Co-administration of crude leaf extract of *Eremomastax Speciosa* and Artemether-Lumefantrine restores Haematological parameters in *Plasmodium Berghei* infected Mice.

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ABSTRACT

The World Health Organization had advocated for the use of artemisinin-based combination therapy (ACT) in the treatment of malaria. Many patients who take the standard antimalarial drugs still feel unwell despite parasite clearance from blood due to the impact of parasitaemia on body tissues, organs and systems. Derangement in haematological parameters with clinical consequences is an established feature of malaria infection. Our study evaluated the effects of combining artemether-lumefantrine with crude leaf extract of *Eremomastax speciosa* on the haematological parameters of mice infected with *Plasmodium berghei*. Fifty mice weighing 30-35g were divided into five groups with 10 mice in each. The groups of mice were inoculated *plasmodium berghei* from a donor mouse. One non-parasitized group served as normal control group. Three parasitized groups were treated with therapeutic dose of artemether-lumefantrine, 300 mg/kg crude extract of *E. speciosa* and combination of both drugs and extracts. A parasitized group and a non-parasitized untreated group were used as controls. ACT and leaf extract were administered orally for three and ten days respectively. Haematological profile was determined from fresh whole blood using automated analyzer. Results obtained showed that co-administration of Artemether-Lumefantrine with crude leaf extract of *E. speciosa* significantly (P < 0.05) increased the erythrocytes and leucocytes indices of mice when compared with values obtained for parasitized untreated group. The values were comparable to that obtained for non-parasitized control mice. The increases in red and white blood cells indices in *P. berghei* infected mice may be due to synergistic action of component phytochemicals in the extract with the Artemether-lumefantrine. We concluded that administration of the ACT with the plant extract may relieve Plasmodium-induced anaemia, which is a major cause of mortality and prognosis predictive factor in malaria disease. The triple regimen may also relieve malaria-induced immuno suppression.

Key words: Malaria, haematological indices, *Eremomastax speciosa*, Artemether-lumefantrine.

INTRODUCTION

Treatment of Malaria continues to pose a huge challenge to both sufferers and healthcare professionals. Apart from parasites’ resistance to the commonly available antimalarial agents, the multifaceted impact of parasitaemia on the body systems and organs contribute to the challenge of malaria treatment (Uwah et al., 2014; Yeung et al., 2004; CDC, 2010). It is well established that treatment of malarial disease goes beyond parasite clearance from blood. Most patients do not admit that they are well despite parasites elimination from blood, due to the impact of the parasitaemia on the body systems and organs. For this reason many patients, especially in the rural areas, have lost faith on the antimalarial drugs, hence embarking on use of herbal remedies, either alone or in combination with prescribed drugs (Kuo et al., 2004), to alleviate their tiredness, anorexia, weakness, diarrhea,
vomiting, headache, dizziness and insomnia associated with the disease. Derangement in haematological parameters is a regular finding in Plasmodium specie infection (Das et al., 2017; Karolina et al., 2012). The pathogenesis of anemia in patients with P. falciparum parasitaemia is multifactorial (Pierre et al., 2011; Buffet et al., 2009). The parasites produce enzymes which hydrolyze haemoglobin. Their toxins released into the blood stream are reported to cause lysis of infected and uninfected red blood cells, suppression of haematopoiesis and increased clearance of red blood cells by the spleen which leads to anaemia. In naïve subjects with acute P. falciparum infections and without comorbidities, red blood cells loss is an important mechanism of anemia (Pierre et al., 2011; Price, et al., 2001). Dyserythropoiesis and inhibition of erythropoietic process by plasmodial toxins are suspected to also play predominant role in anaemia of acute malaria (Buffet et al., 2009). Hence, severe anaemia and cardiovascular decompensation remains one of the major causes of mortality in malaria infection, especially in pregnant women and children under the age of five years. Consequently, any formulation that significantly relieves parasite-induced derangement in haematological parameters is a fundamental factor in the treatment of the disease (Das et al., 2017).

Drug-herb combination therapy is fast gaining prominence globally. In the USA, it was reported that about 40% of the patients in primary care clinics believed that taking prescriptions medications and herbal remedies together was more effective than taking either alone and nearly 50% of the herb users concomitantly used drugs (Kuo et al, 2004). Between 60% and 85% native Africans use herbal medicine usually in combination (Wyk, 2009). In Nigeria, researchers reported that pregnant women used both traditional herbal medicine and pharmaceutical drugs with the highest prevalence of concomitant use among nulliparous mothers (Gharoro and Igbafe, 2000). *Eremomastax speciosa* (Hochst) is a tropical stout erect multi-branched herb that grows as a weed in the forest (Heine, 1966). Due to its numerous medicinal values, it is now grown in farmlands around living houses. The plant is a perennial plant that is orderly distributed in tropical Africa, from West Africa through Central African Republic, North Congo-Kinshasa to South and South West Ethiopia and Madagascar (Aman et al, 2014). The crude leaf extract of *E. speciosa* is locally used in southern Nigeria as enema to treat splenic disorders, fever and internal heat (especially in pregnant women). Leaf extract is also used as an anti-anaemic (Etukudo, 2003). The Douala people of Cameroon employ *E. speciosa* variously for treatment of malaria, kidney pains, scabies, anaemia, diabetes, and nerves pain (Dibong et al., 2011). Okokon et al. (2008) reported that the ethanolic crude extract demonstrated antianaemic property. The study was carried out to evaluate the effect of concomitant administration of crude leaf extract of *E.speciosa* with artemether-lumefantrine on the erythrocytes and leucocytes profile of mice infected with *Plasmodium berghei*.

**MATERIALS AND METHODS**

**Collection and identification of plant material**

The fresh leaves of *Eremomastax speciosa* were harvested from a farmland, were identified and authenticated by a taxonomist in the Department of Botany, University of Uyo, Akwa Ibom State, Nigeria, where a voucher specimen was deposited in the herbarium.

**Inoculation of experimental mice with Plasmodium Berghei**

Fifty albino mice which weighed between 30 - 35g were divided into five groups of ten mice each. A donor mouse was chloroform anaesthetized and infected blood was obtained by cardiac puncture using sterile syringes and needles. A volume 0.1 ml of the infected blood was mixed with 10 ml of normal saline, from where 0.2ml of the mixture (equivalent to 0.2 ml of blood which contained about 1 x 10⁷ *Plasmodium berghei* parasitized erythrocytes) was administered to each animal intraperitoneally. The inoculum consisted of 5 x 10⁷ *P. berghei* infected erythrocytes per ml from the donor mouse with a 66% parasitaemia. A non-parasitized group served as normal control. The animals were fed *ad libitum* with Guinea grower feed and kept at room temperature of 28.0 ± 2°C for the period which the experiment lasted (Adekunle et al., 2007). All the inoculated animals were kept for seven days for the parasite to develop. At the end the seventh day, thick films were made from blood collected through tail puncture of all the parasitized mice to ascertain parasitaemia using the method described by Greenwood and Armstrong (1991).

**Preparation of antimalarial drugs and plant extract**

Cotcham brand of Artemether-lumefantrine containing 20 mg of artemether and 120 mg of lumefantrine was dissolved in a calculated amount of 0.9% saline in water (normal saline). Weights of 0.08mg and 0.64mg of artemether and lumefantrine respectively were sustained in 0.5 ml of solvent, equivalent to 3 mg/Kg body weight of artemether and 18 mg/Kg body weight of lumefantrine. Fresh leaves of *E. speciosa* were washed, deveined and pounded using a mortar and pestle. A 3.4 kg of the sample was macerated with 6000
ml of tap water. The mixture was sieved using a sieve cloth to separate the filtrate from the residue. The filtrate was concentrated in a water bath at 40°C to obtain a greenish black crude extract which dissolved completely in water to give a homogeneous solution. The extract was stored in the refrigerator at 4°C and used in this study.

**Experimental design and treatment of experimental animals**

Calculated amount of prepared solution of artemether-lumefantrine were administered orally to the respective group of mice, depending on the group mean weight of the animals. A dosage of 300 mg/Kg body weight of *E. speciosa* was administered orally. This was based on already established safety dose of the plant crude leaf extract (Ndem et al., 2015; 2013; Okokon et al., 2008). The untreated control groups were administered normal saline. The extracts were administered once daily for ten days, Artemether-lumefantrine was administered in two divided doses twice a day on the last three days of treatment. All the experimental animals had free access to normal rat chow and water *ad libitum* throughout the treatment period.

**Collection of blood sample and determination of haematological indices**

The animals were chloroform anaesthetized blood sample obtained by thoracotomy and cardiac puncture using sterile syringes and needles Whole blood samples collected in EDTA anticoagulant bottles were used in the haematological indices determination. Computerized Blood Auto Analyser was employed in the determination of haematological parameters. Analysis was carried out within six hours of blood sample collection.

**Statistical analysis**

Standard computerized statistical tools were used in the analysis of the results obtained. All data were expressed as mean ± standard deviation (SD). Analysis of Variance was used to analyze data, while Student’s t-test was used for comparison. Any difference in mean was considered significant at p < 0.05.

**RESULTS**

**Erythrocytes Indices and platelets**

For results of erythrocyte indices (Table 1), the RBC count was significantly (p < 0.05) decreased when compared with the normal control (Group I). Test

### Table 1: Erythrocytes panel and platelets of Plasmodium berghei infected Mice treated with Artemether-Lumefantrine, Eremomastax speciosa leaf extract and Hippocratea africana root bark extract.

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatment</th>
<th>RBC count ((X10^6/µL))</th>
<th>Haemoglobin ((g/dl))</th>
<th>PCV ((%))</th>
<th>MCH ((pg))</th>
<th>MCHC ((g/dl))</th>
<th>MCV ((FL/µ3))</th>
<th>Platelets ((X10^3/µL))</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Non-parasitized</td>
<td>7.65 ± 0.81</td>
<td>14.94 ± 1.32</td>
<td>45.94 ± 1.09</td>
<td>18.58 ± 1.22</td>
<td>35.92 ± 1.17</td>
<td>54.03 ± 1.38</td>
<td>940.55 ± 10.18</td>
</tr>
<tr>
<td></td>
<td>Untreated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Parasitized</td>
<td>4.82 ± 0.65^a</td>
<td>8.05 ± 1.53^a</td>
<td>24.31 ± 1.64^a</td>
<td>14.20 ± 1.45^a</td>
<td>29.63 ± 1.67^a</td>
<td>42.21 ± 1.19^a</td>
<td>528.48 ± 9.37^a</td>
</tr>
<tr>
<td></td>
<td>Untreated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>ACT Only</td>
<td>5.58 ± 0.92^a,b</td>
<td>11.9 ± 1.61^a</td>
<td>34.17 ± 1.50^a,b</td>
<td>16.18 ± 1.32^a,b</td>
<td>31.04 ± 1.72^a,b</td>
<td>47.37 ± 1.80^a</td>
<td>650.31 ± 15.48^a,b</td>
</tr>
<tr>
<td>IV</td>
<td><em>E. speciosa</em> Only</td>
<td>4.95 ± 0.54^a,b</td>
<td>9.86 ± 1.28^a</td>
<td>29.88 ± 1.07^a,b</td>
<td>15.84 ± 1.18^a,b</td>
<td>28.55 ± 1.37^a,b</td>
<td>44.53 ± 1.75^a,b</td>
<td>680.70 ± 12.10^a,b</td>
</tr>
<tr>
<td>V</td>
<td>ACT + <em>E. speciosa</em></td>
<td>7.48 ± 0.59^b</td>
<td>15.92 ± 1.55^b</td>
<td>46.11 ± 1.52^b</td>
<td>17.94 ± 1.15^b</td>
<td>36.29 ± 1.55^b</td>
<td>53.56 ± 1.45^b</td>
<td>920.52 ± 12.11^b</td>
</tr>
</tbody>
</table>

*e = Mean ± Standard Deviation of 10 determinations,

a = significantly different when compared with normal control (administered normal saline) at p < 0.05

b = significantly different when compared with test group II (parasitized untreated) at p < 0.05

ACT=Artemether-Lumefantrine.
was significantly (p < 0.05) decreased when compared with the normal control (Group I). Test groups III and parasitized untreated group, but significantly (p < 0.05) decreased when compared with normal control group. The value recorded for Group V treated with the extract plus artemether-lumefantrine (ACT) was significantly (p < 0.05) increased when compared with parasitized untreated group, but not significantly (p > 0.05) decreased when compared with the normal control group. The haemoglobin (Hb) concentration recorded for parasitized untreated group was significantly (p < 0.05) decreased when compared with the normal control group. Test groups III and I recorded were significantly (p < 0.05) increased when compared to the parasitized untreated group, but significantly (p < 0.05) reduced when compared with normal control group. Test group V had PCV significantly (p < 0.05) increased when compared with parasitized untreated group, but non-significantly (p > 0.05) decreased when compared with the normal control group. The percentage packed cell volume recorded for parasitized untreated group was significantly (p < 0.05) decreased when compared with normal control group. Test groups III and IV recorded PCV were significantly (p < 0.05) increased when compared to the parasitized untreated group, but significantly (p < 0.05) reduced when compared with normal control group. Test group V had PCV significantly (p < 0.05) increased when compared with parasitized untreated group, but non-significantly (p > 0.05) decreased when compared with the normal control group. The cell haemoglobin (MCH) recorded for parasitized untreated group was significantly (p < 0.05) decreased when compared with normal control group. The cell haemoglobin concentration (MCHC) recorded for test group V was significantly (p < 0.05) increased when compared with parasitized untreated group, but significantly (p < 0.05) reduced when compared with normal control group. Test groups V recorded Hb was significantly (p < 0.05) increased when compared with parasitized untreated group, but non-significantly (p > 0.05) decreased when compared with the normal control group. The values recorded for test groups III and IV recorded MCH values were significantly (p < 0.05) increased when compared to the parasitized untreated group, but significantly (p < 0.05) reduced when compared with normal control group. Test group V recorded MCV value significantly (p < 0.05) increased when compared with parasitized untreated group, but non-significantly (p > 0.05) decreased when compared with normal control group. The platelets count recorded for parasitized untreated group was significantly (p < 0.05) decreased when compared with normal control group. Test groups III and IV recorded MCH values significantly (p < 0.05) increased when compared to the parasitized untreated group, but significantly (p < 0.05) reduced when compared with normal control group. Test groups V recorded MCH value significantly (p < 0.05) increased when compared with parasitized untreated group, but non-significantly (p > 0.05) decreased when compared with the normal control group.

Leucocytes indices

For the results of leucocyte indices (Table 2), the WBC counts of group II (parasitized untreated) was significantly (p < 0.05) decreased when compared with the normal control group. The WBC value recorded for test group IV was also significantly (p < 0.05) reduced when compared with the normal control group, but non-significantly (p > 0.05) increased when compared with the parasitized untreated group. The values of WBC count recorded for test groups III was significantly (p < 0.05) reduced when compared with normal control group, but significantly (p < 0.05) raised when compared with parasitized untreated group. There was non-significant (p > 0.05) decrease in the values of WBC count recorded for test group V when compared with the normal control group. This value was however significantly (p < 0.05) increased when compared with the parasitized untreated group. Lymphocytes level of group II (parasitized untreated) was significantly (p < 0.05) decreased when compared with the normal control group. The lymphocytes count recorded for test group IV was also significantly (p < 0.05) reduced when compared with the normal control group, but non-significantly (p < 0.05) increased when compared with the parasitized untreated group. The values recorded for test groups III was significantly (p < 0.05) reduced when compared with normal control group, but significantly (p < 0.05) increased when compared with parasitized untreated group. There were non-significant (p > 0.05) decrease in the value of lymphocytes recorded for test groups V when compared with the normal control group. This value was however significantly (p < 0.05) increased when compared with the parasitized untreated group.

Monocytes level of group II (parasitized untreated) was
Table 2: Leucocytes levels and differentials of *Plasmodium berghei* infected Mice treated with Artemether-Lumefantrine, *Eremomastax speciosa* leaf extract and *Hippocratea africana* root bark extract.

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatment</th>
<th>WBC count ($\times10^3$/µL)</th>
<th>Lymphocytes (%)</th>
<th>Monocytes (%)</th>
<th>Basophils (%)</th>
<th>Eosinophil (%)</th>
<th>Neutrophils (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Non-parasitized Untreated</td>
<td>5.18 ± 0.45</td>
<td>35.20 ± 1.65</td>
<td>1.00 ± 0.41</td>
<td>0.00 ± 0.00</td>
<td>4.50 ± 0.64</td>
<td>50.10 ± 1.27</td>
</tr>
<tr>
<td>II</td>
<td>Parasitized Untreated</td>
<td>2.76 ± 0.30</td>
<td>29.85 ± 1.06</td>
<td>3.75 ± 0.48</td>
<td>0.00 ± 0.00</td>
<td>3.00 ± 0.50</td>
<td>44.04 ± 1.31</td>
</tr>
<tr>
<td>III</td>
<td>ACT Only</td>
<td>3.40 ± 0.29</td>
<td>31.51 ± 1.50</td>
<td>5.50 ± 0.50</td>
<td>0.00 ± 0.00</td>
<td>6.02 ± 0.71</td>
<td>46.33 ± 1.25</td>
</tr>
<tr>
<td>IV</td>
<td><em>E. speciosa</em> Only</td>
<td>3.05 ± 0.12</td>
<td>29.02 ± 1.00</td>
<td>4.75 ± 0.25</td>
<td>0.00 ± 0.00</td>
<td>4.54 ± 0.87</td>
<td>44.13 ± 1.35</td>
</tr>
<tr>
<td>V</td>
<td>ACT + <em>E. speciosa</em></td>
<td>4.94 ± 1.16</td>
<td>36.84 ± 1.33</td>
<td>3.75 ± 0.63</td>
<td>0.00 ± 0.00</td>
<td>4.06 ± 0.83</td>
<td>49.09 ± 1.71</td>
</tr>
</tbody>
</table>

*e = Mean ± Standard Deviation of 10 determinations,
*a = significantly different when compared with normal control (administered normal saline) at p < 0.05
*b = significantly different when compared with test group II (parasitized untreated) at p < 0.05

ACT = Artemether- lumefantrin

significantly (p<0.05) increased when compared with normal control group. The values monocytes recorded for test group III, IV, VI VII and IX were also significantly (p<0.05) reduced when compared with the normal control group, but non-significantly (p>0.05) increased when compared with the parasitized untreated group. The values of monocytes recorded for test groups V and VIII were significantly (p<0.05) reduced when compared with normal control group, but significantly (p<0.05) increased when compared with parasitized untreated group. Basophils were not demonstrable using the method adopted for this study. Eosinophils level of parasitized untreated group was non-significantly decreased when compared with the normal control group. Test groups III recorded eosinophils value that was significantly (P<0.05) increased in comparison with parasitized untreated group and the normal control group. Eosinophils values recorded for test groups V was significantly (p<0.05) increased when compared with the parasitized untreated group, but non-significantly (p>0.05) increased when compared with the normal control group. Neutrophils level of group II (parasitized untreated) was significantly (p<0.05) decreased when compared with the normal control group. Test groups III, IV and VI recorded neutrophils levels that were significantly (p<0.05) decreased when compared with normal control group, but non-significantly (p>0.05) increased when compared with parasitized untreated group. Neutrophils values obtained for test groups VII, VIII and IX were significantly (p<0.05) raised compared with the parasitized untreated group, but non-significantly (p>0.05) reduced when compared with normal control group.

**DISCUSSION**

Available and affordable therapy that relieves anaemia and immuno suppression in malaria infected patients is very crucial in the management of the disease because of the impact of parasitaemia on haematological indices (Karolina et al., 2012; Das et al., 2017). Combination therapy has replaced monotherapeutic approaches in the treatment of malaria infection (WHO, 2015). The result of our study showed that infection with *P. berghei* significantly (p<0.05) reduced RBC count,
haemoglobin concentration, packed cells volume and other indices of red blood cells. This collaborated with the results reported by several researchers (Uwah, 2015; Adekunle et al., 2007; Sharma et al., 1993; Niazi, 1995). The reduction in the red blood cells parameters is mainly due to parasite-induced haemolysis of the red cells. Ineffective erythropoiesis and splenic sequestration also contribute to the reduction in red blood cells count, haemoglobin concentration and haematocrit (Farogh et al., 2009). This parasites-induced lysis of infected and uninfected RBCs, suppression of haematopoiesis and increased clearance of RBCs by the spleen leads to anaemia (Rosenthal, 2010).

The signals for recognition of uninfected red blood cells for removal by macrophages are believed to be enhanced and uninfected RBCs bind increased amounts of immunoglobulin and/or complement as demonstrated in the direct antiglobulin test (Weatherall, 2002; Facer, 1979). All these mechanisms are believed to contribute to the reduction in erythrocytes count, haemoglobin concentration and packed cells volume.

The result showed significant improvement in erythrocyte indices of mice treated with ACT only and crude leaf extract of *E. speciosa* only, in comparison with parasitized untreated mice. However, though recovery of the group treated with ACT only was more than treated with crude leaf extract of *E. speciosa* only. This implies that ACT only had a better haematoprotective effects on the mice when compared with crude extract of *E. speciosa* only. Artemether-lumefantrine administered concomitantly the crude extract of *E. speciosa* significantly (p<0.05) raised the red blood cells indices of parasitized animals to levels comparable to normal mice. Increase in the erythrocytes indices by the co-administration of the extract and ACT was significantly higher than that observed for either extract of *E. speciosa* or ACT. The co-administration enhanced a significant recovery from both parasite-induced and ACT-induced red blood cells indices derangements. The observed increase in red blood cell count may be attributed to the direct synergistic stimulation on haemopoietic tissues such as the liver and bone marrow by ACT and phytochemicals in the plant extract (Osime et al., 2008; Montejo et al., 2015). Extracts of *E. speciosa* have been reported to possess antianaemic properties by Ndém et al. (2013). These antianaemic potentials have been attributed to alkaloids in the herbs which stimulate the phosphorylation of proteins, hence increased haematopoiesis (Eteng et al., 2003; Eteng et al., 1998). The restorative effect of co-administration of *E. speciosa* leaf extract and artemether-lumefantrine observed in this study may be considered a triple regimen for treatment of malaria with anaemia, considering the reported safety profile of the plant extract (Ndém et al., 2013).

The study also evaluated the effects of the various treatments on the leucocytes indices of the mice, namely the white blood cells count and differentials. Mice infected with *Plasmodium berghei* showed a significant (P<0.05) reduction in the white blood cells indices. This neutropenia corroborates with earlier reports by George and Ewelike-Ezeani (2011); Uwah et al. (2014) and Adekunle et al. (2007). Infection with *Plasmodium* was reported to be associated with impairment of immune responses and immuno suppression is believed to have evolved as a mechanism by which the parasite can prevent immune-mediated clearance (Sprør et al., 1989). Malaria infection has been widely reported as an immunosuppressive condition (Riley et al., 1991; Thursz et al., 1995). The leucocytes panel can predicts the immunity. Some therapies have been reported to affect the immunity status and some herbs are known to function in different ways to stimulate the immune system cells, which include macrophages, phagocytes, monocytes and neutrophils (Krawiec, 2017). Administration of crude leaf extract of *E. speciosa* only significantly (P<0.05) increased the WBC count and differentials of parasitized mice. Concomitant treatment of artemether-lumefantrine with extract of *E. speciosa* almost completely reversed the parasite-induced derangements observed in leucocyte indices back to values comparable to non-parasitized mice. These imply that the concomitant therapy could protect the animals from parasite-Induces leucopenia and ultimately parasite-induced immuno depression. The plant extracts contain phytochemicals that may possess stimulatory effect on leukocytosis, particularly lymphocytosis and monocytosis, while inducing neutropenia. Krawiec (2017) reported that some herbal extracts possess strong immuno modulatory effects by either stimulating or inhibiting white blood cells, which are the major cells involved in immune responses.

**CONCLUSIONS**

The use of artemisinin-based combination therapies (ACT) alongside with medicinal plants is a very common practice in Nigeria. Co-administration of artemether-lumefantrine with crude leaf extract of *E. speciosa* increased indices of red blood cells in *plasmodium berghei* infected mice, probably due to erythropoiesis inducing effect of component phytochemicals working synergistically with the drugs. The drug-extract combination produced a significant recovery from both parasite-induced and ACT-induced anaemia. It also completely reversed the derangement observed in leucocyte indices in parasitized animals back to normal values, hence, protecting the animals from parasite-Induces leucopenia and ultimately parasite-induced immuno depression as observed in this animal model. Hence, administration of ACT with the plant
extract may relieve malaria-induced anaemia which is a major cause of mortality in malaria disease and also relieves malaria-induced immunosuppression.

REFERENCES


