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Effect of atrazine on Nile tilapia (*Oreochromis niloticus*)

Agbon, A. O. / Omoniyi, I. T. / Abdul, W. O. /

Adeosun, F. I. / Idowu, A. A. / Odulate, O.

Abstract

Mechanization of agriculture to promote and improve the yields from agricultural practices has necessitated the use of pesticides and other agrochemicals. The effects of using these pesticides on the environment are rarely considered by farmers. This study investigated the acute and sub-lethal effect of atrazine on tilapia, an ubiquitous culturable fish species. The 96 hr LC_{50} was determined using static renewal bioassay method while the effect on haematological parameters was determined after exposure for 3 weeks to sub-lethal doses of Atrazine. The LC_{50} was found to be 6.977mg/l. Sub-lethal exposure resulted in anaemia and increased the white blood cell counts.

Keywords: Nile tilapia, Atrazine, lethal, sub-lethal.

Introduction

The issue of food security in Nigeria has raised questions on how to feed the teeming population that is in excess of 140 million inhabitants. Food security in Nigeria has been a topical issue of discourse in government circle since the initiation of the Millennium Development Goals (MGDs) at the onset of the twenty first century. Government representatives have not failed to emphasize the importance of food to household/family and national security. This informed the government initiative to set up the National Special Programme on Food Security (NSPFS) in 2000. To meet food security, the three tiers of governments have intensified the promotion of agriculture beyond subsistence scale. The mechanization of agriculture cannot be divorced from the use of pesticides and other agrochemicals to promote and improve the yields from agricultural practices. The effect of using these pesticides on the environment is rarely considered by farmers and, perhaps, government itself. There is abundant literature to support the reports of over-dosage and gross abuse by illiterate, semi-literate and even literate farmers. Water, soil, and sediments serve as the ultimate sinks for most chemicals produced and used by man. These pesticides end up in water bodies where they could exert either acute or sub-lethal effects on the aquatic biota. Scientists, resource managers and medical experts today widely accept the idea that human society is dependent upon a healthy environment and that continued environmental degradation threatens the quality of life (Bickham et al., 2000). A standard approach for evaluating the threat a xenobiotic poses to environmental health is to test whether environmentally realistic concentrations have adverse effects on organisms that may be harbingers of possible risk to humans or ecosystem services. This study was conducted to determine the acute and haematological effects of atrazine on tilapia.

Material and Methods

A total of 150 tilapia fish were obtained from the 3-ha reservoir of the integrated fish farm of the University of Agriculture, Abeokuta and taken to the laboratory where they were acclimated in out-door rectangular glass-fibre tanks of 2m X 1m X 0.5m for a period of two weeks prior to the commencement of experiment. From the out-door fibre-glass tanks, 120 healthy tilapia with a mean weight of 11.53±2.32g and mean standard length of 10.50±2.15cm, were selected and then transferred in-doors into transparent glass aquaria of 0.6m X 0.3m X 0.3m 48 hours prior to introduction of toxicant. All the glass aquaria were covered with 1mm mesh size nylon net on a wooden frame to prevent the fish from jumping out of the tanks. The water in out-door rectangular tanks were routinely refreshed every other day by 50% exchange using declorinated municipal water supply from underground water storage tanks. The atrazine which was purchased from a government accredited Agro-Allied shop had stock solution concentration of 600g/l Atrazine.

During acclimation and exposure to sub-lethal tests, 10 fish/tank the fish were fed 3% body weight daily with 2mm size Multi feed® extruded fish feed (45% protein). The total ammonia-nitrogen (TAN), nitrate-nitrogen and pH were monitored with HANNA Scientific® water quality kit once a week while dissolved oxygen and temperature were measured with Oxyguard® Handy Beta meter daily. These were done to ensure that the parameters were within the tolerant range for the fish.

The lethal test to determine the 96-hr LC_{50} was conducted using the method described by FAO (1977). The concentrations of atrazine used were 5, 6.25, 7.50 and 8.75 mg/l while the control had no toxicant. Observations of the state of the fish in test aquaria tanks were made at fixed intervals from start viz: 3, 6, 12, 24, 48, 72 and 96 hours. A record of number of survivors in each concentration was made. From these data, the LC_{50} values were calculated by probit analysis using the US EPA software (Probit program version 1.5).

Sublethal tests were conducted in duplicate bioassays with concentrations of 1.20 and 0.62mg/l atrazine. The tilapia were exposed for a period of 21 days after which 5 fish each were taken from each treatment replicate including control, for haematological analysis. The blood samples were obtained from each of the fish via puncture of the dorsal aorta and collected in heparinized microcapillary tubes for assay. Three sub-samples were taken from each fish. The Blood samples collected were subjected to standard haematological methods according to Svoboda et al. (1991).

Results

The LC_{50} was calculated to be 6.977mg/l with 95% confidence interval of between 6.55 and 7.35mg/l. The mean haematological parameters are presented in Table 1 while the water quality parameters which were measured were found to be within the acceptable range for the test fish (Table 2).

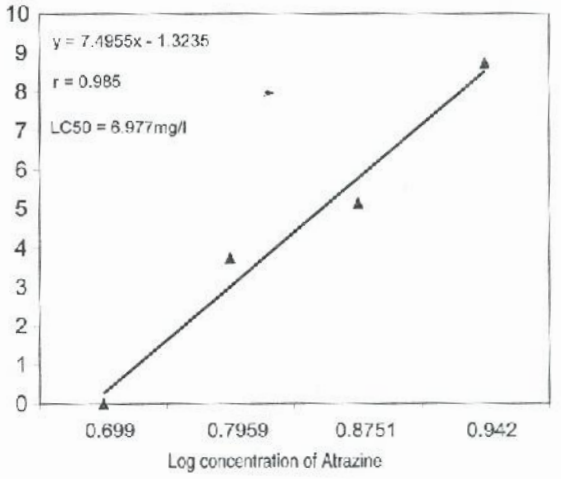

Fig. 1: Probit plot showing tilapia mortality in Atrazine

Table 1: Mean (± SD) values of haematological indices of tilapia exposed to sublethal concentrations of Atrazine.

Parameters	Concentrations of toxicant		Control
	1.2 mg/l	0.62mg/l	
PCV (%)	26.17 ± 1.47	22.83 ± 2.32	28.50 ± 5.01
Hb (g/dl)	8.75 ± 0.47	7.65 ± 0.82	9.57 ± 1.71
RBC (10^5/mm^3)	2.97 ± 0.23	2.57 ± 0.29	3.20 ± 0.56
*WBC (No./mm^3)	5566.67 ± 294.39	5300 ± 328.63	5500.00 ± 209.76
Neutrophils (%)	66.3 ± 0.30	66.33 ± 0.13	65.50 ± 0.50
Eosinophils (%)	0.33 ± 0.03	0	0
Basophils (%)	0	0	0.33 ± 0.03
Lymphocytes (%)	28.25 ± 0.33	26.75 ± 0.25	27.75 ± 0.25
Monocytes (%)	6.95 ± 0.50	6.75 ± 0.25	6.33 ± 0.11

Table 2: Water quality parameters during exposure

Parameter	Control	Treatment
Temperature	24 – 27.3	26 – 27.3
pH	7.52 – 7.56	7.27 – 7.50
Dissolved oxygen	4.7 – 5.4	3.8 – 4.0

Parameter	Control	Treatment
Conductivity	99.1 – 103.0	68.1 – 83.7
Hardness	30.0 – 60.0	39.0 – 42.0
Total Alkalinity	60.0 – 69.0	45.0 – 75.0
Ammonia-Nitrogen	1.0	0.50 – 1.50
Nitrate – Nitrogen	>10	<10
Unionised Ammonia	0.131	0.0048 – 0.026

Discussion

Acute toxicity testing is the accepted valid parameter for government regulations and guidelines for water pollution and control (Rand et al., 1995). The acute toxicity test of Atrazine in tilapia bioassays revealed the 96 hr LC_{50} to be 6.977mg/l. Sub-lethal test revealed that it induced anaemia which could be attributed to destruction of erythrocytes or the inhibition of erythropoiesis and hemosynthesis (Omoregie et al., 1998; Agbon et al., 2002 and Agbon, 2009) as shown in the significant decrease in RBC count ($p<0.05$) which indicated that the fish were stressed during the sub-lethal exposure to the atrazine.

The PCV values in the tilapia blood were observed to have decreased significantly ($p<0.05$). A decrease in PCV may indicate the extent of the shrinking cell size due to exposure in the toxicant (Ahmad et al., 1995). These decreases in the PCV values indicated that atrazine treatment might be interfering with the normal physiology of RBC. The tilapia blood Hb were observed to have decreased significantly ($p<0.05$). Sawhney and Johal (2000) suggested that depression and exhaustion in haemopoietic potentials occur under anoxic conditions. The significant decrease in Hb concentration may also be due to either an increase in the rate at which the Hb is destroyed or to a decrease in the rate of Hb synthesis (Reddy and Bashamohideen, 1989).

The WBC counts were observed to have increased slightly in this study. Das et al. (2004) reported that increase in WBC count occurred as a protective response to stress while Adekunle et al. (2007) were of the view that elevation of WBC was due to immune response by the tilapia. Further studies of the differentials showed an increase in monocytes with increase in the concentration of the toxicant. This indicates an increase in phagocytic activities to rid the system of damaged broken down tissues.

Conclusion

This study has established that low doses of atrazine could induce anaemia and lymphopoiesis in tilapia hence the need for caution during use by farmers to avoid potential environmental pollution of streams in watershed around their fields.

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