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TOXICOLOGICAL EFFECTS OF SUBLETHAL CONCENTRATIONS OF SNIPER 1000EC ON GROWTH OF *Clarias gariepinus* (BURCHELL, 1822) UNDER LABORATORY CONDITIONS

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ABSTRACT

Indiscriminate use of Sniper 1000EC has become a serious problem among local fishermen in the Northern parts of Niger state. Juveniles of *Clarias gariepinus* (19.47 ± 1.05; mean standard length, 20.00 ± 0.45cm) were subjected to 5 sublethal treatment levels of 0.00, 0.27, 0.31, 0.41 and 0.55mg/l. There was no significant difference between water quality parameters of the exposed and control groups. A 56 days exposure to sublethal concentrations of the toxicant led to a significant decrease ($p<0.05$) in specific and relative growth rate in the exposed fish species in comparison with their controls. Change in weight and length decreases with increasing in sublethal concentrations of sniper 1000EC. It is concluded that depressive growth rate in the exposed fish species were consequences of exposure to the toxicant (sniper 1000EC). It is recommended that the use of Sniper 1000EC by local fishermen be banned to save the aquatic environment from destruction.

Keywords: **Sniper 1000EC, *Clarias gariepinus,* Chronic Toxicity and Growth Rates.**

INTRODUCTION

Length and weight data provide a very useful tool for estimating growth rates, length, and age structures and for the improvement of the knowledge regarding fish population dynamics (Froese, 2006). Length-weight relationship is very useful for fisheries research because they allow the conversion of growth-in-length equation to growth-in-weight for use in stock assessment models (Moutopoulos and Stergiou, 2000). Length-weight relationship allow for estimation of biomass from length observations as well as comparisons of life histories of certain species (Goncalves *et al*., 1996; Froese and Pauly, 1998). They are important component of Fish Base (Froese and Pauly, 1998). Length and weight measurements can give information on the stock composition, life span, mortality, growth and production (Bolger and Connoly, 1989; Erkoyuncu, 1995; Kng, 1996; Moutopoulos and Stergiou, 2000).

Widespread application of various pesticides has aggravated the problem of pollution to aquatic environment. Due to these synthetic chemicals, environment has failed to keep its healthy characteristics. The insecticides of proven economic potentialities could not do well in the ecosystem when viewed on extra fronts since these revenue poisons, in a residual form or as a whole, get into the aquatic ecosystem. They cause a series of problems to aquatic organisms (Mastan and Ramayya, 2010).

Sniper 1000EC (2, 3-dichlorovinyl dimethyl phosphate), a brand of dichlorvos, is contact acting and fumigant insecticide (Abubakar, 2013). Like all organophosphates, it kills insects and other target organisms because of its toxicity to the nervous system. This is achieved by inhibition of enzyme acetylcholinesterase (AchE) that breaks down acetycholine at the receptor site for partial uptake into the nerve terminal. Without functioning AchE, accumulation of acetylcholine results in depolarizing block of muscle membrane, producing rapid twitching of involuntary muscles, convulsions, paralysis and early death. Indiscriminate use of Sniper 1000EC is common among local fishermen from Northern parts of Niger state.

The African catfish (*Clarias gariepinus*) is an important food fish in Nigeria, which is also good for research work (Abubakar, 2012). *Clarias gariepinus* is not only the most predominant fish species raised in aquaculture in Nigeria, but has also served as an experimental model of aquatic vertebrate for two decades (Cavaco, *et al*., 2001). Despite the indiscriminate use of Sniper 1000EC by local fishermen, there is a paucity of information on its toxicity.

The aim of the present study was to evaluate the effect of sublethal concentrations of sniper 1000EC on growth rates of *Clarias gariepinus* (Burchell, 1822) under laboratory conditions.

MATERIALS AND METHODS

Experimental Fish and Test Chemical

Juveniles of *Clarias gariepinus* (mean body weight 19.47 ± 1.05; mean standard length, 20.00 ± 0.45cm) were purchased from a reputable fish farm in Minna, Niger State. The samples were transported to the laboratory in plastic container of 100L capacity filled with water to two-third volume between 07:00 hours and 09:00 hours. They were held in large water baths of 160L capacity and acclimated for 14 days to laboratory conditions. The top of water bath was covered with netted material to prevent jumping out of the fish. A slit was made at the middle of the net to allow for feeding fish and cleaning of the bath. Feeding commenced two days after the arrival and stopped twenty-four hours before the commencement of the experiment. During acclimation, fish were fed twice daily (08:00 and 16:00 hours) with formulated feed (35% crude protein) at 3% body weight. The fishes were accepted as well as adapted to laboratory conditions when less than 5% death was recorded for the 14 days. The water in the bath was changed daily and uneaten food and faecal matters were siphoned out. Dead fish were also removed to minimize contamination of water.

Test chemical (2, 3-dichlorovinyl dimethyl phosphate), a brand of Dichlorvos with the trade name Sniper 1000EC was obtained from Minna central market and was used for the study. The test concentrations were prepared with reference to the Manual of Method in Aquatic Environment Research.

Experimental Design

The experimental design was a complete randomized design. A total of one hundred and fifty (150) juvenile of *Clarias gariepinus* were randomly distributed into the tanks at a stocking rate of 10 fish per tank. The fifteen (15) tanks were assigned to 5 treatments (control inclusive). In order to determine the LC_{50}, the *C. gariepinus* were exposed to four different concentrations of sniper 1000EC for 96hr. LC_{50} value obtained using EPA Probit Analysis programme version 1.5 was 8.21mg/l and one fifteen (1/15), one twenty (1/20), one twenty fifth (1/25) and one thirty (1/30) were taken as sublethal using the method of Abubakar (2013) to produce 0, 0.27, 0.31, 0.41and 0.55mg/L respectively.

Feeding was ad libitum 3 times daily (Table 1). The test solutions were renewed forth-nightly. The average weight and length of the fish were measured bi-weekly using a 3- digital sensitive weighing balance Meter pm 2500 Delta range®. A transparent ruler was used for the measurement of length. The experiment lasted for 56 days (8 weeks). Growth was based on relative and specific growth rates which were calculated using standard formulae:

$$GR = \frac{Wt - Wo}{Wo} \times 100 \qquad \text{..........................} \qquad \text{Haghighi, 2009:}$$

$RG_R = \frac{Wt-W}{t_2-t_1}$ ……………………… Goda *et al.,* 2007:

$SG_R = \ln\frac{Wt-Wo}{Wo}$ ……………………… Akintola et *al*., 2010:

Where:

Wt	=	Final body weight at time t (weeks)
WO	=	Initial body weight at time 0 (weeks)
GR	=	Growth rate
RG_R	=	Relative growth rate
SG_R	=	Specific growth rate
T_1	=	Initial time
T_2	=	Final time

Table 1: Ingredients of Diet Fed to the Fish Species

Ingredients	**% Composition**
Groundnut cake	35
Fish meal	30
Rice bran	20
Bone meal	5
Vegetable oil	5
Vitamin and mineral pre-mix	5
Aqua Feeds Total	**100**

WATER QUALITY PARAMETERS

Dechlorinated municipal tap water was used. It was allowed to stand for 72 hours during which it was aerated. The water quality parameters determined were temperature, dissolved oxygen, pH, water hardness and total alkalinity which could adversely affect survival and growth of fish in tanks. Temperature and dissolved oxygen were monitored on daily basis (09:00 and 14:00 hours) using a thermometer and oxygenometer (Cole Parma model 5946; Sigma Chemical, Berlin, Germany). The values of pH were measured daily using an Orion digital pH meter (Model 210; Sigma Chemical, Lisbon, Portugal). Water hardness were monitored daily using a German hardness scale (degrees of hardness or ^{0}dH) while total alkalinity were monitored on weekly basis using standard method of APHA (1987). These were done to ensure proper recordings and calculations of the parameters.

Statistical Analysis

All the data generated were managed with Microsoft office Excel 2003; they were analyzed with one-way analysis of variance (ANOVA) using Statistical Package for Social Sciences (SPSS), version 16.0 for window. Statistical significance of difference among means was compared for significant differences using Duncan's New Multiple Range tests at 95% probability (Snedecor and Cochram, 1980).

RESULTS

Effects of Sublethal Concentrations on Water Quality Parameters

The water quality variables at various sub lethal treatments for the exposed and control groups did not differ significantly (p>0.05). The mean values recorded for various sublethal concentrations compared with those of the controls are presented in Table 2.

Table 2 Physico-chemical Parameters of Chronic Test Solutions for *Clarias gariepinus* (Mean ± SD)

Concs.	P^H	Temperature (^{0}C)	Dissolved Oxygen (mgL^{-1})	Hardness (mgL^{-1})	Alkalinity (mgL^{-1})
0.00	6.49±0.01	27.4±2.07	6.76±0.02	39.4±2.72	34.3±2.15
0.27	6.51±0.02	27.6±2.49	6.74±0.02	39.5±3.08	34.2±3.06
0.33	6.53±0.04	27.4±2.36	6.74±0.02	40.2±3.03	34.4±2.25
0.41	6.55±0.05	27.3±2.08	6.75±0.02	40.6±2.31	33.6±1.96
0.55	6.52±0.02^a	27.5±2.09	6.77±0.03	39.3±2.00	34.5±1.88

Values of parameters along the same column are not significantly different at (p>0.05).

EFFECT ON GROWTH RATES

Differences in the Mean change in weight and length among the exposed fish species at various concentration levels were significant (p<0.05). Mean change in weight ranged from 19.00gm in the control tank to 14.8gm in the highest concentration tank (0.55mg/L). Mean change in length ranged from 20.4cm in the control tank to 18.8cm in the highest concentration tank (0.55mg/L). Differences were also observed in the growth rates, specific growth rates and relative growth rates of the fish species exposed to the various concentrations of sniper 1000EC. The toxicant exhibited depressive effect on the exposed groups with increase in concentration levels. These are shown in Tables 3 to 6.

The Mean change in weight of *Clarias gariepinus* at different concentration levels of sniper 1000EC are presented on Table 3. The results show that the bi-weekly mean change in weight declined with increase in concentrations of sniper 1000EC.

Table 3: Bi-weekly Mean Change in Weight (gm) *at* Different Concentration Levels of Sniper 1000EC in *Clarias gariepinus*

Concentration (mg/L-1)	Mean Change in Weight (gm)			
	WK2	WK4	WK6	WK8
0.00mg	19.00^{a}	19.3^{a}	19.5^{a}	19.8^{a}
0.27mg	18.00^{b}	17.5^{b}	17.3^{b}	17.2^{b}
0.33mg	17.3^{c}	16.9^{b}	16.4^{c}	16.4^{c}
0.41 mg	16.2^{d}	16.0^{b}	15.7^{d}	15.6^{d}
0.55 mg	15.4^{d}	15.1^{c}	15.1^{d}	14.8^{e}

Means with the same superscript along column are not significantly (p<0.05) different

Data for change in length of *Clarias gariepinus* at different concentration levels of sniper 1000EC are shown in Tables 4 and 5. The Tables revealed that the mean change in length decreased insignificantly (p>0.05) with increase in concentrations of sniper 1000EC.

Table 4: Bi-weekly Mean Change in Length (cm) *at* Different Concentration Levels of Sniper 1000EC in *Clarias gariepinus*

Concentration (mg/L-1)	Mean Change in Length (cm)			
	WK2	WK4	WK6	WK8
0.00mg	20.4^{a}	20.4^{a}	20.5^{a}	20.5^{a}
027mg	20.3^{a}	20.1^{a}	20.0^{a}	20.0^{a}
0.33mg	20.0^{a}	19.8^{a}	19.8^{a}	19.7^{a}
0.41mg	19.6^{a}	19.5^{a}	19.3^{a}	19.2^{a}
0.55mg	19.1^{a}	19.0^{a}	19.0^{a}	18.8^{a}

Means with the same superscript along column are not significantly (p<0.05) different.

Table 5 shows the growth rate, specific growth rate and relative growth rate in weight at various concentration levels of sniper 1000EC in *Clarias gariepinus*. The Table shows that growth rate, specific growth rate and relative growth rate declined with increase in concentration of sniper 1000EC.

Table 5: Mean Initial Weight, Mean Final Weight, Specific Growth Rate and Relative Growth Rate in *Clarias gariepinus*

Concentration (mg/L-1)	Mean Initial Weight (gm)	Mean Final Weight (gm)	Growth Rate (gm)	Specific Growth Rate(gm)	Relative Growth Rate(gm)
0.00mg	15.0[a]	19.8[a]	32.0[a]	1.8[a]	0.32[a]
0.27mg	15.2[a]	19.3[a]	27.0[b]	1.4[a]	0.27[b]
0.33mg	14.9[a]	18.4[b]	23.5[c]	1.2[a]	0.24[c]
0.41mg	15.0[a]	18.0[b]	20.0[d]	1.0[a]	0.20[d]
0.55mg	15.7[a]	18.6[b]	18.5[d]	1.0[a]	0.19[d]

Means with the same superscript along column are not significantly ($p<0.05$) different

The growth rate, specific growth rate and relative growth rate in length of *C. gariepinus* at different concentration levels of sniper 1000EC are shown in Table 6. The Table shows a similar trend as in weight. Growth rate, specific growth rate and relative growth rates also decreased with increase in concentrations of sniper 1000EC.

Table 6: Mean Initial Length, Mean Final Length, Relative Growth Rate and Specific Growth Rate of *Clarias gariepinus*

Concentration (mg/L-1)	Mean Initial Length (cm)	Mean Final Length (cm)	Growth Rate (cm)	Specific Growth Rate (cm)	Relative Growth Rate (cm)
0.00mg	17.8[a]	20.5[a]	15.2[a]	0.9[a]	0.15[a]
0.27mg	17.6[a]	19.8[b]	12.5[b]	0.7[a]	0.13[a]
0.33mg	17.3[a]	19.2[b]	11.0[c]	0.6[a]	0.11[a]
0.41mg	17.1[a]	18.7[c]	9.4[d]	0.5[a]	0.09[a]
0.55mg	17.8[a]	19.1[b]	7.3[e]	0.4[a]	0.07[a]

Means with the same superscript along column are not significantly ($p<0.05$) different

DISCUSSION

This study demonstrates that sniper 1000EC has depressive effect on the growth rate of *Clarias gariepinus* or that the fish exhibited a progressive decline in growth at various concentration levels. The results of water quality parameters of the media were within the optimal range recorded by Omoniyi *et al.,* (2002); as requirements for *C. gariepinus* culture which implied that the parameters did not seem to influence the toxicity of the pesticide to the test fish. Exposure to toxicant without causing death to organisms can still cause harm (Stephan, 1982) and survival of estuarine and marine organisms in relatively low concentrations of toxicant on the first day, does not necessarily indicate that they are resistant to the toxicant pollution (Mironov, 1972). Decreased growth was reported on *Mesidotea etemon* by Percy (1978). A similar reduction in growth was also observed by Toussain, *et al*., (2001) and Onusiriuka

(2002) when they exposed Japanese Medaka fish and *Clarias gariepinus* to sub-lethal concentrations of chloroform and formalin respectively, better growths were reported in control groups of certain fish than those exposed to toxicants as observed in this study. This might be due to the fact that they were able to utilize the feeds or that the feeds were palatable. This observation was in agreement with the reports of Omoregie and Okpanach (1995) in *Tilapia zilli*: Omoregie *et al.,* (1998) in *Oreochromis niloticus*; Omoregie and Onuogu (2000) in *Aphyosemion gardneri*. Most of the authorities often attributed the decline in growth rates to the impairment of feeding by fish in the toxicant polluted area as observed in this study. Several workers have reported similar findings (Shanmugavel, *et al*., 1988; Auta 2001 and Toussain, *et al.,* 2001). This might also be due to the presence of a dominant aggressive fish that caused an increased activity for others and consequently a reduction in their growth rates as well as an increase in their sensitivity of the pollutant. The dose- dependent effects of sniper 1000EC on the growth rates of the fish species suggested that high concentration of the toxicant inhibited the feeding rate of the fish species or make the feed unpalatable for them. Pal and Konar (1987) similarly reported that growth rate of *Oreochromis mossambicus* was considerably reduced by sublethal concentrations of organophosphorus insecticides. Other pollutants have also been reported to decrease fish growth and survival as recorded in Petroleum effluent by Omoregie *et al.,* (1997), Paraquat by Babatunde (1997) and Tannery by Adakole (2005). Decrease in weight and standard length of the treated fish species may be attributed to the stress they experience while adjusting to attain a tolerance level with the toxicant.

CONCLUSION

In this study, abnormalities in growth rates in the exposed fish species were associated with the effects of sublethal concentrations of sniper 1000EC. By this context, the toxicant has to be taken into more consideration as an environmental contaminant.

RECOMMENDATION

The use of sniper 1000EC by fishermen should be banned to save the aquatic environment and more studies recommended for further evaluation of this toxicant.

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