12.31.2024

JOURNAL OF

Health, Metabolism & Nutrition Studies (JHMNS) Vol. 6 No. 3

TOXICITY OF AN ORGANOPHOSPHATE INSECTICIDES (RIDOFF) ON LIVER, AND KIDNEY OF JUVENILE STAGES OF AFRICAN CATFISH (*CLARIAS GARIEPINUS)*

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Abstract

The investigation was concentrated on the toxic effect of organophosphate insecticides (ridoff) on juvenile stage of African catfish (*Clarias gariepinus). C. gariepinus* were exposed to different lethal concentrations (0.3, 0.2, 0.1, 0.05 and 0.025mg/l) of organophosphate insecticides (ridoff) for four days and sub-lethal (0.0125, 0.0250, 0.0500, 0.1000 and 0.2000mg/l) concentrations for 30 days. The control group was free of organophosphate insecticides. ANOVA was used to calculate mean and standard deviation while statistical significance was assessed at 0.05 probability level using Turkey tests. Physicochemical parameters determined were pH, which ranged from 6.68 to 6.75 mg/l respectively. Dissolved oxygen levels ranged from 3.6 to 4.7 mg/l indicating reduced oxygen availability at higher Ridoff concentration. Ammonia concentration increased, ranging from 0.33 to 0.41 mg/l while Nitrate and temperature

Introduction

Naturally chemical and physical causes of disease in aquatic organisms are generally linked to water and food because these are the primary pathways of toxic substances to animals in the aquatic environment. Aquatic toxicity is the study of the effects of anthropogenic chemicals and activities on aquatic organisms (Adewole, 2020).

Ridoff is an organophosphate insecticide used in farm to control insects, with the empirical formula O,S dimethyl N acetylphosporamidothiote ($C_4H_{10}NO_3P_5$) and have the same structural formula as other organophosphate

E-ISSN 3026-8664 P-ISSN3027-2238

levels remained relatively stable, with slight variations at higher concentration. The liver parameters (AST, ALT, ALP, T.P, ALB, and T.B) while kidney parameters are (Ur, Cr, K, Na, CL, and $HC0_3$) standard methods was used to examined both the exposed and control groups. Results showed that AST, ALT and T.B values decreased significantly while ALP, T.P, ALB values increased significantly with increasing concentrations of organophosphate insecticides in liver while in kidney Ur, Cr, CL, and Hco_3 values decreased significantly while K, Na values increased significantly with increasing concentrations of the toxicant . In conclusion the use of organophosphate insecticides adversely affects the wellbeing of *C. gariepinus*. We therefore recommend the discontinued use of this insecticide as it is toxic to non-target organisms including fish and man.

Keywords: Toxin; Effect; Organophosphate; Insecticides; Ridoff ; *Clarias gariepinus;* Liver; Kidney;

Insecticide.

Other organophosphate insecticides include Chlorfenvinphos, parathion, Azinphos, Quinalphos, dimethoate, diazinon, chlorpyrifos (Sophia et al.,2019).

The African catfish (*Clarias gariepinus*) is one of the most abundantly and widely distributed fish in Rivers, its tributaries and lakes. It has an economic importance that contributes significantly to annual fish productions in many countries of the world, but most especially in Africa and many parts of Asia (Ahmad & Gautam, 2014). The African catfish (*Clarias gariepinus*) is appreciated by consumers for the quality of its flesh, it is rich in protein and contains all the essential amino acid in the right proportions and also contains a good selection of minerals, it is mostly smoked and used in soups (Ezemonye & Ogbomida, 2010.). It is the principal clarid cat fish in Africa (Mai, 2011). They are commercially important species of fish for rapid aquacultural expansion in Nigeria and other developing countries because it meets up a partial solution for the increasing demand of protein (Ayande et al., 2015). They grow quickly and are omnivores; they are desirable as food and are valuable species in the world (Mai, 2011). It is recognized by its long dorsal and anal fins, which give it a rather eel-like appearance; the catfish has a slender body, a flat bony head, and a broad terminal mouth with four pairs of barbells. Its prominent barbells give it the image of cat-like whiskers (Ajanaku et al., 2018). The fish is mostly cultured in earthen ponds. But, can be cultured in

other systems such as tanks and hapas. In the wild and riverine systems, they reproduce naturally but considerable effort is required to induce spawning under culture conditions. They are an excellent species for aquaculture as it is omnivorous, grows fast, and tolerates relatively poor water quality (Uedeme-Naa & Deekae,2016).They are geographically located in Africa, the middle east, Brazil and Indonesia. They make fresh water, lakes, rivers, swamps and human made oxidative ponds and urban sewage system their habitats. The adult catfish can be 1-1.5m in length and weigh up to 60kg (Wilfred-Ekprikpo, 2021).

They have been artificially reproduced and cultured under various Nigerian aquaculture systems and are one of the most studied tropical cat fish within the genus *Clarias.* However, there has been a decline in other indigenous fish species of commercial importance as a result of flood, drought, and pollutions from agro and industrial chemicals and also from unknown sources (Aparna & Devidas, 2020).

Fish are very sensitive to changes in their environment and play significant roles in assessing potential risk associated with contamination in aquatic ecosystem hence, they serve as an important bioindicators for aquatic contamination (Sikoki*et* et al., 2013) Recent studies indicated that fishes are quickly becoming scarce owing to the increasing use of chemicals in field and since fish is very important source of proteins and lipids in human diet, health of fish is very important for human consumption (Sandhya et al.,2021). Tanqual et al., (2016) also reported that the indiscriminate use of insecticides and pesticides in the crop field by farmers is the major cause of disappearance of fish from natural waters in Bangladesh.

MATERIALS AND METHODS

Study Area

The study was carried out in the Fisheries unit of the University of Port Harcourt, Rivers State, Nigeria. The experiment was conducted between September and October 2023.

Source of experimental fish

Ninety (90) healthy advanced juveniles of *C. gariepinus (Mean weight 350 +_ 14.12gand mean length 16.8 +_ 3.2 cm)* was obtained from LeBari private fish farm in Choba Port Harcourt, Rivers State Nigeria, in 50 litres capacity plastic containers and was transported to University of Port Harcourt Demonstration

farm (fisheries unit). The body weight and the length of the fish was weighed and measured respectively.

Collection of Test Chemicals

Ridoff insecticide was purchased from Uche agrochemical Shop in wimpy Port Harcourt, Rivers State.

Acclimation and Feeding of Fish

On arrival of the fisheries, five fishes per aquarium was acclimatized in sixty rectangular plastic aquaria (60x45x25cm plastic container) containing thirty(30) litres of water each for seven(7) days. The top of the aquaria was covered with perforated plastic to prevent fish from escape and the water was exchanged daily. The aquaria was washed with a piece of foam and the fishes was fed once daily with 42% crude protein diet at 2% body weight for the juvenile fishes.

Experimental Design

Completely randomized design (CRD) with six treatments levels (control inclusive) with each treatment level having five replicates and three fish per aquarium

Preparation of Test Solution

A range finding test (trial test) was carried out using Ridoff and the trial and definitive test were prepared by serial dilution after which the work was carried out for a period of 30 consecutive days in a renewable bioassay.

Experimental procedures

A range trial test(finding test) was carried out using Ridoff organophosphate insecticide obtained from Port Harcourt. Serial dilution was prepared from solution of the toxicant for trial and definitive test. Five juvenile *C. gariepinus* was exposed to different concentrations of the toxicant (Ridoff organophosphate) after which a definitive point was achieved for the two sizes during the trial test. It was confirmed that concentration within 0.025mg/l was suitable for the survival of the fishes, after monitoring and thorough observation was made, the decision on the definitive test of 0.3, 0.2, 0.1, 0.05 and 0.025mg/l was made which align with Epbah,& Amachree, (2019) work. The preparation was well mixed to

avoid hot spot in five replicates per treatment and injuries or bruises on experimental fishes. Fishes were transferred to another container using scoop net until aquaria with solution was set and the fishes was exposed to Ridoff solution for complete 30days.

Laboratory Analysis

Determination of Physicochemical Properties

Physicochemical parameters of the water in the experimental tank (Dissolved oxygen, pH, Temperature, Nitrate, and Ammonia) were determined weekly for the 30 days study period.

Biochemical Analysis

Assessment of serum levels of liver enzymes was analyzed such as Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), Alkaline phosphate (ALP), Total protein (T.P), Albumin and Bilirubin while the following below were analyzed in the kidney Urea (Ur), Creatinine (Cr), Potassium (K), Sodium (Na), Chloride (CL), and Bicarbonate ($HC0_3$).

Statistical Analysis

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

RESULT ; The result of this study was presented in Table 1, 2 and 3 respectively.

Table 1 Physicochemical Parameters of Water.

Parameter/Conc mg/l	0.0000	0.0125	0.0250	0.0500	0.1000	0.2000
pH	6.70±0.06	6.68±0.08	6.68±0.05	6.70±0.06	6.75±0.05	6.75±0.05
DO	4.70±0.24	4.18±0.31	3.85±0.22	4.08±0.36	3.65±0.33	3.60±0.36
Ammonia	0.33±0.05	0.34±0.06	0.35±0.06	0.37±0.05	0.36±0.06	0.41±0.01
Nitrate	0.02±0.00	0.02±0.00	0.08±0.06	0.02±0.00	0.02±0.00	0.02±0.00
Temperature	26.11±0.11	26.20±0.73	26.48±0.31	26.70±0.24	26.95±0.17	26.83±0.10

p-value = 6.11×10^{-41} for Advanced Juveniles pond

Table 2 Result of serum levels of liver enzymes and concentrations for 30days on C. gariepinus.

Concentrations (Ridoff)	Parameters AST (IU/L)	ALT (IU/L)	ALP (IU/L)	T.P (g/l)	ALB (g/l)	T.B (µmol/L)
0.0000	^{A}36.6± 2.2	^{A}20.8±0.8	^{B}42.4±13.3	^{B}34.4±1.1	^{A}20.2±1.1	^{A}7.8±0.3
0.0125	^{A}34.0± 3.4	^{C}16.9±1.5	^{C}17.2±1.9	^{A}41.2±1.6	^{B}28.6±2.6	^{A}6.7±0.6
0.0250	^{B}28.4±1.2	^{BC}18.4±1.5	^{BC}40.8±4.5	^{A}45.0±2.6	^{B30}.60±3.2	^{A}6.1±0.3
0.0500	^{B}28.4±3.5	^{C}16.6±0.5	^{B}47.8±10.4	^{A} 42.8±3.3	^{B}31.0±4.1	^{A}6.3±0.4
0.1000	^{A}36.6±2.1	^{AB}20.2±1.3	^{A}77.6±18.9	^{A}43.4±1.8	^{B}29.80±5.8	^{A}7.8±0.6
0.2000	^{A}34.6±1.5	^{BC}18.4±1.1	^{AB}54.8±17.7	^{A}46.0±4.4	^{B}28.2±1.1	^{AB}7.1±0.8
P ≤	0.001	0.001	0.001	0.001	0.001	0.001

Superscripts with the same alphabet are not significantly different (Tukey-test, $p<0.05$)

Table 3 Result of parameters in kidney and concentrations on C. gariepinus for 30days.

Concentrations (Ridoff)	parameters Ur (mmol/l)	Cr (µmol/L)	K (mmol/l)	Na (mmol/l)	CL (mmol/l)	HCO_3 (mmol/l)
0.0000	^{A}2.8± 0.5	^{A}64.4±10.3	^{B}1.8 ±0.1	^{B}67.4±2.9	^{A}43.0± 2.4	^{A} 24.4±2.1
0.0125	^{BC}2.1± 0.5	^{B}42.6 ±4.8	^{A}3.2±0.1	^{B}80.2 ±50.9	^{BC}33.0±1.4	^{A}21.8±2.9
0.0250	^{AB}2.5±0.2	^{A}55.0±7.2	^{A}3.6±0.3	^{A}134.8±5.9	^{A} 42.60±3.5	^{A}24.4±1.5
0.0500	^{C}1.8±0.1	^{B}38±2.1	^{B}1.5±0.1	^{B}55.0±5.8	^{C}29.4±1.7	^{A}25.6±3.4
0.1000	^{BC}1.9±0.2	^{B}42.4±1.8	^{B}1.8±0,2	^{B}67.8±8.9	^{C}28.8±2,7	^{A}22.6±2.1
0.2000	^{C}1.7±0.1	^{B}39.6±2.7	^{B} 2.1±0.7	^{B}79.8 ±25.3	^{B}34.6±1.7	^{A}25.0±1.2
P ≤	0.001	0.001	0.001	0.001	0.001	0.119

Superscripts with the same alphabet are not significantly different (Tukey-test, $p<0.05$)

Discussion

This study was carried out on *C. gariepenus,* to understand the possible effects of organophosphate insecticide (Ridoff) on the advanced juvenile 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). Meanwhile Sharma. et al., (2019) reported a lower temperature value (25.3ºC) in their findings and this could be related to the different climatic conditions at that particular geographical location and period. The mean value of ammonia and nitrate obtained in comparison with that of Uedeme-Naa & George (2017) were within the acceptable range and agrees with a scientific study. 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 6.0 – 8.0 and 5.0 – 9.0 mg. 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 t 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*)*.

There are significant decrease observed in some of the hepatological parameters (AST, ALT, ALP, T.P, ALB and T.B) of C. *gariepinus* exposed to ridoff, which shows that insecticides cause a significant reduction in the hepatological parameters of fish (Ada et al, 2012). These reductions could also be the product of uremia and vitamin B_6 deficiency.

Furthermore, the decrease in ALP, in the present study shows impairment of the serum membrane of the liver which may be the cause of reduction of ALP. This reduction in ALP, in the ridoff exposed fishes could also arise due to osmoregulatory imbalances. There was increase in total protein (T.P) when compared with control, which may be as a result of shrinkage of liver observed during dissection of C. *gariepinus* while in ALB (Albumin) there was total increase when compared with control which may be as a result of burn and liver stress observed during the experiment. In total bilirubin (TB) decrease was

observed in some concentrations when compared with control which may be as of results of ridoff organophosphate insecticides served to the fishes, this agreed with the work of Banaee (2013) on Histopathological changes induced by paraquat on some tissues of gourami fish (*Trichogaster trichopterus*).

Furthermore, some kidney parameters such as (Ur, Cr, K, Na, CL and HCO_3) significant decrease, and increase were observed based on the parameter and concentrations. In urea total decrease were observed in all the concentrations , which may be as a result of low-protein diet , malnutrition , impaired metabolic activity in the kidney, in creatinine we observed decrease in all the parameters and concentrations when compared with control, this totally shows that the kidney has been affected negatively as a result of feeding the fishes with ridoff, in the case of potassium total increase were observed in all the concentrations except 0.0500 concentration that has less figures when compared with control , this result shows chronic kidney disease, because whenever the kidney is not working right the potassium level will increase. Base on the sodium result available in this work, we observes increase in all the concentrations except 0.1000 concentration, which indicated that the kidney has problem, while in chloride decrease were observes in all the concentrations which show that their is a loss of body fluid, which may affect the kidney, finally bicarbonate were examined and the result shows decrease in all the concentrations which indicates that kidney of these fishes are not healthy when compare with control. This partially agreed with the work of Katagi (2010) on Bioconcentration, bioaccumulation and metabolism of pesticides in aquatic organisms.

Conclusion and Recommendations

The result of the present investigations or research has shown that the commercial organophosphate insecticide (ridoff) is toxic and has great negative effects on the liver and kidney function of C. *gariepinus.* Further studies are required to investigate the haematological properties of these insecticides in African catfish and other fish species.

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E-ISSN 3026-8664 P-ISSN3027-2238