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Toxicity of Textile Mill Effluent to *Oreochromis niloticus* (Linnaeus,1758) Fingerling

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Abstract

The toxicity of industrial effluent from Odua Textile Mill, Ado-Ekiti on *Oreochromis niloticus* fingerlings was investigated. The fingerlings were exposed to increasing concentrations of the effluent in spring and pond water respectively. The mean lethal concentration (LC50) of the effluent in spring and pond water was 24.00mg/L and 31.2mg/L respectively. Mortality were significantly different ($P<0.05$) in the source of water used. No mortality was recorded for the control (0.00mg/L) and 12.00mg/L respectively for the spring and pond water. That indicated that fingerlings in spring water were more tolerant to industrial effluent than those in pond water.

Keywords: Oreochromis niloticus, Toxicity, Industrial effluent, behaviour

Introduction

Many industries find it more economical to discharge their effluents into streams and rivers which flows to larger water bodies. This according to Chapman (1992) pollute the water. Oladele *et al* (2005) reported that fresh water fishes are often subjected to pollution which could arise from industrial effluents. Omoregie *et al* (2002) identified high levels of some trace metals in local freshwater systems especially rivers arising from industrial processes. The introduction of toxicant into aquatic environment will lead to some physiological disfunction in aquatic organisms (Ogundele *et al.,* 2005).

Effluents from most industries contain metallic substances, some of which are toxic to living organisms including fish (Offem *et al.*, 2005). The result of the study conducted by Offem *et al* (2005) on the toxicity and accumulation of led in the muscle of Nile Tilapia *Oreochromis niloticus* revealed that a percentage mortality of the species increased with concentration and exposure period. Similar study by Omitoyin *et al.*, (2006) showed that Lindane is highly toxic to *Clarias gariepinus* juveniles.

The Nile Tilapia, *Oreochromis niloticus* belongs to the family Cichlidae. Arrignon

(1998) described *Oreochromis niloticus* as the best species for culture among the tilapia family with squat shape. Fagbenro (2002) reported that tilapia species are of major economic importance in tropical and sub-tropical countries throughout the world, particularly in Africa which forms stock mixed-sex tilapia in production ponds. Toxicity test of chemicals on animals has been used for a long time to detect the potential hazard posed by chemicals to man (Offem *et al.*, 2005). Bioassay technique has been the cornerstone of programmes on environmental health and chemical safety (Ward and Parish, 1982). There is therefore the need to investigate the toxicity of the industrial effluent from Odua Textile Mill, Ado-Ekiti in Nigeria.

The objective of the study is to determine the 96h LC50 of the effluent from Odua Textile Mill to the fingerlings of *Oreochromis niloticus*, the behaviour and changes in the external surface.

Materials and Methods

Experimental set up, fish and management

The ninety six hours static bioassay was conducted in the laboratory of the Department of Fisheries, Federal University of Technology, Akure, Nigeria, to investigate the toxicity of textile mill effluent to tilapia fingerlings. The bioassay method of short-term toxicity in aquatic environment outlined by FAO (1986) and APHA (1998) with some modification was applied.

Fingerlings of *O. niloticus* (mean weight 7.08± 0.04g) were purchased from a commercial fish farm at Ado-Ekiti, Nigeria for this study. The effluent used as a toxicant for the investigation was obtained from Odua Textile Mill, Ado-Ekiti, Nigeria.

One hundred and sixty fingerlings of *O. niloticus* were randomly assigned into rectangular glass aquaria of capacity 286litres each containing 180litres of spring and pond water respectively. The fingerlings were acclimated for seven (7) days. They were fed daily with a commercial fish feed (Pellets) containing 40% crude protein at 3% of their body weight (FAO, 1986). Unconsumed feed and faecal wastes were removed and water replenished regularly as recommended by Oyelese and Faturoti (1995). Feeding was discontinued for 24 hours before the commencement of and during the experiment to minimize the production of waste in the test container.

Toxicity experiment

The following concentrations in weight per volume of the effluent of Odua Textile Mill were used for the range finding test: 10.00, 11.00, 65.00 and 70.00 mg/L respectively. They were tested on 6 *O. niloticus* fingerlings per concentration of the effluent, with five replications and 2 control experiments. Based on the results of the range finding test, the following definitive concentrations of the effluent were prepared as: 12.00, 24.00, 36.00, 48.00 and 60.00mg/L replicated five times in twelve (12) glass aquaria. Six acclimatized fishes were released into each aquarium containing the above different concentrations of the effluent using the different media of spring and pond waters. All tests were carried out at room temperature (28.1^{0}C). The behaviour, mortality and other external changes in the body of the test fish were

observed and recorded accordingly.
Dead fish were promptly removed and mortality was specifically recorded at different exposure time intervals as described by Odiete (1999), Omitoyin *et al* (2002). The LC50 values for the fingerlings of *O. nitolicus* were calculated for 96h of exposure time.

Water quality analysis and experimental set up
The water quality parameters such as dissolved oxygen, temperature and the PH of the test media were recorded daily for the 96h exposure period following the standard method on water quality assessment by APHA (1998).

Statistical analysis
The results obtained were subjected to one-way analysis of variance at 5% level of significance to determine the statistical differences between the means of the replicates of each of the test as described by Akindele (1994). Arithmetic graph method according to Finney (1971) was used to determine the median lethal toxicity and concentration.

Results

There were slight variations in the water quality parameters of the spring water and pond water used in the experiment. The water quality analysis showed that PH of spring water was 5.73 while that of pond water was 6.62; dissolved oxygen 6.7mg/L for spring water and 6.65mg/L for pond water. The mean temperature of the spring water was $25^0C \pm 0.2$ while that of the pond water was $28.5^0C \pm 0.3$.

The mean lethal concentration (LC50) of the effluent in spring and pond water was 24.00mg/L and 31.2mg/L respectively as shown in figure 1 and 2 . Total mortality was recorded with 48.00mg/L of the pollutant administered in both spring and pond water. No mortality was recorded with 12.00mg/L and 24.00mg/L concentration of the pollutant in spring and pond water. The fishes showed variation in their tolerance of the same concentration of the pollutant with different types of water media (spring and pond water) as shown in table 1 and 2. It was also observed that the rate of fingerlings mortality in spring water was higher than that in pond water, as 24.00mg/L concentration of the test substance killed some fingerlings in pond water.

Statistically the LC 50 values of *O. niloticus* in spring and pond water were significantly different from one another ($P<0.05$). The LC50 of the textile effluent was attained at low concentration in spring water than in pond water.
Exposure of textile effluent to test fish resulted in behavioural reactions such as increased stressed as evident in erratic swimming, loss of flex, hyperventilation, as well as external surface appearance of motling and discolouration of skin and finally death as shown in Table 3 and 4. These reactions were more pronounced in tanks containing higher levels of toxicants.

Discussion

The stress responses shown by fish exposed to the effluent compared favourably with those observed earlier by Nwana *et al* (2000) who exposed *Clarias gariepinus* to textile effluent and Auta *et al* (2004) who also exposed *C. gariepinus* and *O. niloticus* to acute concentrations of dimethoate. The 96hrs LC50 values recorded for Textile effluent for spring and pond water on Tilapia was more tolerant to the textile effluent. The abnormal behavioural responses in the exposed fish especially in the tanks with higher concentrations of the textile effluent were similar to that earlier reported by Ufodike and Omoregie (1991); Offem *et al.* (2005) and Omitoyin *et al.* (2006) in fishes exposed to toxicants. The stressful behaviour exhibited by the test fish is an indication that the effluent was poisonous.

Increased physical activity, convulsion, excess secretion of mucus, incessant gulping of air, erratic swimming, respiratory distress and paralysis, prior to death were associated with textile effluent toxicant. This agrees with the findings of Alkahem *et al.* (1998) and Auta *et al.* (2002) on *O. niloticus* exposed to trichloroform and dimethoate respectively. Grillistch *et al.* (1999) reported that organisms exhibit behavioural responses to chemical stress both at acute and sublethal toxicity. The ecological importance of this is that the damage to non-target species in the environment and such attribute of the organism, could be effectively used as toxicity biosensor of chemical stress. Other studies on different toxicants especially petroleum related hydrocarbon compounds indicate damage to tissues and retardiation in physiological processes in fish body functions (Omoregie, 1995 and Fryday *et al.*, 1996).

Conclusion

Our results confirmed that textile effluent in both the spring and pond water at increased concentrations, where poisonous to tilapia fingerlings. Discharge of this to water bodies may cause retarded growth, reproductive failure and death. It is therefore our view, that effort be made to stop the discharge of this industrial effluent to our natural water bodies and adjoining environment. This is hoped, will prevent the ecological risk on fish and other aquatic organisms in our water bodies.

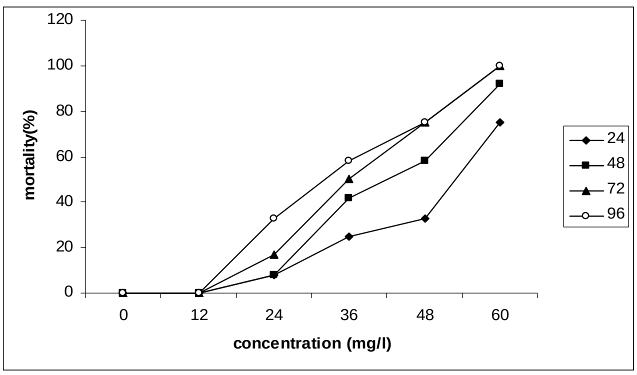

Fig 1 :Mortality of *O. niloticus* exposed to different concentrations of industrial effluent in spring water at different time.

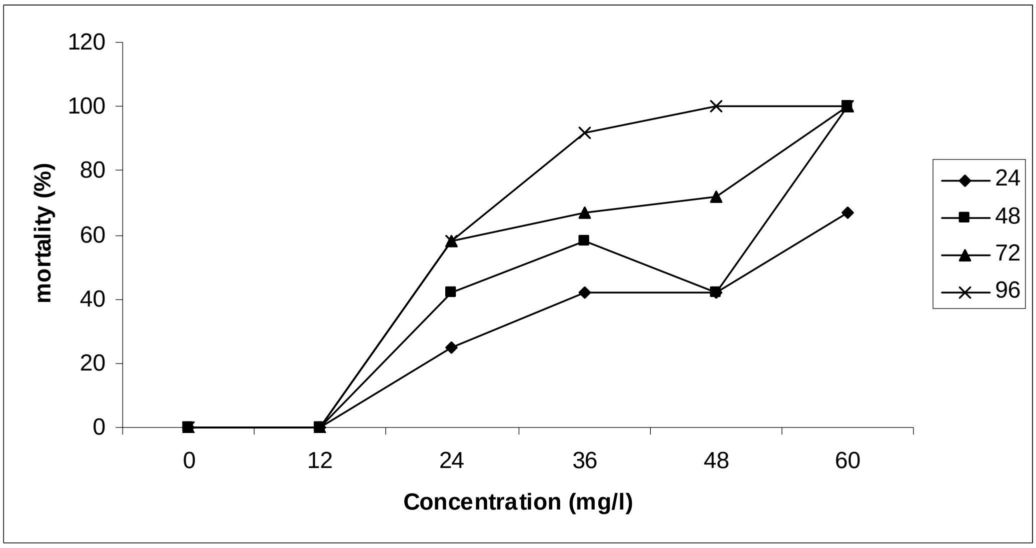

Fig. 2: Mortality of *O. niloticus* exposed to different concentrations of industrial effluent in pond water at different time.

Table 1: The cumulative mortality and survival rates of *O. niloticus* exposed to different concentrations of industrial effluent in spring water at different intervals.

		Time							
Concentration		24		48		72		96	
(Mg/L)	No. of Fish	L	D	L	D	L	D	L	D
0	6	6	0	6	0	6	0	6	0
0	6	6	0	6	0	6	0	6	0
12	6	6	0	6	0	6	0	6	0
12	6	6	0	6	0	6	0	6	0
24	6	4	2	3	3	2	4	2	4
24	6	5	1	4	2	3	3	3	3
36	6	4	2	4	2	3	3	1	5
36	6	3	3	1	5	1	5	0	6
48	6	3	3	1	5	0	6	0	6
48	6	4	2	3	3	1	5	1	5
60	6	2	4	0	6	0	6	0	6
60	6	1	5	0	6	0	6	0	6

Table 2 The cumulative mortality and survival rates of *O. niloticus* exposed to different concentrations of industrial effluent in pond water at different intervals.

		Time							
Concentration		24		48		72		96	
(Mg/6)	No of Fish	L	D	L	D	L	D	L	D
0	6	0	0	0	0	0	0	0	0
0	6	0	0	0	0	0	0	0	0
12	6	0	0	0	0	0	0	0	0
12	6	0	0	0	0	0	0	0	0
24	6	5	1	5	1	5	1	4	2
24	6	6	0	6	0	5	1	4	2
36	6	4	2	4	2	3	3	3	3
36	6	5	1	3	3	2	4	2	4
48	6	4	2	3	3	2	4	2	4
48	6	4	2	2	4	1	5	1	5
60	6	2	4	1	5	0	6	0	6
60	6	1	5	0	6	0	6	0	6

Table 3 Effect of an industrial effluent on body features of O. *niloticus* in pond water

Percentage concentration cm_3/60L	12	24	36	48	60	0	12	24	36	48	60	0	12	24	36	48	60	0
Erratic swimming	-	-	+	+	+	-	-	-	+	+	+	-	-	-	+	+	+	-
Loss of reflex	-	-	+	+	+	-	-	-	+	+	+	-	-	-	+	+	+	-
Discolouration	-	-	+	+	+	-	-	-	+	+	+	-	-	-	+	+	+	-
Change in behavior	-	-	+	+	+	-	-	-	+	+	+	-	-	-	+	+	+	-
Hyperventilation	-	-	+	+	+	-	-	-	+	+	+	-	-	-	+	+	+	-
Motling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Death	-	+	+	+	+	-	-	+	+	+	+	-	-	-	-	+	+	-

+ = Present, -= Not Present

Table 4 Effect of an industrial effluent on body features of O. *niloticus* in spring water

Percentage concentration $cm_3/60L$	12	24	36	48	60	0	12	24	36	48	60	0	12	24	36	48	60
Erratic swimming	-	+	+	+	+	-	-	+	+	+	+	-	-	+	+	+	+
Loss of reflex	-	+	+	+	+	-	-	+	+	+	+	-	-	+	+	+	+
Discolouration	-	+	+	+	+	-	-	+	+	+	+	-	-	+	+	+	+
Change in behavior	-	+	+	+	+	-	-	+	+	+	+	-	-	+	+	+	+
Hyperventilation	-	+	+	+	+	-	-	+	+	+	+	-	-	+	+	+	+
Motling	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Death	-	+	+	+	+	-	-	+	+	+	+	-	-	+	+	+	+

+ = Present, - = Not Present

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