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Integrated Phytochemical and Hematological Assessment of Hydroethanolic Leaf Extract of *Justicia carnea* in Streptozotocin-Induced Diabetic Wistar Rats

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Hematological indices,
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Phytochemical composition.

ABSTRACT
Diabetes mellitus, a multifactorial metabolic disorder, is often associated with hematological and oxidative alterations that contribute to disease complications. This study investigated the phytochemical composition and biochemical effects of the hydroethanolic leaf extract of *Justicia carnea* on hematological parameters in streptozotocin-induced diabetic Wistar rats. Thirty-six (36) male albino Wistar rats were divided into six groups (n = 6). Diabetes was induced by a single intraperitoneal injection of streptozotocin (50 mg/kg), except in the normal control group. The diabetic control group received no treatment, while the reference group received metformin (50 mg/kg). Test groups were orally administered *Justicia carnea* hydroethanolic extract at doses of 100, 200, and 500 mg/kg daily for 28 days. Acute toxicity was assessed using Lorke's method. At the end of the experiment, fasting blood glucose levels were measured, and blood samples were collected via cardiac puncture for hematological analysis. Phytochemical screening revealed the presence of flavonoids, phenols, steroids, tannins, and terpenoids, indicating significant bioactive potential. Proximate analysis showed high carbohydrate (50.91 %) and moisture (21.11 %) content, with lower levels of crude fat (0.25 %) and protein (1.25 %). Treatment with *Justicia carnea* extract produced a dose-dependent improvement in hematological indices, including red blood cell count, hemoglobin concentration, and white blood cells, compared with diabetic controls. These effects suggest a restorative influence on hematopoietic function, potentially mediated by phytochemical constituents with antioxidant or cytoprotective activity. These findings suggest that *Justicia carnea* may possess hematoprotective and restorative properties beneficial in the management of diabetes-induced hematological alterations.

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INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin action, or both. It is a major global health concern with increasing prevalence and significant social, economic, and medical consequences. According to the International Diabetes Federation (IDF,2021), hundreds of millions of adults are currently living with diabetes, and this figure is projected to rise sharply by 2030, with the highest relative increase

expected in sub-Saharan Africa (Teo *et al*., 2024). Within this region, about 20 million people are currently affected, nearly 60% of whom remain undiagnosed, and the number is expected to double to approximately 41 million by 2035 (Saeedi *et al*., 2019). Nigeria bears the highest national burden, with an estimated 3.9 million adults aged 20–79 years living with the condition (Adeloye *et al*., 2017).

Although diabetes was once considered an adult-onset disease, recent trends indicate a rising prevalence among children and adolescents. This increase is closely linked to urbanization, sedentary lifestyles, and the adoption of Western dietary habits rich in refined carbohydrates, fats, and sugars (Musa *et al*., 2024). The nutrition transition across Africa has contributed to a surge in obesity and metabolic disorders, while in rural areas, malnutrition persists due to poverty, food insecurity, and limited access to staple crops such as sorghum, millet, maize, yams, and plantain (Musa *et al*., 2024). Chronic hyperglycemia, if left uncontrolled, leads to microvascular and macrovascular complications involving the kidneys, liver, nerves, and cardiovascular system, often resulting in severe morbidity and mortality (Lenzen, 2019).

Despite notable advances in pharmacotherapy, diabetes management remains challenging due to the high cost, side effects, and limited accessibility of synthetic drugs, particularly in low- and middle-income countries. Consequently, there is growing interest in exploring plant-based therapies with proven efficacy and minimal adverse effects. The World Health Organization has emphasized the importance of scientifically evaluating medicinal plants used in traditional medicine as potential sources of safe and affordable antidiabetic agents (WHO,2013).

The genus *Justicia* is the largest within the family Acanthaceae, comprising approximately 600 species distributed across tropical and subtropical regions of the world (Corrêa *et al*., 2012; Onoja *et al*., 2017). Species of *Justicia* are creeping annual or perennial herbs that may attain heights of 1.5–2 m. In Africa, *Justicia carnea* is one of the most highly valued leafy vegetables and is widely cultivated in home gardens throughout West and Central Africa, particularly in Nigeria, Guinea, Ghana, Togo, Benin, Sierra Leone, Cameroon, and the Democratic Republic of Congo (Lombe *et al*., 2017; Anarado *et al*., 2021). In Nigeria, it is known as “Ogwu obara” (Igbo) or “Ewe eje” (Yoruba), meaning “blood tonic leaf.” The plant is traditionally used for managing anemia, enhancing blood circulation, and improving general well-being. Its leaves are typically boiled or soaked to produce a deep purple extract consumed as a tonic or tea (Ajibesin *et al*., 2008; Onyeabo *et al*., 2017).

Beyond its ethnomedicinal applications, *J. carnea* is valued for its rich phytochemical composition and broad pharmacological potential. Extracts from its leaves and stems have been reported to exhibit antioxidant, antidiabetic, anti-inflammatory, analgesic, antimicrobial, and cardioprotective properties (Radhika *et al*., 2013; Medapa *et al*., 2015; Anyasor *et al*., 2015; Asante-Kwatia *et al*., 2023; Świątek *et al*., 2023; Ojeaburu & Eimoga, 2024). These effects are largely attributed to the presence of bioactive compounds such as flavonoids, alkaloids, phenolic acids, and other secondary metabolites known for their antioxidant and disease-preventive roles (Roy *et al.,* 2022).

Haematological indices, including red blood cell count, hemoglobin concentration, hematocrit, and mean corpuscular indices, are valuable biomarkers for assessing the physiological and pathological state of the blood (Xie *et al*., 2013; Onyeyili *et al*., 2013). In diabetes mellitus, oxidative stress, inflammation, and vascular damage can lead to alterations in these parameters. Anaemia is common among diabetic patients, especially those with nephropathy, due to impaired erythropoietin synthesis and oxidative damage to erythrocytes. Hyperglycemia-induced oxidative stress and the formation of advanced glycation end products (AGEs) further contribute to hematological abnormalities and vascular injury (Singh *et al*, 2014; Rhee and Kim,2018).

Given the increasing burden of diabetes and the limitations of current therapeutic options, there is a compelling need to investigate natural products with demonstrated efficacy and low toxicity. *Justicia carnea*, widely used in traditional medicine across Nigeria and other tropical regions, represents a promising candidate due to its reported antidiabetic, antioxidant, and hematopoietic activities.

Therefore, this study aimed to evaluate the effects of the hydroethanolic extract of *Justicia carnea* leaves on hematological indices in streptozotocin-induced diabetic Wistar rats. The study specifically sought to determine whether the extract could ameliorate diabetes-associated hematological alterations, thereby providing scientific support for its potential therapeutic use in the management of diabetes mellitus and its complications.

MATERIALS AND METHODS

Materials

The materials used in this study included *Justicia carnea* leaves, Wistar rats, analytical-grade reagents, and standard laboratory apparatus**.**

Chemicals and Reagents

The following chemicals and reagents were used: streptozotocin (STZ), metformin, dimethyl sulfoxide (DMSO), ethanol, anhydrous sodium carbonate, sodium hydroxide, chloroform, sulphuric acid, acetone, ferric chloride, ammonia, and hydrochloric acid. All chemicals were of analytical grade and obtained from reputable suppliers.

Plant Material

Fresh leaves of *Justicia carnea* were collected from a botanical park in Ugbowo, Benin City, Edo State, Nigeria, located along the Benin–Lagos expressway. The plant was identified and authenticated in the Department of Plant Biology and Biotechnology, University of Benin, Benin City, Edo State, Nigeria. A voucher specimen (no. UBH-J386) was deposited in the herbarium of the Department.

Preparation of the Hydroethanolic Extract (HEE) of *J. carnea* Leaves

Fresh leaves of *Justicia carnea* were thoroughly washed under running tap water, shade-dried at room temperature, and pulverized into a fine powder using a mechanical grinder. The powdered material (500 g) was macerated with 80% ethanol (v/v) in distilled water as the extraction solvent. The solvent was added at a ratio of 5:1 to 10:1 (v/w; 500–1000 mL) to ensure complete immersion of the plant material. The mixture was sealed in a clean, dry glass flask and kept at room temperature (approximately 25 °C) for 3–7 days with intermittent stirring two to three times daily to facilitate efficient extraction of phytoconstituents. After maceration, the mixture was filtered through Whatman No. 1 filter paper under gentle suction to separate the filtrate from the plant residue (marc). The marc was pressed to recover any residual extract and re-extracted once with fresh hydroethanolic solvent when necessary. The combined filtrates were concentrated under reduced pressure using a rotary evaporator (Büchi, Germany) to remove the solvent and then freeze-dried to obtain a solid hydroethanolic extract (HEE). The extract was stored at –4 °C in an airtight container until required for experimental use.

The percentage yield of the extract was determined using the formula:

$$\text{Yield } (\%) = \frac{\text{Weights of solvent free extract (g) x 100}}{\text{Dried extract weight (g)}}$$

Phytochemical and Proximate Analyses

Phytochemical Screening

Qualitative phytochemical screening of the hydroethanolic extract of *Justicia carnea* leaves was performed to identify the presence of major secondary metabolites, including phenols, flavonoids, alkaloids, saponins, tannins, steroids, terpenoids, anthraquinones, coumarins, and cardiac glycosides. All assays were conducted following standard phytochemical procedures as previously described in the literature.

Glycosides: The presence of glycosides was determined using the method of Sofowora (1996).

Flavonoids: Flavonoids were identified according to the procedures outlined by Sofowora (1996) and Harborne (1998).

Tannins: Tannins were identified following the method described by Harborne (1998).

Saponins: The method of Obadoni and Ochuko (2001) was employed to test for saponins.

Alkaloids: Detection of alkaloids was carried out using the procedures of Harborne (1998).

Steroids: The presence of steroids was confirmed following the method of Finar (1986).

Terpenoids: Terpenoids were analyzed using the method described by Edeoga *et al*. (2005).

All qualitative reactions were visually observed for characteristic color changes or precipitate formation, which indicated the presence of specific phytochemical constituents.

Proximate Analysis

The proximate composition of the *J. carnea* leaf was determined to evaluate its nutritional and biochemical profile. Parameters analyzed included moisture content, ash content, crude protein, crude fiber, crude fat, and carbohydrate content.

Moisture content was determined by oven-drying at 105 °C to constant weight. Dried samples were subsequently analyzed for crude protein, crude fiber, ash content, and crude fat following the official methods of the Association of Official Analytical Chemists (AOAC, 1990). Crude protein was estimated using the micro-Kjeldahl method for nitrogen determination, and crude fat was extracted using the Soxhlet extraction technique. Carbohydrate content was calculated by difference according to AOAC (2000) procedures. Results were expressed as percentages of the dry weight of the sample

Experimental Animals

Thirty-six (36) male Wistar rats (8 weeks old), weighing between 180–200 g (mean weight: 190 ± 10 g), were obtained from the Animal House, Department of Biochemistry, University of Benin, Benin City, Nigeria. The animals were acclimatized for two weeks under standard laboratory conditions (room temperature 25 ± 2 °C, relative humidity 55–65%, and a 12-h light/dark cycle). Rats were housed in metal cages and provided standard grower's mash and clean drinking water *ad libitum*. All animal procedures complied with the National Research Council guidelines (NRC,2011) for the care and use of laboratory animals and were approved by the Research Ethics Committee of the Faculty of Life Sciences, University of Benin, Benin City, Nigeria, with an approval reference number (FLSRE-2023-018).

Determination of Basal Blood Glucose

Before diabetes induction, rats were fasted overnight with free access to water. Fasting blood glucose levels were determined between 07:00 and 08:00 a.m. using an ACCU-CHEK glucometer. A small incision was made at the tip of the tail, and a drop of blood was applied to the test strip. The ACCU-CHEK test system employs mutant glucose

dehydrogenase (Mut.Q-GDH) derived from *Acinetobacter calcoaceticus* (recombinant in *E. coli*), which catalyzes the oxidation of glucose to gluconolactone, producing an electrical current proportional to glucose concentration. This enzyme modification minimizes maltose interference, ensuring high analytical precision.

Acute Toxicity Study

The acute oral toxicity of the hydroethanolic extract of *Justicia carnea* leaves was evaluated using the method of Lorke (1983). Eighteen (18) healthy rats were used in a two-phase study.

In Phase I, nine rats were divided into three groups (n = 3 per group) and administered oral doses of 10, 100, and 1000 mg/kg body weight of the extract, respectively. The animals were observed for clinical signs of toxicity and mortality during the first 24 h.

Since no mortality occurred in Phase I, Phase II was conducted with three rats, each receiving a single higher dose of 1500, 2500, and 5000 mg/kg body weight. Animals were observed for 24 h and monitored for an additional 48 h for delayed toxicity or mortality.

Experimental Design

After acclimatization, diabetes was induced in thirty (30) rats by a single intraperitoneal injection of streptozotocin (STZ; 50 mg/kg body weight) dissolved in freshly prepared ice-cold normal saline. Forty-eight hours post-induction, fasting blood glucose levels were measured, and rats with glucose concentrations ≥ 200 mg/dL were considered diabetic (Aboonabi *et al*., 2014).

Animals were randomly allocated into six (6) experimental groups (n = 6 per group) and treated orally via gastric gavage for 28 consecutive days, as shown in Table 1.

Table 1: Experimental grouping and treatment protocol

Group	Treatment description
1	Normal control (non-diabetic)
2	Diabetic untreated control
3	Diabetic + Metformin (50 mg/kg)
4	Diabetic + *J. carnea* extract (100 mg/kg)
5	Diabetic + *J. carnea* extract (200 mg/kg)
6	Diabetic + *J. carnea* extract (500 mg/kg)

Body Weight Measurement

Body weights of all rats were recorded weekly using an electronic weighing balance before and throughout the treatment period.

Sample Collection and Preparation

At the end of the 21-day treatment, rats were fasted overnight and sacrificed under chloroform anesthesia in a closed chamber. Blood samples were collected via cardiac puncture into ethylenediaminetetraacetic acid (EDTA) tubes for hematological analysis**.**

Hematological Analysis

Hematological parameters were determined using an automated URIT-2900 Plus 3-Differential Hematology Analyzer. The parameters measured included hemoglobin concentration (Hb), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC), total white blood cell count (WBC), lymphocyte count (LYM), and platelet count (PLT).

Statistical Analysis

Data were expressed as mean ± standard error of the mean (SEM). Statistical analyses were performed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Differences between groups were assessed using one-way analysis of variance (ANOVA) followed by Duncan's multiple range test for post hoc comparisons. Differences were considered statistically significant at $p < 0.05$.

RESULTS AND DISCUSSION

Results

Acute Toxicity Study

Tables 1 and 2 present the results of the acute toxicity study. The experimental rats exhibited good tolerance to the administered doses of *Justicia carnea* extracts, as no mortality was recorded.

Table 2: Phase1 acute toxicity study

Dose (mg/kg)	Mortality
10	0/3
100	0/3
1000	0/3

Table 3: Results of phase I1 acute toxicity studies

Dose (mg/kg)	Mortality
1600	0/3
2900	0/3
5000	0/3

Phytochemical Analysis

Table 4: Phytochemical Profile of *J. carnea* leaves

S/N	Phytochemical components	Remark
1	Flavonoids	+++
2	Tannins	++
3	Cardiac glycosides	-
4	Saponin	-
5	Steroids	++
6	Phenols	++
7	Phlabotannins	-
8	Coumarin	-
9	Alkaloids	-
10	Anthraquinone	-
11	Terpenoids	++

Key: - Absent/Undetected ; + Present (but low) , ++ Present (High) ;+++ Present (very high)

Proximate Composition of *Justicia carnea* Leaves

Proximate composition analysis was performed, and the percentage values of moisture, ash, crude protein, crude fibre, crude fat, and carbohydrate are presented in Table 5. The results revealed relatively high levels of carbohydrate and moisture content, indicating that the sample possesses substantial energy value and water content.

Table 5: Proximate Composition of *Justicia carnea* Leaves

Proximate composition	g (%)
Moisture content	21.11±0.31
Ash content	15.96±0.08
Crude fiber	10.52±1.06
Crude fat	0.25±0.02
Crude protein	1.25±0.03
Carbohydrate	50.91±1.32

Data are represented as mean ± SEM (n=3).

Effect of Graded Doses of Hydroethanolic Extract of *J. Carnea* Leaves on Rat Body Weight

The effects of the hydroethanolic leaf extract of *Justicia carnea* on body weight changes in streptozotocin (STZ)-induced diabetic rats are presented in Table 6. An overall increase in body weight was observed across all experimental groups. However, rats in Groups 4 and 5 exhibited significantly lower weight gain than in the normal control and diabetic control groups.

Table 6: Changes in the Body Weight of Diabetic Rats Treated with *J. carnea* Extract

Groups	Initial body weight (g)	Final body weight (g)	Change in body weight (g)
Normal Control	109.52±3.10	190.70±12.34	81.18±10.21
Diabetic control	130.55±12.40	210.11±14.32	79.56±8.12
Metformin	116.31±4.20	176.56±10.12	60.25±8.34
Group 4 (100mg of extract)	116.32±12.10	175.42±16.24	59.10±8.10
Group 5(200mg of extract)	110.02 ±5.41	156.41±4.52	561.39±1.65
Group 6 (500mg of extract)	126.62±5.61	212.12±14.66	85.50±8.10

Values are expressed as Mean ± SEM (n=3). [a] represents a significant difference from normal control ($p<0.05$). [b] represents a significant difference from diabetic control ($p<0.05$)

Effect of HEE of *J. carnea* Leaves on Fasting Blood Glucose Concentration in STZ-induced Diabetic Rats

Table 7 presents the effect of the hydroethanolic extract of *Justicia carnea* on fasting blood glucose levels in streptozotocin (STZ)-induced diabetic rats. The results indicate that the blood glucose levels of the diabetic control and hydroethanolic extract (HEE)-treated diabetic groups increased significantly ($p < 0.05$) three days after STZ administration compared with the normal control. Treatment with the HEE of *J. carnea* leaves produced a dose-dependent reduction in blood glucose levels, comparable to the effect observed with metformin after 28 days of administration. In contrast, the blood glucose levels of the untreated diabetic control group remained significantly elevated ($p < 0.05$) relative to both the normal control and extract-treated groups throughout the 28-day study period.

Table 7: Blood Glucose Concentration (mg/dL) of Experimental Rats

Group	Initial	Week			
		1	2	3	4
1 (Control)	75.01±3.12	--	83.52±3.51^{b}	93.43±2.53^{b}	65.54±2.54^{b}
2 (Diabetic Control)	92.65±5.61	302.25±10.77^{a}	475.00±41.02^{a}	368.00±54.08^{a}	368.21±14.52^{ab}
3 (Metformin)	62.20±4.15	308.50±8.12^{a}	285.65±12.25^{ab}	206.52±14.42^{ab}	165.15±16.21 ^{ab}
4 (100 mg/kg)	58.51±3.25	280.15±12.16^{a}	220.42±14.21^{ab}	224.25±12.35^{ab}	172.52±18.23^{ab}
5 (200 mg /kg)	55.62±2.51	368.14±10.65^{a}	320.15±12.35^{ab}	294.65±14.15^{ab}	225.30±15.22^{ab}
6 (500 mg/kg)	60.42±2.15	277.65±13.31^{a}	245.16±14.21^{ab}	192.02±15.21^{ab}	153.56±11.21^{b}

Values are expressed as mean ± SEM (n = 3). Superscript "a" denotes a significant difference compared with the normal control ($p < 0.05$), while "b" indicates a significant difference compared with the diabetic control ($p < 0.05$). Superscripts "a and b" represent a significant difference from both the normal and diabetic controls ($p < 0.05$), with no significant difference relative to the metformin-treated group.

Hematological Indices

Table 8 presents the effect of HEE of *Justicia carnea* on Hematological indices in streptozotocin-induced diabetic Wistar rats.

Table 8: The effect of HEE of *Justicia carnea* on Hematological indices in streptozotocin-induced Wistar rats

Parameters	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
HGB (g/dL)	13.82±1.60	11.31±0.45^{a}	14.31±0.02^{b}	12.21±0.55	14.21±0.32	13.60±0.31^{b}
RBC (×10^{6} cells/µL)	6.32±0.62	5.25 ±0.25	5.62±0.10	5.34±0.21	3.84 ±1.33^{a}	6.10±0.15
WBC (×10^{3}cells/µL)	16.25±3.53	9.95±2.25	16.50±0.02^{b}	8.62±0.06	15.60±1.95^{b}	16.30±2.02^{b}
LYM (×10^{3}/µL)	11.50±0.15	8.55±0.21	15.42±0.05^{b}	7.52±0.51	11.45±2.51^{b}	12.51±1.02^{b}
MON (×10^{3}/µL)	2.82±0.67	0.94±0.21^{a}	1.42±0.05	0.70±0.51^{a}	1.41±0.52^{b}	2.52±0.51^{b}
PLT (×10^{3}/µL)	656.55±4.52	374.51±3.10^{a}	726.34±0.05^{b}	484.35±6.12^{a}	792±9.15	705±10.21

Values are expressed as Mean ± SEM (n=3). ^{a} represents a significant difference from normal control ($p<0.05$). ^{b} represents a significant difference from diabetic control ($p<0.05$)

Discussion

There is growing evidence that *Justicia carnea*, a medicinal plant widely used in traditional medicine, possesses diverse pharmacological properties, including hematopoietic and circulatory benefits. Diabetes mellitus, a major endocrine disorder, is characterized by metabolic derangements in carbohydrate, lipid, and protein metabolism. The global burden of diabetes continues to rise, prompting the search for safer, plant-based therapeutic alternatives with proven efficacy. In this study, the phytochemical composition, proximate content, and hematological effects of the hydroethanolic leaf extract of *J. carnea* were evaluated in streptozotocin (STZ)-induced diabetic Wistar rats.

Acute toxicity and safety evaluation

The acute toxicity assessment revealed that the hydroethanolic extract (HEE) of *J. carnea* was well tolerated at all tested doses, with no mortality or observable signs of toxicity. The absence of behavioral or physiological abnormalities further supports its safety profile and suggests a wide therapeutic margin. These findings indicate that the extract lacks acutely toxic constituents. Nonetheless, the current data are limited to acute exposure, and future studies investigating chronic and sub-chronic toxicity are necessary to fully define its long-term safety and toxicological threshold.

Phytochemical profile and pharmacological implications

Phytochemical screening of the extract revealed the presence of steroids, terpenoids, tannins, flavonoids, and phenolic compounds, which are a class of bioactive metabolites known for their antioxidant, anti-inflammatory, and antidiabetic activities. These compounds likely act synergistically to confer the observed pharmacological effects. Prior studies have reported that *Justicia* species are rich in flavonoids and terpenoids, both of which contribute significantly to their therapeutic potential (Corrêa and Alcântara, 2012). Flavonoids, in particular, are potent free radical scavengers that reduce oxidative stress and slow the progression of chronic diseases, including diabetes and cardiovascular disorders (Panche *et al*., 2016). Phenolic compounds contribute additional immunomodulatory and cytoprotective effects (Balasundram *et al*., 2006).

The presence of steroids and terpenoids further underscores the pharmacological value of *J. carnea*. Phytosterols have been shown to regulate lipid metabolism and improve plasma lipid profiles (Berger *et al.,* 2004), while terpenoids possess diverse bioactivities, including antimicrobial, anti-inflammatory, and antidiabetic effects (Ojo *et al*., 2025). Tannins, although sometimes associated with antinutritional effects at high concentrations, are potent antioxidants and antidiabetic agents; their potential adverse effects can be mitigated through traditional processing methods such as boiling or soaking (Soetan and Oyewole, 2009). Collectively, the phytochemical complexity of *J. carnea* provides a strong biochemical basis for its observed biological activities and its traditional use as a medicinal plant.

Nutritional composition and functional relevance

Proximate analysis of *J. carnea* leaves revealed high carbohydrate (50.91 ± 1.32%) and moisture content (21.11 ± 1.32%), moderate levels of ash (15.96 ± 0.08%) and crude fibre (10.52 ± 1.06%), and low concentrations of crude fat (0.25 ± 0.02%) and protein (1.25 ± 0.03%). These values are consistent with previous findings (Asogwa *et al*., 2020). The high carbohydrate content suggests that the leaves can serve as an important energy source, while the high ash fraction reflects mineral richness, essential for enzymatic reactions and metabolic homeostasis (Vunchi *et al*., 2011). Dietary fibre is known to improve gastrointestinal motility, attenuate glucose absorption, and support cardiovascular health (FAO, 1990; SACN, 2018).

The low crude fat content makes *J. carnea* a suitable dietary component for individuals requiring low-fat intake, while the modest protein level provides additional nutritional value in regions where the leaves are consumed as a vegetable or infusion. Overall, these attributes support the plant's classification as a functional food with both nutritional and therapeutic relevance.

Effects on body weight and glycemic control

Body weight is a sensitive biomarker of general health and systemic metabolic function. STZ-induced diabetes in this study led to a significant reduction in body weight, reflecting the metabolic imbalance associated with insulin deficiency, protein catabolism, and muscle wasting. Administration of the hydroethanolic extract of *J. carnea* produced a dose-dependent improvement in body weight, suggesting a restorative effect on metabolic equilibrium under diabetic conditions. Similar effects have been reported for *Enantia chlorantha*, which mitigated diabetes-induced weight loss in experimental models (Ojeaburu and Olasehinde, 2025).

STZ-induced diabetes results from the selective destruction of pancreatic β-cells, leading to insulin insufficiency, hyperglycemia, and oxidative stress (Qamar *et al*., 2023). In the current study, STZ administration produced a marked elevation in fasting blood glucose (FBG) levels in the diabetic control group, confirming successful diabetes induction (Table 7). Oral administration of *J. carnea* extract significantly reduced FBG levels in a dose-dependent manner, with the 500 mg/kg dose showing comparable efficacy to metformin. This hypoglycemic effect may result from one or more mechanisms, including preservation of β-cell function, stimulation of insulin secretion, or enhancement of peripheral insulin sensitivity (Edem, 2020).

The strong antihyperglycemic activity observed is consistent with previous studies associating flavonoid-rich extracts with improved β-cell viability under oxidative stress (Etame *et al.,* 2019; Qin *et al*., 2022). Flavonoids enhance antioxidant defense systems and attenuate inflammation, thereby protecting pancreatic islets from glucotoxicity and preserving insulin secretory function (Rahmani *et al*., 2023). These mechanisms collectively support the role of *J. carnea* as a promising natural agent in glycemic regulation.

Hematological effects

The hematopoietic system is highly sensitive to physiological disturbances and serves as a reliable indicator of systemic toxicity. Treatment with *J. carnea* extract significantly elevated red blood cell (RBC), hemoglobin (Hgb), monocyte, and platelet counts compared with the diabetic control. The increased RBC and Hgb levels indicate stimulation of erythropoiesis, suggesting that the extract exerts an anti-anemic effect consistent with its traditional use as a blood tonic. Comparable hematopoietic effects have been documented for other medicinal plants such as *Tectona grandis*, *Mangifera indica*, *Amaranthus hybridus*, *Telfairia occidentalis*, and *Xylopia aethiopica* (Diallo *et al*., 2008; Ogbe *et al*., 2010; Oso *et al*., 2019). The observed elevation in platelet counts implies stimulation of thrombopoiesis, which could enhance hemostasis and tissue repair.

Overall, these results corroborate previous reports suggesting that *J. carnea* supports hematopoietic function and recovery from anemia (Adesokan and Akanji, 2011; Akintimehin *et al*., 2021; Oboma *et al.,* 2024).

CONCLUSION

The hydroethanolic leaf extract of *Justicia carnea* demonstrated significant hematopoietic and nutritional benefits, alongside potent antihyperglycemic activity and a favorable safety profile. The extract's phytochemical constituents—flavonoids, phenolics, terpenoids, steroids, and tannins- likely act synergistically to mediate its antioxidant, anti-inflammatory, and hematopoiesis-promoting effects. Enhancements in red blood cell, hemoglobin, and platelet counts validate the plant's ethnomedicinal use as a blood tonic and restorative agent. Furthermore, the plant's rich carbohydrate and mineral content, coupled with appreciable dietary fibre, highlights its potential as a functional food with metabolic and therapeutic relevance. Collectively, these findings indicate that *J. carnea* may serve as a valuable adjunct in the management of diabetes mellitus and associated hematological disorders. Future studies should focus on chronic toxicity assessment, isolation and structural characterization of active compounds, and elucidation of the molecular mechanisms underlying its pharmacological effects to substantiate its clinical potential.

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