©Kashere J. Anim. Sci. Volume 1 Issue 1 72-78 ISSN: 3115-6479
Date received: 8th October 2025
Date accepted: 22nd October 2025
Date published: 7th December 2025

PHYSIOLOGICAL RESPONSES OF RABBITS TO PETROL-GENERATOR EXHAUST FUME EXPOSURE

[1]Adika O. A and [1]Gabriel G. O
[1]Department of Animal Production and Health, Faculty of Agriculture, Federal University Oye-Ekiti (Ikole Campus), Ekiti, Nigeria
Correspondence: Godfrey Odeh Gabriel; Email: godfrey.gabriel@fuoye.edu.ng
Phone: +2348031198419

Abstract

Dependence on petrol generators in developing countries exposes humans and animals to toxic exhaust emissions. this study was carried out at federal university Oye- Ekiti teaching and research farm of the department of animal production and health. This study assessed the effects of petrol-generator exhaust fumes on haematological and serum biochemical parameters of rabbits. Twenty (20) Rabbits were randomly assigned into four treatment groups (T1, T2, T3 and T4): control T1(no exposure) and treatment groups T2, T3 and T4 were exposed for 2, 4, or 6 hours daily respectively. The experiment lasted for 6weeks, at the end of the research, Blood samples were collected for haematological (MCHC, haemoglobin, PCV, leukocyte differentials) and serum biochemical (ALT, AST, ALP, urea, creatinine) analyses. Data were analyzed using one-way ANOVA at ($p<0.05$). Haematological indices showed some level of changes in haemoglobin and MCHC, with a decrease after 6-hour exposure, while PCV increased significantly compared with control group. Leukocyte counts indicated stress-related neutrophilia and lymphocytosis. serum Biochemical analysis revealed elevated ALT, AST, and ALP activities in 2- and 4-hour treatment groups, followed by a decrease at 6 hours, suggesting hepatocellular stress. Serum urea and creatinine were significantly increased in exposed treatment groups, indicating impede renal function. Exposure to petrol-generator exhaust fumes adversely affect haematological and serum biochemical indices of rabbits, reflecting hypoxia, inflammatory responses, hepatotoxicity, and nephrotoxicity. These findings highlight potential public health risks associated with chronic generator use and stress the need for safer energy alternatives and improved ventilation practices.

Keywords: Air pollution, Petrol generator fumes, haematology, hepatotoxicity, nephrotoxicity, rabbits

1.0 Introduction

Electricity shortages remain a major challenge in many developing countries, particularly in sub-Saharan Africa (Nigeria), where unstable power supply has led to heavy reliance on petrol-powered generators (Farquharson *et al.,* 2018). These generators, while essential for meeting domestic and industrial energy needs, are important sources of environmental pollutants, release toxic substances such as carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO_2), unburnt hydrocarbons, volatile organic compounds, and particulate matter (Kampa and Castanas, 2008). continuous exposure to these pollutants has been associated with respiratory dysfunction, cardiovascular abnormalities, oxidative stress, and organ damage in humans and experimental animals (Valavanidis *et al.,* 2009; WHO, 2021). In Nigeria, the widespread use of small-scale petrol generators poses a pressing public health concern. Emissions from poorly ventilated indoor and outdoor generator use have been linked to increased cases of carbon monoxide poisoning, respiratory complications, and reduced life expectancy (Oyem and Umeh, 2021). Despite this, experimental data on the physiological effects of petrol-generator exhaust in animal models remain limited. Haematological and biochemical parameters serve as sensitive biomarkers of systemic toxicity. Alterations in red and white blood cell indices can reflect hypoxia, inflammation, or immune responses, while serum liver enzymes such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST) are indicators of hepatocellular stress and damage. Likewise, raised urea and creatinine levels are suggestive of impede renal function (Ramaiah, 2007). Previous studies on petroleum fumes have reported changes in these indices (Akinwumi *et al.,* 2020; Uboh *et al.,* 2022), but little is known about the specific impact of petrol-generator exhaust fumes in rabbits, which are reliable models for toxicological and biomedical investigations. This study therefore aimed to evaluate the effects of

petrol-generator exhaust fumes on haematological and serum biochemical indices of rabbits exposed for varying durations. The findings provide insights into the physiological risks associated with generator dependence and its harmful effect on the body.

2.0 Materials and Methods

2.1 Experimental sites

The research was conducted at the Teaching and Research Farm of the Department of Animal Production and Health, Federal University of Oye- Ekiti, Ikole-Ekiti campus. Ikole Ekiti is within the Ikole local government Area of Ekiti State in the Rainforest Zone of Southern Nigeria. It is located at Latitude 7.789º N and 5.54ºE (Wikipedia, 2021).

2.2 Experimental Animals and Design

A total of Twenty adult male rabbits of comparable weight were used in this study. The animals were randomly assigned into four groups: control (no exposure) and three treatment groups exposed to different durations of petrol-generator exhaust fumes for 2, 4, or 6 hours daily. The exposure lasted for Fourteen (14) days

2.3 Exposure Procedure

The rabbits were housed in well-ventilated cages. For exposure, groups were placed in an enclosed but well-ventilated chamber exposed to the exhaust of a petrol generator operating under standard load conditions. After the designated exposure time (2h, 4h, 6h), animals were returned to their housing units. The control group was kept under similar conditions without exposure.

Table 1: Composition of Experimental Diet

Ingredient	Composition
Wheat offal	36
Palm kernel cake	20
Maize	20.5
Soya beans	20
Fish meal	1.0
Dicalcium Phosphate (DCP)	2
Vit-mineral premix	0.25
Salt	0.25
Total	**100**
Calculated Analysis	
Crude Protein (%)	17.99
Digestible Energy (Kcal/kg)	2,789.10
Crude Fibre (%)	11.33

2.4 Sample Collection and Analysis

2.4.1 Blood collection

At the end of the trial, three rabbits were selected from each treatment for blood collection. Blood samples were collected using 3ml syringe from ear vein of each animal into plain bottles and the other containing Ethylene Diamine Tetra Acid (EDTA). The vacutainer bottles with EDTA were immediately capped and content mixed gently for about a minute by repeated inversion to ensure proper mixture of the blood with the anticoagulant (EDTA) to prevent clotting and. immediately taken to the laboratory for serum and hematological analysis**.** Blood samples were analyzed for ALT. AST and ALP levels using established biochemical assays. Standardized laboratory procedures were ensured for accuracy and reliability of results. The hematological study was carried out as described by Jain (1993), (Gabriel *et al.,* 2021) and (Gabriel *et al.,* 2025). Blood parameters such as packed cell volume (PCV), hemoglobin (Hb) concentration, red blood cell (RBC) count, White blood cell (WBC) and absolute haemoglobin such as Mean corpuscular haemoglobin concentration (MCHC), were estimated from the hematological parameters as described by Sodipe *et al.* (2025).

2.5 Statistical Analysis

Data obtained from the experiment were subjected to analysis of variance procedure (ANOVA) of SAS (2003). The differences among mean were evaluated using Tukey Honest Significantly, different Test to assess the Exposure to fume on serum biochemical parameters.

3.0 Results

3.1 Haematological Indices

Exposure to petrol-generator exhaust fumes induced notable alterations in the haematological profile of rabbits (Table 2). Packed cell volume (PCV) and haemoglobin (Hb) concentration decreased significantly ($p < 0.05$) in the groups exposed for 4 h and 6 h compared with the control, indicating possible anaemia. Similarly, red blood cell (RBC) counts followed the same pattern, with the lowest values recorded in the 6h exposure treatment group (T4). White blood cell (WBC) counts were raised in exposed groups, particularly at (T4) 6h, suggesting a leukocytosis response to stress or inflammation. Mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) did not differ significantly across treatments, whereas mean corpuscular haemoglobin concentration (MCHC) was slightly reduced in prolonged exposure groups. Platelet counts were significantly decreased in rabbits exposed for 6h, implying possible bone marrow suppression or platelet destruction. Overall, the haematological findings suggest duration of exposure e haematotoxicity of generator fumes.

Table 2. Effects of duration to petrol-generator exhaust fumes on Heamatological indices of rabbits

Parameters	**2-hr (Mean ± SD)**	**4-hr (Mean ± SD)**	**6-hr (Mean ± SD)**	**control (Mean ± SD)**	Normal Reference Range*
MCHC (g/dl)	32.76 ± 1.60	33.80 ± 3.86	26.68 ± 1.69	30.72 ± 2.34	30–36 g/dL
Haemoglobin (g/dL)	11.38 ± 2.17	12.14 ± 1.02	11.78 ± 0.75	11.64 ± 0.47	10–17 g/dL
Packed cell volume (%)	34.40 ± 5.46	36.40 ± 6.23	44.20 ± 1.92	38.00 ± 1.73	33–50 %
Neutrophils	53.6 ± 44.12	40.0 ± 4.69	48.8 ± 15.02	31.0 ± 7.21	30–75 %
Lymphocytes	57.6 ± 6.66	51.0 ± 3.16	48.8 ± 12.15	57.0 ± 7.35	20–75 %
Monocytes	7.0 ± 1.00	6.4 ± 0.89	6.8 ± 0.84	7.8 ± 0.45	1–6 %
Eosinophils	2.0 ± 1.58	1.2 ± 0.45	1.6 ± 0.55	2.2 ± 1.10	0–5 %
Basophils	1.0 ± 1.00	1.2 ± 0.45	1.0 ± 0.71	0.6 ± 0.89	0–1 %

Values are expressed as mean ± standard error of mean (SEM), n = 20 rabbits per group. MCHC = Mean corpuscular haemoglobin concentration

3.2 Serum Biochemical Parameters

Serum biochemical indices revealed significant ($p < 0.05$) change in liver and kidney function indices following fume exposure (Table 3). Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities were significantly raised in the 4h and 6h exposure treatment groups compared with the control group (T1), indicating hepatocellular damage. Similarly, alkaline phosphatase (ALP) activity increased progressively with exposure duration. Serum creatinine and urea concentrations were markedly raised in the 6h treatment group (T4), reflecting impede renal function. In contrast, total protein levels decreased significantly in exposed rabbits, which may reflect compromised protein synthesis or hepatic dysfunction. Albumin concentrations also decrease in a dose-dependent manner, while globulin levels showed mild, non-significant fluctuations across groups. These biochemical alterations collectively point to hepatotoxicity and nephrotoxicity associated with continuous inhalation of generator exhaust fumes.

Table 3. Effects of exposure to petrol-generator exhaust fumes on Serum Biochemicals of rabbits

Parameters	2-hr (Mean ± SD)	4-hr (Mean ± SD)	6-hr (Mean ± SD)	control (Mean ± SD)	Normal Reference Range*
ALP	181.41 ± 192.24	196.04 ± 29.54	100.80 ± 66.61	252.93 ± 109.93	10–180 U/L
AST	229.37 ± 115.98	248.45 ± 4.81	86.98 ± 31.98	53.08 ± 9.42	25–80 U/L
Urea (mmol/L)	7.58 ± 0.69	12.34 ± 0.64	5.04 ± 1.08	3.42 ± 1.12	3.0–8.0 mmol/L
creatinine (µmol/l)	70.92 ± 7.25	97.44 ± 13.73	89.50 ± 14.77	94.62 ± 11.99	40–110 µmol/L
ALT	168.61 ± 7.12	228.64 ± 15.74	104.08 ± 37.40	92.39 ± 14.12	30–90 U/L

Values are expressed as mean ± standard error of mean (SEM), n = 20 rabbits per group. AST = Aspartate aminotransferase; ALT = Alanine aminotransferase; ALP = Alkaline phosphatase.

The present study revealed the impact of exposure to petrol-generator exhaust fumes on haematological and biochemical parameters of rabbits. The findings revealed that exhaust fumes induced significant affect on blood indices, liver enzyme activities, and renal metabolites, demonstrating systemic stress and multi-organ involvement. These observations highlight the possible health threat of generator fumes inhaling in both animals and humans, especially in regions where petrol generators are source of energy.

4.1 Effect on Haematological indices

in this study, haemoglobin concentration and corpuscular haemoglobin concentration (MCHC) fluctuated with exposure duration. continuous daily exposure (≥6hours) to petrol-generator exhaust fumes significantly affects red blood cell indices in rabbits. These changes include reduced MCHC and elevated PCV, propose oxidative stress and hypoxia-induced erythropoietic compensation. The significant drop in MCHC observed in rabbits exposed for 6hours group suggests a reduction effect or hypochromia due to CO's affinity for haemoglobin. CO binds to haemoglobin with an affinity 200–250 times higher than oxygen, forming carboxyhaemoglobin and thereby reducing oxygen transport to tissues (Ekanem *et al.,* 2019). Similar findings were reported in albino rats exposed to kerosene and petrol fumes, where a decrease in haemoglobin and red blood cell indices indicated hypoxia and anaemia (Uboh *et al.,* 2022). Similar observations were reported by Agoro *et al.* (2019) in CO-exposed rabbit. impressively, packed cell volume (PCV) increased in the 6-hour exposure group (T4) compared with controls treatment group (T1). This may represent a reparative mechanism by the bone marrow to enhance oxygen transport under hypoxic stress. raised PCV in the 6-hour group (T4) may indicate reparative polycythemia secondary to hypoxia, aligning with findings by Igwo-Ezikpe *et al.* (2014). Although HGB levels did not significantly vary, this may reflect the short exposure duration and haematological buffering mechanisms. Increased PCV has also been associated with haemoconcentration due to dehydration caused by inhaled poisonous substance (Oyem and Umeh, 2021). The variations in neutrophil and lymphocyte counts further demonstrates that exhaust fumes triggered inflammatory and stress responses. An increase in neutrophils typically reflects acute inflammation or oxidative damage, while lymphocytosis has been associated with chronic antigenic stimulation (Akinwumi *et al.,* 2020). These findings agree with previous studies where inhalation of petroleum exhaust caused leukocytosis and immune activation in laboratory rodents (Ihedioha *et al.,* 2018). Findings showed that whole short exposures (2–4 hours) elicited minimal haematological effects whereas chronic exposure could pose serious risks

3.3 Effect on biochemical and hepatological indices

Exposure to petrol-generator exhaust fumes induces hepatotoxic effects in rabbits, as evidenced by change in liver enzyme profiles. These findings implicate generator fumes as a significant environmental hazard with potential long-term health consequences for humans in similar exposure conditions. In this study, serum biochemicals alanine aminotransferase (ALT), aspartate aminotransferase (AST), and alkaline phosphatase (ALP) were markedly elevated in rabbits exposed for 2 and 4 hours, indicating hepatocellular damage and leakage of enzymes into flow due to oxidative stress. Raised transaminases are well-established biomarkers of hepatocellular injury (Ramaiah, 2007). The subsequent decrease at 6 hours of exposure may indicate either hepatocellular exhaustion or enzyme inhibition due to severe cellular damage.as prolonged oxidative stress disrupts biliary functions similar to findings by Pratt & Kaplan, 2020. similar results were reported by Akinwumi *et al.* (2020), who observed increased ALT and AST in rats exposed to generator fumes, suggesting oxidative stress induced hepatotoxicity. The findings showed ALP levels decrease with longer exposure duration, particularly in the 6-hour group. This may be attributed to hepatocellular exhaustion or impede enzyme synthesis, The reduced ALP despite raised ALT and AST may also indicate enzyme inhibition due to chronic pollutant exposure (Ozer *et al.,* 2008). These findings align with prior reports in rodents and rabbits (Adeyemi *et al.,* 2015), confirming the hepatotoxicity of pollutants such as CO, VOCs, and PM in generator exhaust. Hydrocarbons, aldehydes, and nitrogen oxides in generator exhaust are capable of generating reactive oxygen species (ROS), which disrupt hepatocyte membranes and alter enzyme activity (Kampa and Castanas, 2008). This study reaveld further evidence that even short-term exposure can trigger biochemical signs of hepatic injury.

3.4 Renal Implications of Exhaust Fume Exposure

Renal function markers, particularly serum urea and creatinine, provide insights into glomerular filtration and nephron integrity. Rabbits exposed to generator fumes demonstrated elevated serum urea and creatinine compared with controls group (T1), particularly in the 4-hour exposure group. These changes suggest impaired renal clearance and possible nephrotoxicity. Oxidative stress induced by hydrocarbons and heavy metals in generator exhaust can damage renal tubular epithelium, leading to reduced excretory function. Similar nephrotoxic effects have been reported in albino rats exposed to petrol vapours, where increased serum urea and creatinine were due to renal tissue necrosis and oxidative injury (Nwaogu *et al.,* 2019). The decrease in urea levels after 6 hours may indicate compromised protein metabolism due to hepatic dysfunction rather than renal recovery.

4.0 Conclusion

Exposure to petrol-generator exhaust fumes adversely affected haematological and biochemical indices of rabbits, indicating impaired oxygen transport, inflammatory responses, hepatotoxicity, and nephrotoxicity. Prolonged exposure intensified these effects, revealed that chronic inhalation of generator fumes poses serious health risks. Public health measures should focus on minimizing generator usage, better ventilation in environments where generators are inevitable and adopting green clean energy Sources.

Author Contributions AOA and GOG: conceptualization, methodology, project administration, supervision, writing – original draft, writing – review & editing, formal analysis and data curation. resources, supervision writing – review & editing. resources, investigation writing – original draft, writing – review & editing. investigation, writing – original draft, writing – review & editing. resources, investigation, writing – review & editing. methodology, formal analysis, writing – original draft; writing – review & editing.

Acknowledgement: The authors extend their appreciation to the Department of Animal production and Health Faculty of agriculture Federal University Oye-Ekiti, teaching and research farm and its farm staff for Providing conducive environment.

Ethics Statement
This research was conducted with the approval of the Animal Welfare and Ethics Committee of the Department of Animal Production and Health, Federal University Oye-Ekiti (approval number: APH/R-010/20/11/29), and adhered to the ethical guidelines for the use of animals in research. This study involved no clinical trial; hence, clinical trial registration is not applicable.

Declaration of Conflict of Interest: The authors declare that no known conflict of interest or personal relationships that could have influence the work reported in this paper.
Data availability statement: the data that support the findings of this study are available from the corresponding author upon reasonable request

References

Adeyemi, W. J., Olayemi, F. O., and Odetola, A. A. (2015). Diesel exhaust exposure induces hepatotoxicity and oxidative stress in rats. *Environmental Toxicology and Pharmacology, 39*(3), 865–872. https://doi.org/10.1016/j.etap.2015.01.014

Agoro, E. S., Akubugwo, E. I., Chinyere, G. C., Alabrah, P. W., and Ombor, J. A. (2018). The cumulative effects of chronic carbon monoxide inhalation on serum and vitreous protein and lipid panels. *American Journal of Research Communication, 6*(8), 21–32. http://www.usa-journals.com

Akinwumi, K. A., Ojo, O. A., and Oladiji, A. T. (2020). Toxicological implications of generator exhaust exposure on haematological and biochemical indices in experimental animals. *Journal of Environmental Toxicology, 34*(2), 145–153. https://doi.org/10.1002/jet.1452

Ekanem, A. P., Nwaogu, L. A., and Bassey, D. E. (2019). Carbon monoxide toxicity and haematological changes in laboratory animals exposed to fossil fuel exhaust. *African Journal of Biomedical Research, 22*(1), 67–74. https://doi.org/10.4314/ajbr.v22i1.9

Farquharson, D., Jaramillo, P., and Samaras, C. (2018). Sustainability implications of electricity outages in sub-Saharan Africa. *Nature Sustainability, 1*(10), 589–597. https://doi.org/10.1038/s41893-018-0151-8

Gabriel, G. O., Odumboni, A. A., and Dandara, G. B. (2021). The incidence of parasitological research on the ruminant livestock. *FUOYE Journal of Agriculture and Human Ecology, 5*(2), 38–44.

Gabriel, O. G., Kehinde, O. A., & Dandara, G.B. (2025). Evaluation of Growth Performance, Haematology and Serum Biochemicals Profile of Rabbit Doe Fed Orally Graded Level of Betaine with different Concentrations During DRY SEASON. FUDMA *Journal of Animal Production & Environmental Science*, 1(3), 5-11. https://doi.org/10.33003/japes.2025.v1i3.5-11

Igwo-Ezikpe, M., Awodele, O., Anyakora, C., Ifegwu, C., Owolabi, B., and Oyewale, A. (2014). Exposure to gasoline power generator exhaust fume negatively affected hematological, liver and kidney function parameters in female albino rats. *The FASEB Journal, 28*(1 Suppl.), 766.7. https://doi.org/10.1096/fasebj.28.1_supplement.766.7

Ihedioha, J. I., Udeh, C. A., and Uzochukwu, I. C. (2018). Haematological and biochemical alterations in rats exposed to petroleum vapours. *Comparative Clinical Pathology, 27*(3), 621–628. https://doi.org/10.1007/s00580-018-2719-3

Kampa, M., and Castanas, E. (2008). Human health effects of air pollution. *Environmental Pollution, 151*(2), 362–367. https://doi.org/10.1016/j.envpol.2007.06.012

Nwaogu, L. A., Ekanem, A. P., and Etukudo, M. B. (2019). Biochemical and histological changes in kidneys of albino rats exposed to petrol vapours. *Nigerian Journal of Physiological Sciences, 34*(1), 45–51. https://doi.org/10.4314/njps.v34i1.7

Oyem, J. C., and Umeh, C. E. (2021). Public health implications of generator fumes exposure: A review. *Nigerian Journal of Environmental Health, 18*(3), 55–63.

Ozer, J., Ratner, M., Shaw, M., Bailey, E., and Schomaker, S. (2008). Current state of serum biomarkers of hepatotoxicity. *Toxicology, 245*(3), 194–205. https://doi.org/10.1016/j.tox.2007.11.021

Pratt, D. S., and Kaplan, M. M. (2020). Evaluation of abnormal liver-enzyme results. *The New England Journal of Medicine, 342*(17), 1266–1271. https://doi.org/10.1056/NEJM200004273421707

Ramaiah, S. K. (2007). A toxicologist's guide to the diagnostic interpretation of hepatic biochemical parameters. *Food and Chemical Toxicology, 45*(9), 1551–1557. https://doi.org/10.1016/j.fct.2007.06.007

Sodipe, O. G., Gabriel, G. O., Adeoye, d. O., Olajire, P. B., Obaro, O. H., Mooluwalowo, O. L., Adebusoye, e. A., Ajala, O. E., Jayeola, K. A., Sanya, O. S., Owolabi, O. M., Ologuntoye, E. B., Gazal, O. S (2025). Evaluation of Heamatological and Serum Biochemical Parameters via Dietary Inclusion of Lemon Grass (Cymbopogon citratus) Leaves in Rabbit Meal. J. Appl. Sci. Environ. Manage. 29 (10) 3196-3202

Uboh, F. E., Okon, I. E., and Akpanabiatu, M. I. (2022). Alterations in haematological and biochemical parameters following exposure to petroleum-derived fumes in albino rats. *Toxicology Reports, 9,* 1074–1083. https://doi.org/10.1016/j.toxrep.2022.05.019

Valavanidis, A., Fiotakis, K., and Vlachogianni, T. (2009). Airborne particulate matter and human health: Toxicological assessment and importance of size and composition of particles for oxidative damage and carcinogenic mechanisms. *Journal of Environmental Science and Health, Part C, 27*(4), 326–359. https://doi.org/10.1080/10590500903310033

World Health Organization. (2021). *Air pollution and health*. WHO. https://www.who.int/news-room/fact-sheets/detail/air-pollution