Oral and Intraperitoneal Acute Toxicity Studies of Sesamum radiatum Aqueous Leaf Extract in Female Wistar Rats

Kouamé Amoin Flora Kouacou, Brou André Konan, Koffi Bruno Koko

UPR-Nutrition and Pharmacology, Laboratory of Biology and Health, UFR-Biosciences, Félix Houphouët-Boigny University, P.O. Box 582 Abidjan 22, Côte d'Ivoire.

Background and aims: Sesamum radiatum leaves are commonly used by African and Ivorian people in particular to treat various diseases. However, few studies have been done on the pharmacological properties and even less on the acute toxicity of this medicinal plant in Côte d'Ivoire. Also, the present work was carried out in order to contribute to correcting this through a comparative study of the acute oral and intraperitoneal toxicity of the aqueous extract of the leaves (ESera) in the female Wistar rat.

Méthodes: According to the modified OECD 423 method, 2 groups of 6 rats were treated with ESera at 50 mg/kg and 2000 mg/kg in a single dose respectively by intraperitoneal and oral administration in comparison with the control group (NaCl 0.9 %). Dice weighing at regular intervals of 2 days of body weight and the removal of some organs and blood samples at the end of the 14-day observation period allowed the measurement of biological parameters.

Results: Irrespective of the administration route, ESera did not cause clinical signs of suffering, behavior change and death in rats. The morphology and the relative weight of the organs (heart, kidneys, liver and lungs) were not modified. Treated animals exhibited weight growth kinetics similar to those of the controls. Greater weight gains (p < 0.05) were obtained with ESera. The study carried out on the blood samples showed statistically significant changes (p < 0.05) in certain hematological and serum biochemical parameters. The changes observed were greater with ESera 50 mg/kg intraperitoneal administration.

Conclusion: Sesamum radiatum aqueous extract did not cause death or organ changes in rats during the 14 days of observation. However, in order to better determine its toxicity, other studies must be carried out due to the disturbances observed in hematological parameters, transaminases and electrolytes.

Keywords: Acute toxicity, Hematological parameters, Biochemical parameters, Organ biometry

INTRODUCTION

For thousands of years, plants have been used for human and veterinary health care. Even today, populations increasingly use these plants for primary health care throughout the world. Ito et al. (2012) report that 70-95% of people in developing countries use plants to treat various diseases. Plants have contributed enormously to the development of modern therapy. And this growing interest of populations for plants would be justified by poverty faced with the high costs of pharmaceutical products and hospital services and especially cultural beliefs in the therapeutic virtues of medicinal plants. This belief is reinforced by the strong contribution that these plants have made to modern therapeutics. Indeed, more than 25% of modern medicines are derived from medicinal plants.

However, empirical and/or uncontrolled use poses problems with real risks of poisoning, metabolic disorders, liver damage, kidney dysfunction, cardiovascular disorders and various other diseases. Various scientific studies must therefore be made for a rational and efficient use of medicinal plants. It is in this context that scientific works have been undertaken on medicinal plants, including Sesamum radiatum. Belonging to the Pedaliaceae family, Sesamum radiatum is a plant commonly used to treat various diseases and to facilitate childbirth in parturient women. Previous works have shown the therapeutic potential of this plant due to its richness in secondary metabolites and its pharmacological properties.

The effect of plants depending on several factors including soil, geography, climate, pharmacological and toxicological studies have been undertaken on Sesamum radiatum harvested in Côte d'Ivoire. It is in this context that the present work has been carried out in order to study the acute toxicity of the aqueous extract of the leaves of this medicinal plant in the female Wistar rat.

MATERIALS AND METHODS

Plant material and extract

Fresh leaves of Sesamum radiatum (Pedaliaceae) were harvested in March 2018 in Koumassi (Abidjan, Côte d'Ivoire).
They have been identified and authenticated by an expert in Botany, Prof. Emma Aké-Assi at the National Floristic Center (CNF, UFR-Biosciences, Félix Houphouët-Boigny University). The authentication was made with reference to a specimen cataloged in this center under the number B9408 of June 17, 1966.

The extraction process was implemented according to the method described by some authors: 25-28. The fresh leaves were washed and dried at room temperature (28 ± 2 °C). Dried leaves were pulverized to powder using a laboratory blender (Mark RETSCH, type SM 100n Germany). The powder (100 g) was macerated 24 hours in 11 water. The mixture was filtered (Whatman n°1) for 3 times until complete exhaustion. The filtrate was concentrated under reduced pressure using a rotary evaporator (Büchi R110, type MKE 6540/2) at a temperature of 60 °C and dried in a drying oven at 50 ± 5°C. The concentrated extract obtained (ESera: Sesamum radiatum aqueous leaf extract) was stored at 4°C until experiments. Concentrations of ESera to be tested were prepared extemporaneously by dilution in NaCl 0.9 % saline solution.

**Animals and ethical consideration**

Female Wistar rats (Rattus norvegicus) weighing 157-167 g and aged 8-10-week-old were used for the subacute oral toxicity study. They were obtained from the Vivarium (Animal house) at the École Nationale Supérieure (ENS), Abidjan, Côte d’Ivoire. Animals housed in metabolic cages and maintained under standard laboratory conditions (temperature 25 ± 2 °C) with daily and light cycle (12/12 h). They were allowed free access to standard dry pellet diet and water ad libitum. Rats are fasted 18 hours before the experiment. Animals were treated according to good laboratory practices 29. The experimental protocols were conducted in accordance with the protocols for the protection of experimental animals of the European Council on Legislation 2012/707 30.

**Chemicals used**

Isoflurane (Forêne®, Roche, France), Sodium chloride crystals (Delbet, France) and Commercial Kit (Spinreact, Spin) were used.

**Study design**

Three groups of six rats were used for the acute toxicity study conducted according to the OECD 423 protocol 31 modified by Ahmed et al. (2010) 32. Thus, Group 1 (Control) received per os the saline solution NaCl 0.9 %, Group 2 received ESera 2000 mg/kg per os and Group 3 received ESera 50 mg/kg intraperitoneally. The drugs were administered in a single dose on D1 and the animals were observed until D14. Clinical signs and toxicity were observed immediately after administration, 3 h after administration of drugs daily in all animals. Rats were observed daily to record any apparent physiological and/or behavioral changes. Weighings were made on D1, D14 and at regular intervals of 2 days in order to assess the evolution of the animals’ body weight. At D15 (D14 + 1), the 16 hr-fasted rats were anaesthetized with Isoflurane and blood was collected in test tubes from the retro-orbital sinus. All animals were sacrificed and organs (heart, kidney, liver, lungs) were sampled for biochemical parameters measurement.

**Measurement of biological parameters**

**Weight gain**

Weight gain (WG) was determined according to the method used by Méité et al. (2016) 33. It was calculated with the body weights measured at D1 and D15 and is given by the following equation:

\[ W_{G} (g/d) = \left( W_{15} - W_{1} \right) / \text{Duration (14 days)} \]

**Relative organ weights**

Organs removed and freed of any adhesion were weighed for the calculation of the relative weights (RW) according to the formula below:

\[ \text{RW} (%) = \left( \text{Organ Weight} / \text{Animal Final weight (J15)} \right) \times 100 \]

**Hematological parameters**

Blood samples were collected in Ethylene Diamine Tetra-Acetic acid (EDTA) coated bottles. Samples were analyzed for the assessment of the number of Red blood cells (RBCs), White blood cells (WBCs), platelets, lymphocytes, hemoglobin (Hb), hematocrit, Mean Corpuscular Volume (MCV), Mean Cellular Hemoglobin (MCH) and Mean Cellular Hemoglobin Concentration (MCHC) according to standard methods using the Sysmex NX-100 I Kobe auto-analyser (Japan).

**Biochemical essays**

Blood samples collected in non-heparinized tubes were allowed to clot for about 15 min and centrifuged at 3000 rpm for 5 min. Serum was separated from the clot with pasteur pipette and dispensed into clean tube for the measurement of the biochemical indices. Analysis of the selected serum biochemical indices were carried out on each sample using the Sysmex NX-100 I Kobe auto-analyser (Japan). Parameters measured were the Aspartate aminotransferase (AST) and Alanine transaminase (ALT) for liver profile and the Urea, Creatinine, Na⁺, Cl⁻ and K⁺ for the kidney profile.

**Data analysis**

The values were expressed as mean with standard error of the mean (m ± sem). The data were evaluated by analysis of variance followed by Tukey-Kramer with GraphPad Instat software (Microsoft, San Diego, California, USA) method. The graphical representations of data were performed by the GraphPad Prism 5 software (Microsoft, San Diego, California, USA). The difference between the averages is considered statistically significant when p < 0.05.

**RESULTS**

**Mortality and clinical signs of toxicity**

No signs of toxicity were observed in female rats after administration of ESera 50 mg/kg and 2000 mg/kg respectively by intraperitoneal and oral roots. In terms of the acute toxicity, there was no change in the general appearance of rats (hair, skin, eyes, ears and mouth). The animals had no diarrhea, hematura, uncoordinated movements, or respiratory distress during the study period. No symptoms of illness were observed during the 14 days of treatment. All animals survived after 14 days of observation.

**Effects of Sesamum radiatum aqueous leaf extract on animals weight**

**Body weight evolution**

L’administration intrapéritonéale de ESera 50 mg/kg et l’administration orale de ESera 2000 mg/kg n’ont pas entraîné de perte de poids chez les râtes. La croissance pondérale n’a pas été perturbée par les deux doses de ESera (Figuer 1). Il a été une augmentation régulière du poids corporel avec une des cinétiques semblables à celle des témoins ayant reçu la solution saline NaCl 0.9 %. Le poids était passé de 167 ± 0.90 g (J1) à 186.5 ± 1.30 g (J14) contre 157.83 ± 1.83 g à 184.33 ± 2.78 g et 162 ± 0.40 g à 183.2 ± 2.50 g respectivement pour ESera 50 mg/kg administré par voie intrapéritonéale et ESera 2000 mg/kg par voie orale. La comparaison du poids corporel à J14 à celui mesuré à J1 a montré une augmentation significative à p < 0.05 pour chaque groupe d’animaux.
Figure 1: Evolution of the body weight of female rats 14 days after administration of a single dose of *Sesamum radiatum* aqueous leaf extract. m ± sem, n = 6, ESera: *Sesamum radiatum* aqueous leaf extract, ipa: intraperitoneal administration, poa: per os administration

Weight gain

L’extrait de plante (ESera) donné per os à 2000 mg/kg et à 50 mg/kg par voie intrapéritonéale a entraîné chez les rats une augmentation significative du gain de poids en comparaison à celui des témoins ayant reçu la solution saline NaCl 0.9 % (Table 1). Les gains de poids obtenus étaient 1,40 ± 0,18 % pour les témoins contre 1,51 ± 0,19 % (p < 0,05 ) pour ESera 2000 mg/kg administré par voie orale. Le gain de poids le plus élevé à p < 0,01 a été enregistré suite à l’administration intrapéritonéale de ESera 50 mg/kg avec une valeur de 1,89 ± 0,24 %.

Table 1: Weight gain in female rats 14 days after administration of single doses of *Sesamum radiatum* aqueous extract

<table>
<thead>
<tr>
<th>Treatment groups</th>
<th>Weight gain (g/day)</th>
<th>NaCl 0.9 % (Control)</th>
<th>ESera 50 mg/kg poa</th>
<th>ESera 2000 mg/kg ipa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m ± sem, n = 6, *p &lt; 0.05: significant, **p &lt; 0.01: significant, ESera: <em>Sesamum radiatum</em> aqueous leaf extract, ipa: intraperitoneal administration, poa: per os administration</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Effects of *Sesamum radiatum* aqueous leaf extract on biometric parameters of organs

Morphology of organs

Macroscopic examination did not reveal any modification of the removed organs (heart, liver, kidney, and lungs) in the rats. Organ shape and color were unaffected by the different doses of ESera given to the animals. No anomaly (hypertrophy, atrophy, presence of nodules) was observed.

Relative organ weights

Table 2 presents the relative organ weights of rats. Analysis of the data collected showed that the administration routes and the doses of *Sesamum radiatum* aqueous leaves extract did not significantly modify (p > 0.05) the relative weights of the regulating organs (heart, kidneys, liver and lungs) during the 14-day study period.

Table 2: Relative organ weights of rats 14 days after administration of single doses of *Sesamum radiatum* aqueous extract

<table>
<thead>
<tr>
<th>Treatment groups</th>
<th>Relative organ weights (%)</th>
<th>Heart</th>
<th>Kidneys</th>
<th>Liver</th>
<th>Lungs</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl 0.9 % (Control)</td>
<td>0.37 ± 0.08</td>
<td>0.52 ± 0.06</td>
<td>3.93 ± 0.52</td>
<td>0.94 ± 0.12</td>
<td></td>
</tr>
<tr>
<td>ESera 50 mg/kg ipa</td>
<td>0.39 ± 0.04 **</td>
<td>0.63 ± 0.11 **</td>
<td>3.84 ± 0.23 **</td>
<td>0.84 ± 0.10 **</td>
<td></td>
</tr>
<tr>
<td>ESera 2000 mg/kg poa</td>
<td>0.36 ± 0.09 **</td>
<td>0.57 ± 0.08 **</td>
<td>3.78 ± 0.34 **</td>
<td>0.73 ± 0.08 **</td>
<td></td>
</tr>
</tbody>
</table>

m ± sem, n = 3, *p > 0.05: no significant, ESera: *Sesamum radiatum* aqueous leaf extract, ip: intraperitonial administration, po: per os (Oral) administration
Effects of *Sesamum radiatum* aqueous leaf extract on hematological parameters

**Red cell lineage**

Red cell parameter values were modified by ESera (Table 3). The changes recorded with ESera 2000 mg/kg ipa were not statistically significant (*p > 0.05*) for all the parameters studied in comparison with those of the controls. Except the MCHC which increased from 31.57 ± 0.92 g/100 mL (controls) to 32.03 ± 0.75 g/100 mL, the other erythrocyte parameters decreased with the single dose of ESera 2000 mg/kg poa insignificantly. ESera 50 mg/kg ipa caused a significant increase at *p < 0.05* of MCHC estimated at 33.03 ± 0.54 g/100 mL. On the other hand, decreases were observed for the other parameters in comparison with those of the controls. They were significant for MCH (17.45 ± 0.5 pg; *p < 0.05*), Hb (11.87 ± 1.01 g/100 ml; *p < 0.001*), and Hematocrit (35.98 ± 1.92%; *p < 0.0001*). As for the red blood cell count, it decreased insignificantly (*p > 0.05*) with a value of 6.61 ± 0.67 x 10^6/mm³ (ESera 50 mg/kg ipa) and 7.67 ± 0.53 x 10^6/mm³ (ESera 2000 mg/kg poa) against 7.83 ± 0.48 x 10^6/mm³ (Controls).

**Leukocyte lineage**

The measured leukocyte parameter values are reported in Table 3. The overall level of leukocytes (white blood cells) was not statistically modified (*p > 0.05*) by the treatment with the two doses of the plant extract. However, the levels of certain types of leukocytes experienced significant changes. Thus, ESera 50 mg/kg ipa induced a significant increase in the level of lymphocytes (82.25 ± 1.43%; *p < 0.01*) and that of monocytes (8 ± 0.67 x 10^3/mm³; *p < 0.001*) and an equally significant drop in eosinophils (1.33 ± 0.44 x 10^3/mm³; *p < 0.01*). The respective values of these parameters were 78.67 ± 1.67 %, 3.33 ± 0.44 x 10^3/mm³ and 2 x 10^3/mm³ in controls. In rats treated with ESera 2000 mg/kg poa, only the lymphocyte level changed. A statistically significant increase at *p < 0.01* was observed with a value of 82.33 ± 1.11 % against 78.67 ± 1.67 % in the control females.

**Platelets**

Blood platelet count was greatly reduced in the presence of doses of *Sesamum radiatum* aqueous extract (ESera). Indeed, the platelet count which was 1080.50 ± 144 x 10^3/µL (Controls) dropped significantly to a value of 929.17 ± 1.44 x 10^3/µL with ESera 2000 mg/kg poa (*p < 0.0001* and 690 ± 1.67 x 10^3/µL (*p < 0.0001*) for ESera 50 mg/kg ipa (Table 3).

<table>
<thead>
<tr>
<th>Table 3: Hematological parameters of female rats 14 days after administration of single doses of <em>Sesamum radiatum</em> aqueous extract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hematological parameters</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>Erythrocyte lineage</strong></td>
</tr>
<tr>
<td>RBCs (10^6/mm³)</td>
</tr>
<tr>
<td>Hb (g/100 mL)</td>
</tr>
<tr>
<td>Hematocrit (%)</td>
</tr>
<tr>
<td>VGM (fl)</td>
</tr>
<tr>
<td>MCH (pg)</td>
</tr>
<tr>
<td>MCHC (g/100 mL)</td>
</tr>
<tr>
<td><strong>Leukocyte lineage</strong></td>
</tr>
<tr>
<td>WBCs (10^3/mm³)</td>
</tr>
<tr>
<td>Eosinophiles (10^3/mm³)</td>
</tr>
<tr>
<td>Lymphocytes (%)</td>
</tr>
<tr>
<td>Monocytes (10^3/mm³)</td>
</tr>
<tr>
<td>Platelets (10^3)/µL</td>
</tr>
</tbody>
</table>

**Effects of *Sesamum radiatum* aqueous leaf extract on biochemical parameters**

**Biochemical markers of kidney**

As shown in Table 4, the level of urea did not change significantly (*p > 0.05*) 14 after single doses of ESera were applied to rats. This observation was not made with creatinine. Indeed, variations of this biological marker have been recorded. Compared to the control value (6.67 ± 0.44 mmol/L), ESera 50 mg/kg ipa caused a significant decrease (*p < 0.001*) in the creatinine level with a value of 3.33 ± 0.44 mmol/L. On the contrary, a significant increase at *p < 0.01* was obtained with ESera 2000 mg/kg poa. At this dose of 2000 mg/kg poa, ESera made it possible to record a creatinin value of 8.00 ± 0.44 IU/L in female rats *Rattus norvegicus.*

Regarding electrolytes (Table 4), statistically significant increases were observed. Na⁺ was estimated at 141.00 ± 1.33 mmol/L (*p < 0.01*) and 143.00 ± 1.33 mmol/L (*p < 0.001*) with ESera 2000 mg/kg poa and ESera 50 mg/kg ipa respectively against 138 ± 1.33 mmol/L in the control rats having received the saline solution NaCl 0.9 %. Cl⁻ concentration increased non-significantly (*p > 0.05*) with ESera 50 mg/kg ipa (98.17 ± 1.22 mmol/L) whereas a significant rise at *p < 0.05* was recorded in animals treated with ESera 2000 mg/kg poa (99.17 ± 0.56 mmol/L). Its value was 97.00 ± 1.33 mmol/L in controls. As for the potassium ion (K⁺), its value of 4.69 ± 0.50 mmol/L (Controls) dropped significantly to 3.87 ± 0.44 mmol/L (ESera 50 mg/kg ipa) and 3.73 ± 0.44 mmol/L (ESera 2000 mg/kg poa) respectively against 4.32 ± 0.44 mmol/L (Controls).
mmol/L) and highly significant at \( p < 0.0001 \) for ESera 50 mg/kg ipa.

**Biochemical markers of liver**

Transaminases (ALT and AST) were modified differently by the plant extract (Table 4). ESera caused a statistically significant decrease at \( p < 0.0001 \) in ALT. Its value was measured at 46.17 ± 1.89 IU/L (Controls) against 34.00 ± 1.00 IU/L (ESera 50 mg/kg ipa) and 29.17 ± 0.89 IU/L (ESera 2000 mg/kg poa). At the AST level, its initial value of 153.83 ± 1.50 IU/L (Controls) increased significantly at \( p < 0.0001 \) for ESera 50 mg/kg ipa and reached 162.83 ± 0.89 IU/L. Conversely, ESera 2000 mg/kg poa with a value of 132.17 ± 0.56 IU/L induced a significant decrease (\( p < 0.0001 \)) in AST transaminase.

**Table 4:** Serum biochemical parameters of female rats 14 days after administration of single doses of *Sesamum radiatum* aqueous extract

<table>
<thead>
<tr>
<th>Biochemical parameters</th>
<th>NaCl 0.9 % (Control)</th>
<th>ESera 50 mg/kg ipa</th>
<th>ESera 2000 mg/kg poa</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kidney profile</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urea (g/L)</td>
<td>0.23 ± 0.03</td>
<td>0.19 ± 0.02**</td>
<td>0.27 ± 0.02**</td>
</tr>
<tr>
<td>Creatinine (UI/L)</td>
<td>6.67 ± 0.44</td>
<td>3.33 ± 0.44***</td>
<td>8.00 ± 0.67**</td>
</tr>
<tr>
<td>Na⁺ (mmol/L)</td>
<td>138 ± 1.00</td>
<td>143.00 ± 1.33**</td>
<td>141.00 ± 1.33*</td>
</tr>
<tr>
<td>Cl⁻ (mmol/L)</td>
<td>97.00 ± 1.33</td>
<td>98.17 ± 1.22ns</td>
<td>99.17 ± 0.56*</td>
</tr>
<tr>
<td>K⁺ (mmol/L)</td>
<td>4.69 ± 0.50</td>
<td>8.88 ± 0.45***</td>
<td>5.17 ± 0.92*</td>
</tr>
<tr>
<td><strong>Liver profile</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALT (UI/L)</td>
<td>46.17 ± 1.89</td>
<td>34.00 ± 1.00****</td>
<td>29.17 ± 0.89****</td>
</tr>
<tr>
<td>AST (UI/L)</td>
<td>153.83 ± 1.50</td>
<td>162.83 ± 0.89****</td>
<td>132.17 ± 0.56****</td>
</tr>
</tbody>
</table>

**DISCUSSION**

*Sesamum radiatum* aqueous leaves extract (ESera) administered at 50 mg/kg intraperitoneally did not cause any death in rats. This result differs from that of Konan et al. (2012) 24 which showed that this extract was toxic according to Diezi’s scale 34. This difference would be related to the low dose used in the present study. It is well below the lethal dose of between 169.7 and 142 mg/kg obtained by these authors. Indeed, several studies have all demonstrated that the toxicity of a plant extract depends on several factors including the dose, the administration route, the animal species and even the chemical composition of the plant. 35,36 Oral administration of ESera 2000 mg/kg also did not cause rat death. Esera administered orally would have a toxicity greater than 2000 mg/kg and would be classified in category 5 (non-toxic substances) according to the OECD globally harmonized classification system. Thus, the two doses of ESera administered by different routes do not appear to have had any toxic effect in rats.

This non-toxicity of ESera was also observed at the levels of certain biological parameters. No clinical sign of toxicity was recorded during the 14 days of the experiment. Underpinning by a positive weight gain, the treated rats had continuous growth with kinetics similar to those of the controls. At the macroscopic level, the morphology and the relative weights of the regulatory organs studied (heart, kidneys, liver and lungs) were not significantly modified. Similar results were observed by Allo et al. (2020) with *Lippia multiflora* 25.

Examination of hematological and serum biochemical parameters revealed that some of these parameters were highly modified by the doses of the plant extract. These effects were greater with intraperitoneal administration of ESera 50 mg/kg. These modifications were not observed by Konan et al. (2012) who conducted their investigation over a 24-hour period 24. The modification of hematological parameters, electrolytes, urea, creatinine, AST, ALT and other transaminases would testify to ionic imbalance, metabolic disturbances and organ dysfunctions 37. Referring to this, ESera could have deleterious effects in the long term. This toxicity in the long term was evoked by Karharo and Adams (1974) 13. According to these authors, Fulani herders avoid places where *Sesamum radiatum* grows abundantly. For them, its abundant/or regular consumption causes severe diarrhea and severe poisoning in livestock.

**CONCLUSION**

To summarize this work, the analysis of the results on toxicity, organ biometrics and weight growth has showed that *Sesamum radiatum* aqueous extract would not be toxic in rats. Indeed, this extract did not cause death, clinical signs of suffering and behavior change. The morphology and the relative weight of the regulating organs did not vary significantly in comparison with the controls. The animals had positive growth and weight gain. However, the observation of significant changes in certain hematological and serum biochemical parameters leads to other toxicological studies. Long-term repeated administration toxicity tests must be carried out in order to better assess the lethality of this plant. These works should include lipid profile, redox status and organ histopathology.

**ACKNOWLEDGMENTS**

The authors express their thanks to Prof. Emma Aké-_ASSI, botanist of the National Floristic Center of Felix Houphouët-Boigny.

**FUNDING**

This research did not receive any specific grant from any funding agency in the public, commercial, or not-for-profit sector.
AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed in the current study are available from the corresponding author on reasonable request.

DECLARATIONS

We confirm that this work is original and has not been published elsewhere, nor is it currently under consideration for publication elsewhere.

AUTHORS’ CONTRIBUTION

KAFK collected the data and carried out statistics analysis. The first draft was prepared by KBK, and BAK supervised the work.

CONSENT FOR PUBLICATION

This manuscript does not contain any individual person's data, and further consent for publication is not required.

COMPETING INTERESTS

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

REFERENCES


