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In Vivo Antimalarial Activity of *Cleome gynandra* Extracts

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Abstract: *Cleome gynandra* is a commonly neglected plant in East and West Africa. It is used as a vegetable and for the treatment of malaria and several ailments. Samples of the plant were collected from Nigeria, Tanzania and Uganda. The plant samples were extracted with hexane, ethyl acetate and methanol and the extracts were subjected to phytochemical screening and *in vivo* antimalarial activity. Chromatographic techniques were used to isolate apigenin, caffeic acid, ferulic acid, kaempferol, taraxasterol, pheophytin A, sitosterol, stigmasterol, monoacetyl glycerol, 2-monoacetyl glycerol, oleic acid, mixtures of fatty acids and triglycerides, hexadecanoic acid and two novel eicosatetraenes identified as 5,7,13,15-eicosatetraen-9, 12-diol and 9-hydroxy-5,7,13,15-eicosatetraen-12-one. The compounds were identified based on their NMR spectra and compared with literature reports. The combined methanol and ethyl acetate extracts of the plant were evaluated for *in vivo* antimalarial activity against *Plasmodium berghei* NK65 using white albino mice. Forty eighty mice of either sex were separated into eight groups of six each. Seven groups were *intraperitoneally* inoculated with 10^7 *Plasmodium berghei* NK65 per body weight. The 8thgroup was neither infected nor treated. Group 2-7 were orally administered with 12.5, 25, 50, 100 and 200mg/kg of the plant extract and 25mg/kg of Halofantrine (as control) for four days, whereas the mice in group 1 were not treated. The *in vivo* antimalarial results revealed significant clearance of *Plasmodium berghei*NK65 from group 4 administered 50mg/kg of the plant extract and group 7 administered 25mg/kg of halofantrine on the 14th day of post infection. Group 1 which was infected and untreated showed significant level of parasitaemia up till 14th day of post infection. The dose at 50 mg/kg body weight of extract showed the best activity against *Plasmodium berghei* NK65since it showed 73.2% clearance.

Keywords: *Plasmodium berghei*, Phytochemical, Eicosatetraenes, Nigeria, Tanzania, Uganda.

1. INTRODUCTION

Cleome gynandra L. is a species of *Cleome* (Cleomaceae) widely known as spider plant, African cabbage and cat whiskers. The plant is used as a vegetable and in traditional medicine for various ailments [1-3]. It usually grows as a weed but may be cultivated in some countries such as Zambia, Uganda and Kenya [4-7]. An ethnobotanical survey of the plant revealed its use for the treatment of malaria, which has become one of the greatest obstacles to living and development in Africa. It causes more deaths than can be counted and afflicts more infants than adults [8-10]. It causes interruption of farm work, education, commercial activities and decreases general wellbeing and life expectancy [11,12]. The search for new malaria remedies has become urgent and every available lead is being explored for efficacy and scientific rationalization [13-16]. This hopefully could lead to a new drug that will help combat the present situation of drug resistance and prolonged treatment. Natural compounds identified through ethnobotanical studies have served as leads in such new drug development [17]. The promotion of diets rich in plant-based foods such as vegetables and fruits is recommended by many health organizations as a way of enhancing individual health. Though these vegetables may have commercial benefits to the farmers and traders, most of the vegetables commonly consumed in Africa are not cultivated or conserved and could easily go into extinction. There is therefore a need to make a case for their cultivation and conservation by increasing their value and identifying species and varieties with unique constituents. It is also necessary to identify species that can withstand drought and can be cultivated in commercial quantities. Phytochemical analysis of medicinal plants is an important step in the discovery of new drugs. Previous phytochemical investigation of *Cleome gynandra*has shown it to be a rich source of flavonoids, phenolic and terpenic compounds [3,18,19]. The leaves in particular contain nutrients such as vitamin A and C, minerals (calcium and iron) and proteins [20]. This report is on a further phytochemical screening and antimalarial activity of the extracts of *Cleome gynandra*.

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E-ISSN: 0000-0000/16 © 2016 Synchro Publisher

2. MATERIALS AND METHODS

2.1. Collection and Identification of Plant Material

The plant materials (leaves, seeds stem and roots) were collected from Zaki- Biam in Ukum L.G.A, Anyiin in Logo L.G.A and Makurdi in Makurdi L.G.A of Benue State in July 2014. The plant was identified by the Forestry and Wild Life Department, University of Agriculture, Makurdi where a voucher specimen was deposited in the herbarium for future reference. Other samples were collected from collaborators in Tanzania and Uganda.

2.2. Methods

2.2.1. Preparation and Extraction of Plant Materials

The dry plant materials were powdered and macerated (200 g each) with hexane, ethyl acetate and then methanol (1500 ml each for 72 h). The extracts were filtered and concentrated using a rotary evaporator. The crude extracts were weighed and kept for further analysis.

2.2.2. Thin Layer Chromatography (TLC)

Thin layer chromatography (TLC) was carried out using pre-coated Silica gel 60TLC Aluminium sheets to examine and compare the crude extracts and column fractions.

2.2.3. Column Chromatography (CC)

The extracts (about 2 g each) wereloaded unto silica gel columns and eluted gradient-wise using mixtures of hexane, ethyl acetate and methanol. Eluates were collected in 30ml vials. Similar fractions were combined based on TLC.

2.2.4. Nuclear Magnetic Resonance (NMR)

Combined fractions were examined by ^{1}H NMR and interesting fractions were subjected to ^{13}C and 2D NMR. Data were processed using MestReNova software and known compounds were identified based on literature reports.

2.3. *In Vivo* Antimalarial Assay

The combined methanol and ethyl acetate crude extract of the plant was evaluated for *in vivo* antimalarial activity at the Department of Veterinary Physiology, Pharmacology and Biochemistry, College of Veterinary Medicine, University of Agriculture, Makurdi, Benue State. The assay was carried out according to Saganuwan *et al*. [21].

2.4. Animals and Diet

All animals were handled according to laboratory animal care guidelines [22] and recommended procedures of the Department of Veterinary Physiology, Pharmacology and Biochemistry, College of Veterinary Medicine, University of Agriculture, Makurdi Ethical Committee on the use of animals. A total of 48 mice of either sex aged 8.5±1.5 weeks old and weighed 31.75± 5.4 g were obtained from College of Health Sciences Animal House, Benue State University, Makurdi. They were housed in the Department of Veterinary Physiology, Pharmacology Laboratory, University of Agriculture, Makurdi for acclimatization. Feed (Growers marsh®) and water were provided *ad libitum.*

2.5. Preparation of Stock Solution

About 10 g of the combined methanol and ethyl acetate extracts of the plantplaced in a beaker and 90 ml of distilled water was added to obtain a 10 % stock solution and was stored in a refrigerator at 4^{0} C until required.

2.6. *Plasmodium berghei*

Plasmodium berghei, strain NK 65 (rodent malaria parasite) was obtained from the Department of Pharmacology, Ahmadu Bello University, Zaria. The parasite which produced acute infections in mice with a prepatent period of 3-5 days was maintained by serial passage using one quarter milliliter of infected blood containing 10^{7}plasmodium.

2.7. Parasite Inoculation

The required blood volume was obtained from the tail of the donor mouse and diluted serially in normal saline solution. The final suspension contained about 1x 10^{6} infected red blood cells in every 0.2 ml that was injected into mice intraperitoneally to initiate infection and was observed daily for presence of the parasites.

2.8. Therapeutic Dose Selection

In a previous study, Bala *et al*. [7] determined the LD_{50} of amethanol extract of the aerial parts of *Cleome gynandra* at a dose of 2000 mg/kg body weight and therapeutic doses were selected within$1/10^{th}$ and $1/100^{th}$ of this value, hence 12.5, 25.0, 50.0, 100.0 and 200.0 mg/kg were chosen for this study.

2.9. *Plasmodium berghei* Treatment

A total of 48 mice were screened for the presence of haemoparasites. The mice were divided into eight

groups of six mice each. Group 1-7 were inoculated intraperitoneally with 10^7 *Plasmodium berghei* per gram body weight while group 8 served as the negative control. On the third day of infection, group 2, 3, 4, 5 and 6 were treated with the combined methanol and ethyl acetate extracts at dose level 12.5, 25.0, 50.0, 100.0 and 200.0 mg/kg of body weight, whereas group 7 was treated with Halofantrine as a standard drug at a dose level of 25.0 mg/kg body weight. The plant extracts and the standard drug were administered orally and daily for four days to the infected mice while the control groups (1 and 8) received 0.2 ml of normal saline for the four days of treatment. Parameters used to assess the therapeutic activity of the extract in mice were presence of parasite in the blood film and parasite load, haematological parameters such as white blood cell counts, packed cell volume, erythrocyte counts, haemoglobin, differential leucocyte counts, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration and frequency of death. These parameters were assessed daily before infection and on the 1st, 2nd, 3rd, 4th, 6th, 8th, 10th and 14th day post infection. Blood samples were obtained from the nicked tail vein of the infected mice and were examined using thick and thin blood films for parasite identification and parasitized erythrocytes counts respectively [23].

2.10. Thick Blood Film Preparation

About 50µL of ethylene diamine tetra acetate (EDTA) anticoagulant blood was placed on a clean dry grease free microscope slide and spread to make a thick smear and allowed to dry. The dry film was dipped into field's stain A (polychrome methylene blue) for five minutes. The excess stain was drained off and washed gently for five seconds in clean water and any excess water drained. The drained slide was dipped into field's stain B (eosin) for three seconds and excess stain drained. The slide was then gently washed in clean water and placed in an upright position to dry [23].

2.11. Thin Blood Film Preparation

About 50µL of ethylene diaminetetraacetate (EDTA) anticoagulant blood was placed on one end of a clean dry grease free microscope slide and spread immediately using a smooth edge spreader. The slide was then labeled using grease pencil and the film was allowed to air dry in an insect and dust free area. The dried film was placed horizontally on the staining rack. The fixed slide was covered with field's stain B (eosin) of 1 in 5 dilutions and an equal volume of field's stain A (polychrome methylene blue) was added and allowed to mix for one minute. The stain was then washed off with clean water and the back cleaned and placed on a rack to dry [23].

2.12. Parasite Count

A thin blood film was used for parasite counts using parts of the film where the white cells were evenly distributed and the parasites were well stained. White blood cells were counted systematically using the oil immersion objective (x100) and counting at the same time the number of parasites in each field covered. A hard tally counter was used for counting.

$$\text{No of parasites per microliter (µL) of blood} = \frac{\text{White blood cells count (WBC) x parasites counted against 100 WBC}}{100}$$

For the objective lens (x100), an area of thin film, where the total number of red blood cells was approximately 250 per field, was selected. The total number of parasitized red blood cells in four fields were counted; assumed as 1000 red blood cells. The percentage value of parasitized red blood cells was calculated as follows (Cheesbrough, 2005).

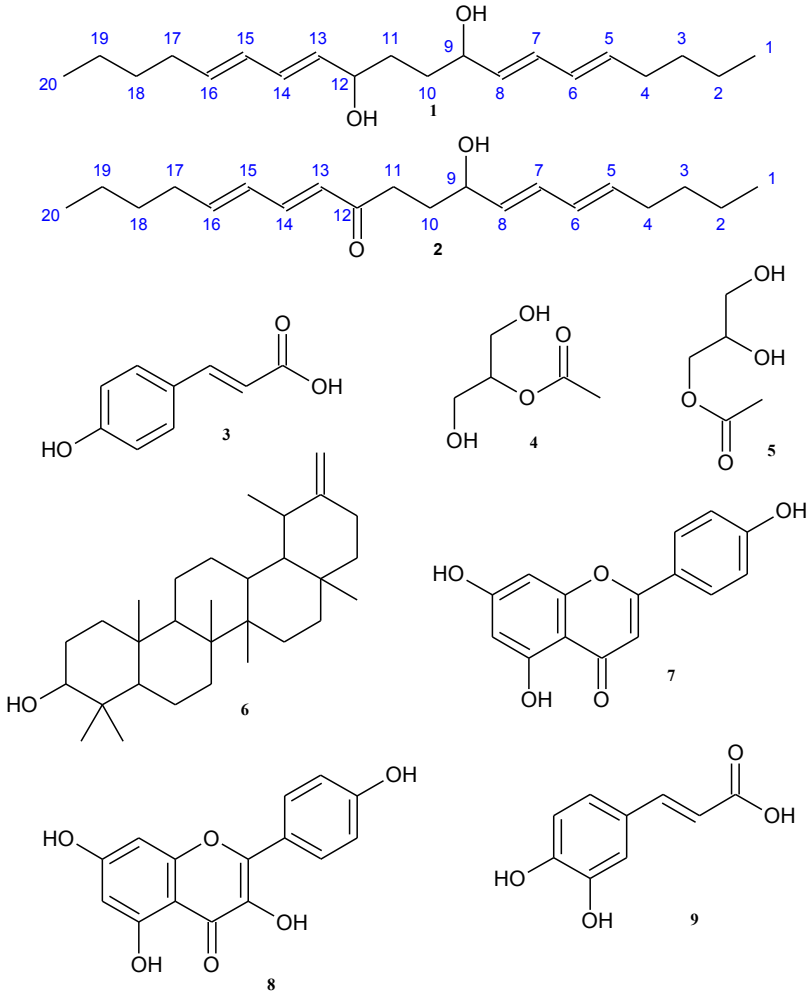
$$\% \text{ parasitized} = \frac{\text{No. of infected erythrocytes x 100}}{\text{Total No. of erythrocytes counted}}$$

2.13. Statistical Analysis

All the data generated on percentage of parasiteemia and haematological parameters were expressed as mean ± standard error of mean (SEM). Multiple variable analysis of variance (MANOVA) was used to analyze the results. Pillaias trace was used to detect the least significant difference among all the treatment groups as well as between the treatment groups and the control groups at 5% level [24].

3. RESULTS

Yield of crude extracts was between 8.0 and 35.5 g from 500 g of plant material. The compounds isolated were two novel eicosatetraenes; 5,7,13,15-eicosatetraen-9, 12-diol **1** and 9-hydroxy-5,7,13,15-eicosatetraen-12-one **2** [3,25-27]. The others were known compounds namely ferulic acid **3**, glycerol-2-acetate **4**, glycerol-1-acetate **5**, taraxasterol **6**, kaempferol **7**, apigenin **8**, caffeic acid **9**, pheophytin A, sitosterol, stigmasterol, , oleic acid, tetradecanoic acid, hexadecanoic acid [28-31]. Compounds **1**, **2**, **3**, **4**, **6**, **9** as shown in Figure **1** and pheophytin A are being reported from this plant material for the first time.



Position	Compound 1		Compound 2	
	^{1}H (δ ppm) (*J* in Hz)	^{13}C (δ ppm) (multiplicity)	^{1}H (δ ppm) (*J* in Hz)	^{13}C (δ ppm) (multiplicity)
1	0.86	14.2	0.89	14.0
2	1.26	22.6	1.36	22.7
3	1.36	31.5	1.43	32.5
4	2.14	27.8	2.19	27.7
5	5.42 (dt, 11.2, 7.5)	133.1	6.20	145.8
6	5.93 (dd 11.1,11.2)	127.8	6.19	128.8
7	6.44 (dd, 15.2, 11.1)	126.0	7.15 (dd, 15.6, 10.0)	143.2
8	5.61 (dd, 15.4, 7.0)	135.7	6.10	127.7
9	4.12	73.0	-	201.3
10	1.51	37.2	2.18	32.8
11	1.51	37.2	1.54	37.2
12	4.07	73.0	4.28	86.9
13	5.53 (dd 15.0,7.0)	133.4	5.38	128.9
14	6.13 (dd 15.0,10.1)	131.2	5.76 (dd 15.5,7.4)	136.9
15	5.99 (dd 15.0,10.1)	129.5	5.38	128.9
16	5.67 (dt, 14.9, 7.4)	135.6	5.77	136.6
17	2.04	32.7	2.08	29.5
18	1.36	31.5	1.42	31.8
19	1.26	22.8	1.36	22.7
20	0.86	14.2	0.89	14.0

Figure 1: Compounds isolated from the plant extracts.

3.1. *In Vivo* Antimalarial Assay

All mice infected with *Plasmodium berghei* exhibited weakness, anemia, diarrhea, thirst and loss of body weight. The uninfected control mice showed no signs of illness. The effect of the combined methanol and ethyl acetate extract of *Cleome gynandra* on mean erythrocytes count, mean white blood cell count, percentage parasitized red blood cells, mean differential leucocytes count and other haematological parameters of mice infected with *Plasmodium berghei* are given in Tables **1-5** while the effect of the parasite on erythrocytes on day 1 post infection is shown in Figure **2**.

The effect of combined methanol and ethyl acetate extract of *Cleome gynandra* on percentage parasiteaemia of mice infected with *P. berghei*. The percentage parasitaemia was significantly (P<0.05) increased in all the infected groups. On day 1 post infection, the parasitaemia (2.56±0.34%) increased to 5.07±1.03% on day 2 and the highest was observed on day 14 (10.95±1.68%). All the animals in this group died. However group 2 mice showed parasitaemia (1.60±0.23%) on day 1 which increased to 3.64±0.54% on day 2 and 9.44±4.40% on day 14. Group 3 showed parasitaemia (0.97±0.20%) on day 1which increased to 2.12±0.41% on day 2 and 6.76±1.88% on day 14. Group 4 mice treated with 50 mg/kg showed very significant decrease of parasiteamia (4.03±0.55%) on day 14 but Halofantrine showed highest significant decrease on day 14 (2.77±0.66%). Group 5 and 6 showed percentage parasitaemia of 6.28±1.94% and 7.16±0.45% on day 14 respectively (Table **3**).

Table **2** shows the effects of methanol and ethyl acetate extracts of *Cleome gynandra* on mean erythrocytes count of mice infected with *Plasmodium berghei*. The infected untreated group showed significantly (P< 0.05) increased erythrocytes on 2nd day post infection ($6.62\pm0.22\times10^{12}$/L), day 3 ($7.54\pm0.29\times10^{12}$/L) and day 4 ($7.56\pm0.28\times10^{12}$/L). However all the group administered 12.5, 25.0, 50 and 100 mg/kg of the extract showed decreased erythrocyte counts on day 6 and 14 except the group administered 200 mg/kg body weight, which showed significantly (P< 0.05) increased erythrocytes on day 14. But the Halofantrine treated group showed significantly decreased erythrocytes on day 4 ($4.23\pm0.60\times10^{12}$/L) and day 6 ($3.89\pm0.5\times10^{12}$/L) and the erythrocytes count was restored to a normal value on day 14. Nevertheless, the uninfected untreated showed relatively constant value of erythrocytes (P<0.05) throughout the period of experimentation.

Table **3** shows the effects of *Cleome gynandra* extract on the packed cell volume (PCV), haemoglobin concentration (HC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC). PCV decreased significantly (P< 0.05) on day 6 running through to day 14 in group 1-6 and increased on day 14 in group 7 respectively. The values of PCV was significantly increased (P< 0.05) in group 8 throughout the period of experiment. However, haemoglobin concentration also decreased significantly (P<0.05) on day 4 passing through day 14 in group 1-6 and increased on day 4 in group 1. But haemoglobin concentration decreased on day 6 in group 7, whereas the values of

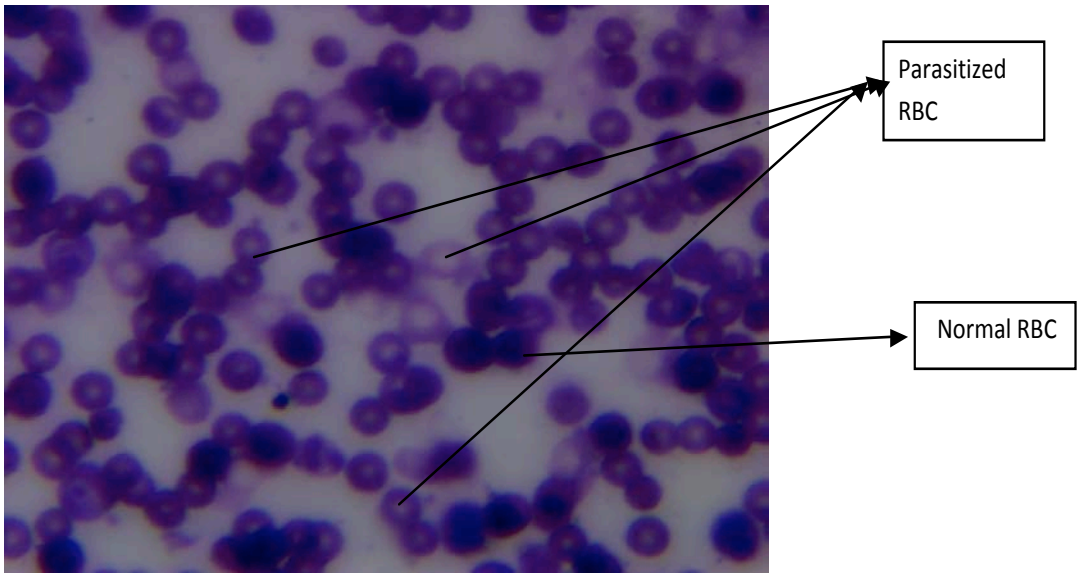


Figure 2: *Plasmodium berghei* NK65 in the erythrocytes of mice day 1post infection.

Table 1: Effects of Combined Methanol and Ethyl Acetate Extract of *Cleome gynandra* on Percentage (%) Parasitemia of Mice Infected with *Plasmodium berghei* NK65

Group	Dose (mg/kg)	Days of Infection							
		1st	2nd	3rd	4th	6th	8th	10th	14th
1	Infected untreated	2.56±0.54	5.07±1.03[a]	7.51±1.52[a]	9.90±2.06[a]	10.44±1.36[a]	10.14±1.41[a]	9.44±0.86[a]	10.95±1.68[a]
2	12.5	1.60±0.23	3.64±0.54[a]	6.12±1.00[a]	8.65±1.26[a]	8.58±1.79[a]	9.08±2.40[a]	4.74±1.06[a]	9.44±4.40[a]
3	25.0	0.97±0.20	2.12±.041[a]	3.39±0.62[a]	4.53±0.83[a]	3.10±0.57[a]	6.81±1.11[a]	10.09±1.03[a]	6.76±1.88[a]
4	50.0	1.14±0.22	1.99±0.44[a]	2.56±0.69[a]	3.43±0.92[a]	9.62±1.81[a]	15.01±6.50[a]	12.25±1.35[a]	4.03±0.55[a]
5	100.0	1.78±0.27	4.06±0.56[a]	3.76±0.85[a]	8.35±0.89[a]	7.07±1.48[a]	14.81±2.68[a]	21.34±7.65[a]	6.28±1.94[a]
6	200.0	1.44±0.27	2.75±0.50[a]	3.91±0.76[a]	4.84±0.87[a]	7.12±1.35[a]	9.91±1.90[a]	6.27±2.21[a]	7.16±0.45[a]
7	25.0 (Halofantrin)	0.98±0.24	2.07±0.44[a]	3.22±0.67[a]	5.21±1.19[a]	3.65±0.82[a]	6.91±1.96[a]	3.49±1.53[a]	2.77±0.66[a]
8	Uninfected untreated	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Mean ± SEM of eight observations.
a = significantly higher (p<0.05) in comparison with the experimental groups.

Table 2: Effects of Combined Methanol and Ethyl Acetate Extract of *Cleome gynandra* on Mean Erythrocytes Count (×10^{12}/L) of Mice Infected with *Plasmodium berghei* NK65

Group	Dose (mg/kg)	Days After Infection								
		Pre Infection	1st	2nd	3rd	4th	6th	8th	10th	14th
1	Infected untreated	4.93 ±0.55	5.80±0.35	6.62±0.22[a]	7.54±0.29[a]	7.56±0.28[a]	5.92±0.08	4.84±0.38	3.75±0.45[b]	3.50 ±0.36[b]
2	12.5	6.97 ±0.29	6.67±0.14	6.38±0.25	5.91±0.31	6.06±0.44	3.92±0.40[b]	3.17±0.43[b]	1.99±0.23[b]	2.18±0.68[b]
3	25.0	6.69 ±0.24	5.79±0.17	5.01±0.31	4.24±0.50	4.25±0.53[b]	3.50±0.27[b]	5.04±0.70	6.51±1.03	2.17±0.77[b]
4	50.0	6.37 ±0.49	6.00±0.41	5.61±0.40	5.22±0.47	5.23±0.47	5.33±0.89	5.05±0.56	4.79±1.50[b]	2.81±1.58[b]
5	100.0	6.58±0.94	5.69±0.74	4.67±0.66	3.91±0.58	3.89±0.56[b]	2.64±0.41[b]	5.11±0.67	7.91±1.66	4.84±1.20
6	200.0	6.39 ±0.42	5.92±0.32	5.26±0.30	4.60±0.45	7.39±0.36[b]	5.42±0.45	5.13±1.10	4.26±0.96	11.15±5.15[a]
7	25.0 (Halofantrin)	7.43 ±0.44	6.43±0.29	5.43±0.41	4.36±0.64	4.23±0.60[b]	3.89±0.51[b]	4.91±1.18	5.18±1.23	6.61±0.45
8	Uninfected untreated	7.82 ±0.44	7.81±0.44	7.80±0.44	7.81±0.44	7.79±0.44	7.77±0.46	7.76±0.46	7.75±0.45	7.67±0.46

Mean ± SEM of eight observations.
a = significantly higher (p<0.05).
b = significantly lower (p>0.05).

HC in group 8 were not affected. MCV significantly decreased (P< 0.05) on day 4 to day 14 in group 1, 2 and 4 but significantly increased (P< 0.05) on day 14 in group 3, 6, 7 and 8 respectively. Also MCH significantly decreased from day 4 to day 14 in group 1, and decreased on day 14 in group 2 and 5 but increased in group 3, 4, 6 and 7 respectively. MCHC values of all the experimental rats were not significantly (P< 0.05) affected in all the experimental animals.

Table **4** shows white blood cells count of P*lasmodium berghei* infected mice treated with combined methanol and ethyl acetate extract of C*leome gynandra*. There was no significant difference (P >0.05) in the values of white blood cells of all the mice between day 1 and day 4 post infection except the group 5(14.73± 0.06×10^9/L) mice treated with 100 mg/kg body weight of the extracts. However, white blood cells increased significantly (p<0.05) from day 6 to day 14 in the mice treated with 12.5, 25.0, 50.0, 100.0 and 2000.0 mg/kg body weight of the extract as well as infected untreated group. But the group treated with halofantrine showed significant (P <0.05) increase in WBC on the 8th day. But uninfected untreated group did not show significant increase in WBC throughout the period of experimentation.

Table **5** shows the effects of combined methanol and ethyl acetate extract of *Cleome gynandra* on mean differential leucocytes count of mice infected with *Plasmodium berghei*. The neutrophils significantly (P< 0.05) decreased from 1st day post infection passing through other days to the last day of experimentation. Neutrophils significantly (P<0.05) decreased in group 1 (28.83±1.74), 2 (27.67±1.20) 3 (27.17±0.79), 4 (20.75± 1.03) 6 (25.00±3.51), and 7 (26.83±1.33) on day 14 of

Table 3: Effects of Combined Methanol and Ethyl Acetate Extract of *Cleome gynandra* on other Haematological Parameters of Mice Infected with *Plasmodium berghei* NK65

Parameter	Group	Dose (mg/kg)	Pre-Infection	Days of Infection							
				1st	2nd	3rd	4th	6th	8th	10th	14th
PCV (%)	1	Infected untreated	44.00 ±0.73	47.10±0.489	50.35±0.95	53.55±1.59	53.67±1.61[a]	38.67±0.95[b]	29.83±0.60[b]	23.00±1.34[b]	19.33±1.98[b]
	2	12.5	51.67 ±1.12	49.96±1.96	44.91±1.44[b]	38.35±2.00[b]	36.50±1.91[b]	31.17±2.63[b]	21.17±2.79[b]	15.00±2.17[b]	8.50±1.50[b]
	3	25.0	48.50 ±0.89	45.89±0.98	40.67±1.69[b]	43.28±1.28[b]	40.67±1.69[b]	45.33±1.48	37.67±2.67[b]	31.67±3.41[b]	20.00±7.75[b]
	4	50.0	49.33 ±1.43	45.96±1.24	42.58±2.00[b]	39.19±3.08[b]	39.17±1.33[b]	35.17±2.65[b]	28.33±3.30[b]	19.40±4.34[b]	31.00±21.00[b]
	5	100.0	53.33 ±1.23	49.18±1.63	44.23±2.31[b]	40.46±3.08[b]	40.33±3.04[b]	39.17±3.23[b]	36.60±5.31[b]	30.60±8.78[b]	28.75±9.44[b]
	6	200.0	46.80 ±0.91	46.80±0.65	45.91±0.60	45.03±0.74	44.67±0.42	33.83±0.79[b]	31.50±1.55[b]	34.25±0.75[b]	15.33±0.33[b]
	7	25.0 (Halofantrin)	45.50 ±1.18	46.83±0.91	47.94±0.72	49.05±0.58	47.50±1.61	34.33±1.76[b]	39.67±2.89[b]	44.33±1.31	49.67±0.95[a]
	8	Uninfected untreated	46.67 ±1.76	48.61±1.15	51.38±0.76[a]	53.99±0.58[a]	54.50±0.56[a]	54.00±0.86[a]	53.83±0.70[a]	53.50±0.96[a]	53.67±0.49[a]
HC (g/dL)	1	Infected untreated	14.67 ±0.24	15.63±0.24	15.97±0.43	16.32±0.94	17.89±0.54[a]	12.89±0.32	9.94±0.20[b]	7.67±0.45[b]	6.45±0.59[b]
	2	12.25	17.22 ±0.37	14.95±0.60	13.27±0.67	11.59±0.81[b]	12.17±0.64[b]	10.39±0.87[b]	7.06±0.93[b]	5.00±0.72[b]	2.33±0.00[b]
	3	25.0	16.17 ±0.30	14.82±0.68	14.33±0.60	13.53±0.77[b]	13.56±0.56	15.11±0.49	12.56±0.89[b]	10.61±1.20[b]	6.47±2.64[b]
	4	50.0	16.44 ±0.48	15.19±0.68	13.95±0.49	12.72±0.55[b]	13.06±0.44[b]	11.72±0.88[b]	9.45±1.10[b]	6.47±1.45[b]	10.33±7.00[b]
	5	100.0	17.78 ±0.41	16.37±0.54	14.95±0.73	13.86±0.94[b]	13.44±1.01[b]	13.06±1.08[b]	12.20±1.77[b]	10.20±2.93[b]	9.58±3.14[b]
	6	200.0	15.67 ±0.30	15.41±0.19	15.06±0.17	14.92±0.21	14.84±0.14	11.28±0.26[b]	10.50±0.52[b]	11.42±0.25[b]	5.11±0.11[b]
	7	25.0 (Halofantrin)	15.22 ±0.40	15.58±0.32	15.93±0.25	16.13±0.28	15.83±0.54	11.61±0.53[b]	13.22±0.97	14.78±0.44	16.56±0.32
	8	Uninfected untreated	15.56 ±0.59	16.34±0.45	17.23±0.30	18.00±0.28	18.17±0.19	18.00±0.28	17.94±0.23	17.83±0.32	17.89±0.16
MCV (fL)	1	Infected untreated	84.11±8.79	77.00±4.85[b]	69.91±1.55[b]	62.87±3.72[b]	62.83±3.73[b]	67.12±3.15[b]	64.07±6.11[b]	66.73±9.40[b]	57.56±6.36[b]
	2	12.5	76.24±3.96	70.69±1.92[b]	65.14±2.12[b]	59.59±4.25[b]	61.47±4.59[b]	86.12±15.63	70.38±8.89	78.18±12.16	45.62±21.06[b]
	3	25.0	73.60±3.51	83.70±5.83[a]	93.73±10.41[a]	103.83±15.34[a]	103.93±15.31[a]	130.57±9.26[a]	200.00±0.00[a]	53.27±7.69[b]	96.82±12.72[a]
	4	50.0	75.37±2.81	75.99±3.40	76.61±4.32	77.22±5.41	77.22±5.42	71.87±7.82	59.29±7.53[b]	54.43±13.84[b]	23.27±2.19[b]
	5	100.0	89.59±12.48	95.48±10.43	101.51±10.09[a]	107.76±11.61[a]	110.55±11.98[a]	166.41±25.86[a]	71.15±2.01[b]	76.83±32.10	72.51±14.24
	6	200.0	74.58±4.17	84.75±2.13	94.93±5.33	105.10±9.43	105.11±9.43	64.84±6.06[b]	77.08±9.20[b]	64.26±7.24	102.24±9.33[a]
	7	25.0 (Halfan)	58.86±2.52	80.30±9.55	101.95±20.12[a]	123.19±30.77[a]	123.20±30.78[a]	98.98±18.86[a]	102.88±21.02[a]	194.92±55.25[a]	123.56±46.00[a]
	8	Uninfected untreated	58.86±4.03	63.00±3.80	67.18±4.08	70.00±5.63	71.30±4.77[a]	70.82±4.55[a]	70.64±4.52[a]	70.34±4.71[a]	71.78±4.78[a]
MCH (g/L)	1	Infected untreated	31.58±3.40	25.73±3.60[b]	21.89±3.01[b]	19.95±2.99[b]	20.24±1.36[b]	21.46±1.45[b]	21.35±2.04[b]	21.64±3.20[b]	19.19±2.12[b]
	2	12.5	24.97±1.31	23.48±0.50	21.98±0.71	20.49±1.53[b]	20.49±1.53	28.70±5.21	23.46±2.93	26.06±4.05	15.19±7.01[b]
	3	25.0	24.70±1.07	28.01±1.88[a]	31.34±3.44[a]	34.65±5.10[a]	34.64±5.10[a]	43.52±3.09[a]	28.18±5.47	17.87±2.68[b]	32.29±4.24[a]
	4	50.0	26.23±1.43	26.07±1.44	25.91±1.66	25.75±2.04	25.74±1.81	23.95±2.60	19.96±2.51	17.60±0.45[b]	82.19±68.51[a]
	5	100.0	29.03±11.42	31.57±3.76	34.44±3.69[a]	37.04±3.99[a]	36.85±3.99	55.48±8.62	23.71±0.70[b]	37.58±12.04	15.58±6.29[b]
	6	200.0	24.86±1.39	28.27±0.72	32.12±1.42[a]	35.54±1.97[a]	35.14±3.10[a]	21.62±2.02	22.41±2.11	23.92±2.70	33.66±3.03[a]
	7	25.0 (Halfan)	20.91±1.27	27.02±1.48[a]	35.81±4.95[a]	43.27±8.43[a]	44.27±10.12[a]	32.99±6.29[a]	34.29±7.01[a]	59.93±17.83[a]	25.55±1.51[a]
	8	Uninfected untreated	20.18±1.27	21.33±1.32	22.57±1.43	23.76±1.59	23.77. ±1.59	23.61±1.52	23.56±1.50	23.45±1.57	23.77±1.56
MCHC (PG)	1	Infected untreated	33.33±0.00	32.33±0.50	31.39±1.03	30.42±1.55	29.68±1.65	31.87±1.45	33.33±0.00	33.34±0.00	33.35±0.01
	2	12.5	33.34±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.01	33.33±0.01	33.30±0.01
	3	25.0	33.34±0.01	33.33±0.00	33.34±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.79±0.46	33.33±0.00
	4	50.0	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.34±0.01	33.33±0.01	33.33±0.00
	5	100.0	33.33±0.00	33.33±0.00	33.32±0.01	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00
	6	200.0	33.31±0.03	33.15±0.16	33.37±0.01	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.32±0.01
	7	25.0 (Halfan)	33.46±0.12	33.42±0.08	33.37±0.04	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00
	8	Uninfected untreated	33.33±0.00	33.33±0.00	33.33±0.00	33.34±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00	33.33±0.00

Mean ± SEM of eight observations.
a = significantly higher ($p<0.05$).
b = significantly lower ($p>0.05$).
PCV - Packed Cell Volume; MCH - Mean Corpusular Haemoglobin; MCHC - Mean Corpusular Haemoglobin Concentration; HC - Haemoglobin Concentration; MCV - Mean Corpusular Volume.

experimentation respectively. Lymphocytes significantly ($P< 0.05$) increased in group 1 (68.33±0.33) on day 6, group 2 on day 4 (70.00±1.24) and day 6 (69.00±0.97), group 4 on day 4 (4.50±0.76), day 6 (70.00±0.58), day 8 (70.67±2.29), day 10 (69.83±0.40) and day 14 (71.50±6.65) respectively. However there was significant ($P<0.05$) increased lymphocytes in day 6 in group 6 day 7 (71.50±0.72) and day 8 (68.00±1.67) respect-

Table 4: Effects of Combined Methanol and Ethyl Acetate Extracts of *Cleome gynandra* on Mean White Blood Cells Count (×10^9/L) of Mice Infected with *Plasmodium berghei* NK65

Group	Dose (mg/kg)	Pre-infection	Days of Infection							
			1st	2nd	3rd	4th	6th	8th	10th	14th
1	Infected untreated	6.10±0.80	6.08±0.77	6.05±0.70	6.03±0.72	6.00±0.80	8.35±0.85[a]	9.94±0.91[a]	12.40±0.87[a]	14.86±1.11[a]
2	12.5	6.23±0.73	7.25±0.70	8.28±0.96	9.30±1.34	9.87±1.24	15.70±3.23[a]	17.87±2.44[a]	15.95±2.19[a]	31.70±3.10[a]
3	25.0	5.60±0.76	6.03±0.72	6.47±0.70	6.90±0.67	6.90±0.67	5.63±0.84	9.10±1.11[a]	11.73±2.70[a]	24.72±5.5[a]
4	50.0	7.17±0.45	6.34±0.51	5.50±0.71	4.67±0.97	4.67±0.98	11.93±2.16[a]	15.97±5.07[a]	22.92±6.09[a]	15.65±3.34[a]
5	100.0	9.16±1.19	11.20±0.93	13.24±2.15	15.28±3.25	14.73±2.96[a]	19.87±5.87[a]	19.44±2.29[a]	14.00±4.36[a]	10.25±2.58
6	200.0	8.07±1.01	7.67±0.81	7.22±082	6.77±0.99	6.73±1.10	8.17±1.51	14.07±3.57[a]	8.63±2.43	31.73±3.80[a]
7	25.0 (halofantrin)	6.93±1.62	6.85±1.05	6.96±0.57	7.07±0.53	7.07±0.53	6.93±1.19	11.10±1.86[a]	7.33±1.80	4.93±0.94
8	Uninfected untreated	10.30±1.15	10.30±1.15	10.30±1.15	10.30±1.15	10.30±1.15	10.15±1.22	10.02±1.31	10.04±1.13	10.35±1.26

Mean ± SEM of eight observations.
a = signicantly higher (P<0.05).

ively. The values of the lymphocytes in group 8 were not significantly (P< 0.05) affected. But the values of eosinophils significantly increased (P<0.05) from day 4 to day 10 in group 1, 2, 4, 5 and 6. Although there was significant (P<0.05) increase in the value of monocytes from day 4 which ran through to day 14 of experimentation. There was a no record value of basophil throughout the period of experimentation.

4. DISCUSSION

Oils from plant seeds, nuts, fruits and leafy vegetables are receiving growing interests due to their high concentration of bioactive lipid components, such as polyunsaturated fatty acids, essential fatty acids and phytosterols which have shown various health benefits. Essential fatty acids are obtained from diets but a healthy body can manufacture other essential fatty acids as long as it gets enough linoleic acid. *Cleome gynandra* can provide some of these health benefits due to the abundance of fatty acids in its extracts. The essential role of linoleic acid in human diet is related to both the intermediate and end products that results through several biochemical pathways. Linoleic acid is metabolized in the body to form γ-linoleic acid and subsequently to arachidonic acid. Arachidonic acid is metabolized in the body into eicosanoids. This compound ultimately becomes the prostaglandins, which affect such varied functions as blood clothing, inflamemation response and immunoregulation. The parasite *Plasmodium berghei* NK65 appeared in the blood of the test mice 24 hours post infection. Parasitaemia, weakness, anaemia and death were observed in the infected mice [21,32]. Parasitaemia comparatively decreased on day 14 of the infection after treatment with varying doses of *C. gynandra* extracts at 12.5, 25, 50, 100 and 200 mg/kg and Halofantrine (25 mg/kg). However group 4 treated with 50 mg/kg body weight showed decreased parasitaemia on day 14 (4.03± 0.55%) as compared with the parasitaemia observed on day 8 (15.01±6.50%) but the Halofantrine treated group showed lower parasitaemia on day 14 (2.77± 0.66%) as compared to day 8 (6.27±2.21%). The higher potency of the extract at dose level of 50 mg/kg may be due to toxic effect on the parasites. The reduced antiplasmodial effect at 100 and 200 mg/kg body weight compared with 50mg/kg body weight of the extract may be due to a therapeutic window phenomenon [21]. The antimalarial activity of tropical plants used by herbalists have been attributed to their phytochemical constituents [11,15] hence the activity observed for *C. gynandra* is also due to the phytochemicals present in the extracts. The death of animals in all the groups except group 7 and 8 may be due to toxic effects of *Plasmodium berghei* and the extracts. There are reports on the antimalarial activity of many African plants used to treat malaria in Nigerian and African traditional medicine [15,33]. Some of these plants show schizonticidal activity *in vitro* [15] and *in vivo* only for early infections but lack activity when the infection is established [34]. *Cleome gynandra* is used by local people against malaria, although it may not offer adequate treatment for the disease, it can be used for the relief of acute malaria attacks. The mechanism of action of *C. gynandra* extract may be similar to that of halofantrine, a standard antimalarial drug, which induces destruction of the asexual forms of the plasmodium parasite [35]. Halofantrine decreased the level of parasites in infected mice twice that of 50 mg/kg of the *C. gynandra* extracts. The hexane, ethyl acetate,

Table 5: Effects of Combined Methanol and Ethyl Acetate Extracts of *Cleome gynandra* on Mean Differential Leucocytes Count (%) of Mice Infected with *Plasmodium berghei* NK65

Parameters	Group	Dose (mg/kg)	Pre-Infection	Days after Infection							
				1st	2nd	3rd	4th	6th	8th	10th	14th
Neutrophils	1	Infected untreated	35.00±1.13	33.00±0.89	30.83±0.83 [b]	28.50±0.85 [b]	28.33±0.80 [b]	32.33±2.40	33.50±0.96	28.50±0.72 [b]	28.83±1.74 [b]
	2	12.5	32.67±0.92	30.00±0.82	27.83±0.98 [b]	25.5±1.12 [b]	25.17±1.30 [b]	25.83±1.25 [b]	31.83±1.08	28.40±1.83 [b]	27.67±1.20 [b]
	3	25.0	34.50±0.72	31.00±0.58[b]	27.40±0.37 [b]	23.83±0.54 [b]	23.83±0.54 [b]	26.83±0.70 [b]	26.33±1.69 [b]	23.50±0.34 [b]	27.17±0.79 [b]
	4	50.0	35.50±1.12	29.67±0.67 [b]	24.83±1.08 [b]	19.0±1.13 [b]	18.17±0.87 [b]	24.67±0.67 [b]	21.83±2.54 [b]	26.00±1.14	20.75±1.03 [b]
	5	100.0	32.83±0.89	32.17±0.31	31.33±0.33	30.83±0.60	30.50±0.43	29.67±0.71 [b]	34.33±0.67	31.40±2.42	33.80±0.80
	6	200.0	35.00±0.89	33.17±0.54	31.33±0.33 [b]	29.67±0.49 [b]	29.67±0.49 [b]	24.50±0.43 [b]	31.33±1.67	30.17±1.47	25.00±3.51 [b]
	7	25.0 (Halofantrine)	34.83±1.28	32.17±1.05	29.50±1.06 [b]	26.83±1.11 [b]	25.83±0.87 [b]	23.00±0.86 [b]	24.33±1.67 [b]	26.00±1.14 [b]	26.83±1.33 [b]
	8	Uninfected untreated	33.00±0.45	31.83±0.40	30.50±0.43 [b]	29.33±0.49 [b]	29.33±0.49 [b]	32.00±0.45	35.00±1.00	27.33±0.80 [b]	31.00±1.24
Lymphocytes	1	Infected untreated	63.33±1.12	63.33±0.99	64.17±0.75	65.00±0.69	64.33±0.71	68.33±0.33 [a]	64.00±1.61	65.33±0.49	65.00±1.65
	2	12.5	65.50±0.76	67.33±0.67	68.33±0.99	69.67±1.31	70.00±1.24[a]	69.00±0.97 [a]	63.83±1.25	63.67±2.03	65.77±2.02
	3	25.0	63.67±0.88	65.33±0.61	67.33±0.42	70.00±0.26	69.67±0.42	67.67±0.71	65.83±1.64	64.50±1.38	66.00±0.58
	4	50.0	63.00±1.06	66.67±0.76	70.33±0.71	73.67±0.95	74.50±0.76 [a]	70.00±0.58 [a]	70.67±2.29 [a]	69.83±0.40 [a]	71.50±0.65 [a]
	5	100.0	65.17±0.65	64.00±0.93	64.17±1.08	63.67±1.45	65.00±0.73	64.83±0.60	62.17±0.31	62.17±0.95	62.60±0.51
	6	200.0	63.17±0.95	63.67±0.49	64.33±0.33	64.00±0.26	64.83±0.48	70.00±0.26 [a]	66.00±1.84	63.17±1.11	69.33±3.38
	7	25.0 (Halfan)	63.67±1.15	64.83±1.14	65.67±0.99	66.67±0.95	66.83±1.01	71.50±0.72 [a]	68.00±1.67 [a]	67.33±0.84	66.33±0.92
	8	Uninfected untreated	64.67±0.56	65.33±0.49	65.50±0.34	65.67±0.49	66.17±0.31	66.17±0.31	61.00±0.63	66.83±0.31	65.00±1.39
Eosinophils	1	Infected untreated	0.83±0.17	0.83±0.17	0.83±0.17	0.67±0.21	3.17±0.17 [a]	2.50±0.43 [a]	2.33±0.21 [a]	2.17±0.17 [a]	1.83±0.17
	2	12.5	0.83±0.31	0.50±0.22	0.50±0.22	0.50±0.22	2.50±0.22 [a]	2.17±0.17 [a]	2.67±0.21 [a]	3.17±0.17 [a]	2.33±0.33 [a]
	3	25.0	1.00±0.26	0.83±0.17±	1.00±0.00	0.83±0.17	3.67±0.21 [a]	2.33±0.21 [a]	4.17±0.17 [a]	3.83±0.17 [a]	3.67±0.21 [a]
	4	50.0	0.83±0.17	1.17±0.17	1.17±0.17	1.17±0.17	74.33±0.21 [a]	2.17±0.17 [a]	4.00±0.37 [a]	3.50±0.22 [a]	4.00±0.41 [a]
	5	100.0	1.17±0.31	0.17±0.17	0.33±0.21	0.17±0.17	1.50±0.22	2.17±0.17	2.17±0.31	2.83±0.31	2.00±0.32
	6	200.0	0.83±0.17	0.83±0.17	0.67±0.21	0.17±o.17	3.00±0.00	2.33±0.21 [a]	1.83±0.31	3.33±0.21 [a]	3.00±0.00 [a]
	7	25.0 (Halfan)	0.67±0.21	0.33±0.21	1.17±0.17	1.17±0.17	4.17±0.17 [a]	2.33±0.21 [a]	4.17±0.40 [a]	3.67±0.21 [a]	4.17±0.31 [a]
	8	Uninfected untreated	1.17±0.17	0.33±0.21	0.33±0.21	0.50±0.22	2.33±0.21 [a]	1.17±0.21	1.67±0.21	2.83±0.17 [a]	1.17±0.17
Monocyte	1	Infected untreated	0.83±0.17	0.50±0.22	1.00±0.00	1.00±0.00	3.33±0.21 [a]	3.50±0.22 [a]	2.17±0.17 [a]	4.33±0.49 [a]	4.33±0.21 [a]
	2	12.5	1.00±0.00	0.50±0.22	0.33±0.21	0.67±0.21	2.50±0.22 [a]	3.33±0.21 [a]	2.00±0.26 [a]	2.80±0.37 [a]	2.67±0.67 [a]
	3	25.0	0.83±0.17	0.67±0.21	0.83±0.17	0.67±0.21	3.00±0.26 [a]	3.17±0.17 [a]	3.67±0.21 [a]	2.83±0.31 [a]	3.50±0.22 [a]
	4	50	0.83±0.17	0.50±0.22	0.83±0.17	0.83±0.17	3.00±0.26 [a]	3.17±0.17 [a]	3.50±0.34 [a]	3.40±2.53 [a]	3.50±0.29 [a]
	5	100.0	0.83±0.17	0.50±0.22	0.50±0.22	0.67±0.21	2.50±0.22 [a]	3.33±0.21 [a]	1.67±0.21 [a]	2.80±0.34 [a]	1.60±0.24
	6	200.0	1.00±0.00	0.67±0.21	0.67±0.21	0.50±0.22	2.83±0.17 [a]	3.00±0.26 [a]	2.50±0.22 [a]	3.83±0.31 [a]	2.67±0.33 [a]
	7	25.0 (Halfan)	1.00±0.00	0.80±0.18	0.67±0.21	0.67±0.21	3.17±0.17 [a]	3.17±0.31 [a]	3.67±0.21 [a]	3.50±0.43 [a]	2.67±0.21 [a]
	8	Uninfected untreated	1.00±0.00	0.50±0.22	0.33±0.21	0.33±0.21	2.17±0.17 [a]	0.67±0.21	3.00±0.45 [a]	3.33±0.21 [a]	2.33±0.21 [a]
Basophil	1	Infected untreated	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	2	12.5	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	3	25.0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	4	50.0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	5	100.0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	6	200.0	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	7	25.0 (Halfan)	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
	8	Uninfected untreated	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Mean ± SEM of eight observations.

chloroform and methanol extracts of *Abrus precalimis* were observed to have antiplasmodial activity against Chloroquine and Pyrimethamine resistant *Plasmodium falciparum* KI [15]. Terpenoids and furanoterpenes [36], flavonoids and alkaloids [37] are responsible for activity against *Plasmodium falciparum*. The haematological

findings show that the RBC, PCV and Hb levels decreased after infection with *Plasmodium berghei*. The anaemia, which resulted in haemolysis is a consistent observation in malaria parasite infections and have also been reported for mice infected with *Plasmodium berghei* [21,32]. The decreased haemoglobin shows that the liver of the affected mice could still metabolize bilirubin. The increased MCV in group 3, 6 and 7 show that the anaemia is hypocytic hyperchromic. Whereas the low MCV in the group 1, 2 and 4 is suggestive of normocytic hyperchromic anaemia. The leucocytosis observed in the present study indicates that leucocytosis may be have been caused by eosinophila, lymphocytosis and monocytosis. The white blood cell count and differential leucocyte count especially the lymphocytes, eosinophils and monocytes is suggestive of potential plasmodial infection up till day 14 of the study. The observed neutrophenia and lymphocytosis attendant upon infection shows that the infection was severe and relatively chronic. The death of the animals may be due to infection and toxicity of the extract as reports indicate that infection with *Plasmodium berghei* is almost fatal, with death occurring within 1-3 weeks [12].

5. CONCLUSION

Cleome gynandra is an important source of nutrients, essential fatty acids, amino acids, phytosterols, and secondary metabolites and has great medicinal importance. Two novel compounds were isolated from the seeds of *Cleome gynandra*. The plant extracts demonstrated significant ($P < 0.05$) schizont activity in mice infected with *P. berghei* that were not significantly different from that induced by the positive control, Halofantrine ($p<0.05$). This study has shown that *Cleome gynandra* possess immune-inhibitory effect probably as a result of the secondary metabolites present. The antimalarial activity demonstrated by the extracts justifies its use in traditional medicine as a treatment for malaria. This study has thus provided further pharmacological basis for the use of the plant in traditional medicine.

ACKNOWLEDGEMENTS

JOI, CAM, UO and EN are grateful to IFS Sweden for a Collaborative research Grant (J/4028-2) to conduct this study.

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Received on 13-10-2016 Accepted on 03-11-2016 Published on 30-11-2016

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