

HEPATIC RESPONSE IN THREE CHICKEN BREEDS TO AIR POLLUTANTS: PROTECTIVE ROLE OF VITAMIN C SUPPLEMENTATION

Emeka, O.C. *, Adeoye, O.G., Ogbonda, J.E. and Oleforuh-Okoleh, V.U.

Department of Animal Science, Rivers State University Nkpolu-Oroworukwo, P.M.B. 5080 Port Harcourt,
Rivers State, Nigeria

Corresponding author: Corthel0504@gmail.com; +234 8035328185

ABSTRACT

This study examined the protective effects of Vitamin C supplementation on hepatic function indices in three chicken breeds: FUNAAB Alpha (FAC), Ross 308 broilers (BRO), and Nigerian Light local chicken Ecotype from Niger Delta (ND) raised under controlled exposure to crude oil polluted environment. The experiment involved 216 chickens divided into exposed and unexposed groups. Exposure to hydrocarbons disrupted liver enzymes and protein metabolites suggesting risk to organ dysfunction across all breeds. Remarkably, Vitamin C supplementation decreased the levels of Aspartate aminotransferase, Alanine aminotransferase and Alkaline phosphate with noticeable percentages ranging from 0.36-25.82% across all the breeds, underscoring its antioxidant role in supporting liver. Notably, the FAC and ND chickens exhibited higher resilience to hydrocarbon toxicity. The study highlights the significance of dietary Vitamin C in mitigating environmental pollution's effects on poultry, with implications for enhancing poultry health and production in hydrocarbon-exposed regions like the Niger Delta region of Nigeria.

Keywords: Vitamin C, Hydrocarbon toxicity, Liver function, Poultry health, Crude oil fumes

INTRODUCTION

Petrochemical-driven air pollutants presents significant health hazards, especially in regions heavily engaged in crude oil exploration such as the Niger Delta, Nigeria (Echendu *et al.*, 2022). The toxic effects of these pollutants (polycyclic aromatic hydrocarbons, volatile organic compounds, particulate matters and gaseous emissions) directly impair cellular functions by disrupting homeostasis, through the activation of inflammatory signaling pathways, exacerbating reactive oxygen species (ROS) production in a feedback loop (Burritt, 2008; Zhang *et al.*, 2020). Poultry farming serves as a vital source of animal protein and livelihood for many households (). The risk of hydrocarbon pollutant exposure induced oxidative stress which adversely impact poultry health, welfare and productivity (Al-Kerwi *et al.*, 2022). The liver, the primary organ for detoxifying xenobiotic compounds, play a vital role in maintaining the body's biochemical and physiological homeostasis (Gencer *et al.*, 2015). However, exposure to environmental pollutants such as hydrocarbon poses significant threat to its functional integrity resulting in hepatic inflammation, necrosis, and impaired detoxification capabilities (Samet and Wages, 2018; Manisalidis *et al.*, 2020). Understanding the mitigative role of antioxidants such as Vitamin C on liver function of crude oil pollutant-stressed chickens can help sustain poultry farming in polluted regions. Furthermore, there could be breed-specific variations in response to the pollutant stress and antioxidant supplementation. This study aimed at investigating the breed-specific responses and antioxidant interventions of Vit C fed chickens raised under hydrocarbon exposed environment.

MATERIALS AND METHODS

This study was conducted at Department of Animal Science, Rivers State University Teaching and Research Farm, Port Harcourt, Nigeria, using 216 chicks from three chicken breeds: Ross 308 Agriated broilers BRO, FUNAAB Alpha FAC, and Nigerian light local chicken Ecotype from Niger Delta ND (from crude oil polluted communities - Eleme, Okrika, and Gokana), bred under the same environment from day-old to 35 days of age (DOA). At 35 DOA, the chicks (72 per breed) were allotted randomly into control group (CON - no exposure, no vitamin C), and two treated groups identified as EXPO and EXV (Exposed with no vitamin C and exposed with vitamin C respectively) Each experimental group was replicated three times. The treated groups were raised under controlled exposure to air pollutants achieved by spraying crude oil (1000ml) on alternate days in the poultry pen between 0800 – 1200 hours for 35 days. The Vitamin C supplement (Introvit – C WS (Interchemie, Holland) was administered at 0.5 g/10L water (). Commercial finisher feed (19%CP; 3150 ME/kcal) and water were offered *ad libitum*. At the end of the exposure period, three birds were randomly selected from each replicate, and blood samples (3ml) were collected via the brachial vein into sterile plain red-top vials. The samples were subsequently centrifuged at 3000 RPM for 10 minutes to separate the serum which was carefully extracted for liver function and biochemical analysis. The hepatic function indices examined include, Aspartate aminotransferase (AST), Alanine aminotransferase (ALT) and Alkaline phosphate (ALP), total protein TP, albumin ALB, and globulin GLO.

Analysis of Data

Data were analysed using analysis of variance (ANOVA) option of SAS statistical package.

RESULTS AND DISCUSSION

Table 1 shows the effect of breed and exposure on the hepatic function indices of chickens. The findings indicate that exposure significantly elevated hepatic enzymes levels (AST, ALT, and ALP) across all chicken breeds (Al-Badri *et al.*, 2019), with BRO exhibiting the highest enzyme activity likely due to their rapid metabolic and growth rates in high performing breeds (McGill 2016). FAC chicken demonstrated higher levels of TP, ALB, and GLO levels compared to BRO and ND, suggesting enhanced immune competence, nutritional adequacy, and liver health, all of which contribute to improved productivity and resilience in challenging environments.

Table 1 Main Effect of breed and Exposure Type on hepatic indices of chickens studied

Fixed factor	AST(iμ/l)	ALT(iμ/l)	ALP(iμ/l)	TP(g/l)	ALB(g/l)	GLO(g/l)
Main effect of BREED						
FAC	71.00 ^b	11.76 ^a	96.57 ^b	44.87 ^a	27.25 ^a	17.68 ^a
BRO	87.13 ^a	11.03 ^a	112.77 ^a	38.95 ^b	24.77 ^b	14.25 ^b
ND	69.32 ^b	11.31 ^a	101.66 ^b	41.32 ^a	26.84 ^a	14.48 ^b
SEM	3.78	0.22	4.25	1.50	0.85	1.45
Main effect of EXPOSURE Types						
CON(No Hydrocarbon/NoVitc C)	71.14 ^b	11.03 ^a	90.93 ^b	37.46 ^b	26.08 ^a	11.52 ^b
EXPO Hydrocarbon Only	85.9b ^a	11.82 ^a	121.76 ^a	45.86 ^a	26.22 ^a	19.64 ^a
EXV Vit C only	70.39 ^b	11.25	98.32 ^b	41.82 ^{ab}	26.56 ^a	15.25 ^{ab}
SEM	2.97	0.19	5.03	1.52	0.56	1.24 [*]

^{ab}Means within the same column effects with different superscripts are significantly different at P(<0.05); AST: Aspartate aminotransferase (ALT): Alanine aminotransferase; ALP: Alkaline phosphate, TP: Total protein; ALB: Albumin; GLO: Globulin; FAC – Funaab Alpha Chicken; BRO – Ross 308 Agrited Broiler, ND – Nigerian Light local Chicken Ecotype from Niger Delta; CON - No Exposure, No Vitamin C, EXPO – Exposed to hydrocarbon only without Vitamin C; EXV - Exposed to Vitamin C only

Table 2: Interaction effect of breed and exposure type on hepatic indices of chickens studied

Parameter	FAC			BRO			ND			
Liver enzyme	CON	EXPO	EXV	CON	EXPO	EXV	CON	EXPO	EXV	SEM
AST (iμ/l)	67.69 ^c	83.43 ^b	61.89 ^c	77.20 ^b	95.31 ^a	88.88 ^{ab}	68.52 ^c	79.04 ^{ab}	60.41 ^c	3.24
ALT (iμ/l)	11.16 ^b	12.66 ^a	11.46 ^b	10.66 ^c	11.23 ^b	11.19 ^b	11.25 ^b	11.58 ^b	11.11 ^b	0.2
ALP (iμ/l)	78.19 ^c	118.03 ^a	93.49 ^b	108.13 ^b	128 ^a	102.18 ^b	86.46 ^c	119.25 ^b	99.28 ^c	4.77
Total Protein(g/dl)	41.37 ^b	48.31 ^a	44.93 ^b	34.93 ^b	43.36 ^a	38.57 ^b	36.09 ^b	45.92	41.95 ^{ab}	1.51
Albumin (g/dl)	27.84 ^a	25.70 ^b	28.22 ^a	23.87 ^b	24.86 ^b	25.58 ^b	26.53 ^a	28.09 ^a	25.89 ^b	0.66
Globulin (g/dl)	13.73 ^b	22.60 ^a	16.70 ^b	11.26 ^{bc}	18.50 ^b	12.99 ^b	9.56 ^c	17.83 ^b	16.06 ^a	1.31

However, persistently high levels in stressed environments may also signal a compensatory response to chronic oxidative stress or inflammation. Pollutant exposure led to a notable increase in hepatic enzymes (6.68-25.32%) and protein metabolites implying hepatic stress and subclinical liver damage consistent with the inflammatory response noted in pollutant exposed birds (King *et al.*, 2021). However, Vitamin C supplementation significantly reduced enzyme levels and improved hepatic indices, highlighting its antioxidative capacity to mitigate oxidative stress-induced liver dysfunction (Oleforuh-Okoleh *et al.*, 2023). Variations in the breed-specific response to exposure and antioxidant intervention among the breeds as revealed in Table 2 may stem from differences in genetic resilience, metabolic demands and antioxidant defense mechanisms (Miller *et al.*, 2018).

CONCLUSION AND RECOMMENDATIONS

Vitamin C supplementation improved liver biochemical indices in all chicken breeds studied, highlighting its antioxidant benefits, particularly in hydrocarbon-polluted regions. Farmers should use chickens with short generation intervals and locate farms away from toxic hydrocarbons. Further research is needed to assess the impact of prolonged exposure and hydrocarbon levels on birds.

REFERENCES

- Al-Kerwi, M. S. M., Mardenli, O., Jasim, M. R. M., & Al-Majeed, M. A. (2022). Effects of Harmful Gases Emitted from Poultry Houses on Productive and Health Performance. IOP Conference Series: *Earth and Environmental Science*, 1060, 012082. [h\(tps://doi.org/10.1088/1755-1315/1060/1/012082](https://doi.org/10.1088/1755-1315/1060/1/012082).
- Al-Badri A. M., Bargooth, A. F., Al-Jebori, J. G., & Zegyer, E. A. K. (2019). Identification of carbon nanotube particles in liver tissue and its effects on apoptosis of birds exposed to air pollution. *Vet World*, 12(9):1372.
- Burritt, D. (2008). The polycyclic aromatic hydrocarbon phenanthrene causes oxidative stress and alters polyamine metabolism in the aquatic liverwort *Riccia fluitans* L.. *Plant, cell & environment*, 31 10, 1416-31 . <https://doi.org/10.1111/j.1365-3040.2008.01846.x>.
- Echendu, A. J., Okafor, H. F., & Iyiola, O. (2022). Air pollution, climate change and ecosystem health in the Niger Delta. *Social Sciences*, 11(11), 525. <https://doi.org/10.3390/socsci11110525>
- Gencer, Y., Çınar, A. & Comba, B. 2015. Investigation of the effects of stress on some liver enzymes (AST, ALT, ALP) in rats. *Atatürk Üniversitesi Veteriner Bilimleri Dergisi*, 10, (1), 21-26.
- King, M. D., Elliott, J. E., & Williams, T. D. (2021). Effects of petroleum exposure on birds: A review. *The Science of the total environment*, 755(Pt 1), 142834. <https://doi.org/10.1016/j.scitotenv.2020.142834>
- Manisalidis, I., Stavropoulou, E., Stavropoulos, A., & Bezirtzoglou, E. (2020). Environmental and health impacts of air pollution: A Review. *Frontiers in Public Health*, 8, 14. <https://doi.org/10.3389/fpubh.2020.00014>
- McGill M. R. (2016). The past and present of serum aminotransferases and the future of liver injury biomarkers. *EXCLI journal*, 15, 817–828. <https://doi.org/10.17179/excli2016-800>
- Miller J, Clark B, Champlin D, Nacci D, Whitehead, A. (2018) Genetic architecture pollution resistance in multiple populations of Killifish. Society of Environmental Toxicology and Chemistry North America (SETAC-NA) 39th Annual Meeting, Sacramento, California, November 04 - 08, 2018.
- Oleforuh-Okoleh, V. U., Sikiru, A. B., Kakulu, I. I., Fakae, B. B., Obianwuna, U. E., Shoyombo, A. J., Adeolu, A. I., Ollor, O. A., & Emeka, O. C. (2023). Improving hydrocarbon toxicity tolerance in poultry: role of genes and antioxidants. *Frontiers in Genetics*, 14, 1060138. <https://doi.org/10.3389/fgene.2023.1060138>
- Samet, J., & Wages, P. (2018). Oxidative Stress from Environmental Exposures.. *Current opinion in toxicology*, 7, 60-66 . <https://doi.org/10.1016/J.COTOX.2017.10.008>.
- Zhang, X., Deng, Q., He, Z., Li, J., Ma, X., Zhang, Z., Wu, D., Xing, X., Peng, J., Guo, H., Huang, M., Chen, L., Dang, S., Zhu, Y., Zhang, Z., Yang, B., Wang, H., Chen, W. & Xiao, Y. (2020). Influence of benzene exposure, fat content, and their interactions on erythroid-related hematologic parameters in petrochemical workers: a cross-sectional study. *BMC PublicHealth*, 20, 382. doi: 10.1186/s12889-020-08493-z