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The Effect of Sharpshooter -Pesticide on African Catfish (*Clarias gariepinus).*

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Abstract

The need to feed the increasing human population has led to the use of agrochemicals to boost agriculture. The after effect of washing off these chemicals to water ways would reduce the quality of water and ultimately compromise the health of the aquatic animals.The lethality of different concentrations of Sharpshooter on Clarias gariepinus juveniles was studied for a period of 96hours.Evaluation of the water quality, acute toxicity, the 96hours $LC_{50}$of sharpshooter and the behavioural response of fishes exposed randomly to different concentrations of 0.022, 0.036 and 0.044 mg/L respectively were made using Standard methods.The sub-lethal concentration of 0.014 and 0.036 mg/L were determined based on the 96 hours $LC_{50.}$The hepatosomatic index (HSI)was also determined with standard method.In this study the pH, temperature and dissolved oxygen of the test water was altered. The mortality of fish increased with increasing concentration and there were intense struggling behaviours associated with difficulty in breathing, uncontrollable swimming followed by erratic jerky movements before death which increases with time and concentration of exposure. The hepatosomatic index(HSI) an indicator of pollutants impact on the environment decreased within 15 days of exposure and varied in effect with increase in concentration of sharpshooter.This Exposure of Catfish to Sharpshooter reduced the quality of water with stressful behavioural changes and possible negative effect on the function of the fish liver cells with time.

Keywords:*Pesticide, toxicity, Sharpshooter, Clarias gariepinus, Water quality*

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I. Introduction

Having appropriate, safe,drinking water for humans and animals has become a great need in recent times[1,2].However, the increasing demand for the use of synthetic fertilisers and different insecticides and pesticides from human activities in pursuit of industrialisation have led to a swift reduction in the quality of water from natural water resources[3]. Chemicals of agricultural or industrial origins are reported to be source of contaminants to aquatic ecosystems by runoff and ground leaching through the area[4].The development of resistance to most of the insecticides by pest[5] have resulted to application of mixtures and/or rotation of insecticides which are reported to be very effective in enhancing the toxicity of insecticides in different resistant pests strain worldwide [6,7]. Sharpshooter a spectrum insecticide made up of 40% profenofos and 4% cypermethrin as active ingredients is used in treatments of ectoparasitic disease and pest of cotton, maize and vegetables[8]. Pollution of the aquatic environment is one of the major environmental threats in the world as it affects aquatic organisms and even the health of human beings[9]. Increased use of pesticides results in the excess inflow of toxic chemicals, mainly into the aquatic ecosystem [10,11]. The adult catfish is on average 1.25m in length and 60kg in weight. Its head is flat with a broad terminal mouth having four pairs of barbels and large breathing organs with modified gill arches. The fish of the Claridae family is found in Africa, the Middle East, Brazil and Indonesia and lives in freshwater, lakes, rivers and swamps and human made oxidative ponds and urban sewage system[12].

The aim of this work is to determine the effect of exposure of sharpshooter on the water quality and health condition of aquatic organisms particularly on African catfish,*Clarias gariepinus*.

II. Materials and Methods

Source of experimental fish: One hundred pieces of *C.gariepinus*(juveniles) of mean body weight and length 41.6±1.2 (g) and 18.5±2.5 (cm) respectively were bought from Rojenny tourist game village, Idemili LGA.

Anambra State, Nigeria and transported in plastic containers of 300 litre capacity to Heildin fisheries laboratory unit in Enugu state, Nigeria.

Acclimatisation: Within 14 days, the fish acclimated to the laboratory conditions during which they were fed with commercial feed (6mm coppens fish feed), the containers cleaned and the water changed every morning to remove feed waste and faeces. The fish was not fed for 48 hours before and during the exposure time and less than 2% mortality was observed during the acclimatisation.

Range finding test: The range of concentrations used in this experiment were determined by conducting preliminary test with 10 juvenile catfish in 25 litres of de-chlorinated tap water containing 0,022,0.036 and 0.044 mg/L of sharpshooter (mixture of 40% profenofos and 4% cypermethrin) respectively. 96hour lethal concentration (96h LC) values were determined until suitable concentration that produced 100% mortality was obtained. The fish were starved for 24 hours before and during the exposure time.

Procedure Methodology

10 juvenile catfish exposed to different concentrations of0.022,0.036 and 0.044 mg/L in triplicates were used to analyse the mortality rate, behavioural characteristics of the catfish and the physicochemical properties of water such as pH, temperature, and dissolved oxygen every 24 hours for 96hour period [13].

Every morning, dead fishes were removed to avoid contamination at every 24 hours interval for 96 hours. Using the probit method[14], the 96 hours lethal concentration (96h LC_{50}) of sharpshooter was determined while the hepatosomatic indices of the Catfish For 15 days were then calculated based on the 96 hours LC_{50} value for the sub-lethal concentrations of sharpshooter 0.014 and0.036 mg/L respectively [15]. A set of 10 fish in de-chlorinated tap water only served as the control (0.00mg/l).

Statistical analysis

Using the SPSS statistical package (version 17), the standard error mean (SEM) and Duncan's multiple range test were used to determine the significance at 10% probability test. The significance between data were analysed with the one-way analysis of variance (ANOVA).

III. Result

Exposure of pesticide-sharpshooter to catfish altered the physicochemical properties of the water, reduced the percent survival rate, changed the behaviour of the fishes and may alter liver cell functions with increase in concentrations of sharpshooter and time.

Table 1 shows the mean water parameters of juvenile African Catfish C.gariepinus exposed to different concentrations of Sharpshooter.The quality of water when treated with increasing concentrations of sharpshooter (0.022, 0.036, 0.044) mg/L showed statistical non-significance increase in the pH from 6.13 ±0.01 to 7.00±0.020 and decrease in temperature from 27^0 C to 26^0 C while the dissolved oxygen increased statistically significant from 4.80 ±0.10 mg/L to 3.40±0.0mg/L ($P < 0.05$).

Table 1: Mean water parameters of juvenile African Catfish C. gariepinus exposed to different concentrations of Sharpshooter.

Concentration mg/L	pH	Temperature (^{0} C)	Dissolved oxygen Mg/L
Control	6.13 ± 0.10^{a2}	27 ± 0.00^{a2}	4.80 ± 0.10^{a2}
0.022	7.1 ± 0.20^{a2}	26 ± 0.00^{a2}	6.50 ± 0.10^{a2}
0.036	7.16 ± 0.10^{a2}	26 ± 0.00^{a2}	5.13 ± 0.10^{b1}
0.044	7.00 ± 0.20^{a2}	26 ± 0.00^{a2}	3.40 ± 0.0^{b1}
Standard	6.7 – 8.5	26-28	5-10

Values with different alphabetic (lower case) superscripts differ significantly ($P < 0.05$) in mean values within the pesticide concentration. The values with different numeric superscripts differ significantly ($P < 0.05$) in mean values within the exposure duration

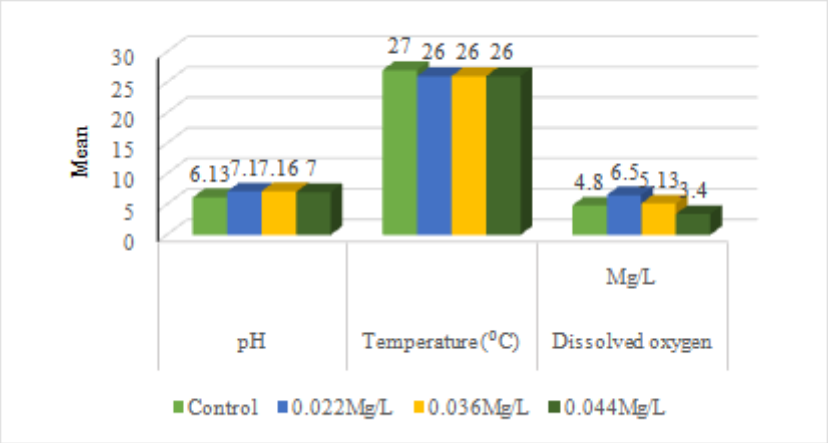


Table 2 show the percent mortality rate of the juvenile African Catfish C. gariepinus exposed to different concentrations of Sharpshooter for 24,48,72 and 96 hours.96 percent mortality of juvenile catfish occurred at the highest concentration of 0.044mg/L sharpshooter within the 24 to 96 hours exposure while the lowest concentration of 0.022mg/L Sharpshooter gave the least percentage mortality of 53. In the absence of a sharpshooter, no death was recorded during the period of exposure. In the figure, $R^2 = 0.99$ shows a strong direct relation between increasing concentration of sharpshooter and percent mortality of Catfish with time.

Table 2: Percentage mortality rate of juvenile African Catfish *C. gariepinus* exposed to different concentrations of Sharpshooter for 24, 48, 72 and 96 hours.

Concentration mg/L	Number of fishes exposed to pesticide	Mortality with time (hours).				Total	% of survival	% of mortality
		24	48	72	96			
Control	30	0^{b1}	0^{b1}	0^{b1}	0^{b1}	0^{b1}	100^{a2}	0^{b1}
0.022	30	2^{b1}	4^{b1}	5^{a2}	5^{a2}	16^{a2}	47^{a2}	53^{a2}
0.036	30	3^{b1}	5^{b1}	6^{a2}	8^{a2}	22^{a2}	27^{a2}	73^{a2}
0.044	30	4^{b1}	6^{a2}	9^{a2}	9^{a2}	28^{a2}	04^{b1}	96^{a2}

Values with different alphabetic (lower case) superscripts differ significantly ($P < 0.05$) in mean values within the pesticide concentration. The values with different numeric superscripts differ significantly ($P < 0.05$) in mean values within the exposure duration.

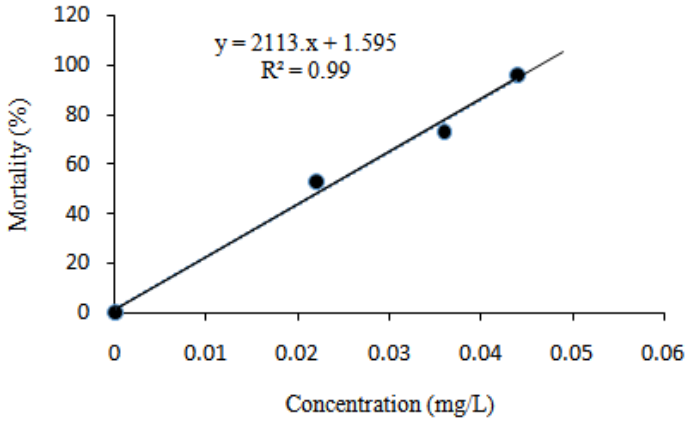


Figure 1: A plot of percent mortality against concentration ofSharpshooter within 96 hours exposure.

Table3 is the lethal concentrations of sharpshooter on juvenile African Catfish C.gariepinus exposed for 24,48,72 and 96 hours. The concentration of sharpshooter that will kill 10-90% (LC_{10-90}) of the experimental organism at 24, 48, 72 and 96hours was significantly different ($P < 0.05$). At the exposure period, the median LC_{50} ranges from 0.028(0.020-0.033) to 0.015(0.005-0.022).Values Outside the brackets are lethal

concentrations (LC). The first value within the bracket is the lower confidence and the second value is the upper confidence respectively.

Table 3: Lethal concentrations (LC) of Sharpshooter on juvenile African Catfish *C. gariepinus exposed* for 24, 48, 72 and 96 hours.

Lethal concentration	Hours			
	24	48	72	96
LC_{10}	0.020 (0.012-0.026)	0.013 (0.007-0.018)	0.011 (0.002-0.019)	0.011 (0.002-0.017)
LC_{20}	0.023 (0.015-0.028)	0.015 (0.009-0.020)	0.013 (0.002-0.020)	0.012 (0.003-0.019)
LC_{30}	0.025 (0.017-0.030)	0.017 (0.011-0.022)	0.014 (0.003-0.022)	0.014 (0.004-0.020)
LC_{40}	0.026 (0.018-0.032)	0.018 (0.012-0.023)	0.015 (0.003-0.023)	0.014 (0.004-0.021)
LC_{50}	0.028 (0.020-0.033)	0.019 (0.013-0.024)	0.016(0.004-0.024)	0.015(0.005-0.022)
LC_{60}	0.029 (0.021-0.034)	0.020 (0.014-0.025)	0.017 (0.004-0.024)	0.016 (0.005-0.022)
LC_{70}	0.029 (0.021-0.034)	0.021 (0.015-0.026)	0.017 (0.005-0.025)	0.016 (0.006-0.023)
LC_{80}	0.031 (0.024-0.036)	0.022 (0.016-0.0227)	0.018 (0.005-0.026)	0.017 (0.006-0.024)
LC_{90}	0.032 (0.025-0.037)	0.023 (0.016-0.028)	0.019 (0.006-0.026)	0.018 (0.007-0.024)

Table 4 shows the behavioural responses of juvenile African Catfish C.gariepinus exposed to different concentrations of Sharpshooter for 24,48,72 and 96 hours. The juvenile catfish exhibited restlessness in behavioural responses associated with faster swimming, opercula activity, surfacing and gulping of air in almost all concentrations at exposure time compared to the control respectively. At all concentrations of sharpshooter,the exposed fish became hyperactive characterised by erratic swimming and jerky movements with time.

Table 4: Behavioural responses of juvenile African Catfish *C.gariepinus* exposed to different concentrations of Sharpshooter for 24, 48, 72 and 96 hours.

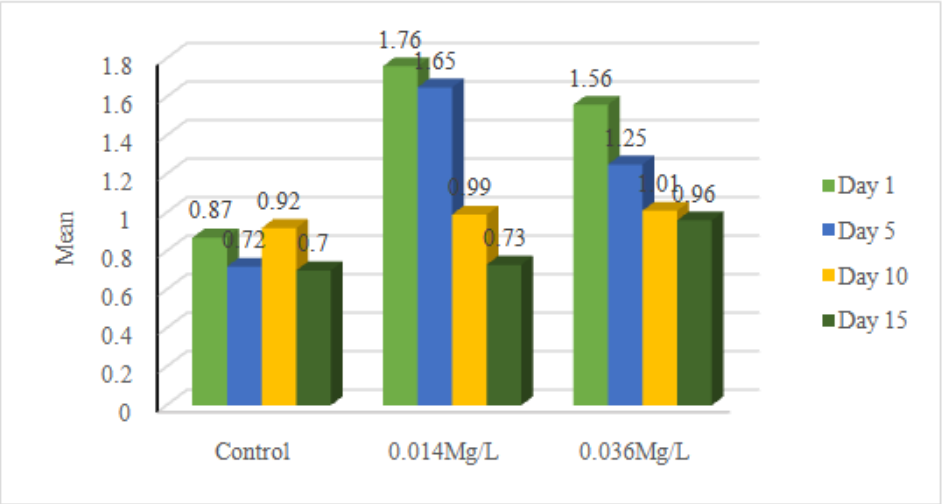
Concentration mg/L/Time	Air gulping	Hyper Activity	Erratic swimming	Equilibrium status	Skin discolouration	Jerking movement
24hrs						
Control	-	-	-	-	-	-
0.022	+	-	+	+	+	-
0.036	+	++	++	+	+	+
0.044	++	+++	++	++	++	++
48hrs						
Control	-	-	-	-	-	-
0.022	+	++	+	+	+	+
0.036	++	+++	++	++	+	++
0.044	+	+++	++	++	++	+
72hrs						
Control	-	-	-	-	-	-
0.022	-	+	+	++	+	-
0.036	++	++	+	++	+	+
0.044	++	+	+	+	-	+
96hrs						
Control	-	-	-	-	-	-
0.022	+	+	++	+	+	-
0.036	++	+++	++	+	+	+
0.044	+++	+++	+++	-	+	+

The following keys represent; - None, + Mild, ++ Moderate, +++ Strong.

Table 5 show the hepatosomatic indices (HSI) of juvenile African Catfish exposed to sublethal concentrations of Sharpshooter for 1,5,10 and 15days.The hepatosomatic indices (HSI) with 95% confidence limits decreased with time (Days 1 – 15) and increased with concentration (0.014 & 0.036 mg/L) though non- significantly.

Table 5: Hepatosomatic indices (HSI) of juvenile African Catfish *C.gariepinus* exposed to sublethal concentrations of Sharpshooter for 1, 5, 10 and 15 days.

Exposure days	Control	Concentration mg/L	
		0.014	0.036
1	0.87 ± 0.07^{b2}	1.76 ± 0.07^{b2}	1.56 ± 0.10^{b2}
5	0.72 ± 0.31^{b2}	1.65 ± 0.021^{b2}	1.25 ± 0.14^{b2}
10	0.92 ± 1.14^{b2}	0.99 ± 1.25^{b2}	1.01 ± 0.20^{b2}
15	0.70 ± 0.00^{b2}	0.73 ± 0.09^{b2}	0.96 ± 0.00^{b2}



IV. Discussion

The use of chemicals in agriculture is certainly inevitable for increase in food production, however, they introduce harmful factors to all living things and environment[16].In this study, use of sharpshooter caused a negative effect on the quality of water altering the mean value of pH, temperature and the level of dissolved oxygen compared with the control respectively. The pH and temperature values fall within the normal range of water quality for aquaculture while the level of oxygen at 0.044mg/L sharpshooter falls below the normal range to 3.40±0.0mg/L[17]. In demonstrating the toxic effects of sharpshooter in the juveniles of the freshwater fish *Clariasgariepinus*, the rate of survival decreased as the concentration of sharpshooter increased. The mortality percent for control, 0.022, 0.036 and 0.044mg/L test samples were 0, 53, 73 and 96 at 96hour exposure to sharpshooter respectively. This finding agrees with earlier reports by [18,19,20,21.] In this research,the LC_{50} value is 0.015 mg/L with lower and upper confidence limits of 0.005 and 0.022 respectively at 96 hours exposure.The reported LC_{50} value for fingerlings of *Tilapia zilli* exposed to urea fertiliser is 15.85g/L[22]. According to [23,24], the toxic effect of pesticides to organisms is dependent on the strains of species, size, age, sex, temperature, water quality and formulation of the test chemicals. A reliable index connecting the physiology and ecology of an organism and its environment enabling the organism to adapt to the effect of external and internal stimuli in order to cope with the challenge of surviving in a changing environment is the behaviour[25]. The results showed that sharpshooter affected the behavioural characteristics of *C.gariepinus*. The control specimens showed normal swimming patterns, skin colour, equilibrium status and fin movements throughout the exposure period. However, with increasing sharpshooter concentrations and exposure duration, the fish exhibited increased hyperactivity,air gasping,uncontrollable swimming and equilibrium instability. This agrees with [26] who reported characteristic behavioural responses of fish to toxicants.Due to prolonged exposure to sharpshooter the fish become fainting and stressed suggesting hypoxia accompanied with detrimental effect on energy production, bodybuilding mechanism and ultimately nervous breakdown of fish.Harmful limitations in the utilisation of energy metabolic processes in fish exposed to environmental stress were reported by [27,28,29].The fish liver has served as a reliable model for understanding how the environmental factors relate with the hepatic structures and the functions[30]. Hepatosomatic index (HSI)measures the overall health condition of fish and has been widely used as a stress indicator due to environmental pollutants [31]. In this work, theHSI increased with increase in concentration of sharpshooter but decreased with time. The HSI values are generally elevated in vertebrates experiencing induction of hepatic microsomal P-450 for detoxification of the pollutants while decline in the HSI may suggest a general detrimental effect of pesticide on the liver of fish[32].

V. Conclusion

From this work exposure of *Clarias gariepinus* to sublethal concentrations of sharpshooter pesticide for a period of 15 days negatively changed the water quality, induced stress-like behaviours, increased hepatic activities and may ultimately cause hepatic cells malfunction with time. Further work at the molecular level of the liver will help confirm this finding.

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