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The Efficacy of Herbal Medicine in the Treatment of Malaria in Owerri

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ABSTRACT

This study was aimed at determining the efficacy of herbal medicine sold in Owerri in the treatment of malaria with specific intention to evaluate the anti-malarial and mortality dose response in albino mice. The study took place in the Glassblowing Unit of Science Laboratory Technology, Federal University of Technology Owerri Imo state. Two different herbal mixtures namely: Goko cleanser (*S. acuta* = 10%, *T. procumbens* = 15 %, *A. boonei* =35%, *P. amarus* = 25% and *C. sinensis* = 15%) and Green Health Herbal mixtures (*P. amarus* = 45%, *N. laevis* =10% and *V. amygdalina* = 55%) were used and a total of Forty four (44) mice, some already infected with *Plasmodium berghei* were purchased from the Department of Pharmacology and Toxicology, University of Nigeria Nsukka, Enugu state weighing 21.27-25.68 g. The animals were grouped into five. The 1st group represented the control (untreated mice with the parasite), the 2nd group was treated with the first herbal mixture (Goko cleanser), the 3rd group was treated with the 2nd herbal mixture (Green health herbal), while the last group was the positive control (healthy rat). Each group was contained four mice. Group A (control) received no medicine and they were infected, Group B was infected with *P. berghei* and regrouped into two (set I and II) containing two mice each. Set I was treated with 200 mg/L and set II was treated with 250 mg/L of the Goko herbal cleanser. Group C was also regrouped into two (Set III and IV) containing two mice each. Set III and set IV were infected with *P. berghei* and treated with 200 and 250 mg/L of the Green Health Herbal mixture respectively while group D were healthy mice. Extra Twenty eight (28) were also joined to the healthy control to conduct mortality dose response test. These animals were monitored for 0, 24, 48 and 72 hrs. Thirty two (32) mice were recruited for mortality dose response test. They were grouped into four based on the doses of herbal mixtures and each group contained 4 mice and each group had experimental set for herbal mixture A and B. The experimental animals were given 0.0 mg/L, 250 mg/L, 500 ml/L, and 1500 mg/L of the herbal mixtures and were routinely inspected for 5 days (24, 48, 72, 96 and 120 hrs.) for signs of toxicity and mortality such as tremors, weakness, restlessness, refusal to feed, falling off of hair, coma, or even death. The data collected were expressed as mean ± SD and subjected to ANOVA with Duncan Multiple Test by 2022 version of SPSS to obtain the LSD at confidence level of 95%. The result showed that % suppressive antimalarial effects of the herbal mixture for the control (100, 121, 142 and 158 %) increased, the herbal mixture A and B at the dose of 200 mg/L (100, 79.7, 66.1 and 51.5; 100, 80.7, 65.2 and 49.8 %) and at the dose of 250 mg/L (100, 85.9, 55.6 and 30%; 100, 76.8, 59.11 and 27.6 %) decreased as the time increased from 0-72 hrs. Consequently, doses of 250 mg/L (0-81%; 0-82.5%) of herbal A and B confer quicker and more efficacious % chemosuppressive effect than doses of 200 mg/L (0-67.4%; 0-68.7%) and at the doses of 500 mg/L (3 mice died) and 1500 mg/L (7 mice died). In conclusion, herbal B exhibited more antimalarial properties than A, although they did not differ significantly ($P > 0.05$). However, herbal medicine is anti-malarial in nature; an overdose of the mixture can be lethal.

INTRODUCTION

Malaria infection is a major public health issue that poses significant hazards to the humans especially in Nigeria, Imo state inclusive [12]. It is caused by blood plasmodial parasites such as *Plasmodium malariae, Plasmodium falciparium, Plasmodium ovale* and *Plasmodium vivax*. Malaria is mostly caused by *Plasmodium*

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malariae and *Plasmodium falciparium* in Nigeria [12]. The primary vector of malaria in human is the female anopheles mosquito. It affects every person who is exposed to its bites but children and pregnant women are most vulnerable. In places with high level of herd immunity, *Plasmodium falciparum* also affect children and women.

Malaria impacts negatively in the economy of countries of Africa. Because of its prevalence, countries where malaria diseases are rampant now budget heavily for the control, prevention and treatment. Global malaria expenditures for both government and out-of-pocket amounted to $ 4.3 billion in 2016, which has increased by 8.6% per year since then [16]. This was based on national accounts systems from 106 countries specifically for prevention and treatment of malaria. Frankly, malaria is endemic in all the states of Nigeria and many people have died because of this ailment. Andrade *et al.* [4] and WHO, [27] reported that in 2020, 241 million cases and 627 thousand deaths of malaria were estimated worldwide.

The prevalence of malaria is associated with the climatic conditions of African countries. Mosquitoes breed mostly in tropical regions with heavy or moderate rainfalls. Stagnant water, empty cans, hidden dark and damp places also support the breeding of mosquitoes. Some authors posited that the abundance of bushes and use of open containers to store water for domestic use particularly during the rainy season causes malaria commonly in rural areas [10]. Similarly, unchecked urbanization also increases the number of slums that resemble rural areas and increase transmission of malaria in some third-world cities particularly in Nigeria. Swamps, gutters and dense vegetation all contribute to the environment's favourable breeding conditions for the vectors. In many Nigerian cities, the issue of rural urban migration, the presence of poverty among the people, environmental degradation and difficulties in providing decent housing, lack of portable water, poor environmental sanitations and improper disposal of wastes all work together to contribute to the rapid and uncontrollable breeding of female anopheles mosquitoes which are the primary transmitter of malaria [10].

People with malaria characteristically feel feverish, chill, headache, myalgias, nausea, abdominal pain and occasionally having diarrhea and cough. It has been reported that it causes stillbirths, spontaneous abortions, or mother-death in most parts of the world including Nigeria [17]. On a serious note, people who live in malaria endemic areas who get infected by severe acute respiratory syndrome – coronavirus-2 (SARS-CoV-2) may have a high risk of severe COVID-19 if they completely ignore malaria status [26].

Herbs, herbal materials, herbal preparations, and completed herbal products with active plant components, additional plant materials, or mixtures are considered herbal medicines [3]. They can be found as liquids, powders, capsules, tablets, ointments, or capsules. Some are produced in advance while others are only made when necessary and are used to not only treat but also maintain or improve health [3, 27]. Due to the general ease of access, social and cultural factors, perceived efficacy, and ideas about its safety, herbal medicine for treating malaria has thus become the standard and has frequently used and patronized by people especially people in rural communities.

Malaria has long been treated with traditional medicine [5].Traditional medicine includes all possible methods of using herbs, herbal materials or herbal medicine to treat diseases. Under an underpinning circumstance and before the advent of English medicine, the use of herbs has been prominent in the treatment of a lot of diseases, malaria inclusive. Herbal medicine is used to treat malaria among all categories, including children less than five years. Herbal medicine are now been commercialized [9, 12]. They are sold in the market and they are consequently receiving good patronages. While most herb medicine producers write the specifications and formations of the herbal medicines on the label, most do not do so as a matter of fact making the users take what they do not know as medicine. Some plants have been notably used in the production of herbal medicine. For example, the stem and bark of *Lophira lanceolata* and *Khaya grandifiola* have been reportedly used to produce herbal medicine notably used to treat malaria [7, 15]. Extract from bitter leaf has also been used to prepared herbal medicine (e.g. Goko cleanser). Similarly, extract of *Newbouldia laevis* has also been incorporated in herbal medicine preparation to inhibit the growth of *Plasmodium berghei* in Swiss Albino mice [22, 1]. This study suggested that herbal medicine can be for the treatment of malaria and all are extracted from different plants known for their high medicinal activities.

Having established a concrete background that herbal medicine is efficacious in the treatment of malaria in our

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communities, it is also pertinent that the side effects of these extracts are known by different laboratory tests. This can evidently give the doses that are safer for curative purposes. However, mortality dose response test is very important while studying the efficacy of herbal medicine. Also, test of toxicity gives clear picture of the level of damage that active ingredients contained in extracts of plant do to the organs, tissues or cells [13]. To show the safety of some herbal medicine on malaria parasite, it is pertinent to look for herbal mixtures that have high efficacious antimalarial properties with low toxicity while treating malaria [19]. It is crystal clear that medicine which stops a disease condition but causes harmful effect on the organs of the body is not worth recommending. The efficacy and mortality dose response of herbal mixtures against malaria parasite *(Plasmodium berghei)* in Swiss albino mice were investigated in this study to verify the safety and dosage in treatment malaria in the community.

MATERIALS AND METHODS

Location of the Study

This research was carried out in the animal house of the Department of Science Laboratory Technology, Federal University of Technology Owerri, Imo state Nigeria in March, 2024.

Collection of the Herbal Mixtures

Two different herbal mixtures namely: Goko Cleanser whose composition was *Sida acuta* = 10%, *Tridax procumbens* = 15 %, *Aistoma boonei* =35%, *Phyllanthus amarus* = 25% and *Citrus sinensis* = 15% and Green Health Herbal mixtures (*Phyllanthus amarus* = 45%, *Newbouldia laevis* =10% and *Veronica amygdalina* = 55%) were collected on the month of March, 2024 from Konga pharmaceutical stores at Douglas Owerri Market, Owerri Municipal Council of Imo state Nigeria. The herbal mixtures were taken to the Microbiology Laboratory of Science Laboratory Technology, FUTO where they were used for the analyses again *Plasmodium berghei.*

Experimental Animals

The albino mice used in this study were purchased from the Department of Pharmacology and Toxicology, University of Nigeria Nsukka, Enugu state and were already infected with *Plasmodium berghei*. They were kept in normal cages in the Glassblowing Laboratory Unit, Department of Science Laboratory Technology at the Federal University of Technology Owerri, Imo state. The mice used were aged 4-6 weeks and weighed between 21.27- 25.68 g. They were acclimatized for three weeks before the commencement of the study and fed with finisher pellet feeds with tap water throughout the study period similar to Ene *et al*. [14]. The animals were completely preserved from insecticidal bites from any source before the commencement of the experiment.

Grouping of the Experimental Animals

Total numbers of Twenty one (21) experimental animals were used. The animals were grouped into five groups. The first group represented the control (untreated mice with the parasite), the second group was treated with the first herbal mixture (Goko cleanser), the third group was treated with the second herbal mixture (Green health herbal), while the last group was the positive control (healthy rats). Each group was sub-divided into four sections (labeled 1, 2, 3 and 4). Group A (control) received no medicine and they were infected, Group B was infected with *Plasmodium berghei* and administered 200 and 250 mg/L of the Goko herbal cleanser. Group C was infected with *Plasmodium berghei* and administered 200 and 250 mg/L of the Green Health Herbal mixture. These animals were monitored for 0, 24, 48 and 72 hrs.

Anti-malaria Tests

All the 21 mice were pre-screened for *Plasmodium* parasite by making a thin smear of the blood taken from the tail tip of each mouse. Thin blood smears were made from the tail blood of each mouse, stained with Giemsa stain to reveal parasitized erythrocytes and viewed under a microscope. The parasitaemia was determined by

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counting the number of parasitized erythrocytes out of 500 erythrocytes in random fields of the microscope [20]. The parasitized red blood cells were determined in each rat across the group and the mean values were obtained. Furthermore, the mean parasitized erythrocytes of the untreated rats were related with those that were given the doses over time. From the mean values of the parasitized cells obtained from the microscopic observation, the percentage parasitaemia was calculated in comparison with the control using the formula:

$$\text{Percentage parasitaemia} = \frac{\text{Number of parasitized erythrocytes}}{Total\ number\ of\ erythrocytes\ counted} \times 100.$$

Prophylactic Test

Anti-plasmodial test was conducted for the herbal mixtures using prophylactic and suppressive in vivo anti-plasmodial models. The repository test was done using the method described by Arnold *et al.* [6]. In this test, thin films of blood samples obtained from the tail of each mouse treated with herbal medicine were collected, made on microscopic slides, stained with Giemsa stain and viewed under the microscope to determine the percentage chemosuppression. Another blood samples were also collected from that of the negative controls and viewed. This was done at the 0, 24, 48 and 72 hr. The formula below was used and all the data collected were recorded accordingly.

The percentage chemosuppression was calculated using the formula:

$$\frac{\text{Percentage parasitaemia of negative control} - \text{Percentage parasitaemia of test group}}{Percentage\ Parasitaemia\ of\ Negative\ Control} \times 100.$$

Mortality dose Response Test

The mortality dose response test was carried out on the mice. A total of thirty two (32) mice were recruited for the mortality dose response test. They were grouped into four based on the four doses of the herbal mixtures and each containing four mice. The experimental animals were given 0.0 mg/L, 250 mg/L, 500 mg/L, 1500 mg/L of the herbal mixtures. The animals were routinely inspected for 5 days (24, 48, 72, 96 and 120 hrs.) for signs of toxicity such as tremors, weakness, restlessness, refusal to feed, falling off of hair, coma, or even death [14].

Analysis of result

Data generated were expressed as mean ± standard deviation. Bar-charts plotted using MS Excel 2020 version containing the error bars and further subjected to Analysis of variance from which Duncan Multiple Test was carried out using SPSS, 2022 version to obtain the LSD at the confidence level of 95%.

RESULTS AND DISCUSSION

Table 3.1: Suppressive Anti-malaria effects of the herbal mixtures

Reduction/Suppression of parasites										
	Dose (mg/L)									
Time (hrs.)	Control	% Para.	200 mg/L for A	% Para	250 mg/L for A	% Para	200 mg/L for B	% Para	200 mg/L for B	% Para
0	44.3 ± 2.9^{a}	100	44.3 ± 5.3^{a}	100	51.8 ± 8.9^{a}	100	46.8 ± 10.9^{a}	100	42.8 ± 6.9^{a}	100
24	53.4 ± 4.4^{b}	121	35.3 ± 1.7^{b}	79.7	44.5 ± 9.0^{b}	85.9	37.8 ± 7.5^{b}	80.7	32.8 ± 6.6^{b}	76.8
48	63 ± 1.6^{c}	142	29.3 ± 3.7^{c}	66.1	28.8 ± 6.7^{c}	55.6	30.5 ± 4.7^{c}	65.2	25.3 ± 6.5^{c}	59.11
72	70.3 ± 1.5^{d}	158	22.8 ± 2.8^{d}	51.5	14.5 ± 1.3^{d}	30.0	23.3 ± 2.5^{d}	49.8	11.8 ± 2.4^{d}	27.6

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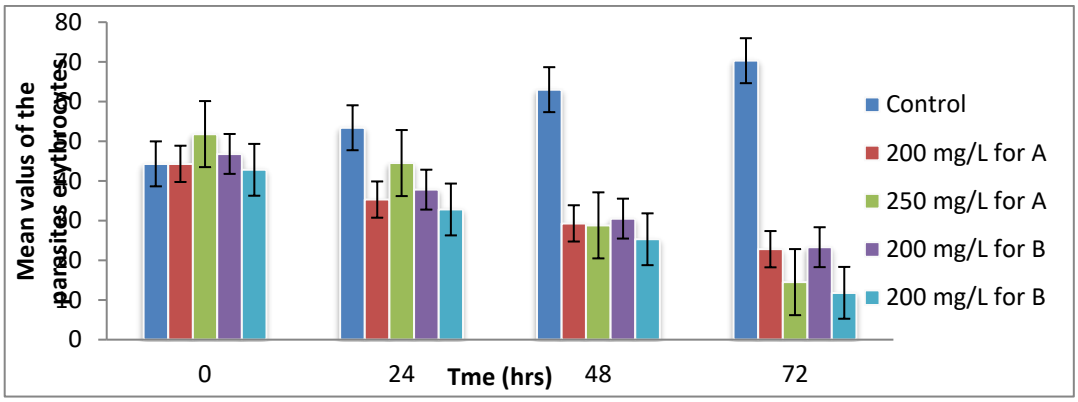
Key: Herbal A: Goko cleaner; Herbal B: Green Health Herbal Mixture. Total Number of mice: 21. Control: Untreated mice with *Plasmodium berghei.* All data were obtained from the four duplicates and expressed in Mean ± SD. a, b, c, d; figures with the same superscript in the same column are not significantly different (P>0.05).

Percentage parasitaemia = $\frac{\text{Number of parasitized erythrocytes}}{Total\ number\ of\ erythrocytes\ counted} \times 100.$

The table above is the result of the suppressive antimalarial effects of the herbal mixture on treated and untreated mice for 4 days. From the result contained in the Fig 4.1 above, the reduction/ /suppression of parasites across the concentrations over the experimental period differed significantly (P> 0.05). Interestingly, At first, the percentage parasitemia at all dose in 0 hour of the experiment was 100 % but as time goes on the untreated mice' parasite erythrocyte mean value increased from 100-158% (44.3-70.3 cells) but there are drastic reduction in the number of infected cells on the treated mice as shown on the Table 3.1.

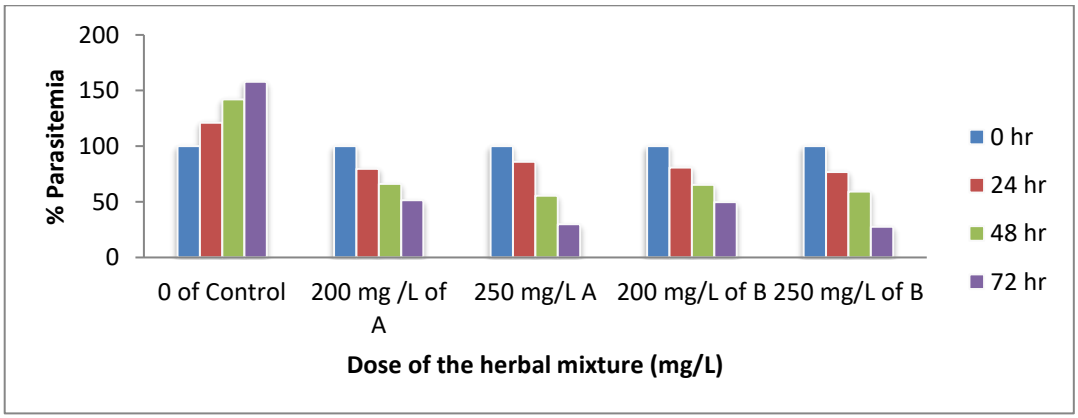
Fig 3.1: Bar chart showing the effects of herbal mixtures of the Plasmodium parasite in the albino mice over the experimental period with different doses



Key: Herbal A: Goko cleaner; Herbal B: Green Health Herbal Mixture. Control: Untreated mice with *Plasmodium bergheri.*

Presented on fig 4.1 above is the relationship between the mean values of the parasitized red blood cells against the different doses of herbal mixtures. In the untreated mice, the mean values of the infected erythrocytes as the experiment progressed tend to increase indicating that parasites continued to infect more red blood cells. On the other way round, those administered with the herbal mixture reduced were observably experiencing reduced mean values as the experiment progressed from 0-48 hrs. with insignificant differences statistically. This reduction indicates that the herbal mixtures exhibit prophylactic effects.

Fig 3.2: Bar chart showing the % parasitemia against the dose of the herbal mixture on the mice over time



Key: Herbal A: Goko cleaner; Herbal B: Green Health Herbal Mixture. Control: Untreated mice with *Plasmodium berghei.*

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Presented on fig 4.2 above is the relationship between the % parasitemia against the different doses of herbal mixtures. In the untreated mice, the % parasitemia increased as the experiment progressed. This indicated the parasites continued to infect more red blood cells as time progressed. On the other way round, those administered with the herbal mixture reduced were observably experiencing reduced % parasitemia as the experiment progressed from 0-48 hrs. This clearing indicates that the herbal mixtures exhibit anti-plasmodial effects on the mice.

Table 3.2 % chemosuppression with the herbal mixtures in mice

Time (hr.)	% Para. of Control	% para of 200 mg /L of A	% chemsup. of 200 mg /L of A	% Para. 250 mg/L of A	% chem. at 250 mg/L of A	% Para 200 mg/L of B	% chemsup. for B at 200 mg/L	% Para of 250 mg/L of B	% chemsup. for B at 250 mg/L
0	100	100	0	100	0	100	0	100	0
24	121	79.7	34.1	85.9	29.0	80.7	33.3	76.8	36.5
48	142	66.1	53.4	55.6	60.8	65.2	54.1	59.11	58.4
72	158	51.5	67.4	30	81.0	49.8	68.5	27.6	82.5

Key: Herbal A: Goko cleaner; Herbal B: Green Health Herbal Mixture. Control: Untreated mice with *Plasmodium bergheri*, Para: Parasitemia, Chem: Chemosuppression.

The percentage chemosuppression was calculated using the formula:

$$\frac{\text{Percentage parasitaemia of negative control} - \text{Percentage parasitaemia of test group}}{\textit{Percentage Parasitaemia of Negative Control}} \times 100.$$

Table 4.2 above shows the result of the prophylactic activity of the herbal mixtures on the mice. The % chemosuppression on the *Plasmodium berghei* increased as the % parasitemia decreased on administration of the two herbal mixtures. Consequently, the doses of 250 mg/L (0-81%; 0-82.5%) of herbal A and B confer quicker and more efficacious chemosuppressive effect than the 200 mg/L (0-67.4%; 0-68.7%). Comparatively, herbal B exhibited higher prophylactic effect than A although they do not differ significantly.

Table 3.3: Mortality of the mice at different phases and dose of the mixture

	Mortality							
	0.0 mg/L		250 mg/L		500 mg/L		1500 mg/L	
Time (Phase) (hrs.)	A	B	A	B	A	B	A	B
24	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	1	0
72	0	0	0	0	1	0	2	1
96	0	0	0	0	2	1	3	2
120	0	0	0	0	2	1	4	3

Key: 0.0 g/Kg = Distilled water; A = Herbal Mixture A; B = Herbal mixture B. Total number of mice used: 32; Number of groups: 4

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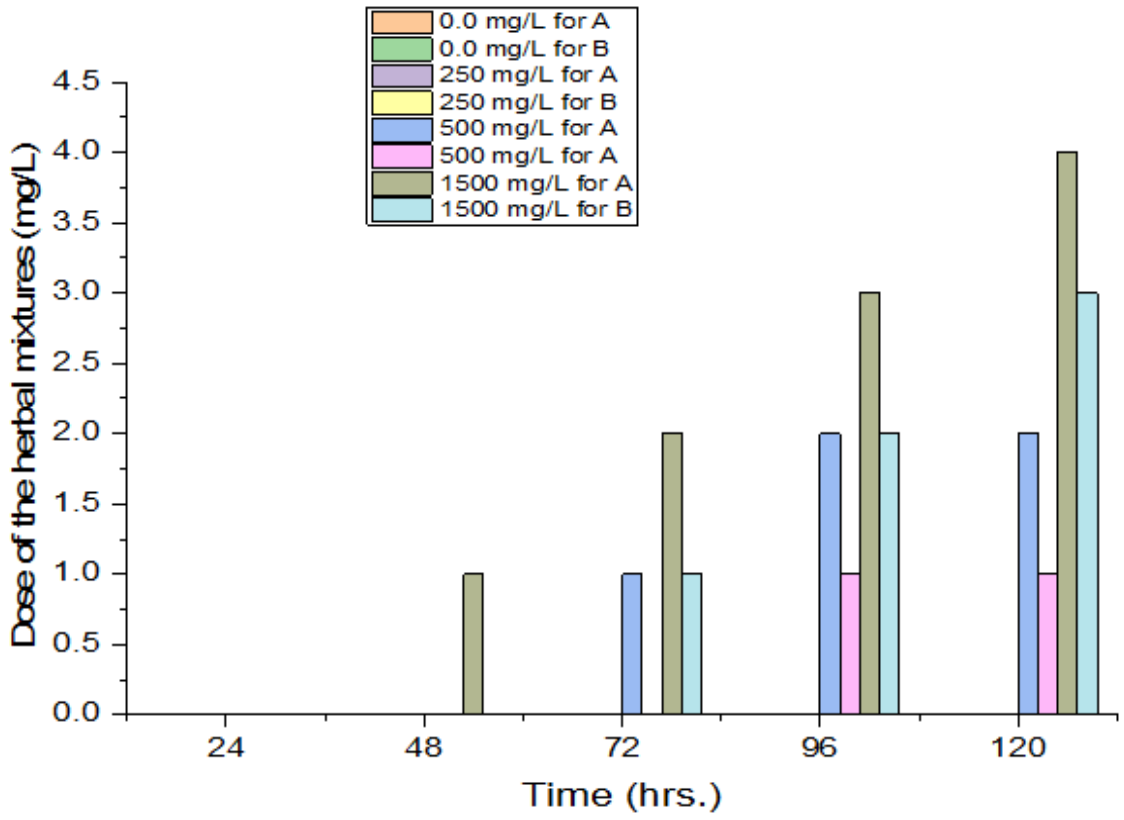
The result presented in Table 4.3 above represents the mortality of the mice at different phases and concentrations of the mixture during the mortality dose response tests. At the concentrations of 0.0 mg/kg (control) and 250 mg/L of both mixtures A and B, there was no mortality at the end of the experimental time frame. First mortality was observed after 72 hrs. and 96 hrs. with herbal mixtures A and B at the dose of 500 mg/L, respectively. At the end, 2 and 1 casualties were observed with 500 mg/kg using herbal A and B. When the concentrations of the herbal mixtures were increased to 1500 mg/L, at 2 days (48 hrs.), the first death was witnessed in mice treated with A, and at the end of the experimental period, all the mice died, but with herbal B, the first mortality was witnessed after 72 hrs., and 3 later died with the 1500 mg/L dose. This result shows that the lethal dose of herbal A is lesser than that of B.

Fig 3.3: Bar chart showing the mortality of the mice after 120 hrs.



DISCUSSION

Malaria remains the deadliest disease with the highest death toll on the African and Asian continents, especially in Nigeria, where medical facilities have deteriorated over the years due to government negligence in public health services [28]. Because the Nigerian government has failed in its responsibilities, many have resorted to the use of herbal mixtures to treat malaria. This is not restricted to malaria only; they also use herbal mixtures to treat other infections such as typhoid fever, yellow fever, diarrhea, gonorrhea, dysentery, meningitis, etc. If these herbal mixtures do take care of these diseases without affecting the liver, they have actually remained unraveled to the users, but researchers, in their wider knowledge, have tried to carry out toxicity tests on these herbal mixtures in order to give details on the modus operandi, side effects, and doses of using them. The answer remained that herbal mixtures taken at higher doses can lead to liver and kidney-related diseases [13].

The suppressive antimalarial effects of the herbal mixtures on treated and untreated mice for 4 days were experimented with, and the results are presented in Table 3.1. From the results obtained, the reduction or suppression of parasites across the concentrations over the experimental period differed significantly ($P < 0.05$). Interestingly, at first, the percentage of parasitemia at all doses in the first hour of the experiment was 100%, but as time went on, the untreated mice' parasite erythrocyte mean value increased from 100 to 158% (44.3 to 70.3 cells), but there was a drastic reduction in the number of infected cells in the mice treated with

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both herbal mixtures. Descriptively, the Goko cleanser (Herbal A) used at a concentration of 200 mg/L reduced the number of parasitized red blood cells from 100 to 51.5%; at 250 mg/L, the parasitized red blood cells were reduced from 100 to 30%, indicating that increased dosage resulted in increased efficacy observed from 0-72 hours. Similarly, the Green Health Herbal Mixture (herbal B) used at the concentration of 200 mg/L also reduced the number of parasitized erythrocytes from 100 to 49.8%, and at 250 mg/L, the mixture decreased the parasitized red blood cells from 100 to 27.6% when monitored from 0 to 72 hours, respectively. Comparatively, herbal B cleared more parasites than A at the same doses, although they did not differ significantly. The result of this research corroborated with that of Yusuf *et al.* [29], Arnold *et al.* [6], Ukawuibe *et al.* [24], and Forge and Nna [14], who reported that herbal mixtures have shown sedative, anticonvulsant, and antidepressant properties in addition to anti-diabetic, anticancer, and antimalarial properties from herbal mixtures from *Newbouldia laevis* leaf, stem, and bark. Herbal mixtures have shown high anti-plasmodial effects and additional recommended antimalarial properties [25]. The root and flower can be joined with other plant parts to boost the antimalarial activity of the herbal mixture [25]. Herbal mixtures are also frequently used to treat a wide range of illnesses, such as fever, conjunctivitis, migraine, skin infections, stomach ache, epilepsy, and malaria [25].

Malaria parasites, if not treated, would continue to infect more red blood cells, just as observed in the untreated mice infected with *Plasmodium berghei* and demonstrated in Figures 3.2 and 3.3. According to the results of this study, the symptoms of malaria observably continue to rise as the parasite populates. After 72 hours of the study, the mice had severe symptoms of malaria. For example, the malaria paroxysm comprises three successive stages [28]. The first is a 15- to 60-minute cold stage characterized by shivering and a feeling of cold [28]. The result of the research corroborated the report of Dehghan *et al.* [11]. According to Dehghan *et al.* [11], the symptoms of infected mice included seclusion, temperature dysfunction, intense and fast breathing and increased heart rate, humping, blistering body hair (ruffled fur), particularly on the back, eye weeping or closing, inactivation and reluctance to move in high parasitemia, hard walking, losing skin, ear discoloration, anemia, lightening the blood color from dark red to light red/fawn, RBC reduction, cerebral complications, and death. The decline in the chart demonstrated that the infected mice were responding to the treatment being given to them over a period of time.

The percentage of chemosuppression of the herbal mixtures was also monitored, and it increased as the percentage of parasitemia decreased on the administration of the two herbal mixtures. Consequently, doses of 250 mg/L (0-81%; 0-82.5%) of herbal A and B confer a quicker and more efficacious chemosuppressive effect than doses of 200 mg/L (0-67.4%; 0-68.7%) as the time moved from 0-72 hours. Comparatively, herbal B exhibited a higher prophylactic effect than A, although they did not differ significantly. This is in agreement with the reports of Ogugua *et al.* [20], who investigated commercial herbal preparations in the amelioration of *Plasmodium berghei* NK65-induced aberrations in mice. The result showed that % parasitemia increased in the untreated mice but reduced in the treated mice, but the reduction in % parasitemia of the treated mice showed an increase in % chemosuppression. From the result of this study, the parasitized red blood cells by *Plasmodium berghei* were cleared up to 81%, 82.5%, 67.4%, and 68.7% at doses of 250 mg/L and 200 mg/L, respectively, for herbal A and B. This is also consistent with the study of Salawu *et al.* [22], who reported a decrease in parasitemia in infected mice on administration of the herbal mixture of *Newbouldia laevis,* and the chemosuppression at a concentration of 59 mg/kg was 68%.

The mortality effects of the herbal mixtures (A and B) were studied at doses of 250, 500, and 1500 mg/L, with the results shown in Table 3.3 and demonstrated with Fig. 3.3. The control and herbal mixtures had no impact on the mice at 250 mg/L for the duration of the trial, but at doses of 500 mg/L (3 mice died) and 1500 mg/L (7 mice died), both herbal mixtures began to affect the animals over time, resulting in their deaths. There was no mortality at the end of the experiment at concentrations of 0.0 mg/L (control) and 250 mg/L for both A and B. The first fatality occurred after 72 and 96 hours with herbal mixtures A and B at doses of 500 mg/L, respectively. At the end, 2 and 1 casualties were observed with 500 mg/L using herbal A and B. When the concentrations of the herbal mixtures were increased to 1500 mg/L, at 2 days (48 hrs.), the first death was witnessed in mice treated with A, and at the end of the experimental period, all the mice died, but with herbal B, the first mortality was witnessed after 72 hrs., and 3 later died with the 1500 mg/L dose. This result showed that herbal A was more lethal than herbal B. The response to the toxicity of this study fairly agrees with the reports of Ukaga *et al.* [23] and Balogun *et al.* [8], but perfectly disagrees with the results of Adumanya *et*

al. [2] and Onyejike *et al.* [21]. Adumanya *et al.* [2] assessed the oral acute toxicity of the herbal medicine using Wistar albino rats. The result of the research showed that the herbal mixture was safest at a dose of 5000 mg/kg or less when taken orally, contrary to the findings of this research (250 mg/L). In their experiment, no Wistar rat was lost throughout the course of the experiment. The side effects of taking the herbal medicine topically were not reported, and the authors recommended that an overdose of the herbal medicine is not advisable because of the deleterious effects on the hepatocytes via photomicrograph. Consequently, Onyejike *et al.* [21] used concentrations of 1000, 1500, and 2000 mg/kg on mice and discovered that there were moderate to no mortality effects on the mice. Although herbal medicine is efficaciously anti-malarial in nature, an overdose of the mixture can be lethal.

CONCLUSION AND RECOMMENDATIONS

Herbal medicine is a natural and effective means of treating malaria, especially where orthodox medicine is unavailable or in short supply relatively. This is because herbal medicine has a wide spectrum of antimalarial mechanisms. Normally, well-prepared and examined herbal mixtures may only be toxic at relatively high doses, unlike the English medicine that can be fatal at just a little-abused dose. From the results of this research, Goko cleanser and Green Health Herbal mixtures exhibited antimalarial activity relatively and moderately at the doses of 200 mg/L and 250 mg/L, showing percentage parasitemia reductions of 51.5%, 49.8%, 30%, and 27.6%, respectively. Consequently, at the concentrations of 500 mg/L and 1500 mg/L, the herbal mixtures became very toxic, leading to the death of some of the mice. More research should be done with sophisticated instruments in order to highlight the active contents of the herbal medicine and the usage of herbal mixtures should be properly regulated by the professional bodies in charge of drugs and medicine. Also, the government of every country should extend her helping hands to rural communities and build more primary health centers because it will help to reduce the use of herbal mixtures as malaria medicine. Furthermore, efforts to introduce a malaria vaccine should be expedited, especially in the developing countries, in order to reduce the child-mother malaria-associated mortality rate. Pregnant women, children, and adults should always sleep under insecticide-treated nets (ITNs) and should try as much as possible to visit health posts when they are suspectedly infected with malaria parasites. Lastly, education on environmental and personal hygiene should be constantly given to the general public by health agencies because this is a veritable tool to curb mosquito breeding, and producers of herbal mixtures should always try as much as possible to write down the efficacy, lethal concentrations, and the side effects of the herbal mixtures on the labels.

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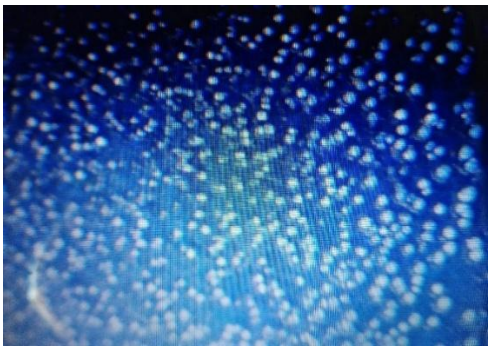
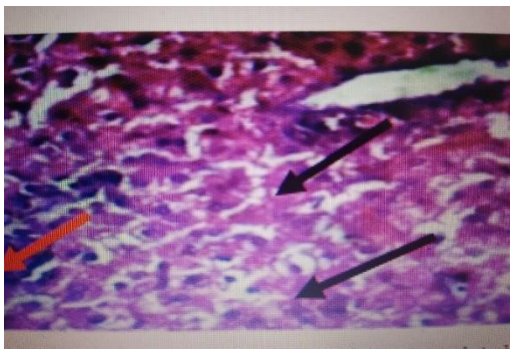
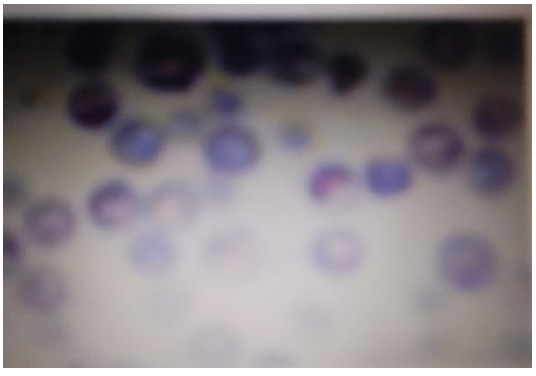


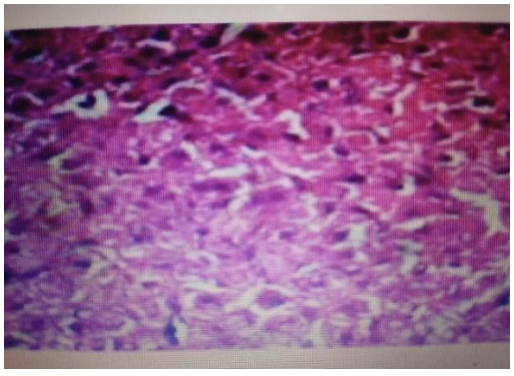
Micrograph of the RBC of the healthy mouse



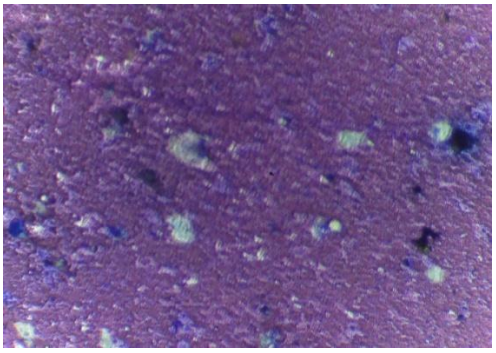
RBC of the untreated group infected with *P. berghei*



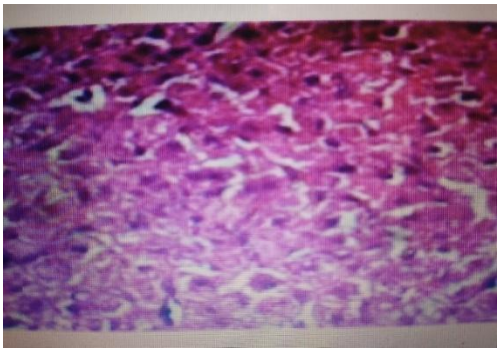
The RBC of the treated mouse with Herbal A (250 mg/l)



The RBC of the treated mouse with A (200 mg/l)



The RBC of the treated mouse with Herbal B (250 mg/l)



The RBC of the treated mouse with B (200 mg/l)