

Impact of Ridoff Insecticide on Biochemical Functions of *Clarias Gariepinus* Juveniles and Adults

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Abstract

Ninety healthy advanced juveniles of *C. gariepinus* (Mean weight 350g and mean length 16.8cm) and Ninety (90) adults (Mean weight 850g and mean length 28.2cm) were exposed to Ridoff insecticide in a renewable bioassay for 30 days in varied concentration levels of 0.0125, 0.025, 0.05, 0.10 and 0.20 mg/l to access impact on water quality and biochemical parameters. pH, DO, NH₃, NO₂ and temperature were all within the same range as control except at 0.025, 0.10 mg/l and 0.20 were DO dropped below the control and at 0.20mg/l where NH₃ was higher than the control for juveniles while in adults all the physicochemical parameters were within the same range as control. The increase and decrease of all the enzymes (AST), metabolites and electrolytes activities were dose dependent when compared with control.

Keywords: Ridoff, biomarker, enzymes, metabolites, electrolytes.

1. Introduction

Biochemical toxicity of organophosphate derivatives in fishes was investigated by Swarnima., (2019) reported that organophosphorus compounds have replaced organo-chlorides to a greater extent and are frequently sprayed on crops. These xenobiotics primarily find their way into aquatic ecosystems thereby inducing toxicity to non-target species. Among the various harms caused to fishes by organophosphates is alteration in their biochemical indices this is important as it induces severe damage to various vital metabolic processes in fish. The primary effect of organophosphate toxicity is their mechanism of action as well as the inhibition of acetylcholine esterase enzyme in synapses which leads to severe morbidity, loss of balance and motion or even paralysis. Adiola *et al.*, 2025 reported that various biochemical metabolisms like protein metabolism, lipid metabolism, carbohydrate metabolism and liver enzymes get severely impaired due to the toxicity induced by organophosphates. Therefore, it is necessary to protect the natural water bodies from getting contaminated with insecticide to allow fishes to grow healthier and be harmless for human consumption. Achikanu & Ani (2021) conducted a study to investigate the sublethal toxic effects of dichlorvos on biochemical parameters of African catfish. The study examined the impact of dichlorvos exposure on liver enzymes, acid phosphatase (ACP), serum total protein (STP), blood urea, and creatinine levels over a 15-days period. The study found no significant changes in liver enzymes (ALT, AST, and ALP) at the two concentrations of

dichlorvos tested compared to the control group on day 1. However, significant increases in liver enzyme activities were observed on days 5 and 10, with minimal changes on day 15 for ALT. This suggests that the toxic effect of dichlorvos on the liver is dependent on the duration of exposure rather than the dose. Notably, ALP levels increased more than other liver enzymes, indicating possible intra-hepatic cholestasis induced by dichlorvos exposure. The study observed a significant increase in ACP levels on days 5 and 10, independent of the dose, suggesting a potential risk of prostate cancer following consumption of contaminated fish. This elevation in ACP activity indicates a biochemical response to dichlorvos exposure, possibly linked to tissue damage or stress. Serum Total Protein levels showed insignificant reductions at both concentrations of dichlorvos tested on days 1, 5, and 10 but significantly increased at 21ml/l on day 15. This suggests that longer exposure to dichlorvos may interfere with protein synthesis or cause protein loss via excretion, indicating potential negative effects on kidney and liver function. The changes in STP levels appear to be dependent on the duration of exposure rather than the dose. The study found no significant changes in blood urea and creatinine levels in African catfish exposed to dichlorvos. While temporary increases were observed at 21ml/l on days 1, 5, and 10 compared to the control group, these changes may be attributed to temporary conditions such as dehydration rather than damaged pancreatic cells. Oghale et al., (2021) investigated Biochemical changes in the serum such as glycogen, total protein, cholesterol, urea, and creatinine were analyzed after the exposure period of 28 days, the glycogen level decreased in all sublethal exposures. An increase in cholesterol at lower exposure concentrations, followed by a slight increase in urea and creatinine among treated groups was recorded. Behavioral changes which include changes in skin color, jerking, restlessness, and erratic swimming, among others were observed. Based on the result of this study, it was concluded that *C. gariepinus* juveniles are very sensitive to low concentrations of dimethoate. Dimethoate is highly toxic to juvenile catfishes and as such measures must be taken to avoid its run-off into our aquatic environment thus jeopardizing the recruitment of juvenile catfishes into the fishery. Erhunmwunse et al., (2018) conducted a study to investigate the biochemical effects of imidacloprid exposure on various enzymes and metabolites in fish. The study examined the levels of alanine aminotransferase (ALT), aspartate aminotransferase (AST), amylase, lipase, total bilirubin, and conjugate bilirubin, shedding light on the impact of imidacloprid on fish metabolic activities and liver function. The study found increased concentrations of ALT and AST in fish exposed to imidacloprid, with notable elevations observed at higher concentrations of the insecticide. While these changes were not significantly different from the control, the considerable increases in enzyme levels suggest a potential response to imidacloprid-induced stress. Previous research on other fish species exposed to neonicotinoids, including imidacloprid, has reported similar elevations in ALT and AST levels, indicating a common biochemical response to insecticide exposure. The study observed a concentration-dependent increase in amylase and lipase activity in catfish exposed to imidacloprid. Significant differences from the control were noted at higher concentrations of imidacloprid, suggesting a potential impact on carbohydrate and lipid metabolism. Increased amylase and lipase activity may be indicative of tissue damage, stress response, or altered energy demands in fish exposed to imidacloprid. While no significant difference was observed in total bilirubin levels between control and imidacloprid-exposed fish, there were fluctuations in conjugate bilirubin levels. The overall trend showed higher bilirubin levels in exposed fish compared to the control, with potential implications for liver function and bile pigment metabolism. Previous studies have linked increased bilirubin levels to hepatic necrosis and liver diseases in fish exposed to neonicotinoids and biodiversity.

Xxx In an attempt to define and measure the effects of pollutants on aquatic organisms, biomarkers and bioindicators are employed in several studies on xenobiotics. The principle of this approach is the analysis of electrolytes (Jee and Kang, 2005). According to Adhikari *et al.*, (2004), toxicants act by the disruption of cell membrane permeability replacing the structural or electro-chemical important element in the cell which causes functional failure. The basic function of electrolytes in the body lies in controlling fluid distribution, inter and extra cellular acids, basic equilibrium, maintaining osmotic pressure of body fluids and normal neuro muscular irritability (Adeyemo, 2005). Sodium (Na^+); Potassium (K^+) and Calcium (Ca^{2+}) are the major cations of the extra cellular fluid (Celik *et al.*, 2005; Adeoye, 2007). Electrolyte variations in fish exposed to toxicants including detergents influence their performance in diverse ways such as reproduction, size of eggs among others. (Fu *et al.*, 1990; Chowdhury *et al.*, 2004). Since fresh water fish take up most of the ions necessary for homeostasis from the water via their gills, the drop of plasma electrolytes apparently result in the increase of efflux of ions across organs and an impairment of active ion uptake by the chloride cells of the gill (Wendelaar-bonga and Luck, 2007; Faulker and Meites, 1982). George and Uedeme-Naa, (2020) reported in their work on simulated responses of Juveniles and adults of *Clarias gariepinus* to Linear Alkylbenzene Sulfonate (LAS) based detergent that the decrease and increase of electrolyte activities as LAS concentration increases in all the organs concerned depicts that liver tissue of the exposed fish might have been impaired. This was in agreement with Thophon *et al.*, (2003) that LAS influenced the volume of electrolytes (Na^+ , K^+ , Ca^{2+} , Cl^- and HCO_3^-) in gill, kidney, muscle, plasma, and liver with increase in concentration. This could result in instability of fish in terms of osmoregulation over time because electrolyte concentrations are indicative of the ability of organisms to osmoregulate. Stability is often compromised with stress, disease of gill lesions that increase gill permeability to ions (Al-Kahem, 1994). Osmoregulation dysfunction is an inherent part of stress in fish (Harrel and Moline, 1992, Weirich *et al.*, 1992). The decrease in Na^+ levels in the gill of juvenile and adult, adult kidney, juvenile plasma and liver of *C. gariepinus* in this study with increasing concentration of LAS could be due to the epinephrine released during the stress responses which increased oxygen demand, dilation of gill blood vessels and increased use of vessels that are not normally used at rest. This increased the surface area of the gills that is available for gas exchange. Water influxes and ion losses are reduced, a phenomenon known as osmoregulatory compromise (Calamari and Marcetti, 1973). Minerals are mainly responsible for the maintenance of osmotic pressure in blood and proper functioning of all types of tissues (Hoffman and Lammel, 1984). The presence of activator ion of alkali metal series of Na^+ and K^+ are essential for the activity of many enzymes in fish (Kimerle, 1989). Toxic metals, detergents and pesticides can alter the electrolytes in the blood (Ludwig and Serekan, 1988). ATP and its related systems are known to participate in several metabolic processes, whilst Na^+ and K^+ ATPase located in the cell membrane has been implicated in the active transport of Na^+ and K^+ across the cell membrane (Taylor *et al.*, 2003). The changes in the levels of Na^+ in this study might be due to gill damage and inhibition of enzyme activity. Changes in plasma ion content (decrease or increase) have been attributed to kidney damage and altered enzyme activity (Blaxhall, 1999). Generally, the level of sodium and potassium ions in the organs of both life stages of *C. gariepinus* were either higher or lower than the control values, a reflection of changes in the fluxes of these electrolytes as a result of exposure to varying concentrations of detergents. Sodium and potassium ions are essential for the activities of many enzymes and have been implicated in the transport of ATP which participates in several metabolic processes (Rajannal *et al.*; 1981; Adegoye, 2007). Changes in these ions indicate damage to the gills and

kidney (Gabriel *et al*; 2010). These authors observed that slight increase in sodium and potassium ions may favour improvement in the renal function which is achieved through the re-absorption of these ions from the blood by the kidney regulations of cations like Na^+ , K^+ and Ca^{2+} and anions such as HCO_3^- , and Cl^- . These ions levels in blood plasma are measured by osmolarity or specific ion concentration have proved potential and sensitive biomarkers of chemical exposure. Circulation levels of sodium and chloride has been indicated as useful measures of stress, primarily due to the active movement of these ions across the gill structure (Asadi *et al*; 2006). In this present study, elevated levels of Na^+ and Cl^- observed in *C. gariepinus* exposed to detergent was more pronounced in the adult fish. A similar observation in elevation of Na^+ and Cl^- in fish was reported in Atlantic salmon (Salmon Solar) treated with LAS (Iverson and Eliassen, 2009). Stoskopf and Posner (2008) suggested that the impairment of ionic balance and regulation were due to the inhibition of ATPase in the gill. Also, Fleming *et al*. (2009) noted profound disturbance in Na^+ and Cl^- electrolyte levels in Gulf of Mexico sturgeon (*Acipenser oxyrinchus*) exposed to detergent for short term immobilization. This may be due to an initial adrenaline mediated stress response.

2. Materials and Methods

2.1 Source of experimental Materials: Ninety (90) healthy advanced juveniles of *C. gariepinus* (Mean weight 350g and mean length 16.8cm) and Ninety (90) gravid females and matured males of *Clarias gariepinus* (Mean weight 850g and mean length 28.2cm) were obtained from a farm Aqua life consult Aluu, Rivers State, Nigeria.. Insecticide (Ridoff) was purchased from an agrochemical authorized dealer within Port Harcourt, Rivers State.

2.2 Acclimation and Feeding of Fish: Five fish per aquarium were acclimatized in sixty rectangular plastic aquaria (60x45x25cm) filled with 20liters of water each for seven (7) days. The top of the aquaria was covered with perforated plastic to prevent fish from escaping and for adequate aeration, the water was exchanged daily. The aquaria was washed with a piece of foam and fish were fed once daily with 42% crude protein diet at 2% body weight for adv. juvenile fish and 1% for adult fish.(Gabriel et al.,2004)

2.3 Experimental Design: Completely randomized design (CRD) with five treatments levels and a control, each treatment level having five replicates and three fish per replicate

2.4 Preparation of Test Solution: Definitive tests of 0.0125, 0.025, 0.05, 0.1 and 0.2 mg/L excluding control were achieved after series of range finding tests (trial test) of Ridoff insecticide following Santanu (2013) standard method.

2.5 Experimental procedures: The varied concentrations were thoroughly mixed to avoid hot spot in four treatments with three fish per replicate of five. To prevent injuries, both specimens were transferred to empty containers using scoop net until aquaria with prepared solutions were ready. This renewable static bioassay was carried out for 30 consecutive days at a feeding rate of 3% body weight.

2.6 Sample collection: At the end the experimental period of 30days the total length (TL) of the fish was measured from the tip of the anterior part of the mouth to the caudal fin using a meter rule calibrated in centimeter. Fish weight was measured after drying with a piece of clean towel. Weighing was done with a table top weighing balance to the nearest gram. Blood samples were collected from the fish from behind the anal fin with a 21G size needle and a syringe and preserved in EDTA for hematological studies. The blood for the enzyme analysis was stored in heparinized bottles. Fish were killed with a blow on the head after blood collection and dissected in order to collect samples (0.5g) of gill, liver, kidney, muscle with the aid of penknife

2.7 Determination of physicochemical properties of culture medium: pH, Dissolved oxygen, Ammonia –Nitrogen (NH₃-N), Temperature. Nitrate were determined weekly for the 30 days study period.

2.7.1 pH: The effluent was collected in a clean glass bottle, pH of the sample was measured on getting to the laboratory, using model 291MK pH meter produced by Hannah INC.LTD, China. The pH meter was first calibrated with standard buffer solution of pH 7 . This was carried out by pouring small amount of buffer, pH 7 into a clean beaker and a magnetic stirrer bar dropped into it. The beaker was placed on magnetic stirrer to get a homogenous mixture. The meter electrode was lower into the beaker, with the tip immersed in the buffer solution and the magnetic stirrer started. The meter was adjusted to read pH value of the buffer. The electrode was removed, and washed with distilled water and dried with soft tissue paper .

2.7.2 Dissolved Oxygen (DO): The Winkler's method was used in detecting the dissolved oxygen in each of the aquaria. Water samples for dissolved oxygen were collected and the 1ml of potassium fluoride solution, 2ml alkaline iodine solution, 2ml manganese sulfate solution, and 2ml concentrated sulphuric acid were added. Then 200ml of treated sample was used in the titrimetry and the liberated iodine in the treated sample were titrated with a prepared standard solution of 0.025N solution through sulfate titrant. Two-milliliter starch indicator was added to the sample, when its color turned pale straw in the process of titration, the value was recorded and used in the calculation.

Calculation

Average volume of 0.025N used = 5.65ml

Volume of treated sample = 200ml

Collected sample aliquot = 200X 300

$$\frac{300}{---} T$$

The 200ml sample aliquot for reagents was corrected to 300ml

T = total volume of reagents added to the sample bottle

Thus DO = $\frac{A \times N \times 8000}{B}$

(APHA 1998)

B

Where ; A = Millimeter of titration

B = Millimeters of correction sample aliquot

C = Normality of sodium throsulphate .

2.7.3 Ammonia –Nitrogen (NH₃-N): The phenate method of ammonia determination was adopted for the study. 10.0ml sample in a 50ml beaker, a drop of MnSO₄ solution was added. This was placed on a magnetic stirrer and 0.5ml hypochlorous acid reagent was added, thus reagent was added without delay using burette. The set up was stirred vigorously during addition of reagent, procedure was carried out for blank and standard, followed by measurement of absorbance at 60nm using reagent blank to zero the spectrophotometer.

2.1.4 Temperature: This was done using a mercury in glass thermometer. Sufficient time was allowed for thermometer to reach a constant reading in °C.

2.7.5 Nitrite: The reagent was in a fine powder form, a spoon-like object according to manufacturer's guide was used to add 2 drops into the water sample, mixed and observed for color change, the observed color was then compared to the nitrite colorimeter to estimate the concentration of nitrite.

2.8 Evaluation of biochemical parameters of *C. gariepinus* exposed to ridoff

2.8.1 Aspartate aminotransferase (AST): This was measured by monitoring the concentration of oxaloacetate hydrazones formed with 2,4-dinitrophenylhydrazine. The procedure involved labeling test tubes as sample blank and sample. To all test tubes, 1.5 ml of reagent 1 (R1) was pipetted, and 0.1 ml of the sample was added, mixed, and incubated for 30 minutes at 37°C. Then, 0.5 ml of reagent 2 (R2) was pipetted into all test tubes, and another 0.1 ml of the sample was added to the sample blank tube, mixed, and allowed to stand for exactly 20 minutes at 25°C. Finally, 5.0 ml of NaOH was added to all test tubes, mixed, and the absorbance was read at 450 nm (unit u/l) against the sample blank after 5 minutes.

2.8.2 Alanine aminotransferase (ALT): This was measured by monitoring the concentration of oxaloacetate hydrazones formed with 2,4-dinitrophenylhydrazine. The procedure was as follows: test tubes were labeled as sample blank and sample. Reagent 1 (R1) of 1.5 ml was pipetted into all the test tubes, and 0.1 ml of the sample was added, mixed, and incubated for 30 minutes at 37°C. Then, 0.5 ml of reagent 2 (R2) was pipetted into all test tubes, and another 0.1 ml of the sample was added to the sample blank tube, mixed, and allowed to stand for exactly 20 minutes at 25°C. Finally, 5.0 ml of NaOH was added to all test tubes, mixed, and the absorbance was read at 450 nm (unit u/l) against the sample blank after 5 minutes.

2.8.3 Alkaline phosphate (ALP): This was measured using buffered sodium thymolphthalein monophosphate. The addition of an alkaline reagent halted enzyme activity and simultaneously developed a blue chromogen, which was measured photometrically. The procedure was as follows: test tubes were labeled as STD (standard), blank, and test. Into all test tubes, 0.5 ml of ALP substrate was pipetted and incubated at 37°C for 3 minutes. Then, 50 µl of the standard sample and distilled water were added to the appropriate tubes and incubated for exactly 10 minutes at 37°C. Following this, 2.5 ml of ALP color developer was pipetted into all the test tubes and mixed thoroughly. The spectrophotometer was set to 590 nm, zeroed with the blank, and the absorbance of each sample was read and recorded.

2.8.4 Total protein (T.P): Cupric ions is an alkaline medium, interact with protein peptide bonds resulting in the formatting of a coloured complex, In this analysis test tubes are labeled as standard, blank and test, 1ml reagent was pipetted into all the test tubes and 0.02ml of the

standard, sample and d/w was added into appropriate tubes and incubated for exactly at 35°C for 30 minutes, zeroed at 540nm with the blank, read and record the absorbance.

2.8.5 Albumin: The measurement of serum albumins is based on their binding to the indicator bromocresol green (BCG), forming a complex that absorbs at 578 nm. The absorbance is directly proportional to the concentration of albumin in the sample. The procedure is as follows: test tubes were labeled as standard, blank, and test. Into all the tubes, 3 ml of albumin reagent was pipetted. Then, 0.01 ml of the sample was added to the appropriate tubes, mixed, and incubated for 10 minutes at 25°C. The spectrophotometer was zeroed with the blank at 578 nm, and the absorbance of each sample was read and recorded.

2.8.6 Bilirubin: Total bilirubin is determined in the presence of caffeine, which releases albumin-bound bilirubin by reacting with diazotized sulphanilic acid. The procedure is as follows: test tubes were labeled as standard, blank, and test. Into all the tubes, 0.2 ml of reagent was pipetted. One drop of sodium nitrate was added to the tubes labeled sample. Then, 1 ml of caffeine was pipetted into all the tubes, followed by the addition of another 0.02 ml of the sample. The tubes were mixed and incubated for 10 minutes at 25°C. After incubation, 1 ml of tartrate was pipetted into all tubes, mixed, and incubated for an additional 5-30 minutes at 25°C. The spectrophotometer was zeroed at 590 nm, and the absorbance of each sample was read and recorded.

2.8.7 Urea (Ur): Urea in serum was hydrolyzed to ammonia in the presence of urease. The ammonia was measured photometrically by Berthelot's reaction. There are three different test tubes labeled sample, blank and standard, 0.1ml of the reagent (R₁) was pipetted into all the test tubes, 10ul of the samples, standard and distilled water was added into the appropriate tubes mixed and incubated at 37°C for 10 minutes, 2.5ml of R₂ & R₃ was pipetted to all the tubes mixed and incubated at 25°C for 15 minutes and the absorbance was read and recorded at 546nm.

2.8.9 Creatinine (Cr): Creatinine reacted with picric acid in an alkaline solution to form a colored complex. The amount of complex formed is directly proportional to the creatinine concentration. The test tubes were labeled sample, blank, and standard, 2.0ml of the reagent (R₁) was pipetted into all the test tubes, and 0.1ml of the sample, standard and distilled water was added into respective tubes, mixed carefully and after 30 seconds, the absorbance of the standard and sample was. The calculation of creatinine was calculated as follows

$$\text{Creatinine concentration} = \frac{\text{absorbance of sample} \times \text{concentration of standard}}{\text{Concentration Absorbance of standard}} =$$

$A_1 - A_2 = A$. or absorbance of sample concentration.

2.8.10 Potassium (K⁺): The amount of potassium was determined by sodium tetraphenyl boron in a specifically prepared mixture to produce a colloidal suspension. The turbidity is proportional to the potassium concentration in the sample.

The test tubes were labeled sample, blank, and standard, 1ml of the reagent was pipetted into all the test tubes, 10ul of the sample was added into appropriate tubes mixed and allowed for 3 minutes at 25°C, the spectrophotometer was zeroed using blank at 500nm and absorbance was read and recorded.

2.8.11 Sodium (Na^+): The present method is based on the reaction of sodium with a selective chromogen producing a chromophore whose absorbance varies directly as the concentration of sodium in the test sample. The test tubes were labeled sample, blank, and standard, 1.0ml of the reagent was pipetted into all the test tubes, 0.01ml of the sample was added into appropriate tubes mixed, and incubated for 5 minutes at 25°C , and absorbance was read and recorded at 630nm.

2.8.12 Chloride ion (Cl^-): The quantitative displacement of thiocyanate by chloride from mercuric thiocyanate and any subsequent formation of red ferric thiocyanate complexes was measured calorimetrically. The test tubes were labeled sample, blank, and standard, 1.0ml of the reagent was pipetted into all the test tubes, 10ul of the sample was added into appropriate tubes mixed, and incubated for 5 minutes at 25°C , and absorbance was read and recorded at 480nm.

2.8.13 Hydrogen Bicarbonate ion (HCO_3^{2-}): Serum HCO_3 is reacted with excess standard HCL. The remaining HCL was back titrated with standard NaOH using phenol red as an indicator. CO_2 -free distilled water was added into 250ul 50ml conical flask, 200ul sample, 0.01N, HCL 1ml, mixed well, and added 3 drops of phenol red, the flask was whirled to release the CO_2 . The resultant solution was titrated with 0.01N and NaOH until the initial light-yellow color faded to a light purple at the endpoint. The remaining NaOH that did not take part in the reaction was read. The reading obtained was divided by two; this gave the concentration of HCO_3 in the sample (unit mmol/l)

2.9 Statistical Analysis

The results of the samples were analyzed using origin-pro version 9.9.0.225 package. Descriptive statistics of variance (ANOVA) was used; statistical significance was assessed at 0.05 probability level using Tukey tests. The means of the treatments was repeated using least significant difference (LSD) test.

3.0 Result

3.1 Physicochemical Parameters of Water.

Tables 1a and 1b provide the mean parameter values for advanced juveniles and adults in water across different treatments from week 1 to week 4. The mean pH concentrations ranged from 6.6 to 6.8. When the monthly mean values were analysed, treatments with concentrations of 0 mg/L and 0.0125mg/L exhibited the highest pH levels, while those with concentrations of 0.1mg/L and 0.2mg/L showed the lowest value.

Specifically, at a concentration of 0mg/L, the pH value was 6.75 ± 0.05 and at concentration of 0.0125mg/l, the pH remained 6.75 ± 0.05 . For concentrations of 0.025mg/l and 0.05mg/l, the pH values were 6.7 ± 0.06 . At a concentration of 0.1mg/l, the pH increased slightly to 6.68 ± 0.08 , and at a concentration of 0.2mg/l, it remained at 6.68 ± 0.05 .

The Dissolved Oxygen (DO) concentrations, a critical parameter for aquatic life, displayed variation across various treatment concentrations for both adv. juvenile and adult specimens. Among adv. juveniles, DO levels ranged from 3.6 to 4.7 mg/l, while adults exhibited slightly higher concentrations, ranging from 4 to 5 mg/l. Notably, treatments with a concentration of 0mg/l (Control) consistently yielded the highest DO levels for both adv. juveniles and adults. Conversely, concentrations of 0.1mg/l and 0.2mg/l consistently correlated with the lowest DO levels, indicating potential adverse effects on oxygen availability within the aquatic environment

The ammonia concentrations varied across different treatment concentrations for both adv. juveniles and adults. In adv. juveniles, ammonia levels ranged from 0.33 to 0.41 mg/l, while in adults, they ranged from 1.32 to 1.48 mg/l. Treatments with a concentration of 0mg/l exhibited lower ammonia levels for both adv. juveniles and adults (0.33 mg/L for juveniles and 1.32 mg/l for adults), whereas concentrations of 0.1mg/l and 0.2mg/l showed slightly elevated levels (ranging from 0.36 to 0.41 mg/l for adv. juveniles and from 1.39 to 1.48 mg/l for adults).

The nitrate concentrations varied across different treatment concentrations for both adv. juveniles and adults. In adv. juveniles, nitrate levels ranged from 0.02 to 0.08 mg/l, while in adults, they remained more consistent, ranging from 0.03 to 0.09 mg/l. Treatments with concentrations of 0mg/L (Control) showed relatively stable nitrate levels across both adv. juveniles and adults (0.02 mg/l for adv. juveniles and 0.03 mg/l for adults), with some slight variation observed in treatments with concentrations of 0.025 and 0.05 mg/l. Notably, a slightly higher nitrate level of 0.08 mg/l was observed in adv. juveniles at a concentration of 0.025 mg/l.

The temperature varied across different treatment concentrations for both adv. juveniles and adults. In adv. juveniles, temperature levels ranged from 25.8 to 26.95°C, while in adults, they ranged from 25.8 to 27.4°C. Treatments with concentrations of 0mg/l (Control) exhibited relatively consistent temperature levels across both adv. juveniles and adults, with minor fluctuations observed in treatments with concentrations ranging from 0.0125 to 0.2 mg/l. Notably, the highest temperature recorded for juveniles was 26.95°C at a concentration of 0.1 mg/L, while for adults, it was 27.4°C at a concentration of 0.2 mg/l.

Table 1a: The Mean Value of Physicochemical Parameters of culture medium for Advance juvenile

mg/L	pH	DO	NH ₃	NO ₂	0 ^c
0.00	6.70±0.06	4.70±0.24	0.33±0.05	0.02±0.00	26.11±0.11
0.0125	6.68±0.08	4.18±0.31	0.34±0.06	0.02±0.00	26.20±0.73
0.025	6.68±0.05	3.85±0.22	0.35±0.06	0.08±0.06	26.48±0.31
0.05	6.70±0.06	4.08±0.36	0.37±0.05	0.02±0.00	26.70±0.24
0.10	6.75±0.05	3.65±0.33	0.36±0.06	0.02±0.00	26.95±0.17
0.20	6.75±0.05	3.60±0.36	0.41±0.01	0.02±0.00	26.83±0.10

Table 1b: The Mean Value of Physicochemical Parameters of culture medium for Adult

mg/L	Ph	DO	NH ₃	NO ₂	0 ^c
0.00	6.70±0.05	5.00±0.00	1.48±0.04	0.03±0.00	26.45±0.28
0.0125	6.70±0.05	4.90±0.09	1.48±0.04	0.03±0.00	26.00±0.5
0.025	6.68±0.04	4.00±0.00	1.32±0.04	0.03±0.00	25.80±0.27
0.05	6.73±0.04	4.01±0.00	1.43±0.04	0.03±0.00	26.88±0.26
0.10	6.63±0.05	4.20±0.17	1.40±0.05	0.03±0.00	26.78±0.31
0.20	6.7±0.05	4.10±0.11	1.39±0.08	0.09±0.04	27.40±0.12

3.2 Biochemicals

3.2.1 Aspartate aminotransferase - AST

The AST concentrations of the adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 2. At a control concentration of 0 mg/L the mean AST values were 26.4mmol/l and 24.8 mmol/l for adv. juveniles and adults, respectively. At 0.0125 mg/L, the mean AST values were 29.2 mmol/l and 28.2mmol/l for adv. juveniles and adults,

respectively. Similarly, at 0.025 mg/L, the mean AST values were 30.6mmol/l and 28.6mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/L, the mean AST values were 40.04 mmol/l and 24.8 mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/L, the mean AST values were 25 mmol/l and 28 mmol/l for adv. juveniles and adults, respectively. At 0.20 mg/L, the mean AST values were 37 mmol/l and 24.8 mmol/l for adv. juveniles and adults, respectively.

Table 2 Mean Concentration of Aspartate amino transferase in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticides.

Mg/L	AJ	%	A	%
0.00	26.40±2.074	14%	24.0±3.70	13%
0.0125	29.20±6.34	15%	28.20±3.27	15%
0.025	30.60±4.45	16%	28.6±2.70	15%
0.05	40.4±16.7	21%	24.8±3.11	13%
0.10	25±1.581	13%	28.0±2.55	15%
0.20	37±1.58	20%	24.8±1.92	13%

p-value=0.827

3.2.2 Alanine aminotransferase - ALT

The ALT concentrations of advance juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 3. At a control concentration of 0 mg/l, the mean ALT values were 21mmol/l and 20.2 mmol/l for juveniles and adults, respectively. At 0.0125 mg/L, the mean ALT values were 22.6 mmol/l and 23.6mmol/l for adv. juveniles and adults, respectively. Similarly, at 0.025 mg/l, the mean ALT values were 21.6mmol/l and 22.6mmol/l for juveniles and adults, respectively. At 0.05 mg/l, the mean ALT values were 22mmol/l and 19.8 mmol/l for juveniles and adults, respectively. At 0.10 mg/l, the mean ALT values were 20 mmol/l and 20.6 mmol/l for juveniles and adults, respectively. At 0.20 mg/l the mean ALT values were 22mmol/l and 20mmol/l for advance juveniles and adults, respectively.

Table 3 Mean Concentration of Alanine amino transferase in the plasma of *Clarias gariepinus* exposed to different concentrations of Ridoff insecticide.

Mg/L	AJ	%	A	%
0.00	21±1.581	16%	20.2±1.483	16%
0.0125	22.6±2.074	17%	23.6±2.7	18%
0.025	21.6±2.074	17%	22.6±4.16	17%
0.05	22±10.12	17%	19.8±1.924	15%
0.10	20±1.581	15%	20.6±1.949	16%
0.20	22±2.55	17%	20±1.581	15%

p-value=0.746

3.2.3 Alkaline phosphate - ALP

The ALP concentrations of adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 4. At a control concentration of 0 mg/l, the mean ALP values were 17mmol/l and 19.6 mmol/l for adv. juveniles and adults, respectively. At 0.0125 mg/l, the mean ALP values were 22.0 mmol/l and 60.2mmol/l for adv. juveniles and adults, respectively.

Similarly, at 0.025 mg/l, the mean ALP values were 20.4mmol/l and 47.4mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/l, the mean ALP values were 17mmol/l and 42.4 mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/l, the mean ALP values were 20 mmol/l and 40.3 mmol/l for adv. juveniles and adults, respectively. At 0.20 mg/l the mean ALP values were 20mmol/l and 19.8mmol/l for adv. juveniles and adults, respectively.

Table 4 Mean Concentration of Alkaline phosphate in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticides.

Mg/L	AJ	%	A	%
0.00	17.0±1.58	15	19.6±1.14	17
0.0125	22.0±2.92	19	60.2±5.45	52
0.025	20.4±2.07	18	47.4±5.18	41
0.05	17.0±1.58	15	42.4±3.05	36
0.10	20.0±1.58	17	43.2±3.56	37
0.20	20.0±1.58	17	19.8±1.30	17

Key: AJ – Advanced juvenile; A - Adult
p-value = 0.746

3.2.4 Total protein - TP

The TP concentrations of advance juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 5. At a control concentration of 0 mg/l, the mean TP values were 53.6mmol/l and 61.8 mmol/l for adv. juveniles and adults respectively. At 0.0125 mg/l, the mean TP values were 70.0 mmol/l and 49.2mmol/l for adv. juveniles and adults, respectively. Similarly, at 0.025 mg/l, the mean TP values were 58.6mmol/l and 48.0mmol/l for adv. juveniles and adults respectively. At 0.05 mg/l the mean TP values were 54.8mmol/l and 54.2 mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/l, the mean TP values were 59 mmol/l and 49.4 mmol/l for adv. juveniles and adults, respectively. At 0.20 mg/l the mean TP values were 70.6mmol/l and 63.4mmol/l for adv. juveniles and adults, respectively.

Table 5: Mean Concentration of Total protein in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticides.

Mg/L	AJ	%	A	%
0.00	53.6±10.74	15%	61.8±4.44	17%
0.0125	70±10.22	19%	49.2±3.11	13%
0.025	58.6±8.91	16%	48±4	13%
0.05	54.8±5.67	15%	54.2±5.72	15%
0.10	59±6.67	16%	49.4±3.36	13%
0.20	70.6±3.05	19%	63.4±2.074	17%

3.2.5 Albumin - Alb

The Albumin concentrations of advance juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 6. At a control concentration of 0 mg/l, the mean ALB values were 35mmol/l and 34.6mmol/l for juveniles and adults, respectively. At 0.0125 mg/l, the mean ALB values were 38.6mmol/l and 34.4mmol/l for adv. juveniles and adults, respectively. Similarly, at 0.025 mg/l, the mean ALB values were 34.2mmol/l and 35.0mmol/l for adv. juveniles and adults respectively. At 0.05 mg/l, the mean ALB values were

31mmol/l and 36 mmol/l for juveniles and adults, respectively. At 0.10 mg/L, the mean ALB values were 33.8mmol/l and 35.8 mmol/l for adv. juveniles and adults respectively. At 0.20 mg/l, the mean ALB values were 43.4mmol/l and 38.6mmol/l for adv. juveniles and adults, respectively.

Table 6: Mean Concentration of Albumin in *Clarias gariepenus* exposed to different concentrations of Ridoff insecticide.

Mg/L	AJ	%	A	%
0.00	35±6.4	16%	34.6±5.46	16%
0.0125	38.6±6.11	18%	34.4±3.05	16%
0.025	34.2±4.76	16%	35±4.12	16%
0.05	31±4.47	14%	36±3.81	17%
0.10	33.8±6.83	16%	35.8±1.924	17%
0.20	43.4±2.074	20%	38.6±3.05	18%

p-value = 0.568

3.2.6 Total Bilirubin - TB

The TB concentrations of adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 7. At a control concentration of 0 mg/l, the mean TB values were 5.18mmol/l for both juveniles and adults. At 0.0125 mg/l, the mean TB values were 5.6mmol/l and 5.5mmol/l for juveniles and adults, respectively. Similarly, at 0.025 mg/l, the mean TB values were 5.88mmol/l and 5.94mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/L, the mean TB values were 5.9mmol/l and 5.24 mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/l, the mean TB values were 5.08mmol/l and 5.64 mmol/l for adv. juveniles and adults, respectively. At 0.20 mg/l, the mean TB values were 7.4mmol/l and 4.78mmol/l for adv. juveniles and adults, respectively.

Table 7: Mean Concentration of Total Bilirubin in *Clarias gariepenus* exposed to different concentrations of Ridoff insecticides.

Mg/L	AJ	%	A	%
0.00	5.18±0.444	15%	5.18±0.773	15%
0.0125	5.6±0.982	16%	5.5±0.316	16%
0.025	5.88±0.74	17%	5.94±0.439	17%
0.05	5.9±0.339	17%	5.24±0.428	15%
0.10	5.08±0.798	14%	5.64±0.68	16%
0.20	7.4±0.381	21%	4.78±0.487	14%

p-value = 0.858

3.2.6 Conjugate Bilirubin - CB

The CB concentrations of adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 8. At a control concentration of 0 mg/l, the mean CB values were 2.76mmol/l and 2.96mmol/l for juveniles and adults, respectively. At 0.0125 mg/l, the mean CB values were 3.56mmol/l and 3.14mmol/l for adv. juveniles and adults respectively. Similarly at 0.025 mg/L, the mean CB values were 3.4mmol/l and 3.7mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/l, the mean CB values were 3.48mmol/l and 3.28 mmol/l for adv. juveniles and adults respectively. At 0.10 mg/l, the mean CB values were 3.3mmol/l and 3.4

mmol/l for adv. juveniles and adults, respectively. At 0.20 mg/l, the mean CB values were 4.72mmol/l and 3.14mmol/l for adv. juveniles and adults, respectively.

Table 8: Mean Concentration of Conjugate Bilirubin in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticide.

Mg/L	AJ	%	A	%
0.00	2.76±0.559	13%	2.96±0.434	14%
0.0125	3.56±1.006	17%	3.14±0.27	15%
0.025	3.4±0.667	16%	3.7±0.524	17%
0.05	3.48±0.1924	16%	3.28±0.432	15%
0.10	3.3±0.367	16%	3.4±0.62	16%
0.20	4.72±0.311	22%	3.14±0.27	15%

p-value = 0.484

3.2.7 Urea - Ur

The Urea concentrations of juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 9. At a control concentration of 0 mg/l, the mean Urea values were 3.72mmol/l and 3.94mmol/l for adv. juveniles and adults, respectively. At 0.0125 mg/l, the mean Urea values were 3.28mmol/l and 4.1mmol/l for juveniles and adults, respectively. Similarly, at 0.025 mg/l, the mean Urea values were 3.36mmol/l and 3.46mmol/l for juveniles and adults, respectively. At 0.05 mg/l, the mean Urea values were 3.6mmol/l and 3.46 mmol/l for juveniles and adults, respectively. At 0.10 mg/l, the mean Urea values were 4.08mmol/l and 3.32 mmol/l for adv. juveniles and adults respectively. At 0.20 mg/l, the mean urea values were 3.3mmol/l and 3.78mmol/l for adv. juveniles and adults respectively.

Table 9: Mean Concentration of Urea in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticide.

Mg/L	AJ	%	A	%
0.00	3.72±0.55	17%	3.94±0.78	18%
0.0125	3.28±0.13	15%	4.10±0.49	19%
0.025	3.36±0.27	16%	3.46±0.21	16%
0.05	3.60±0.39	17%	3.46±0.37	16%
0.10	4.08±0.55	19%	3.32±0.26	16%
0.20	3.30±0.16	15%	3.78±0.40	18%

P – value =0.864

3.2.8 Creatinine - Cr

The Creatinine concentrations of juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 10. At a control concentration of 0 mg/l, the mean Creatinine values were 73.4mmol/l and 81.6mmol/l for juveniles and adults, respectively. At 0.0125 mg/l, the mean Creatinine values were 66.6mmol/l and 82mmol/l for adv. juveniles and adults, respectively. Similarly, at 0.025 mg/l the mean Creatinine values were 66.4mmol/l and 68.2mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/l, the mean Creatinine values were 75.6mmol/l and 72.6 mmol/l for adv.juveniles and adults, respectively. At 0.10 mg/l, the mean Creatinine values were 84.6mmol/l and 67.6mmol/l for adv. juveniles and adults,

respectively. At 0.20 mg/l, the mean Creatinine values were 63.6mmol/l and 74mmol/l for adv. juveniles and adults, respectively.

Table 10: Mean Concentration of Creatinine in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticide.

Mg/L	AJ	%	A	%
0.00	73.4±9.76	17%	81.6±13.79	19%
0.0125	66.6±2.7	15%	82±8.63	19%
0.025	66.4±4.72	15%	68.2±3.42	16%
0.05	75.6±8.02	18%	72.6±5.32	17%
0.10	84.6±9.37	20%	67.6±5.59	16%
0.20	63.6±2.7	15%	74±7.87	17%

p-value = 0.731

Key: AJ – Advanced juvenile; A – Adult

3.2.9 Potassium ion - K⁺

The K⁺ concentrations of adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 11. At a control concentration of 0 mg/l, the mean K⁺ values were 4.72mmol/l and 3.7mmol/l for adv. juveniles and adults, respectively. At 0.0125 mg/l, the mean K⁺ values were 4.42mmol/l and 4.52mmol/l for adv. juveniles and adults, respectively. Similarly, at 0.025 mg/l, the mean K⁺ values were 4.1mmol/l and 2.64mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/l, the mean K⁺ values were 3.16mmol/l and 2.98 mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/l, the mean K⁺ values were 4.16mmol/l and 4.00 mmol/l for adv. juveniles and adults, respectively. At 0.20 mg/l, the mean K⁺ values were 5.56mmol/l and 4.46mmol/l for adv. juveniles and adults, respectively.

Table 11: Mean Concentration of Potassium ion in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticides.

Mg/L	AJ	%	A	%
0.00	4.72±0.998	18%	3.7±0.339	14%
0.0125	4.4±0.765	17%	4.52±0.286	17%
0.025	4.1±1.306	16%	2.64±0.1673	10%
0.05	3.16±0.619	12%	2.98±0.286	11%
0.10	4.16±0.602	16%	4±0.1581	15%
0.20	5.56±1.258	21%	4.46±0.23	17%

3.2.10 Sodium ions – Na⁺

The Sodium ion concentrations of adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 12. At a control concentration of 0 mg/l, the mean Sodium ion values were 140.2mmol/l and 122.2mmol/l for juveniles and adults, respectively. At 0.0125 mg/L, the mean Sodium ion values were 136.6mmol/l and 137.6mmol/l for adv. juveniles and adults, respectively. Similarly, at 0.025 mg/l, the mean Sodium ion values were 142mmol/l and 107.4mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/l, the mean Sodium ion values were 111.2mmol/l and 115 mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/l the mean Sodium ion values were 138.8mmol/l and 126.8 mmol/l for

adv. juveniles and adults, respectively. At 0.20 mg/l, the mean Sodium ion values were 151.6mmol/l and 138.6mmol/l for adv. juveniles and adults, respectively.

Table 12: Mean Concentration of Sodium ion in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticides.

Mg/L	AJ	%	A	%
0.00	140.2±28.20	17%	122.2±4.97	15%
0.0125	136.6±15.32	17%	137.6±6.35	17%
0.025	142.0±23.00	17%	107.4±2.074	13%
0.05	111.20±5.26	14%	115±4.12	14%
0.10	138.80±14.1	17%	126.8±4.44	15%
0.20	151.6±20.29	18%	138.6±10.09	17%

p-value=0.3016

3.2.11 Chloride ion – Cl⁻

The Cl⁻ concentrations of adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 13. At a control concentration of 0 mg/l, the mean Cl⁻ values were 72.8mmol/l and 80.2mmol/l for adv. juveniles and adults, respectively. At 0.0125 mg/l, the mean Cl⁻ values were 75.2mmol/l and 81.4mmol/l for juveniles and adults, respectively. Similarly, at 0.025 mg/L, the mean Cl⁻ values were 78mmol/l and 72.4mmol/l for adv. juveniles and adults, respectively. At 0.05 mg/l, the mean Cl values were 82.4mmol/l and 74.4 mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/l, the mean Cl⁻ values were 70.4mmol/l for both adv. juveniles and adults. At 0.20 mg/l, the mean Cl⁻ values were 77.6mmol/l and 82.4mmol/l for adv.juveniles and adults, respectively.

Table 13: Mean Concentration of Chloride ion in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticide.

Mg/L	AJ	%	A	%
0.00	72.8±5.72	16%	80.2±4.55	18%
0.0125	72.8±5.72	16%	81.4±10.81	18%
0.025	78.0±2.00	17%	72.4±1.95	16%
0.05	82.4±5.22	18%	74.4±5.68	16%
0.10	70.4±12.9	15%	70.4±8.08	15%
0.20	77.6±1.14	17%	82.4±4.16	18%

p-value = 0.369

Key: AJ – Advanced juvenile; A – Adult

3.2.12 Bicarbonate ion - HCO₃⁻

The HCO₃⁻ concentrations of adv. juvenile and adult catfish exposed to various concentrations of Ridoff are summarized in Table 14. At a control concentration of 0 mg/l, the mean HCO₃⁻ values were 28mmol/l and 27.2mmol/l for adv. juveniles and adults, respectively. At 0.0125 mg/L, the mean HCO₃⁻ values were 26.4mmol/l and 30.8mmol/l for adv. juveniles and adults, respectively. Similarly, at 0.025 mg/l the mean HCO₃ values were 23.6mmol/l and 25mmol/l for adv. juveniles and adults respectively. At 0.05 mg/l, the mean HCO₃⁻ values were 25.8mmol/l and 25mmol/l for adv. juveniles and adults, respectively. At 0.10 mg/l, the mean HCO₃⁻ values was

26mmol/l for both adv. juveniles and adults. At 0.20 mg/l, the mean HCO_3^{2-} values were 27mmol/l and 26.8mmol/l for advanced juveniles and adults, respectively.

Table 14: Mean Concentration of Bicarbonate ion in *Clarias gariepinus* exposed to different concentrations of Ridoff insecticide.

Mg/L	AJ	%	A	%
0.00	28±3.16	18%	27.2±1.924	17%
0.0125	26.4±3.21	17%	30.8±4.87	20%
0.025	23.6±2.074	15%	25±2.74	16%
0.05	25.8±2.59	16%	25±2.65	16%
0.10	26±3.16	17%	26±3.39	17%
0.20	27±3.54	17%	26.8±3.27	17%

Key: AJ – Advanced juvenile; A – Adult

4.0 Discussion

This study was conducted on catfish, *C. gariepinus*, to understand the possible effects of organophosphate insecticide (Ridoff) on the Advanced juvenile and Adult life stages of this comparatively resilient fish species. The pH and temperature of the water from this present study were within the Federal Ministry of Environment (FMEnv), and Nigeria Standardized Aquaculture Practice (NSAP) accepted limits for the sustenance of aquatic life. Water pH measures the acidic and alkaline condition of an aquatic ecosystem, which influences most of the chemicals and biochemical reactions as well as the aquatic productivity (Okey-Wokeh et al., 2021). The moderate pH and temperature values in this experiment reveal that both parameters contribute little to the toxicity of Ridoff insecticide. This agrees with the findings of Ogwu *et al.*, 2013 and Uedeme *et al.*, 2023. Meanwhile, Sharma. *et al.*, 2019 reported a lower temperature value (25.3°C) in their findings and this could be related to the different climatic conditions at that particular geographical location and period. The mean values of ammonia and nitrate obtained in comparison with that of Uedeme-Naa and George (2017) were within the acceptable range. In this experiment, despite using same conditions in all the aquaria, decreasing dissolved oxygen concentration was experienced when compared with the control group. This is in agreement with Akter *et al.*, 2020 who reported that dissolved oxygen in water decreases with increase respiration of the stressed fish. Ogwu *et al.*, 2013, discovered dissolved oxygen at the various test media in which mortality was observed were below the Federal Ministry of Environment (FMEnv) and Nigerian Standardized Aquaculture Practice (NSAP) accepted limits of 6.0 – 8.0 and 5.0 – 9.0 mg/L. The dissolved oxygen stress of aquatic organisms found in water contaminated with insecticide is due to the insufficient supply of oxygen for respiration in the medium (Ogwu *et al.*, 2013). The low dissolved oxygen observed in higher concentrations of Chlorpyrifos 40EC, apart from death, can lead to impaired fish development and maturation (Okey-Wokeh *et al.*, 2020). This agrees with this present study in that the inability of young fishes to withstand oxygen deficiency in the medium is a result of oxidative stress caused by the pressure of the toxicant. The result obtained from this experiment also agrees with the work by (Kanu *et al.* 2011). The result of this study revealed an elevated level of AST as the concentration of the ridoff insecticide increases. AST ranged from 25±1.581 - 40.4±16.65ml/l and 24.8±3.7-28.6±2.7ml/l in Advanced Juveniles and Adult catfish respectively. The elevated increase in AST at different concentrations as compared with the control may be caused by liver damage/tumor, kidney or lung damage. This study agrees with the findings of Gbarasogo (2021) and

Olaniyi *et al.*, (2013) who on exposure of *C. gariepinus* to cassava mill effluent reported increase in the AST and ALT activities. They attributed such to hepatic cellular damage in the test fish. Vasanth *et al.*, (2012) reported increase in the levels of aspartate aminotransferase in *Labeo rohita* after exposure to sublethal concentrations of anthracene for five weeks. Alterations in the activities of the transaminases (AST and ALT) and ALP act as markers to illustrate compromised tissue integrity of the liver (Banace, 2013). Alanine aminotransferase ranged between 20 ± 1.581 - 28 ± 10.12 and 19.8 ± 1.924 - 23.6 ± 2.7 in Advanced juveniles and Adult catfish respectively. There was a moderate increase in enzymes activities as dosages of Ridoff insecticide increased. This agrees with the study of Gbarasogo *et al.*, 2021 who discovered minimal increment in the level of ALT in his findings. ALT is an enzyme that processes proteins and large amount of ALT occur in the Liver cells (Roberts 2009). When the liver is injured or inflamed, the blood level of ALT usually rises. Inferentially, the moderate level and minimal increment in the level of ALT observed in this study disagrees with the result of Dorcas & Solomon, (2014) who observed a significant increase in ALT levels of *Clarias gariepinus* as an indication of inflammation and disease. In this present study, there was a significant increase in the activities of ALT in comparison with the control and this agrees with Adesina *et al.*, 2017. Opute & Oboh, 2021 also reported a progressive elevation of alanine aminotransferase (ALT) across the treatment concentrations when compared to the control in consonance with the present study. It was opined that an increase in the activities of the enzyme may be mainly due to the leakage of ALT from the liver cytosol into the bloodstream as a result of liver damage by atrazine. This is an indication of the hepatotoxic effect of atrazine (Opute and Oboh 2021). It was also observed that Alkaline phosphate ranged between 17 ± 1.581 - 20.4 ± 2.074 and 19.6 ± 1.14 - 60.2 ± 5.45 in advance Juveniles and Adult respectively. As compared with the control group, there was a gradual increase of ALP in advance juveniles, it was highly increased at 0.025mg/L and 0.0125mg/L for advanced juveniles and adults respectively. The high level of ALP found in the Adult catfish at 0.0125mg/L concentration indicates a strong damage of the liver or bone marrow disorders or a tumor in the fish examined at that concentration. The result for the adult catfish from this study disagrees with the findings of Gbarasogo *et al.*, 2021 who observed a moderate level of ALP. However, this result is consistent with the findings of Dorcas & Solomon (2014) who also observed a high level of ALP. The results of liver function test indicated that the concentration of total protein ranged from 53.6 ± 10.74 - 70.6 ± 3.05 and 48 ± 4 - 63.4 ± 2.074 in advanced juveniles and adults respectively. Proteins are mainly involved in the architecture of the cell. This study disagrees with the findings of Gbarasogo *et al.*, 2021 where total protein decreased as the concentration of the toxicant increases. It also disagrees with the findings of Opute & Oboh, 2021 where total protein levels as reported in their study showed a decrease in atrazine treated groups compared with the control. Assessment of protein content of an organism is a diagnostic tool used in determining the physiological and health status of the organism, because it shows the underlying conditions of the cells and tissues. Proteins have been found to possess nutritive, protective, buffering, and energetic functions (Inyang *et al.*, 2010). Proteins are the building blocks of tissues and cells. They are needed for growth and development. They also form the structural part of organs; make up hormones and enzymes. A change in the total protein levels could be attributed to various conditions which may cause either abnormal high production of protein, interfere with the production of albumin or globulin proteins or increase the loss or breakdown of proteins. The results of albumin ranged from 31 ± 4.47 - 43.4 ± 2.074 and 34.4 ± 3.05 - 38.6 ± 3.05 for adv. juveniles and adults respectively. According to Opute and Oboh, 2021 Albumin (ALB) plays an important role in maintaining the osmotic balance between the

circulating blood and the tissue membrane. Albumin is the body's predominant serum-binding protein with several important functions (Opute and Oboh., 2021). The findings from this present study disagrees with Opute and Oboh., 2021 who found out that Albumin levels in the atrazine exposed juveniles depleted from 2.7 g L⁻¹ in the control to 1.5 g L⁻¹ in the 500 µg L⁻¹ atrazine treatment group. An abnormally low level of albumin in the blood is a clinical sign referred to as hypo albuminaemia. Hypo albuminemia can result from decreased albumin production, defective synthesis because of hepatocyte damage, deficient intake of amino acids, increased losses of albumin through gastrointestinal or renal processes, and, most commonly, acute or chronic inflammation (Vincent, 2009). Achikanu & Ani, 2021 in their study showed that there was also a consequent rise in the bilirubin levels on the experimental groups when compared with the normal control group in agreement with this present study. They suggested that organophosphate insecticide induced intra-hepatic cholestasis and consequently jaundice in the experimental groups independent of the dose. The results of this study also showed that the urea concentration ranged from 3.3±0.1581-4.08±0.545 and 3.32±0.259-4.1±0.485, from the result, there was an increase in the level of urea in the advanced Juveniles compared with the control. This result is consistent with the reports of Ogbuewu et al ., 2010 who found an increasing trend in the urea level with increase in concentration, he opined that the animals were tending towards a negative nitrogen balance. Ridoff affected the ionic balance in catfish. Higher Ridoff concentrations generally increased Cl⁻, K⁺, and Na⁺ levels, indicating potential electrolyte disturbances. Chloride and bicarbonate ion levels also fluctuated, suggesting impacts on acid-base balance.

5. Conclusion

The findings from this present study indicate that control treatments (0 mg/l) maintained the highest pH and Dissolved Oxygen (DO) levels, essential for optimal aquatic conditions. Elevated concentrations of the treatment correlated with increased ammonia levels and slight variations in nitrate, potentially indicating adverse effects on water quality. Temperature fluctuations were minimal, suggesting that other parameters, such as pH and DO, are more critical in assessing the environmental impact of the treatments. Overall, maintaining lower treatment concentrations appears beneficial for sustaining healthier aquatic environments for both adv. juveniles and adults' fish. Exposure to Ridoff affected catfish biochemical markers. Higher concentrations generally increased AST levels, indicating liver stress. ALP also rose, especially in adults, suggesting damage to bone or liver tissues. TP and ALB levels fluctuated, reflecting changes in protein metabolism. Elevated TB at higher concentrations suggested possible liver dysfunction. Overall, at even low Ridoff concentrations negatively impacted catfish health, highlighting the importance of regulating its levels in aquatic environments. Ridoff affected the ionic balance in catfish. Higher Ridoff concentrations generally increased Cl⁻, K⁺, and Na⁺ levels, indicating potential electrolyte disturbances. Chloride and bicarbonate ion levels also fluctuated, suggesting impacts on acid-base balance. Creatinine and urea levels varied, reflecting possible changes in kidney function. Overall, Ridoff exposure disrupted normal ionic concentrations in catfish tested, emphasizing the need for careful monitoring and regulation to protect aquatic health.

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