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Effects of Sublethal Concentrations of Formalin on Weight Gain in the Nile Tilapia, *Oreochromis niloticus* (Trewavas)

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Abstract

The effect of sublethal concentrations of formalin on the weight gain of Nile tilapia fingerlings was investigated under laboratory conditions during a 12-week exposure at concentrations of 25.00, 12.50, 6.25, 3.125, 1.56 and 0.00 (control) $mg \cdot l^{-1}$. The toxicant led to depressed weight gain in the fish. The severity of this depression was directly proportional to the toxicant concentrations. However, at 1.56 $mg \cdot l^{-1}$ concentration, no significant depression in weight gain ($P>0.05$) was observed in the test fish. Precautions in the successful use of formalin to control ectoparasites in aquaculture are discussed.

Introduction

Formalin has long been a traditional treatment for fish ectoparasites. It is usually efficient at concentrations of 167-250 $mg \cdot l^{-1}$ for 1 hour (Roberts 1978). It is applied by bath, flush or flowing treatment methods and has proved effective against most ectoparasitic protozoan and some monogeneans. A concentration of 500 $mg \cdot l^{-1}$ for 30 minutes has proved effective against the salmon louse, *Lepeophtheirus salmonis* (Hastein and Bergsjo 1976). Meyer and Collar (1964) noted that it could be used at 25 $mg \cdot l^{-1}$ for an indefinite length of time in bath treatment.

Some disinfectants for the treatment of ectoparasites on cultivable fish species have been known to have cumulative adverse effects on the fish. Wedemeyer (1971) attempted to quantify the stress of chemical treatments in rainbow trout, *Oncorhynchus mykiss*, and coho salmon, *O. kisutch*, and there seemed little doubt that repeated use of disinfectants such as formalin will cause considerable damage to gill epithelia. Smith and Piper (1972) reported that 167 $mg \cdot l^{-1}$ of formalin destroyed and dequamated the gill epithelium of the rainbow trout. Omoregie *et al* (1994) observed that the Nile tilapia exposed to sublethal concentrations of formalin had anemia and hyperglycemia.

The Nile tilapia, which is a common fish in tropical freshwaters, is widely used in aquaculture in several African and Asian countries, hence its choice for this investigation. The objective of this investigation is to evaluate the effects of sublethal doses of formalin on weight gain in the Nile tilapia.

Materials and Methods

Fingerlings of the Nile tilapia (mean weight, 1.82 ± 0.02 g) of the same brood stock were acclimated to laboratory conditions for seven days prior to exposure. Mortality was less than 2% during the acclimation period. Ten fingerlings were stocked in each test aquarium with dechlorinated, aerated tap water. Feeding was done once daily (0800 hours) using a pelleted diet at 4% body weight of the fish. The experimental set-up consisted of twelve 30-liter aquaria. The water was changed once weekly to remove accumulated faecal material and unconsumed feed.

Formalin was obtained as 40% formaldehyde. The following concentrations were delivered into each of the first six aquaria: 25.00, 12.50, 6.25 3.125, 1.56 and 0.00 $mg \cdot l^{-1}$. The remaining six aquaria served as replicates. To prevent problems associated with the degradation of formalin in the various experimental aquaria, fresh concentrations were delivered into each of the aquaria on a daily basis.

The exposure period was 12 weeks, during which the following water quality parameters in each of the test aquaria were monitored weekly according to APHA/AWWA/WPCF (1980): temperature, dissolved oxygen, free carbon dioxide, alkalinity, pH and unionised ammonia. The proximate composition of the pelleted diet fed to the exposed fish were determined according to AOAC (1980). While anesthetized with benzocaine, the fish were individually weighed at the start of the exposure period and fortnightly thereafter. Mean weight gain of the fish were computed per treatment for each weighing period. The amount of feed given were adjusted to the new weight.

Results were subjected to statistical analysis with the Duncan's multiple range F-test to test for the level of significance at 0.05 level of probability within the various concentrations.

Results

The water quality parameters in the various test aquaria did not vary significantly ($P>0.05$) from those of the control experiment during the 12-week exposure period (Table 1). The proximate composition of the experimental diet showed a high protein level (Table 2). Fish exposed to the toxicant had curbed appetite. However, with slow feeding, all fish eventually consumed the food supplied. Table 3 showed the mean weight gain of the exposed fish to the various concentrations. Statistical analysis showed that the test fish exposed to the various sublethal concentrations of formalin had significantly lower weight gain than those of the control fish ($P<0.05$), with depression in weight gain being directly proportional to toxicant concentrations and sampling periods. The

Table 1. Mean water quality parameters* obtained during exposure of the Nile tilapia, *Oreochromis niloticus*, to sublethal concentrations of formalin for 12 weeks.

Parameters	Formalin concentration ($mg \cdot l^{-1}$)					
	25.00	12.50	6.25	3.125	1.56	0.00 (control)
Temperature(^{O}C)	24.04 (0.06)	24.09 (0.07)	24.25 (0.06)	24.27 (0.06)	24.56 (0.03)	24.23 (0.06)
Dissolved oxygen ($mg \cdot l^{-1}$)	6.91 (0.04)	6.90 (0.06)	7.02 (0.06)	6.95 (0.05)	6.92 (0.04)	6.93 (0.07)
Carbon dioxide ($mg \cdot l^{-1}$)	4.72 (0.05)	4.96 (0.04)	4.86 (0.03)	4.82 (0.04)	4.64 (0.07)	4.94 (0.03)
Alkalinity ($mg \cdot l^{-1}$)	32.97 (0.03)	33.49 (0.30)	36.88 (0.08)	34.17 (0.20)	34.17 (0.20)	32.83 (0.20)
pH	6.75 (005)	6.63 (0.04)	6.58 (0.02)	6.65 (0.03)	6.54 (0.03)	6.4 (0.03)
NH_3 (unionized)	0.22 (0.01)	0.23 (0.03)	0.22 (0.01)	0.23 (0.01)	0.22 (0.01)	0.22 (0.01)

*Mean values with standard deviation in parentheses.

Table 2. Proximate compositions of experimental diet (% dry matter)* fed to the Nile tilapia, *O. niloticus*, during exposure to sublethal concentrations of formalin for 12 weeks.

Components	Composition
Protein	55.50 (0.12)
Moisture	9.08 (0.05)
Lipids	3.45 (0.01)
Ash	7.46 (0.4)
Carbohydrate	24.51 (0.10)

*Mean values with standard deviation in parentheses.

Table 3. Mean weight gain (g)* of the Nile tilapia, *O. niloticus*, exposed to sublethal concentrations of formalin for 12 weeks.

Formalin concentration ($mg \cdot l^{-1}$)	Exposure period (weeks)							Weight gain
	0	2	4	6	8	10	12	
25.00	1.81(0.01)	2.04(0.02)	2.28(0.02)	2.53(0.01)	2.79(0.02)	3.04(0.02)	3.28(0.02)	1.47
12.50	1.83(0.02)	2.26(0.02)	2.68(0.02)	3.09(0.03)	3.49(0.03)	3.87(0.03)	4.26(0.02)	2.43
6.25	1.81(0.02)	2.51(0.05)	3.24(0.02)	3.94(0.02)	4.62(0.01)	5.30(0.01)	5.97(0.01)	4.16
3.125	1.79(0.01)	2.73(0.01)	3.65(0.01)	4.56(0.01)	5.47(0.01)	6.37(0.01)	7.24 0.01)	5.45
1.56	1.84(0.05)	3.07(0.01)	4.29(0.01)	5.50(0.01)	6.70(0.01)	7.90(0.01)	9.10(0.01)	7.26
0.00 (control)	1.81(0.01)	3.31(0.01)	4.82(0.01)	6.34(0.01)	7.87(0.01)	9.40(0.01)	10.96(0.02)	9.15

*Mean values with standard deviation in parentheses.

weight gain over the 12-week exposure period were 1.47, 2.43, 4.16, 5.45, 7.26 and 9.15 g with concentrations of 25.00, 12.50, 6.25, 3.125, 1.50 and 0.00 $mg \cdot l^{-1}$ of the toxicant.

Discussion

Results from this investigation indicated that fish exposed to sublethal concentrations of formalin grew significantly less compared to their counterparts not exposed to the toxicant. Observation showed that the water quality parameters in the test aquaria did not vary significantly from those of the control aquaria, with all values within the suggested tolerance range

(Mackereth 1963). Observation also showed that the feed given to the fish was of high nutritional value (Ufodike and Matty 1983). Reduced growth levels was observed in common carp exposed to the insecticide Dipterex. by Chinabut *et al.* (1987), who also noted that growth was inversely proportional to toxicant concentrations. Sublethal concentrations of lead have been implicated with growth retardation in the Nile tilapia (Oladimeji and Ologunmeta 1987). The reduction in the weight gain of the exposed fish is therefore attributed to effects of the formalin on the fish. The suppression of growth may be due to formalin's adverse effects on normal metabolism of the fish. Omoregie *et al.* (1994) have reported that Nile tilapia exposed to sublethal concentrations of formalin had anaemia and hyperglycaemia at the end of the exposure period. The effects of these responses could have contributed to the reduced weight gain observed in this investigation. However, the suppressive effect of the toxicant on nutrient digestibility as earlier reported by Ufodike and Omoregie (1991) could not be ruled out.

Formalin is widely recommended for treatment of ectoparasitic infections of farmed fish species (Roberts 1978). Although its effects against ectoparasites are encouraging, the deleterious consequences on the growth of fish subjected to nominal chronic exposure to formalin calls for the review of its use in aquaculture. Optimal caution should also be observed when formalin is used against ectoparasites.

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