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Effect of Cassava Effluent on the Hatching and Survival of African Catfish, *Clarias gariepinus* Larvae

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Abstract: The effects of different concentrations of cassava effluent on eggs and larvae of *Clarias gariepinus* were evaluated in this study. Based on the range finding test, five concentrations of the effluent 0% (control), 2, 4, 6 and 8% were tested. There was significant difference ($p<0.05$) in the percentage fertlisation of *C. gariepinus* eggs subjected to the various treatments. The higher concentrations of cassava effluents, 8, 6 and 4% were very toxic, less than 20% hatching success. The hatching percentage was inversely proportional to the effluent concentration (from 90.00±1.0% in the control to 16.00±1.5% in 8% cassava effluent concentration). Hatching started (22.0±1.0) hours after fertilization in control media (0% concentration) and lasted for 24.5±0.1 h while hatching began at 23.0±0.5 and 24.5±0.5 h in the 2 and 8% concentrations. There was significant ($p<0.05$) difference in MT_{50} in all the tested concentrations. The MT_{100} were not similar ($p<0.05$) in all the tested concentrations of effluents. Based on the result of this study, cassava effluents adversely affected fish reproductive performance and larvae survival. Therefore, cassava effluents should be diverted away from pond waters.

Key words: *Clarias gariepinus*, eggs, larvae, hatchability, reproductive performance, mortality time

INTRODUCTION

Man is the main cause of pollution in flowing water since they have turned the water to the medium for getting rid of wastes. High concentration of these wastes adversely affects the physico-chemical parameters of water and therefore affects the biota in such water bodies (Adebayo, 2004).

Cassava is endemic to African countries and is a very good source of carbohydrate to man. During the processing of cassava in Nigeria, the effluent is discharged uncontrollable into water bodies without knowing the adverse effect of the effluent to the organism living in the habitat (Wade *et al*., 2002). Eggs and larvae of fish, like all other higher organisms is particularly susceptible to toxic substance (Khan and Weis, 1993). Destruction at this stage of development has fast effect on the size of fish population although adult fish may be tolerant to a certain level of toxicity. The number of spawned eggs and their survival rate are the most common indicators of the long-term impact of pollutants on fish reproduction (Kime, 1995). The hatchability of eggs and survival of larvae from exposed parents may reflect both pollutant induced changes in eggs structure which decrease fertilization rate and tetralogical effects resulting in deformed embryos (Khan and Wais, 1993). The survivals of eggs, larvae and fry which are particularly vulnerable to pollutant have a major impact on population dynamics (Adebayo, 2004).

C. gariepinus is the most widely cultivated clariid catfish in Africa. *C. gariepinus* is very well-liked by fish farmers and consumers and are therefore very indispensable to the sustainability of aquaculture. Despite, the breakthrough reported for the induced breeding of the *C. gariepinus*, the supply of the seeds is still much below the demand.

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It is crucial to evaluate the quality of cassava effluent, the concentration that will cause detrimental effect in water bodies as well as the organisms that inhabit such water bodies. The aim of the study therefore is to assess the toxicity of cassava effluent to eggs and larvae of *C. gariepinus*.

MATERIALS AND METHODS

Collection and Conditioning of Broodfish

Clarias gariepinus brooders were procured from Fish farm of Federal University of Technology, Akure, Nigeria. They were acclimated for five days before the beginning of artificial breeding and toxicity tests. The eggs of *C. gariepinus* were obtained by induced breeding of the broodfish as described by Viveen *et al*. (1985). The fertilized eggs were then transferred to Petri dishes of 100 mm diameter containing different concentrations of the cassava effluents.

Collection of Cassava Effluents

Cassava effluent was collected from drainage channel from cassava processing factory. The effluent sample was collected directly from the channel by insertion of plastic containers just below the outlet where the effluent flowed out. The containers were covered with their tightly sealed covers immediately after collection and were taken to the Laboratory for analysis and toxicity test.

Toxicity Test

The control and dilution water were collected from borehole water in which the eggs of *C. gariepinus* were fertilized. Firstly, range finding test was conducted. Each medium (concentration) had three replicates and contained thirty eggs. During the range finding test it was observed that no hatching occurred at 10% effluents concentration. Based on these five concentrations of the effluent 0% (control), 2, 4, 6 and 8% were tested.

Water Quality Monitoring

Water quality parameters were determined for cassava effluent and dilution water (borehole) at the spot of sampling. Dissolved oxygen (DO_2) was determined using dissolved oxygen meter (Model Jenway 9021), pH was determined using pH meter (Model Metler Toledo 320), conductivity was determined by using conductivity meter (Model WPA CM 35) to determine the micro conductance (µs) of samples while Temperature was determined by using mercury-in-glass thermometer calibrated in degree Celsius.

Biological Data Collection

At the end of the experiment the time of hatching was recorded for each concentration, the total number of hatched eggs was also counted and the percentage determined. The hatched but deformed fry were also counted and their percentage determined based on the total hatched fry.

The median mortality time (MT_{50}) was recorded for each concentration. The total mortality time (MT_{100}) was also recorded.

Statistical Analysis

All data collected were subjected to one-way analysis of variance (ANOVA) test using SPSS statistical package (SPSS inc. V3.0 Chicago, Illinois) and where significant difference were shown, means were tested using Least Significant Difference (LSD) test at $p = 0.05$ significance level. All percentage data were transformed to arc sin values prior to analysis (Zar, 1996).

RESULTS AND DISCUSSION

The effects of different concentrations of cassava effluents on eggs and larvae of *C. gariepinus* are shown in Table 1-3. It was established that there was a correlation between the various cassava effluent concentration and sensitivities of embryos. The higher concentrations of cassava effluents, 8, 6 and 4% were very toxic, less than 20% hatching success was achieved as shown in Table 1. The fertilized eggs were greenish yellow in control compared to the dead eggs in cassava effluent which turned whitish.

Hatching started (22.0±1.0) hours after fertilization in control media (0% concentration) and lasted for 24.5±0.1 h. Hatching began at 23.0±0.5 and 24.5±0.5 h in the 2 and 8% concentrations, respectively as shown in Table 2. The yolk absorption started immediately after hatching in all the treatments. The time to record 50% larval mortality and the time to record 100% larval mortality is presented in Table 3. There was significant ($p<0.05$) difference in MT_{50} in all the tested concentrations of cassava effluents. The MT_{100} were not similar ($p<0.05$) in all the tested concentrations of cassava effluents. The dissolved oxygen, pH, conductivity and temperature were 4.6 mg L^{-1}, 7.65, 4.75 µmh cm^{-1} and 25.75°C, respectively (Table 4). The physico-chemical parameter of cassava effluents were 2.0-2.5 mg L^{-1} 5.50-6.15, 2.6-27.5 µmh cm^{-1} and 22-24°C for dissolved oxygen, pH, conductivity and temperature, respectively.

Table 1: Effects of cassava effluents in fertilization hatching rate of eggs and survival of *C. gariepinus* larvae

Effluent concentration (%)	Fertilization (%)	Hatching (%)	Survival (%)	Deformed larvae (%)
0 (control)	90.00±1.0^{a}	76.00±1.5^{a}	59.00±1.0^{a}	0.00±0.0^{d}
2	65.30±1.5^{b}	38.00±1.0^{b}	26.00±1.0^{b}	1.33±0.5^{c}
4	49.00±0.5^{c}	19.00±1.5^{c}	17.00±1.0^{c}	2.33±0.5^{c}
6	35.00±1.5^{d}	16.00±1.0^{d}	15.00±0.5^{cd}	3.00±1.0^{b}
8	16.00±1.5^{e}	14.00±1.0^{d}	12.10±1.0^{d}	5.33±1.5^{a}

Values are mean±SEM from three replicates. Means in each column with different superscript are significantly different ($p<0.05$)

Table 2: Effects of cassava effluents on *C. gariepinus* hatching period and yolk absorption period

Effluent concentration (%)	Hatching time (h)	Hatching period (h)	Yolk absorption period (h)
0 (control)	22.0±0.0^{c}	24.5±0.1^{c}	72.5±0.5^{a}
2	23.0±0.5^{b}	27.0±1.0^{b}	69.2±0.0^{b}
4	23.5±0.0^{ab}	27.8±0.0^{ab}	66.5±0.5^{c}
6	23.9±0.5^{a}	28.6±0.5^{a}	63.5±1.5^{d}
8	24.5±0.5^{a}	29.5±0.5^{a}	58.0±1.0^{e}

Values are mean±SEM from three replicates. Means in each column with different superscript are significantly different ($p<0.05$)

Table 3: Effects of cassava effluents on *C. gariepinus* larval mortality time

Effluent concentration (%)	50% larval mortality time (h) MT_{50}	100% larval mortality time (h) MT_{100}
0 (control)	75.5±0.6^{a}	135.5±0.5^{a}
2	34.0±0.5^{b}	102.5±0.5^{b}
4	17.5±0.4^{c}	89.5±0.8^{c}
6	4.5±0.5^{d}	78.4±0.5^{d}
8	1.5±0.6^{e}	40.5±0.6^{e}

Values are mean±SEM from three replicates. Means in each column with different superscript are significantly different ($p<0.05$)

Table 4: Physico-chemical parameters of dilution water and cassava effluents

Physico-chemical parameters	Dilution water	Cassava effluents
Dissolved oxygen (mg L^{-1})	4.60	2.00-2.50
pH	7.65	5.50-6.15
Conductivity (µmh cm^{-1})	4.75	2.60-2.75
Temperature (°C)	25.50	22-24

There was significant difference ($p<0.05$) in the percentage fertlisation of *C. gariepinus* eggs subjected to the various treatments. This corroborate Adebayo (2004) findings that effluent affect response of eggs to fertlisation. The decreased fertlisation of eggs with increased cassava effluents concentration may be attributed to interaction between the pollutant (effluent) and the micropyle which prevent entry of sperm (Khan and Weis, 1993). This in line with the observations of Vuorinen and Vuorinen (1985) who recorded low egg fertilization and high fry mortality of *Salmo trutta* subjected to kraft mill effluent.

The hatching percentage was inversely proportional to the effluent concentration (from 90.00±1.0% in the control to 16.00±1.5% in 8% cassava effluent concentration). Dethlefsen (1989) in a related experiment on effect of effluent discharges from municipal wastewater in North Sea on eggs of *Merlangius merlangius* observed that average survival and hatching success were slightly lower in treated eggs compared to control. The number of deformed and abnormal larvae that hatched out increased with increasing concentration of cassava effluent. This may be ascribed to the absorption of cassava effluent into the yolk during vitellogeneses which could result in death or malformation of the embryos or larvae.

In this study it was noticed that high cassava concentration was toxic to eggs of *C. gariepinus*. This is in line with Svobodova *et al*. (1993) that hazardous properties of a substance are its potential toxicity, persistence and bioaccumulation. Wade *et al*. (2002) reported that hydrogen cyanide and oxalate concentrations are high in fermented cassava effluent. It clearly shows that cassava effluent has the potential of being toxic.

There was significant difference in the mortality of the larvae of the test media when compared with the control. The survival time of the normal hatched larvae in the various concentrations of cassava effluents also confirmed that the physico-chemical quality of each concentration had a strong effect on the larvae. This was deduced from the fact that 8% effluent had 100% mortality of the larvae at 40.5±0.6 h after hatching, while 2% effluent concentration showed normal larvae survival from over 102.5±0.5 h.

The result of this study shows that cassava effluents adversely affect fish reproductive performance and survival. Therefore, cassava effluents should be diverted away from pond waters.

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