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# *In vivo* Antiplasmodial Activity of Ethanol and Aqueous Extracts of *Uvaria chamae* and *Phyllantus amarus* Plants

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**Abstract**

*Uvaria chamae* and *Phyllantus amarus* plants were tested for in vivo anti-malarial activity in Swiss albino mice infected with chloroquine resistant *Plasmodium berghei* NK 65. Ethanol and aqueous extracts of the leaf, stem bark, and root of U. chamae and of the whole plant of *P. amarus* were used for the in vivo study at a dose of 100 mg/kg body weight. The results show that the two plant extracts exhibited high anti-malarial activity. The parasitemia in the infected mice treated with the extracts were significantly reduced ($p<0.05$) when compared with the untreated negative control and chloroquine standard control. The results show that the ethanol extracts of *U. chamae* and *P. amarus* had much suppressive effect on *P. berghei* infected mice than the aqueous extracts of both plants. Additionally, the ethanol extracts of the roots and leaf of *U. chamae* exhibited higher anti-malarial activity than the stem bark extracts. The plant extracts were also screened for phytochemicals (secondary metabolites). Flavonoids, steroids, saponins, terpenoids, tannins and alkaloids were detected in the two plant extracts. The anti-malarial activity of these extracts is attributed to these secondary metabolites. The results also suggest that the solvent used in extract preparation affects the anti-malarial activity of plants.

**Keywords***: Antiplasmodial activity, plant extracts, phyllantus amarus, Uvaria chamae,*

## 1.0 Introduction

Malaria is caused by a parasite called Plasmodium, which is transmitted via the bites of infected mosquitoes. In the human body, the parasites multiply in the

liver, and then infect red blood cells (Hedrick, 2011). Although there are many species of *Plasmodium*, only five infect humans and cause malaria. *P. falciparum* found in tropical and subtropical areas is the major contributor to deaths from severe malaria. *P. vivax,* found in Asia and Latin America, has a dormant stage that can cause relapses. *P. ovale* is found in Africa and in Pacific islands. *P. malariae* occurs worldwide and can cause a chronic infection. *P. knowlesi* found throughout Southeast Asia (Dondorp, Pongponratn and White, 2004) can rapidly progress from an uncomplicated case to a severe malaria infection. The plasmodium parasite is spread by female Anopheles mosquitoes (Cowman, Berry and Buam, 2012), which are known as 'night-biting' mosquitoes because they most commonly bite between dusk and dawn. If a mosquito bites a person already infected with malaria, it can also become infected and spread the parasite on to other people. However, malaria cannot be spread directly from person to person (Willcox, Burford and Bodeker. 2004). Once you are bitten, the parasite enters the bloodstream and travels to the liver. The infection develops in the liver before re-entering the bloodstream and invading the red blood cells (Rayner, Liu, Peters, Sharp and Hahn, 2011). The parasites grow and multiply in the red blood cells. At regular intervals, the infected blood cells burst, releasing more parasites into the blood. Infected red blood cells usually burst every 48-72 hours (Rayner *et al., 2011*). Each time they burst, the patient experiences a stint of fever, chills and sweating. Malaria can also be transmitted through blood transfusions and the sharing of needles, but this is very rare (Pau, Arley and Robert, *2003*).

Typically, the time between being infected and when symptoms start (incubation period) is 7 to 18 days (Duval, Fourment, Nerrienet, Rousset, Sadeuh, … & Ayala, 2010), depending on the specific infecting parasite. However, in some cases it can take up to a year for symptoms to develop. The early symptoms of malaria are flu-like and include a high temperature (fever), headache, sweats, chills and vomiting (Ene, Obika, Okwu, Alisi and Edeh, 2013). These symptoms are frequently mild and can sometimes be difficult to identify as malaria. With some types of malaria, the fever occurs in four to eight hour cycles. During these cycles, the patient feels cold at first with shivering that lasts for up to an hour. He then develops a fever that lasts for two to six hours, accompanied by severe sweating.

Other symptoms of malaria may include: muscle pains, diarrhoea, and general feeling of unwell (Adeneye, Benebo and Agbaje, 2006).

When a patient suffers from the most serious type of malaria, caused by the *Plasmodium falciparum* parasite, there is a risk that he could quickly develop severe and life-threatening complications such as breathing problems and organ failure if not treated promptly (Ogueke, Ogbulie and Anyanwu, 2007).

Malaria transmission occurs in all six WHO regions. Globally, an estimated 3.2 billion people in 97 countries and territories are at risk of being infected with malaria parasite and developing the disease (map), while 1.2 billion people are at high risk (>1 in 1000 chance) of getting malaria in a year. According to the latest estimates, 198 million cases of malaria occurred globally in 2013 (uncertainty range 124–283 million) and the disease led to 584,000 deaths (uncertainty range 367,000 – 755,000), representing a decrease in malaria case incidence and mortality rates of 30% and 47% since 2000, respectively. The burden is heaviest in the WHO African region, where an estimated 90% of all malaria deaths occur, and in children aged less than 5 years, who account for 78% of all deaths (Kazembe, Munyarari and Charumbira, 2012).

Medicinal plants are of great importance to the health of individuals and communities especially the rural areas of developing communities (Igwe, Ojiako, Emejulu and Iwueke, 2012). Traditional herbal practice has existed in Africa and other cultures for centuries of unknown period (Ene, Ameh, Kwanashie, Agomo and Atawodi, 2008). But until recently, it has been neglected or even outlawed in some cases because of undue pressures from orthodox medicine practitioners and the presumed unscientific mode of the practices (Ene, Atawodi, Ameh, Ndukwe and Kwanashie, 2009a).

Resistance to anti-malarial medicines is a recurring problem (Collins, 2012). Resistance of *P. falciparum* to previous generations of medicines, such as chloroquine and sulfadoxine-pyrimethamine (SP), became widespread in the 1970s and 1980s (Ene, Obika, Okwu, Alisi and Edeh, 2013), undermining malaria control efforts and reversing gains in child survival (Willcox *et al.,* 2004). Also, due to the high cost of the orthodox drugs, most of the population especially those living in the

rural parts of the developing countries including Nigeria have shifted to medicinal plants as their major source of treatment (Ene *et al.,* 2013).This necessitated research into medicinal plants in order to produce cheaper drugs, which could help break this resistance of malaria parasites.

This research is therefore aimed at evaluating the antiplasmodial activity of ethanol and aqueous extracts of *Uvaria chamae* and *Phyllanthus amarus* in Swiss albino mice. *P. amarus* and *U. chamae* belong to the families of Euphorbiaceae and Annonaceae respectively. *P. amarus* is widely distributed in all tropical regions of the planet and is a common pan-tropical weed that grows well in moist, shady and sunny places (Cabieses, 1993; Nanden-Amattaram, 1998). *U. chamae,* on the other hand, is a climbing plant predominantly found in the tropical rainforest of West Africa (Okwu and Iroabuchi, 2009). Both plants are known to posses antiplasmodial and antibacterial activities (Adeneye *et al*., 2006; Ogueke *et al*., 2007; Igoli, Ogaji, Tor-Anyin and Igoli, 2005).

## 2.0 Materials and Methods

### 2.1 Plant source and collection

*Phyllanthus amarus* and *Uvaria chamae* were obtained from the Aguluezechukwu in Aguata Local Government Area of Anambra State of Nigeria. These indigenous local plants were identified and authenticated by a taxonomist, Dr. C. Ibeawuchi of the Department of Crop Science, Federal University of Technology Owerri, Nigeria, with the voucher numbers of UC. CCO.003 and UBAD Pa 001 for *U. chamae* and *P. amarus* respectively.

### 2.2 Plant extraction processes

The whole plant of *P. amarus* and the root, stem bark and leaf of *U. chamae* were harvested in large quantities, washed thoroughly in tap water and dried separately under the shade at room temperature for about 7 weeks before being ground into powdered form using a crusher machine. Maceration method of extraction was used; 100g each of the pulverized parts was macerated separately in 600ml of distilled water and 600ml of ethanol, for 48 hours. Each sample was filtered using Whatman number 1 filter paper to get rid of residues. All aqueous and ethanol filtrates (infusions) were concentrated using water bath at 45$^{O}$C. The extracts were stored in the refrigerator at 4$^{O}$C until required.

### 2.3 Animals and animal husbandary

Thirty-five (35) male Swiss albino mice used for this study were purchased from the Department of Veterinary Parasitology of University of Nigeria Nsukka (UNN) and transported to Federal University of Technology Owerri (FUTO); where the research was carried out. The mice were acclimatized for 2 weeks before the commencement of the study.

### 2.4 *In vivo* culture of the *Plasmodium berghei* in albino mice

The *Plasmodium berghei* infected red blood cells of the mice was intraperitoneally injected into healthy mice as infected blood diluted with phosphate buffered saline (PBS) PH 7.2; so that each 0.2ml had approximately 10 x $10^7$ infected red cells (parasite per kg of body weight) (David *et al*., 2004; Peter and Anatoli, 1998). Parasitemia was confirmed in the test animals after 24hr of passaging, by making blood smears from the tail vein of the infected mice and staining with Giemsa stain and viewing through a microscope at x100 objective (ie emersion oil). The mice (both the infected and uninfected) had free access to standard laboratory mice foodstuff (Vital starter) and water *ad libitum* and were kept under standard laboratory condition.

### 2.5 *In vivo* treatment of the infected albino mice

Four-day curative standard test methods (David *et al*., 2004; Peter and Anatoli, 1998) were used, employing the rodent malaria parasite, *Plasmodium berghei*. The mice were alienated into groups. Three mice were allotted into each of the 11 test/treatment groups. Forty eight hours (48 hrs) after infection with the malaria parasite, the plant extracts were administered to the experimental groups (groups one to eight) at a dose level of 100 mg/kg body weight daily for four days (Ene *et al.,* 2008). The drugs were administered based on the animals' average body weight. Chloroquine (CQ) was administered to the CQ standard (control) group at a standard dose of 10 mg/kg body weight for four days. The standard artesunate drug was administered at a dose of 1.6 mg/kg body weight (Ene *et al.,* 2009a). The negative control group animals were not administered any drug or extract. All drug administration was performed via the intraperitoneal route. The extracts were dissolved to the indicated suitable dose level in solution and suspension, the later requiring complete dissolution in 3% v/v Tween 80. Treatments were performed daily

for 4 consecutive days starting from 48 hours after infection, receiving a total of 4 intraperitoneal doses (David *et al*., 2004). Smears of the animals' blood samples were made, fixed with methanol, stained with Giemsa at pH 7.2 and examined under the microscope using x100 (under immersion oil) to confirm parasitemia or to access the parasitemia level as the case may be. The percentage parasitemia was calculated according to the technique outlined by Iwalewa *et al.,* (1997) as:

$$\text{Percentage parasitemia} = \frac{\text{Number of parasitemia in treated}}{\text{Number of parasitemia in control}} \times \frac{100}{1}$$

This is always assumed to be:

$$\text{Percentage parasitemia} = \frac{\text{Number of parasitemia in treated}}{500} \times \frac{100}{1}$$

**2.6 Phytochemical analysis**

The phytochemical screening of the aqueous and ethanol extracts of *P. amarus* and *U. chamae* were carried out to determine the presence of secondary metabolites using standard procedures (Sofowara, 1982; Trease and Evans, 1983).

**2.7 Statistical analysis**

Data obtained were analysed and compared using Student's "t" test and Analyses of Variance (ANOVA) at 95% confidence level ($p \leq 0.05$).

**3.0 Results**

Normal mice infected with chloroquine (CQ) resistant *P. berghei* but not treated became weak after day six (6) of infection. For the infected mice treated with artesunate (1.6 mg/kg body weight), the parasites were cleared on day five (5) and the animals survived. On the other hands, all the infected mice treated with the ethanol and aqueous extracts of *P. amarus* (whole plant) and *U. chamae* (leaf, stem bark and root) showed clearance of the parasites with increase in days of treatment from day 0 to day 14, ranging from 1.00 ± 0.35 to 0.10 ± 0.10 for ethanol leaf extract of *U. chamae;* 1.40 ± 1.21 to 0.20 ± 0.20 for ethanol stem bark extract; 1.27 ± 0.64 to 0.07 ± 0.12 for ethanol root extract of *U. chamae*; 1.73 ± 1.22 to 0.47 ± 0.42 for aqueous leaf extract of *U. chamae;* 0.87 ± 0.42 to 0.20 ± 0.20 for aqueous stem bark

extract of *U. chamae;* 1.13 ± 0.46 to 0.20 ± 0.00 for aqueous root extract of *U. chamae;* 0.93 ± 0.12 to 0.10 ± 0.10 for ethanol whole plant extract of *P. amarus;* and 1.20 ± 0.69 to 0.13 ± 0.12 for aqueous whole plant extract of *P. amarus,* as compared to 1.33 ± 1.05 to 6.27 ± 0.50 and 1.20 ± 1.00 to 6.20 ± 0.87 in the untreated control and chloroquine standard control groups respectively.

Comparisons were made among all the groups on days 0, 4, 8 and 14. On day 0, there was no statistical significant ($P>0.05$) differences in the level of parasitemia in all the groups. On day 4, there was statistical significant difference ($P<0.05$) in the level of parasitemia in the mice treated with ethanol and aqueous extracts of root, stem bark and leaf of *U. chamae* when compared to the untreated infected mice and chloroquine standard control group (Table 1). There was however, no significant difference ($P>0.05$) in parasitemia level of the infected mice treated with chloroquine when compared with the untreated mice (Table 1).

The result also showed a significant reduction ($P<0.05$) in the level of parasitemia in the mice treated with ethanol and aqueous extracts of *P. amarus* whole plant when compared to untreated infected mice and chloroquine standard control group. On days 8 and 14, a statistical reduction ($P<0.05$) was observed between the percentage parasitemia of the infected mice. There was also a statistically significant difference ($P<0.05$) in the level of parasitemia in the infected mice treated with ethanol and aqueous extracts of *P. amarus* (whole plant) when compared to untreated infected mice and chloroquine standard control. The *P. amarus* whole plant extracts showed a higher anti-malarial activity when compared to the *U. chamae* plant parts extracts (Table 1).

Though the parasitemia was not completely cleared in the tests groups, it was drastically reduced (Table 1). Moreover, this did not lead to the survival of the experimental animals as some of the mice started dying as the parasite load increased after treatment was withdrawn as opposed to the group treated with artesunate which survived.

The result of the phytochemical studies showed the presence of some secondary metabolites like flavonoids, steroids, saponins, terpenoids, tannins and alkaloids in the two plant extracts (Table 2).

**Table 1: *In vivo* effect of crude ethanol and aqueous extracts of different parts of *Uvaria chamae* and whole plant of *Phyllantus amarus* on chloroquine resistant *Plasmodium berghei* NK65.**

| Plant Parts (Extracts) | N | Drug Dosage (mg/kg) | Average % parasitemia | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day 0 | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 | Day 7 |
| EtOH Leaf (U.C) | 3.00 | 100.00 | 1.00±0.35[a] | 0.47±0.12 | 1.20±1.56 | 1.27±0.61 | 0.60±0.72[b] | 0.26±0.23 | 1.07±1.33 | 1.27±1.42 |
| EtOH Stem Bark (U.C) | 3.00 | 100.00 | 1.40±1.21[a] | 0.87±0.31 | 1.40±1.23 | 0.93±0.95 | 1.67±2.02[c] | 0.67±0.31 | 0.87±0.12 | 0.63±0.58 |
| EtOH Root (U.C) | 3.00 | 100.00 | 1.27±0.64[a] | 0.67±0.12 | 0.13±0.23 | 0.20±0.00 | 0.20±0.20[b] | 0.20±0.20 | 0.67±0.81 | 0.63±0.00 |
| Aq. Leaf (U.C) | 3.00 | 100.00 | 1.73±1.22[a] | 1.40±1.11 | 0.67±0.42 | 0.60±0.35 | 0.60±0.35[b] | 0.27±0.12 | 1.60±1.73 | 0.60±0.53 |
| Aq. Stem Bark (U.C) | 3.00 | 100.00 | 0.87±0.42[a] | 0.67±0.42 | 0.60±0.40 | 0.27±0.31 | 0.40±0.40[b] | 0.87±0.99 | 0.73±0.70 | 1.67±2.04 |
| Aq. Root (U.C) | 3.00 | 100.00 | 1.13±0.46[a] | 1.00±0.60 | 1.13±0.81 | 0.87±0.70 | 1.20±0.80[c] | 0.80±0.40 | 1.40±1.00 | 0.37±0.32 |
| EtOH WholePlant (P.A) | 3.00 | 100.00 | 0.93±012[a] | 0.87±0.12 | 1.20±0.53 | 0.60±0.00 | 0.67±0.12[b] | 0.27±0.31 | 1.13±1.03 | 0.93±0.23 |
| AQ WholePlant (P.A) | 3.00 | 100.00 | 1.20±0.69[a] | 1.07±0.50 | 0.87±0.23 | 0.20±0.20 | 0.33±0.23[b] | 0.40±0.20 | 0.40±0.20 | 0.40±0.53 |
| Artemeter STD C0ntrol | 3.00 | 1.60 | 0.73±0.12[a] | 0.40±0.35 | 0.07±0.12 | 0.20±0.20 | 0.07±0.12[b] | 0.00±0.00 | 0.00±0.00 | 0.00±0.0 |
| Untreated Control | 3.00 | TW 80 | 1.33±0.58[a] | 1.43±0.75 | 3.00±1.00 | 4.00±0.00 | 4.05±0.87[c] | 4.07±0.31 | 4.08±0.42 | 4.10±0.45 |
| CQ STD control | 3.00 | 25.00 | 1.20±1.00[a] | 1.67±0.83 | 2.17±0.29 | 2.57±0.40 | 3.03±0.05[c] | 3.23±0.25 | 3.40±0.40 | 3.80±0.14 |

All values were compared with the untreated controls on days 0, 4, 8, and 14 at P=0.05
TW 80=Tween 80, EtOH=ethanol, AQ=aqueous, CQ=chloroquine, STD=standard, U.C=*Uvaria chamae* and P.A=*Phyllantus amarus.*
Values with different superscripts vertically differ statistically (P<0.05)

**Table 1 (continued): *In vivo* effect of crude ethanol and aqueous extract of different parts of *Uvaria chamae* and whole plant of *Phyllantus amarus* on chloroquine resistant *Plasmodium berghei* NK65.**

| Plant Parts (Extracts) | N | Drug Dosage (mg/kg) | Average % parasitemia | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Day 8 | Day 9 | Day 10 | Day 11 | Day 12 | Day 13 | Day 14 |
| EtOH Leaf (U.C) | 3.00 | 100.00 | 0.53±0.42$^{b}$ | 0.07±0.12 | 0.13±0.12 | 0.13±0.23 | 0.13±0.12 | 0.07±0.12 | 0.20±0.07$^{a}$ |
| EtOH Stem Bark (U.C) | 3.00 | 100.00 | 1.20±0.87$^{c}$ | 2.73±0.46 | 0.73±0.81 | 0.20±0.35 | 0.20±0.20 | 0.73±1.10 | 0.20±0.20$^{a}$ |
| EtOH Root (U.C) | 3.00 | 100.00 | 0.56±0.58$^{b}$ | 0.53±0.31 | 0.60±0.72 | 0.40±0.20 | 0.07±0.12 | 0.13±0.23 | 0.07±0.12$^{a}$ |
| Aq. Leaf (U.C) | 3.00 | 100.00 | 1.13±1.10$^{c}$ | 1.33±0.90 | 0.33±0.42 | 0.47±0.50 | 0.40±0.35 | 0.40±0.35 | 0.47±0.42$^{a}$ |
| Aq. Stem Bark (U.C) | 3.00 | 100.00 | 0.53±0.42$^{b}$ | 0.67±0.31 | 0.40±0.40 | 0.73±0.42 | 1.13±0.58 | 0.20±0.00 | 0.20±0.20$^{a}$ |
| Aq. Root (U.C) | 3.00 | 100.00 | 0.40±0.53$^{b}$ | 0.73±0.31 | 0.73±0.42 | 0.73±0.58 | 0.40±0.00 | 0.20±0.00 | 0.20±0.00$^{a}$ |
| EtOH WholePlant (P.A) | 3.00 | 100.00 | 1.00±0.87$^{c}$ | 1.53±1.33 | 0.80±0.80 | 0.67±0.70 | 0.20±0.20 | 0.13±0.12 | 0.10±0.10$^{a}$ |
| AQ WholePlant (P.A) | 3.00 | 100.00 | 0.73±0.78$^{b}$ | 0.40±0.35 | 0.40±0.35 | 0.53±0.42 | 0.27±0.31 | 0.23±0.00 | 0.13±0.12$^{a}$ |
| Artemeter STD C0ntrol | 3.00 | 1.60 | 0.00±0.00$^{d}$ | 0.00±0.00 | 0.00±0.00 | 0.00±0.14 | 0.00±0.00 | 0.00±0.00 | 0.00±0.00$^{b}$ |
| Untreated Control | 3.00 | TW 80 | 4.17±1.26$^{c}$ | 4.20±0.35 | 5.50±0.50 | 5.83±0.29 | 5.87±0.23 | 5.93±0.12 | 6.33±0.58$^{c}$ |
| CQ STD control | 3.00 | 25.00 | 4.17±0.29$^{c}$ | 4.30±0.62 | 4.93±0.12 | 5.10±0.79 | 5.17±1.00 | 5.37±1.09 | 6.03±0.58$^{c}$ |

All values were compared with untreated on days 0, 4, 8, and 14 at P=0.05

TW 80=Tween 80, EtOH=ethanol, AQ=aqueous, CQ=chloroquine, STD=standard, U.C=*Uvaria chamae* and P.A=*Phyllantus amarus.*

Values with different superscripts vertically differ statistically (P<0.05)

**Table 2: Phytochemical screening of aqueous and ethanol extracts of different *P.amarus* (whole plant) and *U. chamae parts***

| Phytochemical | Specific test | Aq. Whole plant (*P. amarus*) | Aq. Stem bark (*U. chamae)* | Aq. Root (*U. chamae)* | Aq. Leaf (*U. chamae)* | EtOH. Whole plant (*P. amarus*) | EtOH. Stem bark (*U. chama)* | EtOH. Root (*U. chama)* | EtOH. Leaf (*U. chamae )* |
|---|---|---|---|---|---|---|---|---|---|
| **Tannins** | Ferric chloride | + | - | - | + | + | - | - | + |
| **Saponins** | Frothing test | + | - | - | + | - | + | - | + |
| **Flavonoid** | Shinodas | - | - | - | - | - | - | - | + |
| | Drangendruff's | + | - | - | - | - | - | - | + |
| | Lead acetate | + | - | - | - | - | - | - | + |
| | ferric chloride | + | - | - | + | + | - | - | + |
| **HCN** | Cyanide test | - | + | + | + | - | - | + | - |
| **Terpenoids** | Salkowskill test | + | + | - | - | + | + | - | + |
| **Steroids** | Lieberman-Burchard test | + | + | + | + | + | + | + | + |
| **Alkaloids** | Wagner's test | + | + | + | + | + | + | + | + |
| | Mayer's test | + | + | - | + | + | + | - | + |
| | Dragendroff's | + | - | - | + | + | + | + | + |

**Legends:** Aq. represents Aqueous, EtOH represents ethanol, HCN represents hydrogen cyanide, + represents present, - represents not present.

## 4.0 Discussion

The use of aqueous ethanol solvents for extraction in this research is in consonance with folkloric practice (Ene *et al*., 2013). In this study, maceration method was used for the extraction. Though maceration has been reported to result in low extract yield compared to soxhlet and some other methods of extraction, yet it was preferred in this work because it does not require heating, thus preserving thermo-labile components of the plants (Ene *et al.,* 2013). The ethanol extracts of both plants (*P. amarus* and *U. chamae*) slightly demonstrated higher activity on the test organisms than the aqueous extracts. This might be due to the active principle(s) being more soluble in ethanol than in aqueous medium (Peace, Ekaete, Chinweizu and Ruth, 2011; Ene *et al.,* 2013).

Phytochemical screening indicated that both plants extracts contain flavonoids, steroids, saponins, terpenoids, tannins and alkaloids. There were *in vivo* anti-plasmodial activity in both ethanol and aqueous extracts of *U. chamae* but the activity was higher with the ethanol extracts of the leaf and root followed by the stem. This might be attributed to the presence of some active ethanol soluble secondary metabolites (Ene *et al.,* 2008; Ene *et al.,* 2009a; Ene *et al.,* 2009b; Ene *et al.,* 2013) in the plant, *U. chamae.* The *in vivo* anti-plasmodial activity was higher with the ethanol extracts of *P. amarus* (whole plant) than with the ethanol extracts *U. chamae* and the aqueous extracts of both plants This might be due to high level of the active components in this extract compared to the others (Ene *et al.,* 2013). *P. amarus* has previously been reported to contain alkaloids, flavonoids, glycosides, saponins, tannins and phenols (Igwe *et al.,* 2012).

In a similar study by Ajaiyeoba *et al.,* (1999) on two Nigerian plants, *Quassia amara L.* and *Quassia undulata,* anti-malarial properties were demonstrated when hexane and methanol extracts at a dose of 100mg/kg body weight of mouse showed significant anti-malarial activities in a 4-day suppressive *in vivo* anti-malarial assay. This is in agreement with the present study where 100mg/kg of the plant extracts were used to treat the test animals.

Dikassso, Makonnen, Debella, Abebe, Urga, Makonnen, Melaku… and makonnen (2006), reported that hydro-alcoholic extracts of *Asparagus africanus Lam* showed *in vivo* anti-plasmodial (*P. berghei*) activity in swiss albino mice. Several

other researchers have made similar observations in anti-malarial activities of *Artemisia maciverae Linn, Artemisia maritime Linn, Picralima nitida, Xylopia aethiopia, Zingiber officnale, P. amarus,* and *U. chamae,* among others (Iwalewa *et al.,* 1997; Badman *et al.,* 1988; Okwu, 2007; Ene *et al.,* 2008; Ene *et al.,* 2009; Ene *et al.,* 2010; Peace *et al.,* 2011; Ene *et al.,* 2013). Such reports/results are in support of anti-malarial activities observed with ethanol and aqueous extracts of *U. chamae* (leaf, stem bark and root) and *P. amarus* (whole plant) at a dose concentration of 100mg/kg body weight in this study.

Results of the present study have shown that there was no significant difference observed between the anti-malarial activities of *P. amarus* (whole plant) and *U. chamae* (leaf, root and stem bark) extracts. However, *U. chamae* is likely to be more potent in its anti-malarial activity since the activities recorded here are per part (leaf, root and stem bark) as against *P. amarus* whose anti-malarial activities was studied in the whole plant.

## 5.0 Conclusion

From this study, it can be concluded that ethanol and aqueous extracts of parts (leaf, stem bark and root) of *U. chamae* and *P. amarus* (whole plant) possess antiplasmodial properties. The ethanol and aqueous extracts of *P. amarus* (whole plant) recorded more suppressive effect on *P. berghei* than the *U. chamae* extracts. This suggests that the use of the whole plant might have a better anti-malarial activity compared to using individual plant parts.

We therefore recommend that the ethanol and/or aqueous extracts of the plants (*U. chamae* and *P. amarus*) be subjected to bioassay guided fractionation to characterize the active principle responsible for their antiplasmodial activity. However, the efficacy of the plants in the treatment of distinct diseases should also be carried out.

## 6.0 Acknowledgement

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