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Sublethal Effect of Dimethoate on Growth and Food Utilization of *Oreochromis niloticus* (Trewavas)

[1]J. Auta and [2]E.O. Ogueji
[1]Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria
[2]Department of Biology, Federal College of Education Katsina, P. M. B. 2041, Katsina State

Abstract: The effect of sub lethal concentrations 1.03, 2.07 and 4.13 mg L^{-1} of the organophosphorus insecticide dimethoate on growth, nutrient and body composition of the fish *O. niloticus* were studied in the laboratory. The growth rates were significantly reduced in fish exposed to sub-lethal concentration of pesticide. The food utilization showed that the control fish gave the best FCR, PER, APP, NPU and PPV, all which were significantly higher ($p<0.05$) than the group of fish exposed to the toxicant. Similarly, the percentage protein, carbohydrate and lipid of the control fish after feeding period were significantly higher than in the exposed fish ($p<0.05$). The study shows that dimethoate causes various physiological disorders in this fish. Therefore, the usage of this pesticide around water bodies should be monitored and controlled.

Key words: Dimethoate, hematological parameters, growth, *O. niloticus*

INTRODUCTION

Dimethoate as organophosphorus insecticide was first described by[1] and was introduced on the market in 1956. Cygon, dimethoate, Rogor, perfekthion, etc are its common trade names. Dimethoate formulations are widely used as a contact and systemic insecticides against a broad range of insects and mites and is applied at 0.3-0.7 kg active ingredient/ha on numerous crops, fruits and vegetables e.g., beans, cotton, wheat, sunflowers etc.[2]. Dimethoate is also used for the indoor control of houseflies. For residual treatment, 10-25 liters formulations are used (0.046-0.5 g active ingredient/m^2 of dimethoate).

Environment contamination with pesticides is a problem of worldwide importance. Data on their Bioaccumulation and excretion by fish are therefore valuable both for the assessment of the safety of pesticides for man and the extent of contamination of the environment. In the country such information are scanty. Ita and[3] reported low fish densities and diversity in 12 reservoirs in Kano State and also the dominance of *Tilapia* and *Clarias* species due to advanced stages of environmental degradation in the reservoirs. Few studies exist on the effects of pesticides on Nigerian fishes in particular and aquatic biota in general[4-10]. Therefore, studies need to be carried out to determine the effect of the different pesticides on aquatic life especially fish in this country. This study therefore investigated the effect of dimethaote on the growth of a common and economically important Nigerian fresh water fish, Oreochromis niloticus.

MATERIALS AND METHODS

Experimental fish: Healthy *Oreochromis niloticus* juveniles (average weight, 8.10±1.10 g and standard length 5.7±0.25 cm) were obtained from Maigana fish farm, Zaria, Kaduna State, Nigeria. The fish were held in the laboratory in large water baths of 160l capacity at 25.5-26.5°C and acclimated for two weeks prior to the experiment. During this period, the fished were fed with pelleted diet containing 35% crude protein twice per day at 5% body weight.

Sub-lethal test: Based on the result of the 96 h LC_{50}[8], juvenile of *Oreochromis niloticus* were exposed to 1.03, 2.07 and 4.13 mg L^{-1} concentrations of dimethaote for 8 weeks. Each concentration was replicated three times. There was a control for each experiment. A total of 120 specimen were randomly assigned to give a loading of 10 fish per tank and feeding was maintained as at during

Corresponding Author:J. Auta, Department of Biological Sciences, Ahmadu Bello University, Zaria, Nigeria

acclimation. The toxicant and test water renewed at two days intervals to maintain the toxicant strength and the level of dissolved oxygen as well as to minimize the level of ammonia during experiment[11].

Growth studies: The guideline 210 of the[12] was followed in trying to monitor growth. However, two exceptions were observed. First instead of exposing 16 fish per tank as recommended, 10 fish were exposed to tanks of 0.6×0.48 0.3 m. This was done to reduce social interactions[13, 14] bound to occur in feeding. Such social interactions are known to affect uptake kinetics of toxicants[15], therefore, causing variations in growth rates. Second, measurements of growth were done for 56 days and not the recommended 28 days. This is because the experiment was designed to last for 56 days so as to observe the long-term effects of the toxicant on growth. Fish were fed at 5% body weight twice daily i.e., morning and evening with 35% crude protein level pelleted diet. Measurement of weight changes was done on a biweekly basis.

Statistical test: Data were subjected to analysis of variance (ANOVA), Duncan Multiple Range Test (DMRT) to test for difference between different levels of treatments and to separate means, respectively, where applicable[16]. Test of significance were at 95% probability.

RESULTS

Growth studies: No mortality was observed in the control tanks. However, mortality was recorded in the exposed of tanks as seen in Table 1. Mortality was dose-dependant.

The control fish gave the best weight gain, SGR, FCR, PER, APP, NPU and PPV, all of which were significantly higher ($p<0.05$) than groups of fish exposed to the toxicant. The poorest growth and food utilization in term of weight gain, SGR, FCR, PER, APP, NPU and PPV, was obtained in fish exposed to 0.83 mg L^{-1} concentration of the toxicant (Table1).

Table 2 shows the proximate composition of *O. niloticus* before and after the experiment. The percentage protein, carbohydrate and lipid of the control fish after the experiment were significantly higher than the exposed fish ($p<0.05$). In the exposed fish, the percentage protein, fat and ash decreased while carbohydrate tends to increase with increasing concentration of the toxicant. Body compositions of the fish were dose-dependent.

Table 1: Growth and nutrient utilization of *Oreochromis niloticus* exposed to sub lethal concentrations of dimethaote.

	Concentration (mg L^{-1})			
Parameter	0.00	0.83	1.04	1.38
No. of fish	10	10	10	10
Mortality%	0	16.67	23.33	40.00
Av. Initial weight (g)	4.87	4.76	4.70	4.87
Av. Final weight (g)	10.29^{a}	6.67^{b}	6.41^{bc}	5.82^{c}
Weight gain (g)	5.42^{a}	2.21^{b}	1.70^{bc}	0.95^{c}
SGR	0.0133^{a}	0.0068^{b}	0.0055^{c}	0.0032^{d}
FCR	17.942^{b}	20.829^{a}	21.310^{a}	22.77^{a}
PER	5.36^{a}	2.21^{b}	2.71^{b}	0.95^{d}
APP NUP	17.21^{a}	3.29^{b}	1.90^{c}	1.10^{d}
PPV	38.26^{a}	31.32^{b}	12.44^{c}	12.71^{c}

Means with the same letter along column are not significant different ($p>0.05$)

Table 2: Body composition of *Oreochromis niloticus* carcasses before and after exposure to sub lethal concentration

Component		Final composition Concentration (mg L^{-1})			
Composition	Initial	0.00	1.03	2.07	4.13
Protein	54.767	66.567^{a}	55.767^{b}	16.700^{c}	16.000^{d}
Carbohydrate	0.540	0.657^{a}	0.403^{c}	0.540^{b}	0.517^{b}
Fat	5.767	7.250^{a}	6.961^{b}	6.867^{b}	4.567^{c}
Ash	25.33	$21.6.00^{b}$	22.407^{a}	18.100^{c}	17.900^{c}

Means with same letter along column are not significantly different ($p>0.05$)

DISCUSSION

The present investigations showed that prolonged exposure of *Oreochromis niloticus* to dimethaote in water induces a variety of anomalies in the feeding behaviour, food utilization and growth of this fish. There was significant reduction ($p<0.05$) in the following growth parameters: Specific growth rate (SGR), Feed conversion ratio (FCR), Protein efficiency ratio (PER), Apparent net protein utilization (App NPU) and Productive protein value (PPV) when compared with control.

The significant dose-dependant reduction in growth and food utilization observed in *O. niloticus* exposed for dimethoate indicates that the fish were severely stressed. The suppressive effect on food consumption due to the toxicant cannot be ruled out. The reported suppression in the mean growth rate, specific growth rate, food conversion efficiency and protein efficiency ratio after exposure of *C. gariepinus* to sublethal concentrations of cymbush pesticide for 28 days. Ghatak and Konar[17] also reported that the feeding rate of tilapia was reduced significantly when exposed to pesticides at various concentrations. Similarly, Ponmani *et al.*,[18] observed significant reduction in feeding rates, consumption, absorption, metabolism and growth as well as conversion efficiencies of *Cyprinus carpio* exposed to sub-lethal concentration of monocrophos.

Also[19] reported that the acetylcholinesterase inhibition decreased the feeding rate due to impairment of impulse transmission. Pal and Konar[20] reported that methyl parathion inhibited the appetite of fish through inhibition of various digestive enzymes. A reduced growth rate may also be attributed to an increase activity associated with attempt to avoid the contaminated water, or an increased expenditure of energy on chemical detoxification and tissue repair. Changes in carbohydrate metabolism can occur in fish exposed to various stressful conditions, for example, the secretion of catecholamine and adrenocorticoid by fish in stressful conditions has been reported[21].

In this study, there was a significant decrease in total protein, carbohydrate and fat content of *O. niloticus* due to dimethaote poisoning. This tends to suggest that the fish were severely stressed and metabolism of protein, carbohydrate and lipid were impaired. Hypoglycemic conditions in *O. niloticus* exposed to petroleum effluent have been reported by[22, 23] observed a dose-dependent depletion of liver glycogen in *O. niloticus* exposed to Pb and attributed this to the inefficient absorption of soluble glucose from the intestine or breakdown of liver cells which store or synthesize glycogen. The reported significant decrease in blood plasma protein concentration after acute exposure of carp *(cyprinus carpio)* to diazinon. Similar results were obtained following acute effect of fenitrothion in the eel[24] and malthion on *Cyprinion watsoni*[25]. The implication of these findings is that the nutritive value of *O. niloticus* is reduced.

This study shows that exposure of *Oreochromis niloticus* to low concentration of dimethaote lead to the impairment of the physiology of this fish such as reduction in growth performance, food utilization and the nutritive value of fish. Therefore, the usage of this pesticide around water bodies used for fish production is dangerous.

REFERENCE

1. Hoegberg, E.I. and J.T. cassaday, 1951. The reaction of O, O-dialkyl thiophosphoric acid salts some alpha-haloacyl derivatives. J. Am. Chem. Soc., 73: 557-559.
2. Worthing, C.R. and S.B. Walker, 1983. The pesticide manual. 7th Edn., lavenham united kingdom, British Crop Protection Council.
3. Ita, E.O. and S. Mohammed, 1987. Further investigation on the fish and fisheries of some randomly selected reservoirs in kano state. Annual Report Kainji Lake Research Institute, pp: 30-33.
4. Omoregie, E., E.B.C. Ufodike and I.R. Keke, 1990. Histopathology of *Orechromis niloticus* exposed to Acetellic 25 EC. J. Aquat. Sci., 6: 13-17.
5. Osibanjo, O. and O. Bamglose, 1990. Chlorinated hydrocarbons in marine fish and shellfish of Nigeria. Mari. Pollut. Bull., 21: 581-586.
6. Muhammed, B., 1995. Haematological effect to lindane on *Oreochromis niloticus*. M.Sc. Thesis. Federal University of Technology, Minna, Nigeria.
7. Babatunde, M.M., 1972. Toxicity of paraquat (Gramazone) to *Oreochromis nilotcus*. M.Sc Thesis. Department of Bio. Sci. Ahmadu Bello University, Zaria, Nigeria.
8. Auta, J., 2001. Toxicity of dimethoate to Juvenile of *Oreochromis niloticus* (trewavas) and *Clarias gariepinus* (Teugels) Ph.D. Thesis Department of Biol. Sci. Ahmadu Bello University, Zaria, Nigeria.
9. Auta, J. J.K. Balogun, F.A. Lawal and J.K. Ipinjolu, 2002. Short- term effects of dimethoate on behaviour of Juveniles of *Oreochromis niloticus* (Trewavas) and *Clarias gariepinus* (teugels). J. Aquat. Sci., 19: 5-8.
10. Oti, E.E., 2003. Acute toxicity of gammalin20 to Chrysichthtys nigrodigitatus (leacepede). Science forum. J. Pure Applied Sci., 6: 219-225.
11. American Public Health Association (APHA), American Water Works Association and Water Pollution Control Federation, 1985. Standard Methods for Examination of water waste water. 16th Edn., APHA, New York, pp: 1193.
12. OECD., 1992. Draft OECD guidelines 210. Fish early-life stage toxicity test, Fish toxicity on egg and sac-fry stages, Fish Juvenile Growth test.
13. Philips, M.J., 1989. The feeding sound of rainbow trout, *Salmo gairdneri* (Richardson). J. Fish Biol., 35: 589-592.
14. Lucas, M.C. and I.G. Priede, 1992. Utilization of metabolic scope in relation to feeding and activity by individual and grouped Zebrafish, *Brachydonio rerio* (Hamilton-buchanan). J. Fish Boil., 41: 175-190.
15. Arthur, A.D. and D.G. Dixon, 1994. Effects of rearing density on the growth response of Juvennile fathead minnow *(Pimephales promelas)* under toxicant induced stress. Can. J. Fish. Aquat. Sci., 51: 365-371.
16. Duncan, D.B., 1955. Multiple range and multiple f-test. Biometrics, 11: 1-42.
17. Ghatak, D.B. and S.K. Konar, 1991. Chronic effects of mixture of pesticide, heavy metal, detergent and petroleum hydrocarbon in various combinations on fish. Environ. Ecolo., 9: 829-836.

18. Ponmani, R., B. Dhakkodi and S. Logaswamy, 1997. Sublethal effect of monocrotophos on food utilization of *Cyprinus carpio*. J. Environ Boil., 18: 321-324.
19. O'Brein, R.D., 1976. Acetylcholinesterase and its inhibition. In Willkinson, C.F., (Ed.) Insecticide biochemistry and physiology. Plenum Press, New York, USA, pp: 271-286.
20. Pal, A.K. and S.K. Konar, 1987. Long-term Effects of Organophosphorous Insecticide Methyl Parathion on Fish. Environ. Ecol., 5: 564-571.
21. Smart, G., 1978. Investigations of the toxic mechanisms of ammonia to fish, gas exchange in rainbow trout (*Salmo gairdneri*) exposed acute lethal concentrations. J. Fish Biol., 12: 93-104.
22. Omoregie, E., E. B.C. Ufodike and C.O.E. Onwuliri, 1995. Effects of petroleum effluent on carbohydrate reserves of the Nile Tilapia, *O. niloticus* (L). West African J. Biol. Sci., 3: 70-76.
23. Oladimeji, A.A. and R.T. Olagunmeta, 1987. Toxicity of water-borne lead to *Tilapia niloticus* (L). Nigerian J. Applied Fish Hydrobio., 2: 19-24 .
24. Sancho, E., M.D. Ferrando and E. Andrev, 1997. Sublethal effects of an organophosphate insecticide on the European eel, Anguilla anguilla. Ecotoxicol. Environ. Saf., 36: 57-65.
25. Khattak, I.U.D. and M.A. Hafeez, 1996. Effects of Malathion on blood parameters of the fish Cyprinon watsoni. Pak. J. Zool., 28: 45-49.