Trends in Applied Sciences Research

ISSN 1819-3579

Academic
Journals Inc.

www.academicjournals.com

Trends in Applied Sciences Research 9 (9): 512-516, 2014
ISSN 1819-3579 / DOI: 10.3923/tasr.2014.512.516

Effects of Sublethal Concentrations of Formalin on the Growth of *Clarias gariepinus* Fingerlings

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ABSTRACT

The study was aimed at investigating the sublethal effects of formalin on the fingerlings of *Clarias gariepinus*. Fingerlings of *Clarias gariepinus* were exposed to various sublethal concentrations (10.0, 20.0, 30.0, 40.0 and 50.0 μL L^{-1}) of formalin obtained as 40% formaldehyde and the concentration of 0.0 μL L^{-1} formalin served as the control. The fish were fed with coppens at 5% body weight and the growth performance was evaluated. The behaviors of fish were observed before and during exposure period. Mean weight gain of fish ranged from 4.577±1.041 in the control to 0.937±0.196 in concentration of 50 μL L^{-1}. Specific growth rate (SGR) ranged from 0.017±0.310 in the control to 0.006±1.050 in concentration of 50 μL L^{-1}. The toxicant led to slightly depressed weight gain in the fish as the concentration increased. However, the slight variations in weight gain did not show any statistical significance ($p>0.05$). Restlessness, erratic swimming behaviour, respiratory distress, vertical movement and death, were observed especially in the concentrations 50.0 μL L^{-1} of formalin. Such observations were not recorded in the control tanks. Despite that formalin is highly effective for treatment of ectoparasitic infections of farmed fishes, limitations cannot be disregarded. Its use in fish must therefore be under stipulated controlled procedures within threshold values.

Key words: *Clarias gariepinus*, formalin, sublethal, concentration

INTRODUCTION

The African catfish, *Clarias gariepinus* is an ecologically important and commercially valued fish in Nigeria. They are frequently and widely cultured in ponds and they also occur freely in Nigerian natural fresh water (Samuel *et al*., 2008). In culture systems, they are exposed to undue stress which predisposes and make them susceptible to various diseases, hence the need for therapeutants.

Formalin is one of the most effective and widely used compounds in fish culture for therapeutic and prophylactic treatment of fungal infection and ectoparasite (including protozoans and monogenic trematodes) of fish and fish eggs through bath, flush or flowing treatment methods (Floyd, 1996; Jung *et al*., 2001). Egusa (1991) recommended the use of formalin at 25 ppm for the white spot disease caused by *Ichthyopthirius multifilis* and at 15-25 ppm in ponds for alternate days for 5-7 days to control trematodes. According to Kabata (1970) treatment for 1 h with 250 ppm formalin destroyed the larvae of the copepod *Salmincola* sp.

Formalin is a 37-50% aqueous solution of dissolved formaldehyde CH_2O (Chinabut *et al*., 1988) and formaldehyde was declared a toxic substance by the 1999 Canadian Environmental Protection

Act (Health Canada, 2007). Although the report from several web articles claiming that formaldehyde has been banned from manufacture or import into the European Union (EU) under REACH (Registration, Evaluation, Authorization and restriction of Chemical substances) legislation is viewed to be misinformation, as official EU chemical databases contradict these claims as of February 19, 2010 and formaldehyde is not listed in the Annex I of Regulation (EC) No. 689/2008 (export and import of dangerous chemicals regulation), nor on a priority list for risk assessment, however, formaldehyde is banned for use in certain applications (preservatives for liquid-cooling and processing systems, slimicides, metalworking-fluid preservatives and antifouling products) under the Biocidal Products Directive (ECED, 2007; ECCP, 2009).

In USA, Paracide F, a preparation containing formaldehyde and methanol (which prevents polymerization and the formation of paraldehyde, which is toxic to fish) is approved as an effective fungicide and for use on the eggs of salmonids and esocids (Piper, 1982; FDA, 1995). In Nigeria however, the type of formalin used in treating fish and disinfect eggs of all cultured fish species is the analytical grade of formalin (Adeyemo *et al*., 2012). Nigerian aquaculture industries have been using formalin extensively as a topical treatment for fish and egg disinfection without paying much attention to the fact that the therapeutant might also be absorbed systemically and may produce significant internal effects.

This study is thus tailored towards determining the sublethal effects of formalin at therapeutic levels on the growth of *Clarias gariepinus* fingerlings.

MATERIALS AND METHODS

Procurement of experimental fish: Fingerlings of the African catfish (*Clarias gariepinus*) of mean weight 2.47±0.30 g obtained from Tidoo fish farm in Makurdi, Nigeria, were brought to fisheries Laboratory, University of Agriculture, Makurdi and acclimated to laboratory conditions for seven days.

Sublethal exposure of experimental fish: The fish were randomly stocked in experimental aquaria at 20 fish per aquarium and exposed to formalin obtained as 40% formaldehyde, delivered at various concentrations for eight weeks. The formalin was delivered at various concentrations of 10, 20, 30, 40 and 50 μL L^{-1} into the different experimental aquaria and 0.00 μL L^{-1} served as the control experiment. The experiment was replicated. To prevent error associated with the degradation of formalin in the various experimental aquaria, fresh concentrations were delivered into each of the aquaria once weekly and water quality parameters in each of the test aquaria were monitored weekly according to APHA (1980).

Growth and behavioral assessment: Fish were fed with coppens at 5% body weight. The fish were weighed at the start of exposure period and weekly thereafter and the feed allowance adjusted accordingly. The behaviors of fish were observed before and during exposure period. Growth parameters were calculated to evaluate the performance of the fish on the experimental diets.

These parameters were computed as follows:

- Mean Weight Gain (MWG) per treatment was determined by computing the difference between the Mean Final Weight (MFW) and the Mean Initial Weight (MIW)
- Specific Growth Rate (SGR) was determined according to Brown (1957)

$$SGR = \frac{Log(MFW) - Log(MIW) \times 100}{Time(days)}$$

Statistical analysis: The results obtained were subjected to statistical analysis using analysis of variance.

RESULTS AND DISCUSSION

The results of the water quality parameters of *C. gariepinus* fingerlings exposed to formalin for 8 weeks showed a deterioration in water parameters as Do ranged from 6.13±0.83 in the control to 3.95±0.46 in concentration of 50 μL L^{-1} as presented in Table 1. This difference was however not statistically significant.

The results from this investigation indicated that fish exposed to sublethal concentrations of formalin had reduced weight gain when compared to the control, although this difference was not statistically significant. The growth indices indicate a positive correlation between higher concentration and reduction in weight gain with mean weight gain ranging from 4.577±1.041 in the control to 0.937±0.196 in concentration of 50 μL L^{-1} as indicated in Table 2. This is in accordance with report of Chinabut *et al.* (1988) who observed that exposure to formalin at therapeutic levels for eight weeks reduced the growth of common carp fry. Similarly, Omoregie *et al.* (1998) had observed depressed weight in Nile Tilapia (*Oreochromis nitlotcus*) exposed to sublethal concentrations of formalin.

This study also revealed that erratic swimming behavior, restlessness, loss of balance, respiratory distress, vertical movement and death, were observed in test media especially at the concentrations of 50.0 μL L^{-1} of formalin whereas such observations were not recorded in the

Table 1: Mean water quality parameters with standard error in parenthesis obtained during exposure of *Clarias gariepinus* to sublethal concentrations of formalin for 8 weeks

	Concentrations (μL L^{-1})					
Parameters	0	10	20	30	40	50
Temperature (°C)	25.50 (0.34)	25.50 (0.34)	25.50 (0.34)	25.50 (0.34)	25.50 (0.34)	25.54 (0.34)
Dissolved oxygen (mg L^{-1})	6.13 (0.83)	5.64 (0.72)	5.09 (0.61)	4.90 (0.46)	4.16 (0.46)	3.95 (0.46)
Free carbondioxide (mg L^{-1})	2.55 (0.21)	2.61 (0.24)	3.07 (0.28)	3.74 (0.24)	5.08 (0.35)	5.49 (0.34)
Total alkalinity (mg L^{-1})	25.61 (1.65)	25.61 (1.65)	26.72 (1.78)	26.72 (1.76)	27.33 (1.59)	28.63 (1.73)
pH	7.05 (0.02)	7.06 (0.02)	7.06 (0.02)	7.06 (0.02)	7.08 (0.03)	7.03 (0.05)
Ammonia (Unionized)	0.21 (0.01)	0.21 (0.01)	0.21 (0.01)	0.21 (0.01)	0.21 (0.01)	0.21 (0.01)

There was no significant differences in parameters for all treatments ($p>0.05$)

Table 2: Growth performance of *Clarias gariepinus* exposed to sublethal concentrations of formalin for 8 weeks

Concentration (μL L^{-1})	Mean initial weight (g)	Mean final weight (g)	Mean weigth gain (g)	Percentage weight gain
0	2.403±0.129	6.980±1.111	4.577±1.041	190.4702
10	2.483±0.179	5.930±1.220	3.447±1.041	138.82
20	2.563±0.075	5.690±2.220	3.127±2.145	122.01
30	2.587±0.243	4.820±2.500	2.233±2.257	86.32
40	2.600±0.118	4.783±0.337	2.183±0.362	83.96
50	2.497±0.111	3.430±1.890	0.937±0.196	37.53

There was no significant differences in parameters for all the treatments ($p>0.05$)

control tanks. Similar observations were made when toxicity of formalin on behaviour and respiration in *Danio rerio* was studied and the exposed fish exhibited abnormal behavior and swimming movements, reduced opercular beats, increased mucus secretion and mortality (Mohammed *et al*., 2012). Okomoda *et al*. (2010), in a study on Heamatological Changes of *Clarias gariepinus* fingerlings exposed to acute toxicity of formalin reported that the fish exposed to the toxicant exhibited loss of balance, respiratory distress, vertical and erratic movement, accumulation of mucus on the body surface and gill filament and death. In accordance with this, Chinabut *et al*. (1988) Observed behavioral changes in fish exposed to formalin which indicated that at high concentration, there was an increase in opercula beat but slower swimming than the controls. Similarly, Wedemeyer and Yasutake (1974) reported that fish exposed to formalin exhibited hyperventilation because formalin decreases the dissolved oxygen content of water. However, Wedemeyer (1971) stated that rainbow trout (*Salmo gairdneri*) and coho salmon (*Oncorhynchus kisutch*) exposed to formalin had a 10-15% decreased in respiration rate. Smith and Piper (1972) noted that 167 mg L^{-1} of formalin led to the destruction and desquamation of the gill epithelium.

Although Formalin used at therapeutic levels in treatments of fish and fish eggs, may not instantly kill the fish, as a toxicant, it could lead to several physiological dysfunctions.

CONCLUSION

Though formalin is recommended for the treatment of ectoparasitic infections of farmed fishes limitations cannot be disregarded. Its use in fish must therefore be under stipulated controlled procedures within threshold values.

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