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Research Article

Phytochemical Profiling and Toxicological Assessment of Ethanolic Leaf Extract of *Pavetta crassipes* in Wistar Rats

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ABSTRACT

Toxicity studies are essential for assessing the safety of medicinal herbs. This study evaluates the phytochemical profile and toxicological assessment of ethanolic leaf extract of *Pavetta crassipes* in Wistar rats. Standard methods revealed the presence of alkaloids, cyanogenic glycosides, flavonoids, phenols, tannins, and terpenoids. Acute and sub-acute toxicity was assessed via oral administration of varying extract doses. During a 14-day acute toxicity trial, no mortality or observable toxicity was noted at doses of 1000, 1500, 2000 and 2500 mg/kg, indicating a median lethal dose (LD_{50}) > 2500 mg/kg. In 28-day sub-acute tests, no significant changes ($p > 0.05$) were observed in body weight, relative organ weight, or in biochemical and haematological parameters compared to controls. Notably, increased extract concentrations were associated with decreased creatinine and increased granulocyte levels. These findings suggest the ethanol leaf extract is likely safe for oral use; however, further research is required to identify optimal concentrations for potential therapeutic applications in humans.

Keywords: Ethanolic extract; *Pavetta crassipes*; Phytochemicals; Toxicity; Wistar rats

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INTRODUCTION

Traditional medicine represents one of the oldest and most culturally diverse therapeutic systems globally, with a particularly prominent role in the African continent. Across many African communities, a significant proportion of the population relies exclusively on medicinal plants for the treatment and prevention of various health conditions (Bello *et al*., 2014). These herbal remedies are often preferred due to their accessibility, perceived safety, affordability, and long-standing empirical use. Given the continent's rich biodiversity, Africa is considered a treasure trove of medicinal plant species, many of which remain underexplored scientifically. Among these, *Pavetta crassipes* has garnered considerable attention owing to its widespread traditional use and potential pharmacological properties (Bello *et al*., 2014; Patrick *et al*., 2023).

Pavetta crassipes, belonging to the Rubiaceae family, is commonly found in the savannah regions of central and western African countries. It is locally known by various names; for example, the Hausa refer to it as '*Gadu*,' the Igbo as '*Nkor*,' and the Yoruba as '*Lolubo*' (Katsayal and Abdurahman, 2002). This plant has a long history of ethnobotanical use, primarily for treating a range of ailments, including infectious and non-infectious diseases. Its reputation stems from traditional knowledge passed down through generations, with documented uses in managing cancer, diabetes, cardiovascular issues, neurological disorders, respiratory conditions, and abdominal problems (Esievo *et al*., 2023; Patrick *et al*., 2023). Beyond medicinal usage, some Nigerian communities incorporate the leaves in culinary practices, adding to the cultural importance of this species (Patrick *et al*., 2023).

Scientific investigations into the phytochemical constituents of *P. crassipes* have identified various bioactive compounds, including alkaloids, flavonoids, phenols, tannins, and terpenoids, which are believed to exert pharmacological effects capable of supporting its traditional applications (Alakali *et al*., 2016).

Besides its ethnomedicinal significance, emerging scientific evidence supports the plant's broad-spectrum pharmacological activities. Notably, studies have demonstrated the plant's antiparasitic effects against *Plasmodium*, *Schistosoma*, and hookworm species, as well as antibacterial activities against *Mycobacterium tuberculosis* (Ouattara *et al*., 2014; Bariweni *et al*., 2018; Bello *et al*., 2014; Ibekwe *et al*., 2018). These findings lend credibility to the ethnobotanical claims and suggest that *P. crassipes* harbors a complex mixture of bioactive compounds with therapeutic potential. However, despite its widespread traditional use and promising pharmacological profile, the safety profile of *P. crassipes* has not been sufficiently established through rigorous scientific evaluation.

While natural origin implies safety in popular perception, numerous medicinal plants have documented toxic effects at certain doses or with prolonged use, underlining the necessity for systematic toxicological screening. Without such data, the potential risks associated with the use of *P. crassipes* (especially at higher doses) remain unknown, which poses concerns for its safe application in modern complementary medicine.

Animal models, particularly mammals such as rats, serve as indispensable tools for assessing whole-organism toxicity, providing relevant insights into potential adverse effects, metabolic pathways, and safe dosage ranges. Given their physiological and anatomical similarities to humans, rodents are considered ideal for such toxicity evaluations (Barré-Sinoussi and Montagutelli, 2015; Olatoye and Arueya, 2018).

Previous toxicity assessments of *P. crassipes* have primarily focused on aqueous extracts administered at low doses, revealing limited toxicological data and calling for further research. For instance, studies by Bariweni *et al*. (2018) and Patrick *et al*. (2023) reported preliminary safety in animal models. Nonetheless, a comprehensive evaluation of the phytochemical constituents and toxicological parameters of high-dose ethanolic extracts is lacking. Since solvent polarity influences phytochemical profiles and toxicity, ethanolic extracts (rich in potentially potent bioactive compounds) necessitate rigorous assessment to establish safety margins. The current study aims to fill this gap by systematically analyzing the phytochemical profile and evaluating the acute and sub-acute toxicity of high doses of ethanolic *P. crassipes* leaf extract in Wistar rats, thereby providing critical data to inform safe therapeutic use and potential translational applications.

MATERIALS AND METHODS

Plant Material Collection

Leaves of *Pavetta crassipes* were collected from the outskirts of Kaduna town, along the Kaduna-Abuja Highway. The plant was identified, verified, and authenticated at the Herbarium Section of the Department of Biological Sciences, Nigerian Defence Academy, Kaduna, under voucher number NDA/BIOH/202444. After collection, the leaves were air-dried at room temperature until thoroughly desiccated. They were then ground and pulverized into a fine powder using a sterile mortar and pestle. The powdered material was stored in an airtight, opaque container to preserve its phytochemical integrity until further use.

Extraction

For extraction, a slightly modified method based on the procedure described by Abdurrahman *et al*. (2020) was employed: One kilogram (1 kg) of the powdered leaves was soaked in three litres (5 L) of ethanol for 48 hours with intermittent agitation. The mixture was then filtered sequentially through muslin cloth and Whatman No. 1 filter paper to remove particulate matter. The filtrate was concentrated by evaporating the solvent using a water bath set at 50°C until complete ethanol removal. The resulting extract was then stored at ambient temperature in a desiccator until phytochemical analysis and toxicity testing.

Phytochemical Screening

Qualitative phytochemical analysis of the ethanolic extract of *P. crassipes* was conducted following established protocols to identify bioactive constituents. The screening procedures were adapted from Banu and Catherine (2015), detecting the presence of phytochemicals such as alkaloids, flavonoids, phenols, tannins, saponins, and terpenoids, among others. Standard reagents and reagents' specific procedures were employed to ensure accuracy in identifying and characterizing the phytochemical profile of the extract.

Experimental Animals

The study utilized forty-six Wistar rats (equally distributed by sex), aged between 12 and 15 weeks, with an average weight of 140–160 grams. The animals were obtained from the National Institute for Trypanosomiasis Research, Kaduna, Nigeria. Prior to the experiment, the rats were housed in standard polypropylene cages under a 12-hour light/dark cycle at controlled laboratory conditions. They were

acclimatized for two weeks, with free access to clean water and a standard laboratory diet (Premier Feed Mills Co. Ltd., Kaduna, Nigeria). Animal care and handling adhered strictly to the guidelines outlined in the European Union directive (2010/63/EU) for the use and care of laboratory animals. All procedures were carried out to minimize animal distress and ensure ethical compliance.

Toxicity Studies

Acute toxicity

The acute toxicity assessment was conducted following the OECD Guideline No. 425 (OECD, 2008) using the Up and Down procedure to estimate the median lethal dose (LD_{50}). Sixteen Wistar rats (8 males and 8 females), randomly selected and weighed, were divided evenly into five groups. Group I (control) received an oral dose of 10 mL/kg distilled water. Groups II, III, IV, and V (experimental) were administered oral doses of the ethanolic *P. crassipes* leaf extract at 1000, 1500, 2000, and 2500 mg/kg, respectively. All administrations were performed via gavage. Post-treatment, animals were closely observed at regular intervals for 24 hours for any signs of acute toxicity, with additional daily monitoring over the subsequent 14 days to detect potential sub-acute toxicity or mortality. Body weights of all animals were recorded on days 0, 7 and 14. At the end of the observation period, the animals were euthanized humanely with chloroform anaesthesia. Necropsy was performed, and vital organs (specifically the kidneys and liver) were carefully dissected, blotted, and weighed. The relative organ weight was calculated using the following formula:

$$\text{Relative organ weight (\%)} = \frac{Organ\ weight\ (g)}{\text{Rat's body weight (g)}} x100$$

Sub-acute toxicity

Following the acute toxicity assessment, the potential adverse effects of repeated oral administration of *Pavetta crassipes* leaf extract were evaluated over a 28-day period. Five groups, each comprising six Wistar rats (three males and three females), were randomly assigned to receive different treatments as follows:

- Group 1: 10 mL/kg of distilled water (control)
- Group 2: Ethanolic *P. crassipes* leaf extract at 1000 mg/kg
- Group 3: Ethanolic *P. crassipes* leaf extract at 1500 mg/kg
- Group 4: Ethanolic *P. crassipes* leaf extract at 2000 mg/kg
- Group 5: Ethanolic *P. crassipes* leaf extract at 2500 mg/kg

The extract and control solutions were administered intragastrically once daily via oral gavage using an orogastric tube. The rats were housed individually in cages, which were maintained under standard hygienic conditions, and observed continuously for signs of mortality or toxicity throughout the experiment. Body weights were recorded weekly to monitor potential weight changes attributable to the extract. On day 29, all rats were anesthetized with chloroform vapor. Blood samples were collected via the carotid artery into EDTA and plain sample vials for haematological and biochemical analyses, respectively. Subsequently, the rats were dissected, and the liver and kidneys were excised, washed, blotted dry, and weighed (Patrick *et al*., 2023).

Assessment of Sub-Acute Toxicity

Body and organ weight measurement

The baseline morphological index (body weight) for each rat was recorded on day 1 prior to administration of the extract. Subsequently, body weights were measured weekly on days 7, 14, 21, and 28 throughout the exposure period. At study termination, the excised liver and kidneys were carefully weighed immediately after being washed, blotted. The relative organ weights were calculated as described in section 2.4.1, expressed as a percentage of the body weight to assess potential organ hypertrophy or atrophy induced by repeated dosing.

Haematological parameters

Blood samples collected in EDTA-treated tubes were analyzed for haematological indices using an automated hematology analyzer (Mytaic 22, Germany). Parameters assessed included packed cell volume (PCV), red blood cell (RBC) count, white blood cell (WBC) count, platelet count, and differential white blood cell counts (lymphocytes, monocytes, and granulocytes). These parameters serve as indicators of hematopoietic and immune system health and were evaluated to detect any haematotoxic effects of the extract.

Biochemical parameters

Serum was obtained from blood samples centrifuged at 3000 rpm for 10 minutes in plain vials. The serum biochemical profile was determined using commercial test kits (Randox Diagnostics, United Kingdom). The parameters measured included total protein, bilirubin, urea, creatinine, albumin, and globulin, which reflect hepatic and renal functions. Additionally, liver enzyme activities (alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP)) was assessed spectrophotometrically using a UV/visible spectrophotometer (Model T80, UK). These tests aimed to identify any hepatotoxic or nephrotoxic effects attributable to the extract.

Data Analysis

All data were compiled and analysed using Minitab version 17.1.0 (Minitab Inc., USA). Results were

expressed as mean ± standard deviation (SD). Statistical comparisons among groups were performed using one-way analysis of variance (ANOVA), followed by Student's t-test for pairwise analysis of significant differences. A threshold of $p \leq 0.05$ was considered statistically significant.

RESULTS

Phytochemical Profile

Qualitative phytochemical screening was conducted to identify the secondary metabolites present in the ethanolic leaf extract of *Pavetta crassipes*. The analysis revealed the presence of key bioactive compounds, including alkaloids, cyanogenic glycosides, flavonoids, phenols, tannins, and terpenoids (Table 1). These phytochemicals are known for their diverse pharmacological activities and may contribute to the observed biological effects of the extract.

Acute Toxicity Assessment

Oral administration of the extract at doses of 1000, 1500, 2000 and 2500 mg/kg body weight did not result in any observable toxicity or mortality within the initial 24-hour period. Over a subsequent 14-day observation period, no mortality or overt toxicity symptoms were recorded in any of the treated animals. All Wistar rats exhibited weight gain during this period, and statistical analysis revealed no significant difference in body weight between the treatment and control groups ($p > 0.05$) (Table 2). Similarly, relative organ weights of the liver and kidneys showed no significant differences across groups ($p > 0.05$) (Table 3). Based on these findings, the median lethal dose (LD_{50}) of the extract exceeds 2500 mg/kg body weight, indicating a high safety margin.

Sub-acute Toxicity Assessment

Throughout the 28-day sub-acute toxicity study, no mortality or adverse toxic effects were observed in Wistar rats subjected to repeated oral dosing of the extract. The weekly mean body weight of the animals increased progressively across both treatment and control groups, indicating normal growth and health status. The increase in body weight did not show any significant difference between the treated and control groups ($p > 0.05$) (Table 4). Similarly, the relative weights of vital organs, including the liver and kidneys, remained statistically comparable across all doses (1000, 1500, 2000, and 2500 mg/kg) and controls ($p > 0.05$) (Table 5).

Haematological analysis revealed that, although granulocyte counts exhibited an upward trend with increasing dosage, the differences between treated and control groups were not statistically significant ($p > 0.05$) (Table 6). Likewise, biochemical parameters, including serum creatinine, showed a decreasing trend as the dose increased; however, these variations were not statistically significant ($p > 0.05$), and all values remained within normal physiological ranges (Table 7). These findings collectively suggest that the repeated administration of the extract, even at the highest tested dose, does not induce significant haematological or biochemical toxicity in Wistar rats, supporting its safety profile during prolonged exposure.

Table 1. Detection of phytochemical constituents in *Pavetta crassipes*

Phytochemical Compounds	Findings
Alkaloids	+
Cardiac Glycosides	-
Cyanogenic Glycosides	+
Flavonoids	+
Phenols	+
Saponins	-
Steroids	-
Tannins	+
Terpenoid	+

Key: **+ =** present, - = absent

Table 2. Effect of single oral dose treatment of ethanolic leaves extract of *Pavetta crassipes* on body weight (g) of Wistar rats

Days	Treatments				
	Control	1000 mg/kg	1500 mg/kg	2000 mg/kg	2500 mg/kg
0	153.11±3.02^a	155.18±3.60^a	153.21±3.37^a	154.09±2.42^a	154.18±2.35^a
7th	156.99±3.67^a	159.05±3.92^a	156.41±3.74^a	157.65±2.68^a	156.94±3.12^a
14th	159.16±4.15^a	162.48±4.21^a	159.22±3.13^a	160.31±2.91^a	159.81±2.88^a

Values are expressed as Mean ± S.D (N = 6). Mean with the same superscript letter are not significantly different ($p > 0.05$)

Table 3. Effect of single oral dose treatment of ethanolic leaves extract of *Pavetta crassipes* on relative organ weights of Wistar rats

Organ Weight	Treatments				
	Control	1000 mg/kg	1500 mg/kg	2000 mg/kg	2500 mg/kg
Liver	2.32±0.11[a]	2.28±0.10[a]	2.30±0.12[a]	2.29±0.12[a]	2.31±0.11[a]
Kidney	0.41±0.07[a]	0.42±0.08[a]	0.41±0.09[a]	0.43±0.08[a]	0.44±0.07[a]

Values are expressed as Mean ± S.D (N = 6). Mean with the same superscript letter are not significantly different ($p > 0.05$).

Table 4. Effect of repeated oral dose treatment of ethanolic leaves extract of *Pavetta crassipes* on body weight (g) of Wistar rats

Days	Treatments				
	Control	1000 mg/kg	1500 mg/kg	2000 mg/kg	2500 mg/kg
0	155.52±4.58[a]	157.48±3.71[a]	155.12±2.78[a]	158.13±2.23[a]	155.68±2.06[a]
7th	160.45±6.54[a]	161.45±4.62[a]	159.23±2.63[a]	162.77±2.29[a]	160.02±2.73[a]
14th	166.53±6.55[a]	167.48±4.61[a]	165.15±2.83[a]	168.72±2.06[a]	166.03±2.65[a]
21st	172.28±6.60[a]	173.25±4.59[a]	168.58±4.62[a]	174.60±2.09[a]	171.67±2.66[a]
28th	177.65±6.57[a]	178.33±4.77[a]	173.73±4.67[a]	179.75±2.17[a]	176.85±2.36[a]

Values are expressed as Mean ± S.D (N = 6). Mean with the same superscript letter are not significantly different ($p > 0.05$)

Table 5. Effect of repeated oral dose treatment of ethanolic leaves extract of *Pavetta crassipes* on relative organ weight of Wistar rats

Organ Weight	Treatments				
	Control	1000 mg/kg	1500 mg/kg	2000 mg/kg	2500 mg/kg
Liver	3.03±0.10[a]	3.03±0.12[a]	3.04±0.12[a]	3.04±0.11[a]	3.03±0.16[a]
Kidney	0.51±0.07[a]	0.52±0.06[a]	0.52±0.08[a]	0.52±0.06[a]	0.52±0.08[a]

Values are expressed as Mean ± S.D (N = 6). Mean with the same superscript letter are not significantly different ($p > 0.05$)

Table 6. Effect of repeated oral dose treatment of ethanolic leaves extract of *Pavetta crassipes* on haematological parameters of Wistar rats

Parameters	Treatments				
	Control	1000 mg/kg	1500 mg/kg	2000 mg/kg	2500 mg/kg
PCV (%)	41.98±0.42[a]	42.25±0.14[a]	42.23±0.31[a]	42.58±0.3[a]	42.90±0.37[a]
RBC (10^6µL)	7.07±0.45[a]	7.22±0.10[a]	7.10±0.3[a]	7.42±0.22[a]	7.30±0.27[a]
WBC (10^3µL)	11.65±0.27[a]	12.17±0.12[a]	12.57±0.51[a]	12.42±0.22[a]	12.12±0.08[a]
PLT (10^3µL)	675.18±7.23[a]	677.97±5.00[a]	675.03±5.08[a]	682.87±4.12[a]	682.23±4.05[a]
LYM (%)	64.65±0.27[a]	64.17±0.12[a]	64.40±0.30[a]	64.42±0.22[a]	64.12±0.23[a]
MON (%)	5.07±0.24[a]	5.12±0.22[a]	5.13±0.23[a]	5.23±0.28[a]	5.12±0.26[a]
RA (%)	34.63±0.08[a]	34.91±0.22[a]	34.72±0.02[a]	34.93±0.22[a]	35.12±0.42[a]

Values are expressed as Mean ± S.D (N = 6). Mean with the same superscript letter are not significantly different ($p > 0.05$). PCV = Packed Cell Volume, RBC = Red Blood Cells, WBC = White Blood Cells, PLT = Platelet, LYMs = Lymphocyte, MONO = Monocyte and GRAN = Granulocyte.

Table 7. Effect of repeated oral dose treatment of ethanolic leaves extract of *Pavetta crassipes* on biochemical parameters of Wistar rats

Parameters	Treatments				
	Control	1000 mg/kg	1500 mg/kg	2000 mg/kg	2500 mg/kg
ALT (U/L)	62.65±2.78[a]	61.67±3.02[a]	58.73±3.87[a]	59.75±2.17[a]	58.28±3.70[a]
AST (U/L)	120.82±5.70[a]	118.72±4.27[a]	122.03±3.12[a]	119.88±2.02[a]	122.08±2.34[a]
ALP (U/L)	102.97±1.37[a]	103.22±1.22[a]	104.20±1.87[a]	102.42±2.64[a]	103.78±1.84[a]
TB (µmol/L)	8.47±0.15[a]	8.38±0.15[a]	8.48±0.10[a]	8.43±0.20[a]	8.40±0.14[a]
CREA (µmol/L)	0.75±0.12[a]	0.62±0.15[a]	0.58±0.13[a]	0.47±0.10[a]	0.38±0.12[a]
Urea (mmol/L)	44.98±1.62[a]	43.50±1.13[a]	44.07±3.67[a]	43.75±1.11[a]	42.45±0.97[a]

Values are expressed as Mean ± S.D (N = 6). Mean with the same superscript letter are not significantly different ($p > 0.05$). ALT = Alanine aminotransferase, AST = Aspartate aminotransferase, ALP = Alkaline phosphatase, TB = Total Bilirubin, CREA = Creatinine

DISCUSSION

Ethanol is widely recognized as an effective solvent for extracting phytochemicals from plant materials due to its ability to solubilize a broad spectrum of secondary metabolites (Abubakar and Haque, 2020). According to Chike-Ekwughe *et al*. (2023), bioactive phytochemicals produced in plant tissues (comprising both primary and secondary metabolites) are largely responsible for the pharmacological activities observed in medicinal plants. For centuries, plants have been employed to treat diverse ailments, largely owing to their rich content of pharmacologically active phytochemicals (Sarkar *et al*., 2024). Numerous bioactive compounds identified in plant extracts, such as flavonoids, alkaloids, phenols, tannins, cyanogenic glycosides, and terpenoids, have been linked to various therapeutic effects, including antibacterial, antioxidant, anticancer, anti-inflammatory, antidiabetic, and anti-arthritic activities (Afu *et al*., 2020). The presence of these secondary metabolites in *Pavetta crassipes* aligns with previous reports by Hadiza *et al*. (2022) and Esievo *et al*. (2023), further confirming the plant's potential medicinal value. The phytochemical profile observed in this study supports the traditional use of *P. crassipes* and underscores its promise as a source for novel therapeutic agents, warranting further pharmacological investigations.

Toxicity evaluation of plant extracts is fundamental in assessing their safety profile and identifying potential adverse effects associated with their use or inadvertent high-dose exposure (Sarkar *et al*., 2024). Repeated toxicity studies, particularly those examining sub-acute toxicity, are critical for determining the safety of phytomedicines during prolonged administration (Ukpabi-Ugo *et al*., 2023). Monitoring changes in body weight during treatment provides insight into the overall health status of the experimental animals, serving as a vital indicator of systemic toxicity (Afu *et al*., 2020). Furthermore, relative organ weight (correlating an organ's weight to that of the animal) offers a more sensitive marker of toxicity, reflecting potential organ-specific damage or hypertrophy (Nandy and Datta, 2012). In this study, no signs of toxicity or mortality were observed in the treated rats. The absence of adverse effects, coupled with the finding that the oral LD_{50} exceeds 5000 mg/kg, aligns with previous reports by Bariweni *et al*. (2018), validating the extract's safety at high doses. Additionally, the slight but statistically insignificant increase in body weight supports earlier findings by Patrick *et al*. (2023).

Hematological and biochemical parameters serve as crucial markers in evaluating the systemic toxicity of foreign substances, including phytotherapeutic agents (Chike-Ekwughe, 2023). In this investigation, repeated oral administration of the ethanolic extract at various doses did not produce significant alterations in hematological indices compared to controls, corroborating prior studies by Bariweni *et al*. (2018). Biomarkers of organ function, particularly enzymes such as alkaline phosphatase (ALP), alanine aminotransferase (ALT), and aspartate aminotransferase (AST), are sensitive indicators of hepatotoxicity, while serum creatinine and urea are primary markers of renal function. The observed reduction in serum creatinine in Wistar rats treated with the ethanolic leaf extract of *P. crassipes* suggests improved renal clearance rather than nephrotoxicity. This effect may be linked to phytochemicals such as flavonoids and saponins, which enhance antioxidant defense and support renal function. Similar nephroprotective responses have been reported for polyphenol- and flavonoid-rich plant extracts that lowered creatinine and urea levels in experimental models (Cardoso *et al*., 2020; Bencheikh *et al*., 2022; Tienda-Vázquez *et al*., 2022). In parallel, the slight increase in granulocyte count indicates mild stimulation of the innate immune system, possibly reflecting the immunomodulatory or adaptogenic potential of the extract. Phytochemicals such as

alkaloids and flavonoids are known to enhance leukocyte activity and immune readiness without inducing toxicity (Cardoso *et al*., 2020; Bello *et al*., 2024). The absence of significant alterations in hepatic enzymes and other haematological indices aligns with previous research, including the findings by Patrick *et al*. (2023), further supporting the non-toxic and physiologically adaptive nature of *P*. *crassipes* extract.

CONCLUSION

The phytochemical analysis confirmed the presence of bioactive secondary metabolites in *Pavetta crassipes* ethanolic leaf extract, supporting its traditional medicinal use. Toxicological evaluations demonstrated that the extract is safe at the doses tested, evidenced by the absence of mortality, stable body and organ weights, and unaltered hematological and biochemical parameters in both acute and sub-acute studies. The lack of significant adverse effects indicates a high safety margin and supports the extract's biocompatibility. Collectively, these findings suggest that *Pavetta crassipes* ethanolic leaf extract possesses potential therapeutic properties, warranting further pharmacological investigation and development as a natural remedy.

To ensure safety and efficacy in potential therapeutic applications, comprehensive toxicological studies should be conducted to establish definitive safety profiles. Additionally, future research should aim to identify the optimal dosage and concentration for therapeutic efficacy in humans, along with elucidating its pharmacodynamic mechanisms and evaluating its efficacy in relevant disease models.

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AUTHOR'S CONTRIBUTION

ORL contributed to the study design and data collection. ORL, AMA and UZ participated in data analysis and manuscript preparation. All authors collaborated in drafting the initial manuscript and provided critical revisions. Both authors reviewed and approved the final version of the manuscript.

COMPETING INTEREST

There is no conflict of interest between the authors.

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