



Contents lists available at [Bio-Research](#)
Journal of Biological Research and Biotechnology

journal homepage: <https://www.bio-research.com.ng> and
<https://www.ajol.info/index.php/br/about>



Influence of *Allophylus africanus* Hydro-Methanol Leaf Extract on Biochemical and Histological Parameters of Gentamicin- Induced Liver and Kidney Injuries in Adult Male Wistar Albino Rats



¹Ogwo Bertha Omasirich, ³Onoja Uwakwe Simon, ⁵Ede Chinonye Getrude, Amah Elekwa Elizabeth, ⁴Ibeabuchi Ezinne Elizabeth and ⁴Onuigbo Obiageli Theresa.

¹Department of Human Nutrition and Dietetics, David Umahi Federal University of Health Science, Uburu, Ebonyi State, Nigeria; ²Department of Medical Biochemistry, David Umahi Federal University of Health Science, Uburu Ebonyi State, Nigeria; ³Department of Nutrition and Dietetics, University of Nigeria, Nsukka; ⁴ Department of Biochemistry, University of Nigeria, Nsukka; ⁵Department of Home Economics Education, Nnamdi Azikiwe University, Awka, Nigeria

Received: 10th November 2025 / Accepted: 10th December 2025 / **Published Online: 15th February, 2026**

© The Author(s), under exclusive license to Bio-Research-Journal-of-Biological-Research-and-Biotechnology, 2025

DOI: <https://dx.doi.org/10.4314/br.v23i3.3>

*Corresponding author: Ogwo Bertha Omasirichi. Email: bertha.ogwo@gmail.com

ABSTRACT

Liver injury refers to any damage to the liver cells (hepatocytes) or liver tissues that impairs the organ's ability to perform its normal functions. Kidney injury refers to damage that compromises the kidney's ability to filter blood, maintain fluid and electrolyte balance, and remove waste products from the body. The liver and kidney injuries can result from toxins, drugs, alcohol, acetaminophen overdose, some antibiotics, and infections. The study investigated the influence of dried *Allophylus africanus* hydro-methanol leaf extract on biochemical and histological parameters of gentamicin-induced liver and kidney injuries in adult male Wistar albino rats. A total of twenty five (25) male Wistar rats (150-200g) were divided into 5 groups of 5 animals each (Group 1, 2, 3, 4 and 5) where the mean weight difference in each group was not more than 5 g. Group 1 (normal control) received only distilled water. Groups 2-5 were induced by oral gavage with 80 mg/kg b.wt. of gentamicin single dose. After, groups 3, 4 and 5 received 100, 200 and 300 mg/kg b.wt of *Allophylus africanus* leaf extract (AALE) respectively, for 10 days. At the end of the experiments, Blood was obtained by cardiac puncture. The liver function test, antioxidant activities and kidney function bio-markers were analyzed to determine the effect of the leaf extract on the treated rats. The animals were sacrificed and the rat's liver and kidney were removed for histological examination. Treatment of rats with 100-300 mg/kg b.wt of AALE significantly ($p < 0.05$) reduced the serum activities of urea, creatinine, AST, ALP, ALT, CAT, total bilirubin and direct bilirubin and significantly ($P < 0.05$) increased total protein, and glutathione peroxidase (GPx) compared to the untreated group. The activity levels of superoxide dismutase (SOD) and glutathione (GSH) of the treated rats were statistically comparable to the normal rats at ($p < 0.05$). The AALE significantly reduced concentration level of potassium ion (k^+) and chlorine ion (Cl). Furthermore, Histopathological analysis revealed that AALE improved the structural damage of glomeruli and renal tubules in treated rats with increased doses of AALE. The results suggest that AALE are capable of ameliorating liver and kidney injuries caused by gentamicin in rats.

Keywords: *Allophylus africanus*, Gentamicin, Liver injury, Kidney injury, Histopathological

Introduction

The liver and kidneys are essential organs responsible for maintaining physiological homeostasis and regulating metabolism. Although each organ has different primary functions, they exhibit considerable functional overlap and interdependence in processes such as the hepatorenal reflex, glucose homeostasis, erythropoietin (EPO) synthesis, and the biotransformation and elimination of xenobiotics (Bencheikh *et al.*, 2021; Watanabe, 2016). Due to their central roles in detoxification, filtration, and metabolic regulation, both organs are particularly susceptible to injury. Damage may arise from diverse etiologies, including environmental chemical exposures and modifiable lifestyle factors. The liver, as the primary site of drug metabolism, is especially vulnerable to pharmaceutical agents. Substantial evidence indicates that medications represent a leading cause of acute liver injury and acute kidney injury in clinical practice (Pandit *et al.*, 2012; Kwiatkowska *et al.*, 2021).

Gentamicin is a widely used aminoglycoside antibiotic that effectively fights bacterial infections (Edeogu *et al.*, 2021). However, it comes with some side effects, including hearing damage (ototoxicity), kidney toxicity (nephrotoxicity), and, more rarely, muscle weakness due to neuromuscular blockade (Al-Naimi *et al.*, 2019; Smith *et al.*, 2010). One way gentamicin causes harm is by triggering the production of free radicals. Lab studies show it generates reactive oxygen species (ROS), which accelerate lipid peroxidation (Tomşa *et al.*, 2021). Gentamicin is one of the most experimentally used drugs to induced acute renal and liver damage in experimental animals (Moghadam *et al.*, 2017; Noorani *et al.*, 2011).

Around the world, people are increasingly turning to herbal medicines to treat a variety of health conditions. Plants and other natural compounds are seen as promising sources of new therapeutic agents (Enenebeaku *et al.*, 2021). Many medicinal plants have been studied for their ability to protect the liver and kidneys, due to their rich mix of bioactive compounds and generally lower risk of side effects (Bhardwaj *et al.*, 2023; Adeleke *et al.*, 2021; Padmaja *et al.*, 2022). One such plant, *Allophylus africanus*, has gained attention for its wide-ranging benefits, including antimalarial, antibacterial, and antioxidant effects (Ferrerres *et al.*, 2018; Okoye *et al.*, 2024; Sofidiya *et al.*, 2012; Balogun *et al.*, 2016). Analysis of its leaf extract has revealed a variety of beneficial compounds, including cardiac glycosides, flavonoids, alkaloids, tannins, steroids, and triterpenes (Brahim *et al.*, 2018). A related species, *Allophylus cobbe*, has shown anticancer activity against human prostate cancer cells (Ghagane *et al.*, 2017). In traditional medicine, *A. africanus* is used in different ways: in Sierra Leone, a decoction is taken orally to relieve colic and reduce fever, while in Senegal, the macerated leaves are applied to treat conjunctivitis (Gathirwa *et al.*, 2011). The leaves of *Allophylus africanus* are traditionally used for the treatment of various ailments such as arthritis, rheumatism, gout, hemorrhoids, dysentery, venereal diseases and malnutrition (Ibrahim *et al.*, 2018) However, its

specific role in renal protection, especially in conditions relating to gentamicin-induced liver and kidney injuries remains unexplored. Therefore, this study investigated the influence of dried *Allophylus africanus* hydro-methanol leaf extract on biochemical and histological parameters of gentamicin-induced liver and kidney injuries in adult male Wistar albino rats.

Materials and methods

Sample Collection

The fresh leaves of *Allophylus africanus* was obtained from a household farms in Alike Obowo Local Government Area, Imo State, Nigeria. The sample was botanically identified at International Centre for Ethnomedicine and Drug Development by Ossai Isaac with a Voucher number: InterCEDD/C103/005 *Allophylus africanus*.

Preparation of extract

Fresh leaves of *Allophylus africanus* were harvested, sorted, and thoroughly rinsed under running tap water. The cleaned leaves were then chopped and allowed to air-dry at ambient temperature for 14 days. Subsequently, the dried material was ground into a coarse powder using a Panasonic MX-GX1021 W electric blender (manufactured in China).

A 500 g portion of the powdered sample underwent maceration in an 80:20 (v/v) methanol–water solvent system, with periodic agitation at room temperature for 48 hours. The resulting suspension was filtered through muslin cloth, and the filtrate was evaporated to dryness in an oven maintained at 45°C. The concentrated hydro-methanol extracts was transferred to airtight containers and stored under refrigeration until required for further analysis.

Experimental animals and treatment

The experimental design was done after the approval of the Institutional Animal Ethics Committee (IAEC) on the use of laboratory animals. The approval registration no: FVM-UNN-IACUC-2024-11/195.

Experimental Animal

A total of twenty-five (25) male Wistar rats, weighing 150–200g, were utilized in this study. The rats were sourced from the Department of Zoology and Environmental Biology, University of Nigeria, Nsukka, and subsequently transferred to the animal housing facility in the Department of Nutrition and Dietetics at the same institution. The rats were maintained under standard laboratory conditions with a 12-hour light/dark cycle (lights on at 07:00 h) and an ambient temperature of 25 ± 2°C. Prior to the initiation of the experiment, the rats underwent an acclimatization period of 4 days. Throughout this phase, they were provided with standard growers mash and water ad libitum and maintained in clean, well-ventilated standard cages under hygienic environmental conditions.

Experimental design

The twenty-five rats were randomly allocated into five groups ($n = 5$), ensuring that the mean body weight difference within each group did not exceed 5 g. The experimental protocol was adapted from Babaeenzhad *et al.* (2019), wherein *Allophylus africanus* leaf extract (AALE) was administered orally 1 hour following the intraperitoneal injection of gentamicin (80 mg/kg) in rats

Group 1 (Normal control): Received 1 mL/kg/day of distilled water orally via gavage throughout the experimental period.

Group 2 (Negative control): Administered a single intraperitoneal injection of gentamicin (80 mg/kg body weight) with no subsequent treatment.

Group 3: Received a single intraperitoneal dose of gentamicin (80 mg/kg body weight), followed by daily oral administration of *Allophylus africanus* leaf extract (AALE) at 100 mg/kg body weight for 10 consecutive days.

Group 4: Received a single intraperitoneal dose of gentamicin (80 mg/kg body weight), followed by daily oral administration of AALE at 200 mg/kg body weight for 10 consecutive days.

Group 5: Received a single intraperitoneal dose of gentamicin (80 mg/kg body weight), followed by daily oral administration of AALE at 300 mg/kg body weight for 10 consecutive days.

All extract administrations were performed via oral gavage. At the end of the treatment period, blood samples were collected from the retro-orbital plexus into non-heparinized tubes. Serum was obtained by centrifugation at 3000 rpm for 10 minutes and used for biochemical analyses. The animals were sacrificed, Blood samples were collected for the analyses. The liver and kidney were carefully excised, fixed in 10% (v/v) formalin, and processed for histopathological examination.

Determination of biochemical parameters

The plasma aspartate transaminase (AST), aspartate aminotransferase (AST) and alkaline phosphatase (ALP) activity were determined using Randox test kits (Randox Laboratories Ltd., Crumlin, United Kingdom) (Reitman and Frankel, 1957). Protein concentration was determined according to the method of Mayne (1996). The plasma creatinine concentration was determined using Randox test kits (Mayne, 1996). Determination of uric acid in serum was done using enzymatic colorimetric method (Barham & Trinder, 1972). Superoxide dismutase activity was assayed by the method of Arthur and Boyne (1985) as contained in Randox kit leaflet. Catalase (CAT) activity was determined using hydrogen peroxide H_2O_2 as a substrate according to the method described by Sinha (1972) and levels of reduced glutathione (GSH) according to the method described by Jollow *et al.* (1974) and concentration of malondialdehyde (MDA) as measurement of lipid peroxidation according to method of by Wallin *et al.* (1993). Determination of serum electrolytes concentration was determined using test kits as described by Gross *et al.* (2011).

Histological examination

Following blood collection, the liver and kidneys were meticulously excised from the abdominal cavity, immersed in 10% formalin solution for 72 hours, and then sliced to a thickness of 2-3 mm. The tissue sections were dehydrated through a graded series of alcohol concentrations, cleared in xylene, and embedded in paraffin wax to form tissue blocks, as described by Drury *et al.* (1967). Paraffin-embedded tissues were sectioned at 5 μ m thickness using a rotary microtome. The resulting ribbons were mounted onto glass slides, dried, and stained with hematoxylin and eosin (H&E) for routine histopathological evaluation. The stained slides were systematically examined under a Motic® light microscope, and representative photomicrographs were captured using a Motic® digital microscope camera at various magnifications.

Statistical analysis

Data generated from the study was statistically analyzed using Statistical Product and Service Solutions (SPSS), Version 25. The means and standard deviations generated were presented. Analysis of Variance (ANOVA) was used, alongside Duncan's new multiple range test, to separate and compare the means. The acceptable level of significance was $p < 0.05$.

Result

The detailed results of the serum biochemical analyses are presented in Table 1. Levels of liver function biomarkers AST, ALT, ALP, and total bilirubin were significantly elevated ($P < 0.05$) in rats administered gentamicin alone, compared to the normal control group. Rats treated with the extract at different doses showed significant ($p < 0.05$) difference in the AST, ALT, ALP activities, total bilirubin, as represented in table 1 when compared to the untreated. The concentrations of creatinine and urea in the gentamicin-treated group significantly increased, however, the concentrations in the AALE-treated groups reversed to normal. Total protein concentrations were significantly ($p < 0.05$) higher in the treated groups and significantly ($p < 0.05$) lower in the negative control group. The results also demonstrated a marked increase in hepatic lipid peroxidation, indicative of elevated oxidative stress in the gentamicin-treated group. Administration of gentamicin alone caused a significant reduction in reduced glutathione (GSH) levels and in the activities of catalase (CAT), superoxide dismutase (SOD), and glutathione peroxidase (GPx) compared with the normal control group ($p < 0.05$). In contrast, treated groups significantly restored the activities of CAT, SOD, GPx and GSH level ($P < 0.05$) in a dose-dependent manner. MDA levels were substantially lower in those treated with AALE and significantly higher in groups treated with gentamicin alone. Administration of gentamicin alone (Group 2) resulted in marked disruptions in serum electrolyte balance compared with the normal control group (Table 1). Specifically, Group 2 exhibited a significant elevation in chloride concentration,

DOI: <https://dx.doi.org/10.4314/br.v23i3.3>

accompanied by decreased sodium levels and a pronounced rise in potassium concentration. Co-administration of AALE (Groups 3–5) produced a dose-dependent improvement in electrolyte profiles, with higher extract doses yielding values progressively closer to normal. Sodium levels increased slightly but significantly across Groups 3–5, while potassium

concentrations were notably reduced compared with the gentamicin-only group. In addition, bicarbonate levels were significantly elevated in all AALE-treated groups relative to the untreated group, indicating further restoration of electrolyte homeostasis.

Table 1: Effects of AALE on liver and kidney function indices, antioxidant enzymes and serum electrolytes in Wistar rats

Parameters	Group 1	Group 2	Group 3	Group 4	Group 5
Urea (mg/dl)	45.33 ± 1.52 ^a	138.0 ± 1.00 ^c	80.67 ± 1.15 ^b	97.33 ± 2.02 ^b	127.67 ± 2.08 ^{bc}
Creatine (mg/dl)	1.33 ± 0.58 ^{ab}	4.51 ± 0.77 ^c	1.38 ± 0.57 ^{ab}	0.71 ± 0.00 ^a	1.77 ± 0.57 ^{ab}
Total bilirubin (mg/dl)	1.00 ± 0.00 ^a	4.67 ± 2.30 ^d	1.75 ± 0.00 ^{ab}	2.78 ± 0.01 ^{bc}	2.60 ± 0.30 ^{bc}
(CB) (mg/dl)	0.40 ± 0.58 ^a	2.33 ± 1.53 ^c	0.50 ± 0.57 ^{ab}	0.63 ± 0.57 ^{ab}	0.34 ± 0.57 ^a
Total protein (g/dl)	5.40 ± 0.00 ^c	2.33 ± 0.58 ^a	4.67 ± 0.57 ^{bc}	5.33 ± 0.57 ^c	4.67 ± 0.57 ^{bc}
(ALT) (IU/L)	5.33 ± 1.53 ^a	11.67 ± 2.08 ^b	5.67 ± 1.53 ^a	5.33 ± 1.57 ^a	5.33 ± 1.55 ^a
(AST) (IU/L)	8.00 ± 1.00 ^a	15.00 ± 2.51 ^b	9.00 ± 2.00 ^a	9.33 ± 1.52 ^a	6.67 ± 1.52 ^a
(ALP) (IU/L)	39.00 ± 0.70 ^{ab}	58.00 ± 0.57 ^c	41.00 ± 0.11 ^b	38.33 ± 1.43 ^{ab}	32.67 ± 0.23 ^a
MDA(mg/ml)	1.33 ± 0.57 ^a	4.67 ± 1.16 ^b	1.53 ± 0.57 ^a	1.42 ± 0.57 ^a	1.49 ± 0.58 ^a
CAT(u/mg)	3.67 ± 0.57 ^C	0.28 ± 0.00 ^a	3.67 ± 2.52 ^c	1.97 ± 1.00 ^{bc}	1.90 ± 1.73 ^{bc}
GPX(u/mg)	54.67 ± 0.09 ^C	23.33 ± 0.60 ^a	32.33 ± 0.40 ^{ab}	34.67 ± 0.51 ^{bc}	44.33 ± 0.28 ^{bc}
SOD (u/mg)	11.15 ± 0.00 ^b	8.00 ± 1.73 ^a	11.27 ± 0.00 ^b	11.45 ± 0.01 ^b	11.35 ± 0.00 ^b
GSH (mg/dl)	2.67 ± 2.08 ^{ab}	1.09 ± 0.58 ^a	3.31 ± 1.53 ^b	2.00 ± 0.00 ^{ab}	2.30 ± 0.00 ^{ab}
chloride (mmol/L)	98.67 ± 1.54 ^a	150.00 ± 3.00 ^c	112.33 ± 2.51 ^a	130.00 ± 1.00 ^{bc}	134.00 ± 1.00 ^{bc}
sodium (mmol/L)	125.00 ± 1.73 ^{bc}	98.67 ± 2.88 ^a	106.00 ± 1.00 ^{abC}	109.00 ± 1.00 ^{abc}	114.33 ± 1.76 ^{abc}
potassium (mmol/L)	12.67 ± 0.15 ^{ab}	30.33 ± 0.40 ^c	11.00 ± 0.10 ^{ab}	20.67 ± 0.30 ^{bc}	22.33 ± 0.11 ^{bc}
bicarbonate (mmol/L)	52.44 ± 2.08 ^c	29.67 ± 0.57 ^a	37.33 ± 1.15 ^{ab}	40.33 ± 1.15 ^{bc}	31.67 ± 1.15 ^{ab}
chloride (mmol/L)	98.67 ± 1.54 ^a	150.00 ± 3.00 ^c	112.33 ± 2.51 ^a	130.00 ± 1.00 ^{bc}	134.00 ± 1.00 ^{bc}

Results were expressed as mean ± SEM of 5 rats. Means of the same row with different letters differ significantly ($P < 0.05$). Group 1 = 5 ml/kg/day of distilled water; Group 2 = 80 mg/kg of gentamicin (single dose); Group 3 = 80 mg/kg of gentamicin (single dose) + 100 mg/kg/day of AALE; Group 4 = 80 mg/kg of gentamicin (single dose) + 200 mg/kg/day of AALE; Group 5 = 80 mg/kg of gentamicin (single dose) + 300 mg/kg/day of AALE.

Histopathology

Liver histopathology

Plate 1A (Normal control): The hepatic architecture was preserved, with hepatocytes arranged in radiating cords around central veins, exhibiting normal histomorphology.

Plate 1B (Negative control): Mild-to-moderate multifocal hepatocellular necrosis and mild periportal hepatocyte swelling around central veins (V) were evident.

Plates 1C–1E (AALE-treated groups, 100, 200, and 300 mg/kg, respectively): Progressive dose-dependent restoration of hepatic architecture was observed, with reduced necrosis and cellular swelling, indicating hepatoprotective effects of AALE.

Kidney histopathology

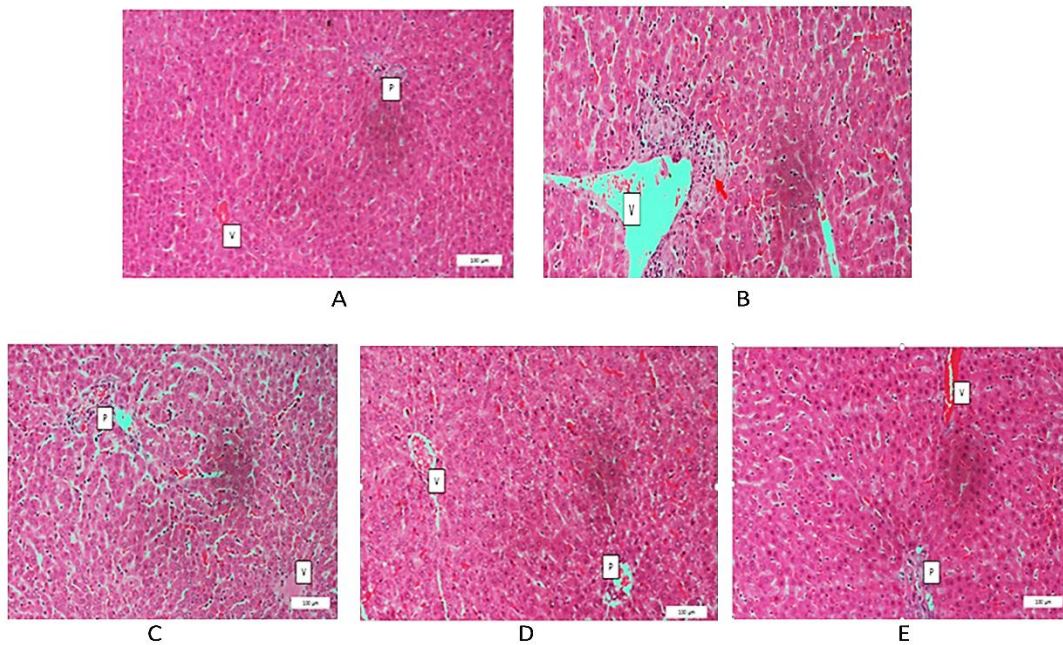
Plate 2A (Normal control): Renal tissue displayed normal histoarchitecture, with intact glomeruli (G) within Bowman’s capsules and well-preserved proximal and distal tubules.

Plate 2B (Negative control): Severe tubular degeneration and necrosis (indicated by arrows) were predominant in the cortical region, reflecting significant nephrotoxicity.

Plates 2C–2E (AALE-treated groups, 100, 200, and 300 mg/kg, respectively): Marked improvement in tubular integrity and reduction in necrotic changes were observed with increasing doses of AALE, demonstrating dose-dependent renoprotective efficacy.

HISTOPATHOLOGICAL FINDING OF LIVER AND KIDNEY TISSUES

1) Liver Tissues changes



2) Kidney Tissues changes

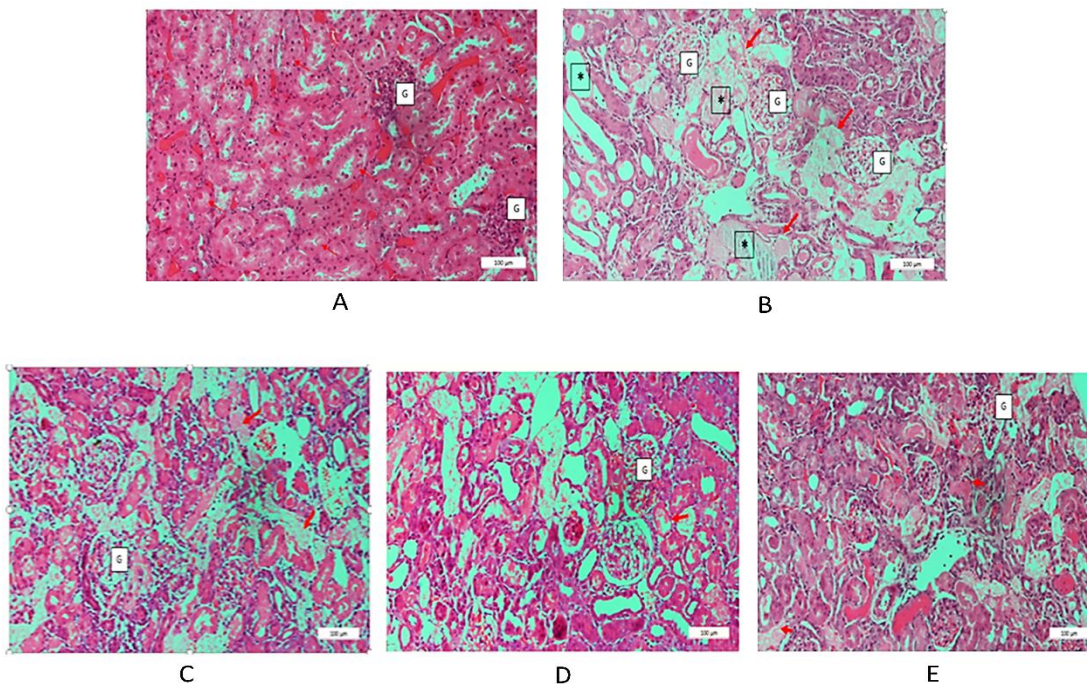


Plate 1: Histopathological changes of Liver and Kidney Tissues. A, kidney of rat that received 1 mL/kg/day of distilled water; B, kidney of rat induced with gentamicin (80 mg/kg) only; C, kidney of rats induced with gentamicin (80 mg/kg) + 100 mg/kgBW of AALE; D, kidney of rats induced with gentamicin (80 mg/kg) + 200 mg/kgBW of AALE; E, kidney of rats induced with gentamicin (80 mg/kg) + 300

Discussion

The liver plays a pivotal role in the detoxification and elimination of xenobiotics from the body. Its functional integrity is commonly assessed through the serum activities of key hepatocellular enzymes, including ALT, AST and ALP, which are primarily localized in the cytoplasm. Elevation of these enzymes in the bloodstream reflects hepatocellular injury and the extent of hepatic damage (Dominic et al., 2012).

In the present study, hepatic function was evaluated by measuring serum biochemical parameters. Rats administered gentamicin alone exhibited significantly elevated serum activity of AST, ALT and ALP compared to the normal control group indicative of substantial disruption in liver architecture and function. AST: 15.00 ± 2.51 IU/L (vs. 8.00 ± 1.00 IU/L in normal control group), ALT: 11.67 ± 2.08 IU/L (vs. 5.33 ± 1.53 IU/L in normal control group), ALP: 58.00 ± 0.57 IU/L (vs. 39.00 ± 0.70 IU/L in normal control group). The observed elevations in these biochemical markers may be attributed to gentamicin-induced lipid peroxidation of hepatocyte membranes, compromising cellular integrity and facilitating the leakage of cytosolic and membrane-bound enzymes into the circulation. Increases in serum enzyme activities following gentamicin exposure have been documented in experimental models, where gentamicin exposure resulted in marked increases in these biomarkers: AST (200 U/L (vs <50 U/L in control), ALP (230 U/L (vs 80 U/L in control) and ALT (58 MMOI/L (vs 26 MMOI/L in control) (Ogundipe et al., 2021). However, co-administration of AALE at doses of 100, 200, and 300 mg/kg body weight produced a significant reduction in ALP activity, with corresponding values of 41.00 ± 0.11 , 38.33 ± 1.43 , and 32.67 ± 0.23 U/L, respectively. Similarly, AALE treatment exhibited a dose-dependent decrease in ALT activity, with the most pronounced reductions observed at 200 and 300 mg/kg (5.33 ± 1.57 and 5.33 ± 1.55 U/L, respectively) reaching values comparable to the normal control group. Notably, administration of 300 mg/kg AALE restored AST activity to levels lower than those of the normal control group (6.67 ± 1.52 vs. 8.00 ± 1.00 U/L), indicating strong hepatoprotective and restorative effects. The decrease in activity of these enzymes shows that the leaf extracts has ability to protect the membrane of hepatocytes from lipid peroxidation. Kolawole et al. (2019) reported a significant reduction in serum AST and ALP activities following administration of aqueous leaf extract of *Phyllanthus amarus* in male Wistar rats with acetaminophen-induced liver damage. Furthermore, the treatment groups exhibited a significant reduction ($P < 0.05$) in gentamicin-induced elevations of serum urea, total bilirubin, conjugated bilirubin, creatinine, and electrolyte levels, indicating effective restoration of renal and hepatic function. The reduction of urea and creatinine levels toward normal values implies that AALE protects the kidneys either by reducing oxidative stress or by inhibiting inflammatory pathways that contribute to renal damage (Tienda- Vázquez et al., 2022).

Additionally, the absence of significant differences in SOD activity and MDA levels between the normal control group and the AALE-treated groups indicates that AALE not only halts the progression of gentamicin-induced oxidative injury but also facilitates the complete restoration of redox homeostasis in the liver and kidney, returning these organs to a physiologically normal oxidative state. Tijani et al. (2020) reported that co-administration of *Chasmanthera dependens* methanol extract with piroxicam significantly lowered MDA levels while enhancing GSH, SOD, and CAT activities, demonstrating the extract's ability to scavenge piroxicam-induced ROS and prevent oxidative stress. The hepatoprotective and renoprotective effects of AALE were further corroborated by histopathological examination of liver and kidney tissues, which closely aligned with the serum biochemical findings. Administration of AALE effectively restored near-normal histological architecture in the liver, demonstrating substantial reversal of gentamicin-induced structural damage.

Conclusion

The result of this study revealed that 80mg/kg of gentamicin could inflict some degree of toxicity to the liver and kidney of the rats. This was shown in the histopathological examination results coupled with markedly elevated levels of liver biochemical markers. Also, significant changes of kidney biochemical indices which includes increased levels of serum urea, creatinine, electrolytes and decreased total protein level was observed in the negative control group. This study demonstrated that treatment with dried *Allophylus africanus* leaf extract significantly decreased physiological and histopathological alterations induced by gentamicin in treated adult male Wistar albino rats. These leaves extracts curtailed the toxic effects of gentamicin on the liver and kidney.

These findings underscore the potential of dried *Allophylus africanus* hydro-methanol leaf extract as a therapeutic agent for the prevention and management of oxidative stress-associated renal and hepatic dysfunction. This will therefore require further research into the underlying mechanism and its clinical efficacy in establishing. *Allophylus africanus* for long-term.

Conflict interest

Authors have no conflict of interest to declare.

Funding Source

This work is made possible with the financial support of TETFUND under the academic Staff Training and Development (AST & D) intervention to David Umahi Federal University of Health Sciences Uburu with grant number (DUFUHS/VC/TETFUND/AST&D/24/067).

Acknowledgements

The authors are extremely grateful to the Tertiary Education Trust Funds (TETFUND)

DOI: <https://dx.doi.org/10.4314/br.v23i3.3>

Author contribution

OBO identified the research problem, designed the experiment, and wrote the manuscript. OUS supervised the work, OOT proofread the manuscript, ECG and AEE conducted the literature review while IEE assembled the methodology.

References

- Arthur, J. R., and Boyne, R. (1985). Superoxide dismutase and glutathione peroxidase activities in neutrophils from selenium-deficient and copper-deficient cattle. *Life Sciences*, 36(16), 1569–1575. [https://doi.org/10.1016/0024-3205\(85\)90381-9](https://doi.org/10.1016/0024-3205(85)90381-9)
- Al-Naimi, M. S., Rasheed, H. A., Hussien, N. R., Al-Kuraishy, H. M., and Al-Gareeb, A. I. (2019). Nephrotoxicity: Role and significance of renal biomarkers in the early detection of acute renal injury. *Journal of Advanced Pharmaceutical Technology & Research*, 10(3), 95–99. https://doi.org/10.4103/japtr.JAPTR_336_18
- Babaeenzhad, E., Mohammadi, E., Saadat, S., & Ahmadvand, H. (2019). Protective effect of *Crocus sativus* L. (saffron) extract on gentamicin-induced nephrotoxicity in rats: Role of oxidative stress and inflammation. *Comparative Clinical Pathology*, 28(5), 1347–1355. <https://doi.org/10.1007/s00580-019-02962-5>
- Balogun, O. S., Oladosu, I. A., & Liu, Z. (2016). Fatty acid profile and in vitro biological activities of *Allophylus africanus* (P. Beauv). *Journal of Herbs, Spices and Medicinal Plants*, 22(3), 238–246. <https://doi.org/10.1080/10496475.2016.1190319>
- Barham, D., & Trinder, P. (1972). An improved colour reagent for the determination of blood glucose by the oxidase system. *Analyst*, 97(115), 142–145. <https://doi.org/10.1039/AN9729700142>
- Bencheikh, N., Bouhrim, M., Kharchoufa, L., Al Kamaly, O. M., Mechchate, H., Es-Safi, I., Dahmani, A., Ouahhoud, S., El-Assri, S., Eto, B., Bnouham, M., Choukri, M., & Elachouri, M. (2021). The nephroprotective effect of *Zizyphus lotus* L. (Desf.) fruits in a gentamicin-induced acute kidney injury model in rats: A biochemical and histopathological investigation. *Molecules*, 26(12), Article 3560. <https://doi.org/10.3390/molecules26123560>
- Bhardwaj, A., Sharma, S., & Sharma, R. (2023). Phytochemicals as hepatoprotective agents: A comprehensive review. *Journal of Ethnopharmacology*, 312, Article 116478. <https://doi.org/10.1016/j.jep.2023.116478>
- Brahim, F. S., Mohammed, Z., Nuhu, A., Shehu, S., & Ilyas, N. (2018). Acute toxicity and anti-inflammatory activity of hydro-methanol leaves extract of *Allophylus africanus* Beauv in rats. *Journal of Herbed Pharmacology*, 7(2), 119–123. <https://doi.org/10.15171/jhp.2018.19>
- Dominic, A. A., Parkavi, C., Murugaiah, K., & Dhanaraj, T. S. (2012). Hypolipidemic activity of *Cyperus rotundus* on CCl₄-induced dyslipidemia in rats. *Asian Journal of Pharmaceutical Technology*, 2(2), 51–53.
- Drury, R. A. B., Wallington, E. A., & Cameron, R. (1967). *Carleton's histological techniques* (4th ed.). Oxford University Press.
- Edeogu, C. O., Kalu, M. E., Famurewa, A. C., Asogwa, N. T., Onyeji, G. N., & Ikpemo, K. O. (2020). Nephroprotective effect of *Moringa oleifera* seed oil on gentamicin-induced nephrotoxicity in rats: Biochemical evaluation of antioxidant, anti-inflammatory, and antiapoptotic pathways. *Journal of the American College of Nutrition*, 39(4), 307–315. <https://doi.org/10.1080/07315724.2019.1662302>
- Enenebeaku, U. E., Okotcha, E. N., Oguoma, L. M. O., Mgbemena, I. C., Enenebeaku, C. K., & Onyeka, C. A. (2021). Biochemical and haematological enhancement activities of aqueous and methanol leaves, stem and roots extracts of *Chasmanthera dependens* (Hochst) and *Dictyandra arborescens* (Welw.). *Bulletin of the National Research Centre*, 45, Article 186. <https://doi.org/10.1186/s42269-021-00642-7>
- Ferreres, F., Gomes, N. M. G., Valentão, P., Pereira, D. M., Gil-Izquierdo, A., Araújo, L., Silva, T. C., & Andrade, P. B. (2018). Leaves and stem bark from *Allophylus africanus* P. Beauv.: An approach to anti-inflammatory properties and characterization of their flavonoid profile. *Food and Chemical Toxicology*, 118, 430–438. <https://doi.org/10.1016/j.fct.2018.05.046>
- Gathirwa, J. W., Rukunga, G. M., Mwitari, P. G., & Mwikwabe, N. (2011). Traditional herbal antimalarial therapy in Kilifi district, Kenya. *Journal of Ethnopharmacology*, 134(2), 434–442. <https://doi.org/10.1016/j.jep.2010.12.036>
- Ghagane, S. C., Puranik, S. I., Nerli, R. B., & Hiremath, M. B. (2017). Evaluation of in vitro antioxidant and anticancer activity of *Allophylus cobbe* leaf extracts on DU-145 and PC-3 human prostate cancer cell lines. *Cytotechnology*, 69(1), 167–177. <https://doi.org/10.1007/s10616-016-0048-3>
- Gross, P. J., Steinberg, S. M., Reilly, J. G., et al. (2011). Practical approach to hyponatremia. *Deutsche Medizinische Wochenschrift*, 136(34–35), 1728–1732. <https://doi.org/10.1055/s-0031-1286059>
- Jollow, D. J., Mitchell, J. R., Zampaglione, N., & Gillette, J. R. (1974). Bromobenzene-induced liver necrosis: Protective role of glutathione and evidence for 3,4-bromobenzene oxide as the hepatotoxic metabolite. *Pharmacology*, 11(3), 151–169. <https://doi.org/10.1159/000136485>
- Kwiatkowska, E., Domanski, L., Dziedziczko, V., Kajdy, A., Stefanska, K., & Kwiatkowski, S. (2021). The

DOI: <https://dx.doi.org/10.4314/br.v23i3.3>

- mechanism of drug nephrotoxicity and the methods for preventing kidney damage. *International Journal of Molecular Sciences*, 22(11), Article 6109. <https://doi.org/10.3390/ijms22116109>
- Mayne, P. D. (1994). *Clinical chemistry in diagnosis and treatment* (6th ed.). Hodder Arnold.
- Moghadam, A., Khozani, T. T., Mafi, A., Namavar, M. R., & Dehghani, F. (2017). Effects of platelet-rich plasma on kidney regeneration in gentamicin-induced nephrotoxicity. *Journal of Korean Medical Science*, 32(1), 13–21. <https://doi.org/10.3346/jkms.2017.32.1.13>
- Noorani, A. A., Karan, A. G., Khushboo, B., & Kale, M. K. (2011). Protective effect of methanolic leaf extract of *Caesalpinia bonduc* (L.) on gentamicin-induced hepatotoxicity and nephrotoxicity in rats. *Iranian Journal of Pharmacology & Therapeutics*, 10(1), 21–25.
- Ogundipe, O. J., Akinpelu, O. F., Oyerinde, A., & Oluwakemi, O. R. (2021). *Ocimum gratissimum* (Linn) leaves extract attenuates oxidative stress and liver injury in gentamicin-induced hepatotoxicity in rats. *Egyptian Journal of Basic and Applied Sciences*, 8(1), 146–155. <https://doi.org/10.1080/2314808X.2021.1925628>
- Okoye, N. N., Nwokoye, J. N., Muobike, C. M., Ojoko, F. O., Emmanuel, D. A., & Uche, F. O. (2024). Comparative phytochemical and antioxidant studies of the hexane and ethyl acetate fractions of the methanol extracts of the stem bark of *Allophylus africanus*. *Journal of Current Biomedical Research*, 4(6).
- Pandit, A., Sachdeva, T., & Bafna, P. (2012). Drug-induced hepatotoxicity: A review. *Journal of Applied Pharmaceutical Science*, 2(5), 233–243. <https://doi.org/10.7324/JAPS.2012.2541>
- Reitman, S., & Frankel, S. (1957). A colorimetric method for the determination of serum glutamic-oxaloacetic and glutamic-pyruvic transaminases. *American Journal of Clinical Pathology*, 28(1), 56–63. <https://doi.org/10.1093/ajcp/28.1.56>
- Sinha, A. K. (1972). Colorimetric assay of catalase. *Analytical Biochemistry*, 47(2), 389–394. [https://doi.org/10.1016/0003-2697\(72\)90132-7](https://doi.org/10.1016/0003-2697(72)90132-7)
- Smith, K. M., Riche, D. M., & Henyan, N. N. (2010). *Clinical drug data*. McGraw Hill.
- Sofidiya, M. O., Jimoh, F. O., Aliero, A. A., Afolayan, A. J., Odukoya, O. A., & Familoni, O. B. (2012). Evaluation of antioxidant and antibacterial properties of six Sapindaceae members. *Journal of Medicinal Plants Research*, 6(1), 154–160. <https://doi.org/10.5897/JMPR11.1123>
- Tijani, A. S., Olori, O. D., & Olatunde, F. (2020). Methanol extract of *Chasmanthera dependens* stem mitigates against mechanisms involved in piroxicam-induced liver damage in rat. *Journal of Complementary and Alternative Medical Research*, 10(4), 16–28. <https://doi.org/10.9734/jocamr/2020/v10i430159>
- Tienda-Vázquez, M. A., Morreeuw, Z. P., Sosa Hernández, J. E., Cardador-Martínez, A., Sabath, E., Melchor-Martínez, E. M., Iqbal, H. M. N., & Parra Saldívar, R. (2022). Nephroprotective plants: A review on the use in pre-renal and post-renal diseases. *Plants*, 11(6), Article 818. <https://doi.org/10.3390/plants11060818>
- Tomşa, A. M., Răchişan, A. L., Pandrea, S. L., Benea, A., Uifălean, A., Pârvu, A. E., & Junie, L. M. (2021). Accelerated lipid peroxidation in a rat model of gentamicin nephrotoxicity. *Experimental and Therapeutic Medicine*, 22(5), Article 1218. <https://doi.org/10.3892/etm.2021.10652>
- Wallin, B., Rosengren, B., Shertzer, H. G., & Camejo, G. (1993). Lipoprotein oxidation and measurement of thiobarbituric acid-reacting substances formation in a single microtiter plate: Its use for evaluation of antioxidants. *Analytical Biochemistry*, 208(1), 10–15. <https://doi.org/10.1006/abio.1993.1002>
- Watanabe, T. (2016). Physiological and pathological interactions between liver and kidney. In H. Ohira (Ed.), *The liver in systemic diseases* (pp. 197–214). Springer. https://doi.org/10.1007/978-4-431-55790-6_11

Publisher's Note: Bio-Research remains neutral with regard to jurisdictional claims in published maps and institutional affiliations. Bio-Research or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.