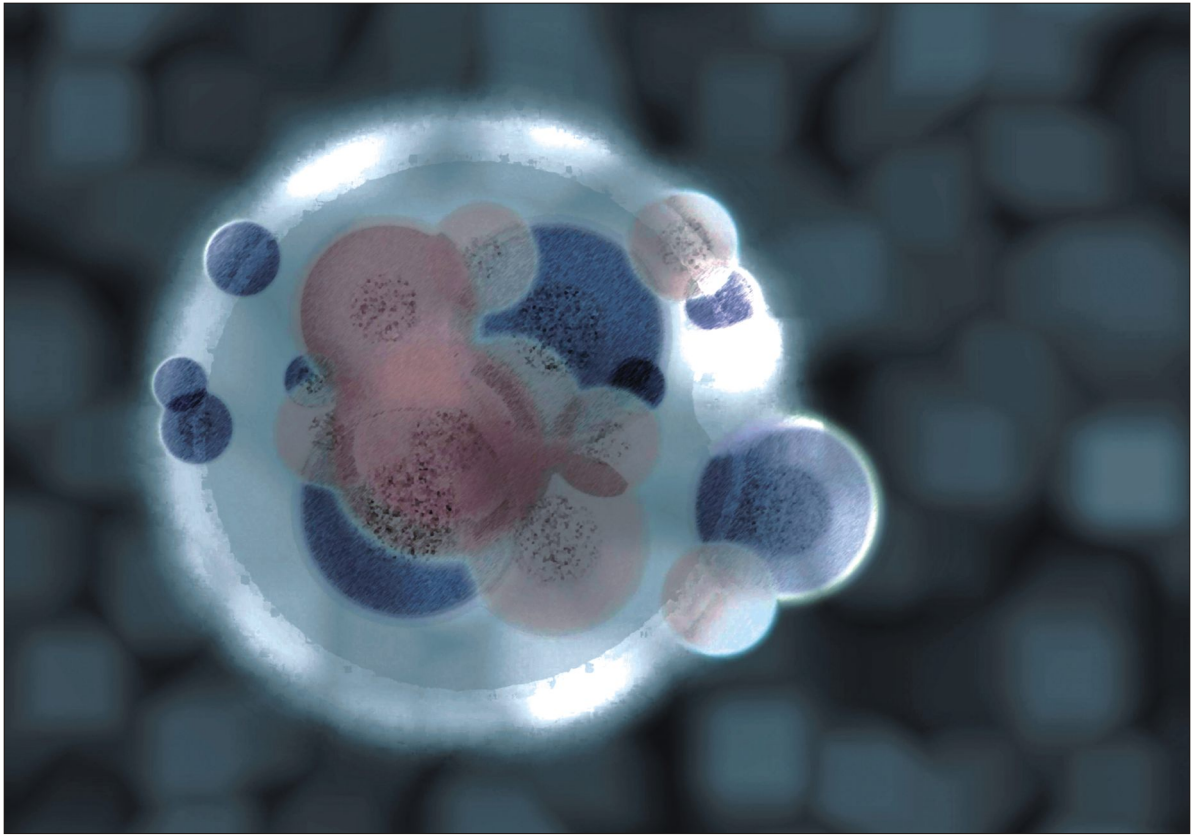




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Research Article

Antihypertensive Effects of *Pandiaka heudelotii* Leaf Extract in L-NAME-Induced Hypertensive Wistar Rats: A Biochemical Evaluation

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Abstract

Background and Objective: *Pandiaka heudelotii* is widely used in traditional medicine across Sub-Sahara Africa for managing hypertension; however, its pharmacological efficacy remains inadequately substantiated. This study investigated the antihypertensive effects of the methanolic leaf extract of *Pandiaka heudelotii* (PHE) in L-NAME-induced hypertensive Wistar rats. **Materials and Methods:** The study used Thirty (30) adult Wistar rats with L-NAME-induced hypertension were randomly assigned to receive either placebo, L-NAME alone, graded doses of methanol leaf extract of *Pandiaka heudelotii* (PHE), or the standard drug captopril. Treatments were administered for 21 days and key outcomes are as presented. Blood pressure was monitored weekly, while plasma lipids, electrolytes, liver enzymes and kidney biomarkers were assessed at the end of the study. **Results:** The PHE administration resulted in a significant, dose-dependent reduction in both systolic and diastolic blood pressure compared to the negative control group. Additionally, treatment with PHE improved lipid profile, normalized liver enzyme activities and restored electrolyte balance, with the most pronounced effects observed at 500 mg/kg. **Conclusion:** These findings demonstrate that *Pandiaka heudelotii* possesses significant antihypertensive and biochemical modulatory properties, thereby providing scientific support for its traditional use in hypertension management.

Key words: Antihypertensive, biochemical parameters, hypertension, L-NAME, *Pandiaka heudelotii* leaf, Wistar rats

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Hypertension, a major contributing factor for cardiovascular disease events such as heart attacks and stroke, represents a quantitative deviation from the normal level of blood pressure and it remains one of the leading causes of cardiovascular morbidity and mortality. This condition poses a severe and growing threat to public health systems worldwide.

Recent estimates indicate that 1.28 billion adults are living with hypertension globally, with low- and middle-income countries bearing the greatest burden¹. This staggering figure highlights the urgent need for effective and accessible interventions. Sub-Saharan Africa is experiencing a rapid increase in prevalence driven by rapid urbanization, changing dietary habits and demographic shifts. In Nigeria, the condition affects more than 30% of adult population and significantly contributes to the burden of cardiovascular diseases^{2,3}.

Late diagnosis and under treatment is common and many synthetic drugs developed for the treatment of hypertension have demonstrated better efficacy (considering its severity and prevalence), but often possess a number of side effects, poor patient adherence and high treatment costs. These limitations include electrolyte disturbances, dry cough, fatigue and sexual dysfunction, which further reduce treatment compliance. Medicinal plants (herbs) have on the other hand been regaining importance as an alternative for the treatment and prevention of cardiovascular diseases and its associated complications, because of their ease of availability, minor side effects and cost effectiveness⁴. Although the mechanisms of action of these plants is reportedly often lacking, they still make an important contribution to healthcare, mostly in developing countries⁵.

Pandiaka heudelotii is a long-branched herb found occurring from Senegal to Southern Nigeria and across Central Africa to Sudan. The plant is used as food and is suspected to possess medicinal properties. The plant is known (Table 1), by different names in the three major ethnic groups in Nigeria.

Pandiaka heudelotii plant extracts is used in several folks or traditional medicines for the treatment of various diseases due to its antimicrobial, anticancer, antioxidant and hepatoprotective activity^{6,7}. Although, very little scientific research has been done on the plant to ascertain these claims.

The need for this study was prompted by claims from a woman in Kogi state, Nigeria, stating that the plant controls her high blood pressure. Combined this with prior studies which showed the plant to contain apigenin, an important class of flavonoid that have hypotensive properties⁸⁻¹⁰.

However, despite its widespread traditional use in the management of hypertension, particularly in parts of Nigeria, scientific evidence supporting its antihypertensive efficacy remains limited. Most available information is derived from ethnobotanical surveys and basic phytochemical analysis, with very few controlled preclinical studies evaluating its effects on blood pressure and associated metabolic parameters. This knowledge gap hinders the development of evidence-based phytotherapeutic products.

The Nω-nitro-L-arginine methyl ester (L-NAME)-induced hypertension model in rats is particularly suitable for assessing plant extracts with potential nitric oxide-modulating or antioxidant properties. L-NAME, a competitive inhibitor of endothelial nitric oxide synthase (eNOS), induces sustained hypertension through reduced nitric oxide production, endothelial dysfunction, oxidative stress and vascular remodeling, features that closely resemble key aspects of human essential hypertension¹¹. This makes the model highly relevant for evaluating the therapeutic potential of traditional medicinal plants like *P. heudelotii*.

The present study however investigates and evaluates the antihypertensive effects of the graded doses of PHE (100, 200 and 500 mg/kg) on hypertension-induced Wistar rats. The scope of the current study does not cover the genetic effect of the plant, nor the mechanisms by which the phytochemicals present in the extract brings about the resultant effects. This study aims to bridge the gap between traditional knowledge and scientific evidence, thereby promoting the development of safe, effective and affordable phytotherapeutic agents for hypertension management in resource limited settings.

MATERIALS AND METHODS

Study area and duration: The study was conducted between October 15, 2025 and November 6, 2025 at the Department of Medical Biochemistry, College of Health Sciences, University of Abuja, Federal Capital Territory, Abuja, Nigeria. Fresh leaves of *Pandiaka heudelotii* were collected from Mpape, a suburb of Abuja, Federal Capital Territory. The plant material was authenticated by a botanist at the Department of Biological Sciences, University of Abuja and a voucher specimen, deposited with the herbarium with a voucher number UNIABUJA/H/125.

Table 1: Local names for the plant *Pandiaka heudelotii*

Ethnic groups	Local name
Hausa	<i>Maasun kadangere</i>
Yoruba	<i>Aresekosun</i>
Igbo	<i>Ile agwo</i>

Plant materials: The leaves were collected, authenticated, shade-dried at room temperature, pulverized into powder, extracted with 99.8% methanol (analytical grade) and rotary evaporated. The resulting methanol leaf extract (PHE) was stored at 4°C until use. Preparation of the plant bioactive component was carried out following the protocols described by Zhu *et al.*⁷ with slight modification in terms of solvent concentration and volume.

Experimental animals: Adult Wistar rats weighing between 120-180 g, 6-8 weeks of age were housed in separate cages, fed on standard feeds and water *ad libitum* and then acclimatized for 14 days. The animals were maintained under standard laboratory conditions with a 12 hrs light/dark cycle at a temperature of 25±2°C and relative humidity of 50-60%.

Ethical statement: All animal experiments were conducted in accordance with the National Institutes of Health Guide for the Care and Use of Laboratory Animals (NIH Publications No. 8023, revised 1978) and the ARRIVE guidelines. The experimental protocol was reviewed and approved by the Animal Ethics Committee of the University of Abuja (Approval Number: UAB/ETHIC/2024/032). All efforts were made to minimize animal suffering.

Chemicals and reagents: Methanol (Analytical grade), Nω-Nitro-L-Arginine Methyl Ester (L-NAME purchased from Bristol Scientific) and 2,2-Diphenyl-1-picrylhydrazyl radical (DPPH) obtained from Sigma Aldrich) were used. Standard drugs included Captopril tablet used as the reference antihypertensive drug and Vitamin C. All chemicals and reagents were of analytical grade.

Equipment: Spectrophotometer (Lab Kit UV spectrophotometer model ST-UV-7558), rotary evaporator, analogue BP apparatus (from ABU Zaria) and blender (Model CB-8231-L) were used in the study.

Lethal dose (LD₅₀) determination: Determination of LD₅₀ (acute toxicity study) was done using Organization for Economic Cooperation and Development (OECD) guideline 425. Nine female rats were used. The rats were divided into three groups of 3 animals each. Each group was administered different doses of 1000, 3000 and 5000 mg/kg. The animals were observed for 24 hrs to monitor their behavior and signs of toxicity and mortality.

Induction of hypertension and grouping of the animals: Hypertension was induced by daily oral administration of L-NAME (40 mg/kg body weight) for 21 consecutive days.

Thirty adult Wistar rats were randomly divided into six groups (n = 5 per group). Group A animals were given distilled water only (Placebo). Group B animals were administered and made hypertensive with 40 mg/kg body weight of N-Nitro-L-Arginine Methyl Ester (L-NAME) for three weeks (negative control). Group C was administered with 100 mg/kg body weight of the Pandiaka heudelotii leaf extract (PHE) and 40 mg/kg body weight of L-NAME for 3 weeks by oral gavage. Group D was co-administered with 200 mg/kg body weight of the Pandiaka heudelotii leaf extract (PHE) and 40 mg/kg body weight of L-NAME for 3 weeks by oral gavage. Group E was co-administered with 500 mg/kg body weight of the Pandiaka heudelotii leaf extract (PHE) and 40 mg/kg body weight of L-NAME for 3 weeks by oral gavage. Group F was co-administered with 25 mg/kg body weight of the standard drug (Captopril) and 40 mg/kg body weight of L-NAME for 3 weeks by oral gavage (Positive Control). All rats were treated for a total number of 21 days. All treatments were made through oral gavage and each dose was administered in the morning before the rat chow.

Blood pressure measurement: The baseline blood pressure was taken before the treatment and subsequently once a week every morning throughout the duration of treatment. Based on previous findings, less than 140 mmHg systolic BP and less than 90 mmHg diastolic BP were used as the criteria (reference value) for normotensive rats¹². A Tail Cuff method was done using an Analog BP apparatus, which has been used in Ahmadu Bello University in the Faculty of Pharmaceutical Science and the Department of Biochemistry and Medicine¹³.

Sample collection: After the administration period of 3 weeks, the animals were humanely sacrificed using ketamine for anaesthesia in a fume box. Blood samples were collected from rats through retro-orbital bleeding. The blood samples were placed in heparin sample bottles and subsequently centrifuged at 1500 rpm for 5 min and plasma obtained for liver and kidney assays.

Analysis of biochemical parameters: Biochemical parameters like Sodium and Potassium were analyzed using Elab Science kit, while Total Proteins, Albumin, Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), Urea, Creatinine, Chloride ion, Total Cholesterol, Triglyceride, High Density Lipoprotein (HDL) and Low Density Lipoprotein (LDL) were analysed using Agape kits following the protocols described earlier¹⁴ with slight modification in terms of solvent concentration and volume.

Phytochemical screening: The analyses were carried out on the crude methanol extract to confirm the presence or absence of the following plant secondary metabolites: Tannins, alkaloids, flavonoids, phenol, saponins, steroid and glycosides using qualitative phytochemical screening tests^{15,16}.

Antioxidant activity: The free radical scavenging activities of the plant extracts against 2,2-diphenyl-1-picrylhydrazyl (DPPH) (Sigma Aldrich) were determined by UV-visible spectrophotometer at 517 nm. Radical scavenging activity on DPPH was measured by a slightly modified method previously described^{17,18}.

Statistical analysis: One-way Analysis of Variance (ANOVA) was carried out using Statistical Analytical System (SAS) version 9.4 to compare the mean difference between and within the groups from the data obtained from the study. Results are presented as Mean $\pm$ Standard Error of the mean and values of $p < 0.05$ were regarded as statistically significant.

RESULTS

Phytochemical screening: Table 2 showed the results of phytochemical analysis of methanol extracts from the leaves of *P. heudelotii*. Qualitative phytochemical screening of the dried leaf extract showed the presence of bioactive constituents including flavonoids, tannins, alkaloids, saponins and glycosides, while steroids and terpenoids were absent.

Antioxidant activity: Table 3 showed the antioxidant activity of *P. heudelotii*. The results indicated that the extract contained natural antioxidants. The sample exhibited a concentration-dependent increase in antioxidant activity (scavenging activity), measured as percentage inhibition of 2,2-diphenyl-1-picrylhydrazyl (DPPH) radicals. The percentage inhibition increased progressively with increasing concentration of the extract.

Systolic and diastolic blood pressure: Table 4 showed the systolic blood pressure (SBP) and diastolic blood pressure (DBP) taken at baseline, after one week and after two weeks. Mean values with $\pm$ superscripts are statistically different ($p < 0.05$) compared to the placebo group; mean values with ∇ superscripts are statistically different ($p < 0.05$) compared to the negative control group; and mean values with $\S$ superscripts are statistically different ($p < 0.05$) compared to the positive control group.

The baseline systolic ($p > 0.05$) and diastolic blood pressure ($p > 0.05$) across the six groups did not differ significantly. The highest systolic and diastolic blood pressure after 1 week and 2 weeks were recorded in the negative control group (L-NAME only). Systolic blood pressure taken after 1 week of administering *Pandiaka heudelotii* extract PHE in all the treatment groups was significantly lower than the negative control group ($p < 0.05$) and similar to the placebo ($p > 0.05$) and positive control group ($p > 0.05$). After 2 weeks, post-treatment systolic blood pressure in the PHE-treated groups was significantly lower (in a dose-dependent pattern) than the negative control group. Only rats treated with 500 mg/kg of PHE exhibited systolic blood pressure similar to the placebo ($p > 0.05$) and positive control group ($p > 0.05$). Similarly, diastolic blood pressure did not differ significantly ($p > 0.05$) between the group treated with 500 mg/kg PHE and the placebo or positive control groups.

Systolic and diastolic blood pressure (SBP and DBP): Mean values with superscripts are statistically different ($p < 0.05$) compared to the placebo group; mean values with superscripts are statistically ($p < 0.05$) different compared to the negative control group and mean values with $\pm$ $\S$ superscripts are statistically ($p < 0.05$) different compared to the positive control group.

Mean values with $\pm$ superscripts are statistically different ($p < 0.05$) compared to the placebo group; mean values with superscripts are statistically ($p < 0.05$) different compared to the negative control group and mean values with $\S$ superscripts are statistically ($p < 0.05$) different compared to the positive control group.

Table 2: Phytochemical constituents of *Pandiaka heudelotii* leaf extract

Parameter	Status
Tannins	+
Alkaloids	+
Glycosides	+
Steroids	-
Terpenoids	-
Saponins	+
Flavonoids	+

+: Present and -: Absent

Table 3: DPPH antioxidant activity of *Pandiaka heudelotii* leaf extract (Scavenging effect on 2,2-Diphenyl-1-picrylhydrazyl Radical - DPPH)

Concentration mg/mL (PHE sample)	% Inhibition sample	% Inhibition Std (Vit C)
1.00	10.00	45.64
3.00	14.12	49.52
5.00	24.60	42.88
7.00	36.36	67.80
10.00	49.68	51.56

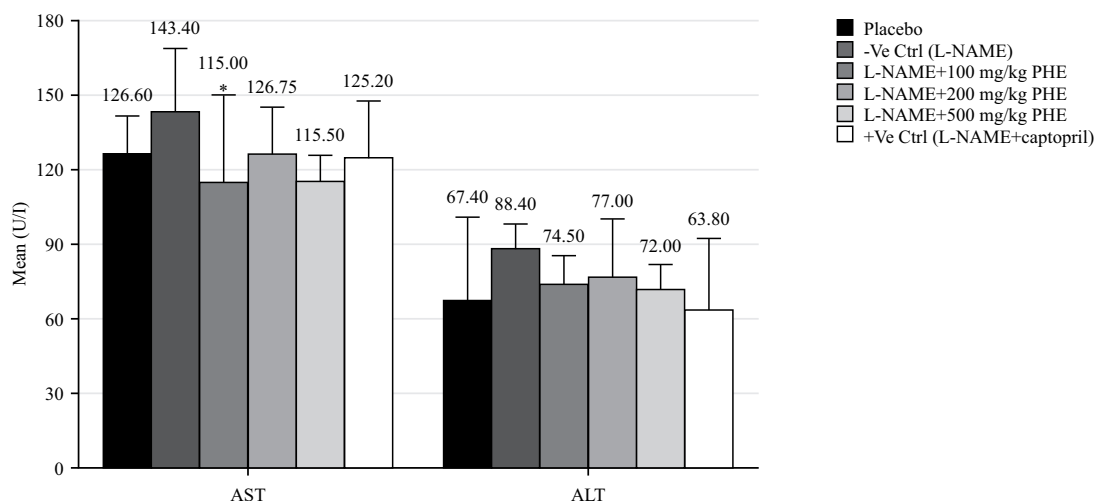


Fig. 1: Effect of *Pandiaka heudelotii* leaf extract on AST and ALT

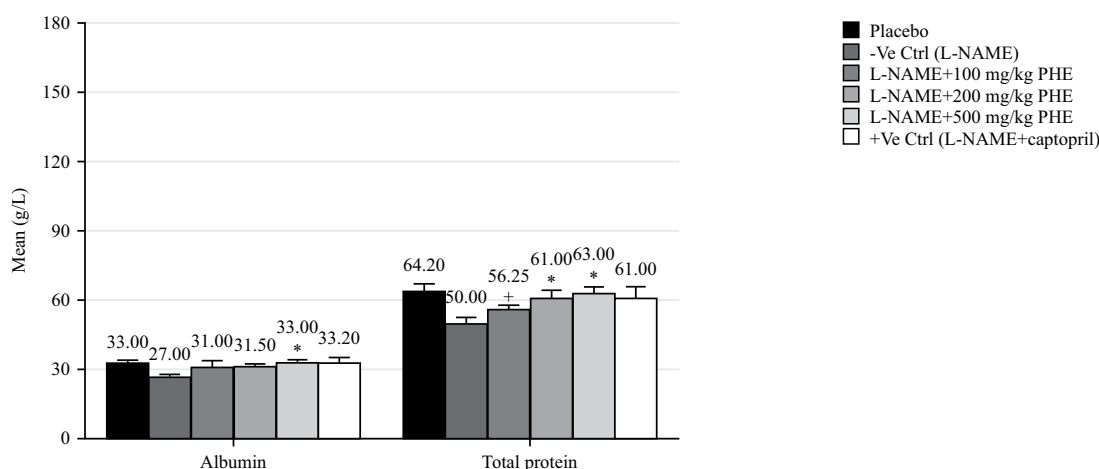


Fig. 2: Effect of *Pandiaka heudelotii* leaf extract on albumin and total protein

Table 4: Systolic and diastolic blood pressure taken at baseline, after 1 wk and after 2 wk

Groups	First week		Second week		Third week	
	SBP (mmHg)	DBP (mmHg)	SBP (mmHg)	DBP (mmHg)	SBP (mmHg)	DBP (mmHg)
A (Placebo)- Water	130.40±6.43	68.60±3.05	137±2.79	67.60±2.51	134.20±6.42	76.20±10.40
B (Negative control) L-NAME	130.80±7.09	72.20±9.04	156.60±3.44 [‡] §	88.60±19.44	184.67±14.01 [‡] §	125.67±27.97 [‡] §
C L-NAME+100 mg/kg	128.50±3.87	70.00±4.08	145.00±6.48 [‡] §	87.50±2.08	161.50±11.00 [‡] §	99.25±13.05
D L-NAME+200 mg/kg	131.75±6.45	68.00±6.06	139.25±0.96 [‡]	90.50±2.52 [‡]	165.75±7.46 [‡] §	99.50±7.72
E L-NAME+500 mg/kg	133.33±7.37	82.67±7.09	137.67±2.52 [‡]	74.00±5.29	146.67±5.03 [‡]	80.67±6.66 [‡]
F (positive control)	128.80±7.16	71.40±8.88	135.20±3.15	72.20±7.73	137.80±2.28	90.00±6.33

Liver biomarkers: Figure 1 and 2 showed the liver enzymes levels. Lower levels of aspartate aminotransferase (AST) were observed in animals treated with PHE in comparison to the negative control group. However, this difference was significant only for those treated with 100 mg/kg of PHE. Additionally, the levels of AST obtained in the group treated with 100 mg/kg of PHE did not differ significantly from the placebo or positive control group.

The levels of alanine aminotransferase (ALT) in all the groups treated with PHE were apparently lower compared to the negative control group but similar to the placebo and positive control group. Albumin and total protein levels of animals treated with 500 mg/kg of PHE were significantly higher than those of the negative control animals and did not differ significantly from the placebo and positive control groups.

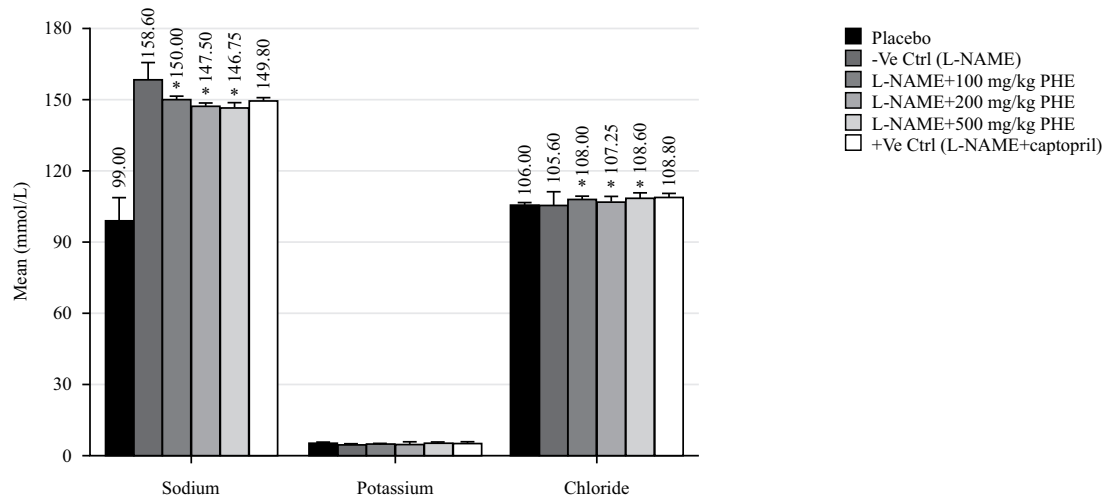


Fig. 3: Effect of *Pandiaka heudelotii* leaf extract on sodium, potassium and chloride

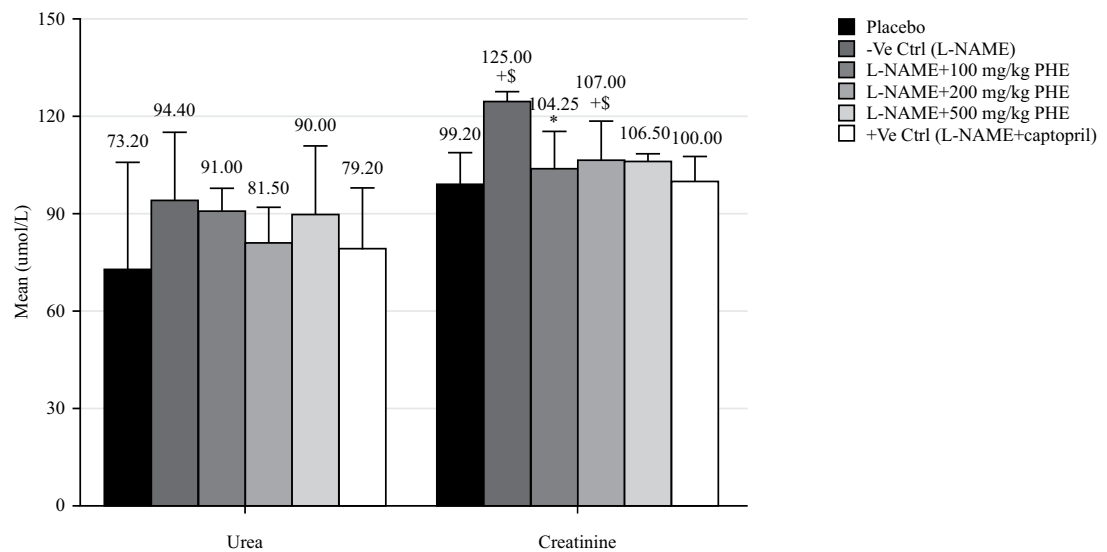


Fig. 4: Effect of *Pandiaka heudelotii* leaf extract on urea and creatinine

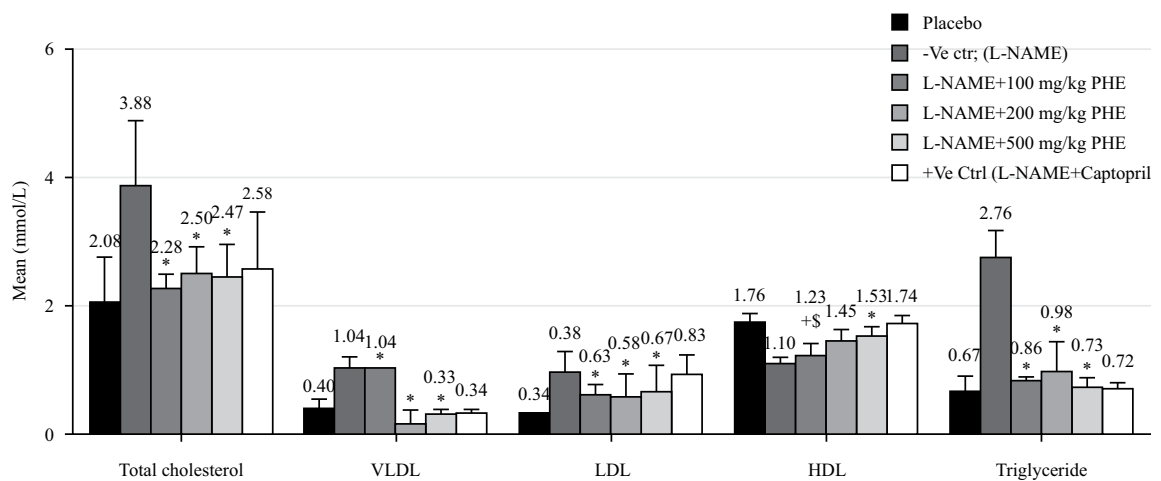


Fig. 5: Effect of *P. heudelotii* leaf extract on lipid profile

Kidney function parameters: Figure 3 and 4 showed the mean levels of serum electrolytes. Sodium and chloride levels in the groups treated with 100, 200 and 500 mg/kg of PHE did not differ ($p>0.05$) from the placebo or positive control group but were significantly lower than those in the negative control group. The chloride level of the negative control group was insignificantly lower than in the other groups. Higher serum creatinine was observed in the negative control group in comparison to the group treated with 100 mg/kg of PHE, the latter of which did not differ from the placebo or positive control group. Serum potassium was apparently lower while urea was higher in the groups treated with PHE compared with the negative control group.

Lipid profile: Figure 5 showed the mean levels of serum lipid profile obtained after administration of PHE. All serum lipid parameters except HDL were higher in the negative control group compared to the treatment groups. Higher total cholesterol, Very Low-Density Lipoprotein (VLDL), Low Density Lipoproteins (LDL) and triglyceride were observed in the negative control group compared to all the PHE-treated groups, which on the other hand showed strong similarity with the placebo ($p<0.05$) and positive control ($p<0.05$) groups. Conversely, the level of high-density lipoprotein (HDL) observed in the negative control group was lower than those of all the groups administered with PHE. However, only the group treated with 500 mg/kg of PHE differed significantly and also showed favourable comparison with the placebo and positive control group.

DISCUSSION

Qualitative laboratory analyses carried on *Pandiaka heudelotii* leaf extract revealed similar phytochemical constituents to that of previous studies indicating flavonoids, alkaloids, tannins, saponins and glycosides with potent antihypertensive, antioxidant and anti-inflammatory effects⁶.

The results from the current study demonstrate the effectiveness of *Pandiaka heudelotii* leaf extract (PHE) in lowering L-NAME-induced systolic and diastolic blood pressures (hypertension) cholesterol, lipid plasma levels and restoring plasma electrolytes. Daily oral administration of PHE for 21 days produced a clear dose-dependent reduction in both systolic and diastolic blood pressure, the effect was even more significant in animal groups treated with the higher dose of 500 mg/kg of *Pandiaka heudelotii* leaf extract (PHE) when compared to the negative control group. These findings provide strong experimental evidence supporting the traditional use of this plant in the management of hypertension.

The L-NAME model employed in this study is particularly relevant because it mimics endothelial dysfunction by competitively inhibiting endothelial nitric oxide synthase (eNOS), resulting in nitric oxide (NO) deficiency, increased vascular tone and progressive elevation of blood pressure¹¹.

Pandiaka heudelotii leaf extract (PHE) is reported to contain apigenin, which decreases blood pressure via improved nitric oxide bioactivity and oxidative stress, regulation of apoptosis-related mitochondrial genes and promotion of vasodilation in vascular endothelium⁷. The significant blood pressure-lowering effect of PHE is mechanistically consistent with the presence of this flavonoid, which is known to enhance endothelial nitric oxide synthase (eNOS) activity and nitric oxide (NO) bioavailability, thereby counteracting the endothelial dysfunction induced by L-NAME. Apigenin also inhibits angiotensin-converting enzyme (ACE) and reduces vascular smooth muscle contraction, providing multiple complementary pathways for blood pressure regulation.

Pandiaka heudelotii leaf extract (PHE) is not only found to be cardio-protective, but also hepato-protective and nephro-protective among other therapeutic potentials, which may not have been evaluated as yet. Significant decrease in the level of liver enzymes alanine transaminase (ALT) and aspartate transaminase (AST) by repeated treatment with *Pandiaka heudelotii* leaf extract (PHE) provides the assumption that it ameliorates hepatocellular injury and initiates liver parenchymal cell regeneration¹⁹. The observed general increase in the level of total protein and albumin concentrations in the treated animals suggests the protection of liver integrity. Similarly, PHE reduced serum creatinine and corrected electrolyte imbalances, indicating nephroprotective effects. These findings are clinically important because hypertension is a leading cause of chronic liver and kidney damage. The hepatoprotective and nephroprotective activities are likely attributable to the combined antioxidant and anti-inflammatory properties of flavonoids and other polyphenols present in the extract, consistent with earlier ethnopharmacological studies on related medicinal plants^{20,21}.

Administration of *Pandiaka heudelotii* leaf extract (PHE) produces reduction in plasma cholesterol and low-density lipoprotein which have been linked to lowered risk of cardiovascular disease and the mechanism may be due to activation of nitric oxide synthase by the constituents present in the plant extract²². This improvement in lipid profile is clinically relevant, as dyslipidaemia frequently coexists with hypertension and increases the risk of atherosclerosis. This antidyplipidaemic effect may be mediated through antioxidant modulation of lipid metabolism, inhibition of HMG-CoA reductase, or enhanced reverse cholesterol transport facilitated by increased NO bioavailability.

The strong concentration-dependent DPPH radical scavenging activity observed in vitro further supports the involvement of antioxidant mechanisms. Oxidative stress plays a central role in the pathogenesis of L-NAME-induced hypertension through NO inactivation and endothelial damage. By neutralizing reactive oxygen species (ROS), PHE likely preserved NO bioavailability and prevented further vascular injury. Similarly, we could deduce that this plant helps in ameliorating sickle cell disease symptoms. Oxidative damage to red blood cells contributes to the pathogenesis of sickle cell anaemia. Therefore, reducing the deleterious effects of oxidants by exposing red blood cells to a number of antioxidants (as found in this plant) has been shown to have protective effects against lipid and protein peroxidation²⁰⁻²³. Further, the antihypertensive effect of PHE (500 mg/kg) which is comparable to captopril (10 mg/kg), suggesting possible ACE inhibition or vasodilatory activity, aligning with traditional use for blood pressure management.

This study employed a well-established L-NAME-induced hypertension model with appropriate controls (placebo and captopril positive control), multiple dose levels and comprehensive evaluation of blood pressure, lipid profile and key organ function biomarkers. The use of the tail-cuff method allowed repeated non-invasive blood pressure measurements, increasing the reliability of the data. The inclusion of both antioxidant assay and multiple biochemical parameters provides a holistic assessment of the extract's therapeutic potential.

Despite these strengths, the study has some limitations. The exact bioactive compounds responsible for the observed effects were not isolated. Although apigenin is a likely contributor, possible synergistic effects among multiple phytochemicals cannot be excluded. Furthermore, this study focused on short-term (21-day) pharmacodynamic effects; long-term efficacy, chronic toxicity and detailed molecular mechanisms were not investigated. Finally, results from rodent models may not fully translate to human hypertension due to physiological differences.

The present findings have important implications. They provide scientific validation for the traditional use of *Pandiaka heudelotii* in hypertension management and suggest its potential as a safe, effective and affordable phytotherapeutic agent, particularly in resource-limited settings where access to conventional drugs is challenging. Further studies are needed to document and elaborate the pharmacokinetic mechanisms as well as the clinical and pharmacological effects of these bioactive compounds and their availability for present and future needs and use.

CONCLUSION

Sufficient evidence from the current study suggests that the control of blood pressure can be achieved with the help of *Pandiaka heudelotii* methanolic leaf extract in the experimental rat models. The ability of the extract to elicit responses that were desirable and comparable to placebo and captopril at higher doses suggests that 500 mg/kg may be its optimal dose in animal models. PHE shows a therapeutic potential in the management of hypertension and possible related cardiovascular pathologies among others and can be a supplement in resource poor environment.

In conclusion, the methanol leaf extract of *Pandiaka heudelotii* (PHE) exhibited significant dose-dependent antihypertensive effects, along with favourable antioxidant, antidiyslipidaemic and organ protective properties in L-NAME-induced hypertensive Wistar rats. At 500 mg/kg, PHE demonstrated efficacy comparable to the standard drug captopril while improving lipid profile and attenuating liver and kidney injury. These findings provide robust scientific validation for the traditional use of *P. heudelotii* in the management of hypertension. Given the increasing burden of hypertension in resource-limited settings, this plant represents a promising candidate for the development of safe, effective and affordable phytotherapeutic agents. However, further studies including bioassay-guided isolation of active compounds, detailed mechanistic investigations, chronic toxicity evaluations and well-designed clinical trials are essential to establish its therapeutic value and safety in humans.

SIGNIFICANCE STATEMENT

Hypertension is a major health concern that requires effective and safe therapeutic options. The present study explores the biological effects of *Pandiaka heudelotii* in an experimental model of elevated blood pressure. Its administration produced favorable changes in cardiovascular and metabolic parameters. These findings provide a basis for further research into the medicinal value of this plant and its possible role in cardiovascular health.

REFERENCES

1. WHO, 2023. Global Report on Hypertension: The Race Against a Silent Killer. World Health Organization, Geneva, Switzerland, ISBN: 978-92-4-008106-2, Pages: 291.
2. Bosu, W.K., S.T. Reilly, J.M.K. Aheto and E. Zucchelli, 2019. Hypertension in older adults in Africa: A systematic review and meta-analysis. PLoS ONE, Vol. 14. 10.1371/journal.pone.0214934.

3. Akinlua, J.T., R. Meakin, A.M. Umar and N. Freemantle, 2015. Current prevalence pattern of hypertension in Nigeria: A systematic review. *PLoS ONE*, Vol. 10. 10.1371/journal.pone.0140021/journal.pone.0140020.
4. Bandaranayake, W.M., 2006. Quality Control, Screening, Toxicity, and Regulation of Herbal Drugs. In: *Modern Phytomedicine: Turning Medicinal Plants into Drugs*, Ahmad, I., F. Aqil and M. Owais, Wiley, New Jersey, United States, ISBN: 9783527609987, pp: 25-57.
5. Pan, S.Y., S.F. Zhou, S.H. Gao, Z.L. Yu and S.F. Zhang *et al*, 2013. New perspectives on how to discover drugs from herbal medicines: CAM's outstanding contribution to modern therapeutics. *Evidence-Based Complementary Altern. Med.*, Vol. 2013. 10.1155/2013/627375.
6. Ifeanchi, M.O., C.C. Ikewuchi and J.C. Ikewuchi, 2017. Investigation of the profile of phenolic compounds in the leaves and stems of *Pandiana heudelotii* using gas chromatography coupled with flame ionization detector. *Food Sci. Nutr.*, 5: 646-652.
7. Zhu, W., Y. Du, H. Meng, Y. Dong and L. Li, 2017. A review of traditional pharmacological uses, phytochemistry and pharmacological activities of *Tribulus terrestris*. *Chem. Central J.*, Vol. 11. 10.1186/s13065-017-0289-x.
8. Jiang, X. and H. Huang, 2025. The therapeutic potential of apigenin against atherosclerosis. *Heliyon*, Vol. 11. 10.1016/j.heliyon.2024.e41272.
9. Gao, H.L., X.J. Yu, H.B. Hu, Q.W. Yang and K.L. Liu *et al*, 2021. Apigenin improves hypertension and cardiac hypertrophy through modulating NADPH oxidase-dependent ROS generation and cytokines in hypothalamic paraventricular nucleus. *Cardiovasc. Toxicol.*, 21: 721-736.
10. Lakhanpal, P. and D.K. Rai, 2007. Quercetin: A versatile flavonoid. *Int. J. Med. Update E-J.*, 2: 22-37.
11. Bader, M., U.M. Steckelings, N. Alenina, R.A.S. Santos and C.M. Ferrario, 2024. Alternative renin-angiotensin system. *Hypertension*, 81: 964-976.
12. Johns, C., I. Gavras, D.E. Handy, A. Salomao and H. Gavras, 1996. Models of experimental hypertension in mice. *Hypertension*, 28: 1064-1069.
13. Lakshmisundaram, R., K.M. Kuppusamy, L. Muruganandham, K.P.R. Baskaran, D. Muniyandi, M.R.K. Rao and J. Jayram, 2025. Biological profiling and phytochemical analysis of *Peristrophe bicalyculata*. Evaluating its therapeutic potential and active compounds. *J. Young Pharm.*, 17: 571-580.
14. Madu, C., B.A. Inyang, K.C. Nwachukwu, M.M. Nwegbu, L.A. Alli and M.P. Okoh, 2021. Protective effects of *Delonix regia* leave extract on sodium arsenite-induced hepatotoxicity in rats. *Am. J. Phytomed. Clin. Ther.*, Vol. 9. 10.36648/2321-2748.9.3.15.
15. Sofowora, A., 1993. *Medicinal Plants and Traditional Medicine in Africa*. 2nd Edn., Spectrum Books, Ibadan, Nigeria, ISBN-13: 9789782462190, Pages: 289.
16. Williamson, E.M., J. Barnes, J. Prieto-Garcia, M. Heinrich and S. Gibbons, 2023. *Fundamentals of Pharmacognosy and Phytotherapy*. 4th Edn., Elsevier, Amsterdam, Netherlands, ISBN: 9780323834353, Pages: 282.
17. Ibanga, O.I., M.E. Usoro, J.N. Elijah, J.U. Emmanuel, G.I. Ufikairom and J.I. Udo, 2022. Ethnobotanical study, phytochemical composition and *in vitro* antioxidant activity of the methanol extracts of thirty-two medicinal plants from Southern Nigeria. *J. Med. Plants Res.*, 16: 288-299.
18. Brand-Williams, W., M.E. Cuvelier and C. Berset, 1995. Use of a free radical method to evaluate antioxidant activity. *LWT-Food Sci. Technol.*, 28: 25-30.
19. Amacher, D.E., 1998. Serum transaminase elevations as indicators of hepatic injury following the administration of drugs. *Regul. Toxicol. Pharmacol.*, 27: 119-130.
20. Vona, R., N.M. Sposi, L. Mattia, L. Gambardella, E. Straface and D. Pietraforte, 2021. Sickle cell disease: Role of oxidative stress and antioxidant therapy. *Antioxidants*, Vol. 10. 10.3390/antiox10020296.
21. Al Balushi, H., A. Hannemann, D. Rees, J. Brewin and J.S. Gibson, 2019. The effect of antioxidants on the properties of red blood cells from patients with sickle cell anemia. *Front. Physiol.*, Vol. 10. 10.3389/fphys.2019.00976.
22. Jobgen, W.S., S.K. Fried, W.J. Fu, C.J. Meininger and G. Wu, 2006. Regulatory role for the arginine-nitric oxide pathway in metabolism of energy substrates. *J. Nutr. Biochem.*, 17: 571-588.
23. Okoh, M.P., L.A. Alli, M.E.E. Tolvanen and M.M. Nwegbu, 2019. Herbal drug use in sickle cell disease management; trends and perspectives in Sub-Saharan Africa-a systematic review. *Curr. Drug Discovery Technol.*, 16: 372-385.