveolens* Leaves Ethanolic Crude Extract (LD_{50})

The Lorke's toxicity test method was used to determine the LD_{50} of *H. suaveolens* leaves ethanolic crude extract. The highest dose, administered **(**5000mg/kg) showed hair erection, reduction in feeding, reduction in locomotion and rigidity. These are all negligible or insignificant toxicity signs [20]. Thus, suggesting that the acute oral toxicity of *H. suaveolens* is above 5000mg/kg.

Antiplasmodial Activities, Change in Haematological Parameters and Change in Body Weight of the Swiss Albino Mice in Relation to the Curative treatments with the Ethanolic Extract of *H. suaveolens*

The in vivo antiplasmodial curative activity of *H. suaveolens* leaves ethanolic crude extract against *Plasmodium berghei* after the study showed a dose-dependent reduction in mean parasitemia, 400mg/kg/day had the least parasitemia followed by 200mg/kg/day and lastly 100mg/kg/day with the highest parasitemia. The group treated with the standard drug ACT, when compared to the groups treated with the plant extract the group treated with ACT had the least mean parasitemia and the negative control group had the highest mean parasitemia among the whole treatment groups. The result of this study further implicates *H. suaveolens* ethanol crude extract to have some antiplasmodial activity which is in accordance with the report of Auta *et al.* [21]. Similarly, Okokon *et al.* [12] also reported that there was a significant reduction in mean parasitemia after their curative study of antimalarial and antiplasmodial activity of husk extract of *Zea mays* administered in different doses when compared with the control groups.

The antiplasmodial activity observed in this study may be attributed to the presence of phytochemicals in the plant extract such as alkaloid and flavonoids [22]. In addition, the GC-MS analysis also revealed some bioactive compounds that are of pharmacological importance; 2-Methyl-7-phenylindole was the compound identified with the highest peak area (Peak 28) and was reported to have some antimicrobial activity [18, 19]. The findings are also in agreement with that of Paulsam and Jeeshna [23] who reported that most plant secondary metabolites exhibit some level bioactive activities.

Hematological parameters which include hemoglobin (Hb) Red Blood Cell (RBC) and Packed cell volume (PCV) helps to indicate anemia in Plasmodium parasitized individuals [24]. The mean change in Hb level of the Swiss albino mice in relation to treatments which was analyzed before and after the four days curative treatment, revealed that the treatments have no effect on the Hb of the Swiss albino mice, the finding disagree with the work of Ayim *et al.* [25] who reported that there was change in the Hb level of Swiss albino mice infected with *P. berghei* and treated with toad venom.

The lack of variation observed in the mean change of the RBC of the Swiss albino mice after the four days in vivo curative treatments with the crude extract and ACT has proven the fact that the extract possesses some antiplasmodial properties. The negative control group was observed to have the least number of RBC which is a result of the effect of the parasite on the RBC since no treatment was administered to the group, which is in agreement with the findings of White, [26] who reported that plasmodium parasites cause's reduction of their host RBC.

The mean change in PCV level of the Swiss albino mice after the four days of curative treatments with the crude extract and ACT was observed to have great variation, the variation observed might be as a result of the various inhibition pace exhibited by the treatments. This in agreement with the findings of Ayim *et al.* [25] who reported from his findings that toad venom was able to help inhibit the effect of *P. berghei* in Swiss albino mice PCV.

The Mean change in the Swiss albino mice body weight after the four days curative treatments was observed to have no variation, this finding concurs with the findings of Zemicheal and Mekonnen [27] they also reported that there was no significant difference in the body weight of the Swiss albino mice used for their study of Antiplasmodial activity of *Vernonia adoensis* aqueous, methanol and chloroform leaf extracts against chloroquine sensitive strain of *Plasmodium berghei*.

Conclusion

The phytochemicals and bioactive compounds present in *H. suaveolens* plant extract may be responsible for the efficacy of the plant against the *Plasmodium* parasite. The bioassay result showed that the plant ethanolic crude extract has effective but dose-dependent curative antiplasmodial properties as the highest dose administered was most effective against *P. berghei*. With further research and developments, the plant may be used for treatment of malaria in man.

Conflict of Interest

There is no conflict of interest.

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