Research Article

Antiplasmodial and Antipyretic Activity and Safety Evaluation of the Methanolic Leaf Extract of *Murraya exotica* (L.)

Arnold Donkor Forkuo 1, Kwesi Boadu Mensah 1, Elvis Ofori Ameyaw, 2
Aaron Opoku Antwi 1, Nana Kofi Kusi-Boadum, 1 and Charles Ansah 1

1Department of Pharmacology, Faculty of Pharmacy and Pharmaceutical Sciences, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
2Department of Biomedical and Forensic Sciences, School of Biological Science, College of Agriculture and Natural Sciences, University of Cape Coast, Cape Coast, Ghana

Correspondence should be addressed to Arnold Donkor Forkuo; forkuoarnold@yahoo.com

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**Background.** The increasing mortality and morbidity of malaria in Africa coupled with the recent reports of antimalarial drug resistance reinforces the need for novel antimalarial agents from natural plant products with folkloric use for the disease. *Murraya exotica* (L.) (Rutaceae) is widely used as an ornamental plant used indigenously to treat fever, cough, and infectious wounds and eliminate pain from injury and trauma. This study was conducted to evaluate extracts of the leaves of *Murraya exotica* (L.) (Rutaceae) for its safety and antipyretic and antimalarial activity in rodent models.

**Method.** In this study, the Peters 4-day suppressive and curative test in *Plasmodium berghei*-infected mice was used to demonstrate the antimalarial activity of the methanolic leaf extract of *Murraya exotica* (L.) (MEE). The study also evaluated the subacute toxicity study and the antipyretic activity of MEE on baker’s yeast-induced hyperthermia in rodent models. *Results.* *Murraya exotica* (L.) extract demonstrated curative antimalarial activity, with a percentage suppression of 45.84, 64.32 ± 0.33, 56.74 ± 2.16, and 64.61 ± 0.67 at doses of 50, 100, 300, and 600 mg/kg, respectively. In the Peters 4-day suppressive test, MEE at dose 600 mg/kg had the highest chemosuppression (76.02 ± 1.38%) compared with artemesunate (2 mg/kg, p.o.) (82.56 ± 0.97%). Subacute oral toxicity studies in Sprague-Dawley rats documented no deaths, with no significant changes in clinical signs, organ weights, and hematological and biochemical parameters. The LD$_{50}$ of MEE was estimated to be above 1000 mg/kg in Sprague-Dawley rats. All doses of MEE and paracetamol reduced pyrexia in 1 h and 2 h after their administration. The percentage reduction of rectal temperature ($T_R$) for the positive control (paracetamol, 150 mg/kg, p.o.) was 44.36% while the *Murraya exotica* extract at doses 50 mg/kg, 100 mg/kg, 300 mg/kg, and 600 mg/kg recorded 67.74%, 40.78%, 66.42%, and 59.42%, respectively. *Murraya exotica* at dose 100 mg/kg exhibited significant reduction ($p < 0.05$) in baker’s yeast-induced pyrexia. *Conclusions.* The findings in this study show the antipyretic, curative, and suppressive antimalarial activity as well as the safety of the methanolic leaf extract of *Murraya exotica* (L.) supporting its traditional use for malaria and fever.

1. **Background**

Despite several years of intense research, malaria remains a deadly worldwide disease. According to the World Health Organization [1], about 219 million cases of malaria were reported in 90 countries with 435,000 deaths in 2017. The WHO African Region was home to 92% of these malaria cases and 93% of malaria deaths. Antimalarial drug resistance remains a major hurdle in the global effort to eradicate malaria [2]. The persistence of this global health problem is partly attributed to the development of resistance by the limited available antimalarials. The artemisinins, though effective in the global fight against malaria, are hampered by limited supply and high cost.

While there is much need for more antimalarial agents, the drug development pipeline remains woefully thin, with
little chemical diversity. Currently, no clinically tested alter-
native to the valuable artemisinins has been developed [3].
Although vaccine development could be the surest long-
term control option, clinical trials are still ongoing [4].

Plant-derived compounds have played a crucial role in
the discovery and development of new drug molecules for
the treatment of several diseases. Medicinal plants have been
used for the prevention and treatment of malaria, and the
isolation of new bioactive compounds from these plants
offers novel, affordable, and efficient options that could serve
as primary molecules for antimalarial treatment with artemi-
sinin and quinine being classical examples [5].

*Murraya exotica* (L.) (Rutaceae) is an example of a
medicinal plant that has been used traditionally in the treat-
ment of malaria [6] with no scientific credence. In southern
China where the plant is actively grown, *Murraya exotica*
(L.) (Rutaceae) has been well documented in the Pharmaco-
poia of the People’s Republic of China for the treatment of
rheumatic arthralgia, stomachache, fever, body swelling,
toothache, and pain [7]. Wu et al. [8] have demonstrated
the antinociceptive and anti-inflammatory activities of 70%
ethanol extracts of *M. exotica* in rat knee osteoarthritis
models.

This study is aimed at evaluating the *in vivo* antimal-
dial, safety, and antipyretic properties of the methanolic leaf
extract of *Murraya exotica* (L.) (Rutaceae) in rodent models.

2. Methods

2.1. Plant Collection and Authentication. The fresh leaves of
*Murraya exotica* (L.) were collected in Bekwai, Ashanti
region (August 2017). Dr. George Henry Sam of the Depart-
ment of Herbal Medicine identified and authenticated the
plant using organoleptic analysis. A voucher specimen
(KNUST/H/M/2017/M007) of the leaves of *Murraya exotica*
(L.) was kept at the herbarium of the Faculty of Pharmacy
and Pharmaceutical Sciences, Kwame Nkrumah University
of Science and Technology (KNUST), Kumasi, Ghana.

2.2. Extraction of Plant Material. The fresh leaves were
washed and air-dried for 2 weeks under shade. The dry leaves
obtained were then milled into powder with a laboratory
scale mill. The powdered leaves (2 kg) were extracted by mac-
eration with 101 of 70% methanol for 72 hours at room tem-
perature and then concentrated under reduced pressure at
40°C into an oily mass in a rotary evaporator. The extract
was further dried in a hot air oven at 40°C for 3 days and then
kept in a refrigerator for later use. The final yield was 24.10%
(w/w). The crude extract obtained is subsequently referred to
as *Murraya exotica* extract (MEE) or the extract in this study.
The various concentrations of the methanolic extract were
prepared in 5% sodium carboxymethylcellulose solution for
the experimental procedures.

2.3. Experimental Animals. Male Sprague-Dawley rats (125–
167 g) and ICR-strain mice (18–22 g) between 6 and 8 weeks
were used. They were obtained from Noguchi Memorial
Institute for Medical Research (NMIR), University of Ghana,
Legon, and kept in the animal house of the Department of
Pharmacology, KNUST. The animals were housed in stain-
less steel cages and maintained under normal animal housing
conditions. This involved the monitoring of room condi-
tions, monitoring of animals for health problems and preg-
nancy, proper cage enclosure conditions, food and water
levels, proper ventilation, light, temperature, and sanitation.
Rats and mice were fed a commercial pellet diet and granted
access to clean water.

2.4. Rodent Parasite. The species of malaria parasite used to
infect the mice was *Plasmodium berghei* NK 65 and was
obtained from Noguchi Memorial Institute for Medical
Research. The parasites were kept alive by intraperitoneal
passage in mice after ≥5% parasitemia has been established.

2.5. Chemicals and Reagents. Methanol, ethanol, ferric chlo-
ride (FeCl₃), hydrochloric acid (HCl), Dragendorff’s reagent,
sulphuric acid (H₂SO₄), sodium hydroxide (NaOH), chloro-
form, acetic anhydride, sodium carboxymethylcellulose, 10%
formaldehyde, and 10% Giemsa. All the chemicals used were
of analytical grade.

2.6. Phytochemical Screening of *Murraya exotica Extract*. The
standard laboratory methods described by Vaghasia et al.
[9] were used in the phytochemical screening of secondary
metabolites of the methanol extract of the leaves of *Murraya exotica* (MEE).

2.7. Peters 4-Day Suppressive Test. The *in vivo* antimalarial
activity of *Murraya exotica* extract (MEE) was assessed using
the 4-day suppressive test in the *P. berghei*-infected mouse
model [10]. Mice infected with the *P. berghei* NK 65 strain
served as the reservoir, parasites were maintained by serial
blood passage in mice, and the blood stage was stored at
−80°C until use. The donor mice were infected with 200 μl
of *P. berghei* parasite inoculum. The parasitized blood of
each donor mouse was collected from the tail vein and diluted
with 0.9% sodium chloride. ICR mice of both sexes were
divided into five groups and each intraperitoneally infected
with 0.2 ml of saline suspension containing 1.0 × 10⁷ parasit-
ized erythrocytes (day 0). Three hours after infection, the
mice in each group (*n* = 6) were treated with oral daily doses
of 50, 100, 300, or 600 mg/kg body weight of MEE for four
consecutive days (test groups 1, 2, 3, and 4, respectively).
Positive and negative control groups were treated daily with
an oral daily dose of artesunate at 2 mg/kg body weight and
5% sodium carboxymethylcellulose, respectively. The para-
sitemia of each mouse was determined under light micro-
scope by examination of Giemsa-stained thin blood
smears prepared from the mouse tail 4 days (96 hours) post

2.8. Antiplasmodial Curative Test. In this study, the antiplas-
modial curative activity of the methanolic extract of *Murraya exotica*
was investigated using the Ryley and Peters method
[12]. Thirty-five (35) mice (18–25 g) were inoculated intra-
peritoneally with 1.0 × 10⁷ cells/mm³ of *Plasmodium berghei*
NK 65 parasite. Parasitemia was confirmed after 72 hours,
and the mice were randomly divided into 6 groups of 5 mice
per group. Groups 5 and 6 served as the positive and negative
controls, respectively. The positive control group was treated with artesunate 2 mg/kg orally, and an equivalent volume of 5% sodium carboxymethylcellulose was given to the negative control group. Groups 1, 2, 3, and 4 were treated with 50 mg/kg, 100 mg/kg, 300 mg/kg, and 600 mg/kg of the plant extract, respectively. The treatment was daily for 5 days, and the oral route was used in each group. Blood samples were taken from the tail vein of each mouse onto a microscope slide to make thin films [13]. Blood smears were taken on days 1, 3, and 6 of drug treatment. The thin films were prepared by fixing the blood on the slide with methanol, then staining the slide with 10% Giemsa for 10 minutes. The thin films prepared were examined microscopically in order to establish the level of parasitemia.

The mean parasitemia in each group of mice for both the curative and the suppressive test was used to calculate the % suppression for each dose using the following formula:

\[
\% \text{parasitemia} = \frac{\text{Number of parasitized RBCs}}{\text{Total number of RBCs counted}} \times 100.
\]  

(1)

Average percentage chemosuppression was calculated as

\[
\% \text{suppression} = \frac{\% \text{parasitemia in the negative control} - \% \text{parasitemia in the test}}{\% \text{parasitemia in the negative control}} \times 100.
\]  

(2)

2.9. Antipyretic Test. The effect of drugs on baker’s yeast-induced hyperthermia as described by Tomazetti et al. [14] and Boakye-Gyasi et al. [15] was employed. A 2-day habituation session was conducted where rectal temperatures \( (T_R) \) of the rats were recorded by inserting a lubricated digital thermometer (external diameter: 3 mm, 0.1°C precision) 3 cm into the rectum of rats. Rats with initial rectal temperature \( (T_R) \) between 36 and 37°C were selected for these antipyretic tests. A pyrogenic dose of baker’s yeast \( (0.135 \text{ g/kg}, \text{i.p.}) \) was injected to each animal on the third day after measuring basal temperatures. Changes in rectal temperature \( (T_R) \) were recorded every hour up to 4 h. Rats with a rise of not less than 0.5°C in rectal temperature were selected for the experiment. Animals were randomly divided into six groups of five rats each. Group 1 received paracetamol \( (150 \text{ mg/kg}, \text{p.o.}) \). Groups 2, 3, 4, and 5 received MEE 50, 100, 300, and 600 mg/kg, \text{p.o.}, respectively. Group 6 did not receive any drug/extract after the yeast administration. Another group of 5 rats (Group 7) received only normal saline \( (0.9\% \text{ NaCl}, \text{i.p.}) \) without baker’s yeast administration. \( T_R \) were monitored hourly over the following 4 h period after extract/drug administration.

2.10. Subacute Toxicity Test. The oral subacute toxicity study of Murraya exotica methanolic leaf extract was carried out in Sprague-Dawley rats using the modified Locke test [16]. Sprague-Dawley rats, weighing 125–167 g were placed in 5 treatment groups. The negative control group (group 5) received normal saline. Various test groups of Murraya exotica were groups 1, 2, 3, and 4 which received doses of 100, 250, 500, and 1000 mg/kg, \text{p.o.}, respectively. The rats were observed for weakness, stimulation, anorexia, sleep, coma, and death in the first five hours and subsequently for 14 days. The variations in weights on day 1, day 7, and day 14 were as well investigated by taking the animals’ weights on a balance on those days. On day 15, the rats were sacrificed by cervical dislocation, the jugular vein cut, and blood allowed to flow freely into tubes with and without ethylenediaminetetraacetic acid (EDTA) as coagulant. They were dissected, and their organs (lungs, liver, heart, and spleen) were weighed individually. The organs were preserved thereafter in 10% formalin. The blood samples of the animals were as well collected in EDTA and plain tubes for hematological and biochemical analyses, respectively.

2.11. Hematological Parameters. Twenty-four hours after the last dose, the animals were sacrificed by cervical dislocation and the blood samples were collected by cardiac puncture. The blood samples for hematological parameters (white blood cell count, red blood cell count, hemoglobin, platelet count, and packed cell volume) were collected into EDTA containers and analyzed using an automated machine (Automated CBC Analyzer: Sysmex KX-21).

2.12. Biochemical Analysis. The blood samples for biochemical parameters (globulin, albumin, alkaline phosphatase, indirect bilirubin, direct bilirubin, total bilirubin, aspartate transaminase, alanine transaminase, gamma-glutamyl transpeptidase, urea, and creatinine) were collected into EDTA tubes and analyzed using an automated analyzer (automated biochemical analyzer).

2.13. Ethical Consideration. The use and handling of animals were in agreement with the National Institutes of Health Guidelines for Care and Use of Laboratory Animals (1985) and was approved by the Institutional Ethical Review committee of the Department of Pharmacology, Kwame Nkrumah University of Science and Technology (KNUST) (No. PHARM/ETHIC/ET194/19).

2.14. Statistical Evaluation. The statistical analysis of data obtained was analyzed using GraphPad V6.0 (GraphPad Prism software, San Diego, USA). The treatment groups and the controls were analyzed and compared using the one-way analysis of variance (ANOVA). The results obtained were expressed as mean ± SEM. The antimalarial activity of MEE was determined from the ratio of percentage of parasitemia reduction in treated and negative control groups.
3. Results

3.1. Phytochemical Screening. The preliminary phytochemical screening of the dried methanolic leaf extract of Murraya exotica showed the presence of tannins, saponins, coumarins, alkaloids, flavonoids, glycosides, and sterols. Table 1 shows the results of the phytochemical screening.

3.2. Antiplasmodial Studies

3.2.1. Rane/Curative Test. ICR mice were treated with 50 mg/kg, 100 mg/kg, 300 mg/kg, and 600 mg/kg of Murraya exotica extract and 2 mg/kg of artesunate (positive control). After day 3 and day 6 of treatment, the positive control (artesunate 2 mg/kg) showed the highest percentage suppression of 57.02 ± 0.33 and 89.13 ± 0.00, respectively. Murraya exotica also showed a significant decrease in the parasitemia after day 3 which further decreased on the 6th day. The highest dose of Murraya exotica extract administered (600 mg/kg) showed the highest parasitemia suppression (64.61%). Table 2 shows the results obtained from the antimalarial study.

3.3. Peters 4-DaySuppressive Test. In vivo 4-day suppressive assay results for the leaf extract of Murraya exotica using Plasmodium berghei-infected mice are summarized in Table 3. 96 hour postinfection, MEE at doses of 50 mg/kg, 100 mg/kg, 300 mg/kg, and 600 mg/kg showed a percentage suppression of 61.55 ± 1.87, 69.20 ± 1.73, 72.42 ± 1.55, and 76.02 ± 1.38, respectively. The positive control (artesunate, 2 mg/kg) assayed in parallel reduced parasitemia by 82.56 ± 0.97% with no observed mortality in the group after 30 days.

3.4. Antipyretic Activity. MEE at all doses reduced pyrexia in the Sprague-Dawley rats. The inhibition remained significant up to 4 h of administration. MEE at 100 mg/kg dose showed the maximum antipyretic effect and returned the body temperature to normal levels (p > 0.05), almost as effective as the standard drug paracetamol (Figure 1).

3.5. Subacute Toxicity. The subacute toxicity study revealed that the methanolic extract of Murraya exotica was safe up to 1000 mg/kg.

3.6. Relative Organ Weight. With regard to the relative organ weight, it was observed that the target organs, heart, kidney, liver, and spleen, of the Sprague-Dawley rats in the test groups did not differ significantly from those of the control group as shown in Table 4.

3.7. Hematological Analysis. In the hematological screening, the following blood parameters assessed, red blood cell count, platelet count, white blood cell count, hemoglobin level, and cell volume, revealed that the methanolic extract of Murraya exotica at doses 100 mg/kg, 250 mg/kg, 500 mg/kg, and 1000 mg/kg did not produce any significant effects when compared to the control. Table 5 shows the results obtained from the hematological analysis.

3.8. Biochemical Analysis. In the biochemical analysis, the various parameters assessed revealed that the methanolic extract of Murraya exotica at doses 100 mg/kg, 250 mg/kg, 500 mg/kg, and 100 mg/kg did not produce any significant effects when compared to the control.

Table 1: Secondary metabolized in the leaves of Murraya exotica (L.).

<table>
<thead>
<tr>
<th>Secondary metabolite</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tannins</td>
<td>+</td>
</tr>
<tr>
<td>Saponins</td>
<td>+</td>
</tr>
<tr>
<td>Coumarins</td>
<td>+</td>
</tr>
<tr>
<td>Alkaloids</td>
<td>+</td>
</tr>
<tr>
<td>Flavonoids</td>
<td>+</td>
</tr>
<tr>
<td>Glycosides</td>
<td>+</td>
</tr>
<tr>
<td>Sterols</td>
<td>+</td>
</tr>
</tbody>
</table>

Key: +: represents present.

Table 2: Percentage suppression of Plasmodium berghei by four dose points of Murraya exotica and artesunate (2 mg/kg) on day 3 and day 6, respectively.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Day 3 (%)</th>
<th>Day 6 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (50 mg/kg)</td>
<td>20.60 ± 0.33</td>
<td>45.84 ± 0.00</td>
</tr>
<tr>
<td>Group 2 (100 mg/kg)</td>
<td>33.67 ± 2.23</td>
<td>64.32 ± 0.33</td>
</tr>
<tr>
<td>Group 3 (300 mg/kg)</td>
<td>19.91 ± 0.67</td>
<td>56.74 ± 2.16</td>
</tr>
<tr>
<td>Group 4 (600 mg/kg)</td>
<td>26.19 ± 0.00</td>
<td>64.61 ± 0.67</td>
</tr>
<tr>
<td>Positive control (2 mg/kg)</td>
<td>57.02 ± 0.33</td>
<td>89.13 ± 0.00</td>
</tr>
</tbody>
</table>

Values expressed as means ± SEM (n = 5), compared to the control by Dunnett’s multiple comparison test.

Table 3: Percentage suppression of Plasmodium berghei by four dose points of Murraya exotica and artesunate (2 mg/kg) on day 4.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% suppression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (50 mg/kg)</td>
<td>61.55 ± 1.87</td>
</tr>
<tr>
<td>Group 2 (100 mg/kg)</td>
<td>69.20 ± 1.73</td>
</tr>
<tr>
<td>Group 3 (300 mg/kg)</td>
<td>72.42 ± 1.55</td>
</tr>
<tr>
<td>Group 4 (600 mg/kg)</td>
<td>76.02 ± 1.38</td>
</tr>
<tr>
<td>Positive control (2 mg/kg)</td>
<td>82.56 ± 0.97</td>
</tr>
</tbody>
</table>

Values expressed as means ± SEM (n = 5), compared to the control by Dunnett’s multiple comparison test.

4. Discussion

The development of resistance to the commonly used antimalarial drugs and its resultant increase in morbidity and mortality due to malaria continue to pose a major public health threat [17]. To address this global threat caused by Plasmodium falciparum malaria, novel antimalarial drugs and potent vaccines are urgently needed. Murraya exotica grows widely in southern Asia, and it is used as an ornamental and hedge plant for its pleasant smell and beauty. However, the leaves and roots of the plant have been
traditionally used as medicine to treat rheumatalgia, toothache, malaria, and body pains from injury and trauma [6, 18]. In this study, the in vivo antiplasmodial and antipyretic activity and the safety profile of the methanolic leaf extract of the plant were assessed.

Phytochemical analysis showed that the *Murraya exotica* extract contains tannins, saponins, coumarins, alkaloids, flavonoids, glycosides, and sterols. Other studies performed also show that *Murraya exotica* extracts contain carbohydrates, proteins, amino acids, and phenolic compounds.

Figure 1: Effect of MEE 50-600 mg/kg, p.o., and paracetamol (150 mg/kg, p.o.) on time-course curve (a) and the total increase in temperature (calculated as AUCs (b)) on baker’s yeast-induced changes of rectal temperatures in rats. Naive represents animals with no treatment with yeast. Values are expressed as mean ± SEM (n = 5). **** p < 0.001 compared to vehicle-treated group (control) (ordinary one-way ANOVA comparison test with descriptive statistics).

Table 4: Effect of the methanolic extract of *Murraya exotica* on organ weights of rats treated for 14 days.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Control</th>
<th>100 mg/kg</th>
<th>250 mg/kg</th>
<th>Relative organ weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>500 mg/kg</td>
</tr>
<tr>
<td>Liver</td>
<td>2.87 ± 0.04</td>
<td>3.40 ± 0.30</td>
<td>3.03 ± 0.14</td>
<td>3.33 ± 0.19</td>
</tr>
<tr>
<td>Kidneys</td>
<td>0.50 ± 0.04</td>
<td>0.61 ± 0.04</td>
<td>0.62 ± 0.02</td>
<td>0.64 ± 0.02</td>
</tr>
<tr>
<td>Spleen</td>
<td>0.38 ± 0.08</td>
<td>0.47 ± 0.03</td>
<td>0.46 ± 0.08</td>
<td>0.50 ± 0.10</td>
</tr>
<tr>
<td>Heart</td>
<td>0.41 ± 0.07</td>
<td>0.37 ± 0.03</td>
<td>0.39 ± 0.01</td>
<td>0.40 ± 0.02</td>
</tr>
</tbody>
</table>

Values are expressed as mean ± SEM (n = 5) compared to the control by the Newman-Keuls test.
aqueous extract for 14 days. Between treated and untreated groups of animals is used con-

terpretation activities [23]. The similarity in the phytochemicals reported was reported to have antihyperlipidemic and antidiabetic activities [24]. The usefulness of relative organ weight in toxicity studies includes sensitivity to predict toxicity, enzyme induction, physiologic perturbations, and acute injury; it correlates well with histopathological changes, and there is little interanimal variability [25]. There were no significant differences in the weights of the target organs of the treatment groups when compared to the control group (Table 4). This indicates that the methanolic extract *Murraya exotica* treatment for 14 days did not cause any detrimental effect on the heart, kidney, liver, and spleen of the Sprague-Dawley rats in the various treatment groups.

Most toxic compounds target the hematopoietic system, an important index of physiology, and hence help to determine the pathological status in man and animals [26]. In the hematological analysis, the values of the different parameters assessed [red blood cell (RBC), hemoglobin (Hb), hematocrit (HCT), white blood cell (WBC), mean cell hemoglobin (MCH), mean cell hemoglobin concentration...
COX-3 or by the enhancement of the production of the retic substances are known to reduce proinflammatory mediators, improve anti-inflammatory actions [28]. The phytochemical screening of the dried methanolic leaf extract of *Murraya exotica* showed the presence of tannins, saponins, coumarins, alkaloids, flavonoids, glycosides, and sterols. Although the active constituents in the plant extract responsible for the antimalarial effects are not known or have yet to be identified, the presence of alkaloids, glycosides, tannins, and flavonoids has been implicated in antipyretic and antimalarial activity and might be as a result of a single, additive, or synergistic action of these compounds [29, 30].

5. Conclusion

The findings in this study show that the methanolic extract of *Murraya exotica* is safe in Sprague-Dawley rats and demonstrate both suppressive and curative antimalarial activity in *Plasmodium berghei*-infected mice. MEE also possessed considerable antipyretic properties at the doses tested in the baker's yeast-induced pyrexia in rodent models. This study gives support to the claim for the traditional use of the plant in the treatment of malaria and fever.

Data Availability

All data generated or analyzed during this study are included in this published article.

Ethical Approval

The use and handling of animals was approved by the Institutional Ethical Review committee of the Department of Pharmacology, Kwame Nkrumah University of Science and Technology (KNUST) (No. PHARM/ETHIC/ET194/19).

Conflicts of Interest

The authors declare that they have no competing interests.

Authors’ Contributions

ADF, EOA, and KBM conceived the research idea and designed the experiment; NKKB, ADF, CA, and AOA performed the experiments and analyzed and interpreted the data as well as prepared the first draft of the paper. All authors read and approved the final manuscript.

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References


