

# Mortality Rate of *Heterobranchus bidorsalis* fingerlings Exposed to Cassava Mill Effluents



**Enetimi Idah Seiyaboh and Sylvester Chibueze Izah\***

Department of Biological Sciences, Niger Delta University, Nigeria

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\***Corresponding author:** Sylvester Chibueze Izah, Department of Biological Sciences, Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria, Tel: +234 703 0192 466, Email: chivestizah@gmail.com

## Abstract

Cassava mill effluent is toxic to the ecosystem and its associated biota. This study evaluated the toxicity of cassava mill effluents against fingerlings of *Heterobranchus bidorsalis*. The fishes with mean length 4.00cm fish were allowed to acclimatize in the laboratory for 7 days. Range finding test was carried out at four varying concentrations. Based on the result of the range finding test the main experiment was carried out at 0.000ml/L, 0.003ml/L, 0.006ml/L, 0.012ml/L and 0.015ml/L. The mortality rate was dose dependent, which showed a significant decline as concentration increased. At 96 hours the mortality rate were 39.55%, 50.00%, 75.00% and 91.68% for 0.000ml/L, 0.003ml/L, 0.006ml/L, 0.012ml/L and 0.015ml/L respectively. This suggests that cassava mill effluents in aquatic ecosystem could adversely affect the health of fishes as well as their distribution and abundance in their ecosystem. Therefore, caution should be exercise during dewatering processes in cassava mills close to surface water.

**Keywords:** Aquatic ecosystem; Cassava mill effluents; Fishes; Mortality and Toxicity

## Introduction

Nigeria is the leading cassava producing nation accounting for over 20% of the global output [1-15]. Cassava is a major staple tuber crop in Nigeria and many other African countries especially in western region. Cassava has several industrial, food and feed applications. Over 60% of total cassava tuber produced in Nigeria is used for the production of *gari* (fermented cassava flake). While the remaining 40% is used for the production of *fufu*, *lafun*, animal feeds and other industrial purposes such as adhesives, etc.

Cassava processing enterprise is dominated by smallholder especially in the Niger Delta region of Nigeria. During *gari* production from cassava tuber large amount of waste water is generated during the dewatering stage [13]. In many rural communities in the Niger Delta region of Nigeria, the effluents generated during cassava processing are discharged into the environment without treatment [4-5]. The effluents may drain to the nearby pit and/ or surface water.

In many coastal communities in the Niger Delta, cassava processing is carried out close to surface water resources. And during the wet season, the effluents often end up in the surface water due to the effect of runoff. The effluents are acidic in nature [16-17]. Hence there is the tendency of the effluents to cause acidification in the ecosystem [13] due to the acidic condition of the waste water [16-17]. Acidification of surface water resources tends to have short and long-term impacts on the species composition (fisheries, plankton, benthic organisms and macrophytes) of the ecosystem with regard to diversity

and abundance [13]. In fishes, Izah et al. [13] reported that acidification of the aquatic ecosystem could lead to disease condition, egg damage, high mortality rate of oyster and species of crustaceans that are acid tolerant on short term basis. The authors furthermore reported that acidification could lead to loss of habitat and growth abnormalities, decline in spawning potential in long term.

Beside acidity, the quality of the cassava mill effluents can be measured based on physicochemical (odour, pH, salinity, electrical conductivity, turbidity, total suspended solids, total hardness, total alkalinity, cyanide, dissolved oxygen, chemical and biological oxygen demand, nitrate, nitrite, sulphate, calcium, sodium, magnesium, potassium, carbonates etc), heavy metals (iron, nickel, manganese, copper, lead, cadmium, zinc, chromium, lead, etc) and microbiological parameters (based on the density of coliforms, total heterotrophic bacteria, total fungi, lactic acid bacteria, lipolytic, cellulolytic, phosphate solubilizing and nitrifying bacteria) [13].

Fishes (especially fin fish) are indicator organisms that are used during toxicological assessment of aquatic ecosystem. During toxicological studies, several parameters including enzymes, metabolites, electrolytes, haematological, histopathological and histology, behavioral response, organosomatic index and mortality rate are measured [13,18-32]. The toxicity of cassava mill effluents have been widely assessed based on mortality, behavioural response, enzyme, histopathological and haematological index using *Clarias gariepinus* as test organisms [30-36].

*Heterobranchus bidorsalis* is another fish species that is also used in toxicological studies especially in the Niger Delta region. *Heterobranchus bidorsalis* is majorly cultured in ponds (earthen and concrete) in many coastal communities in Bayelsa state. But information on toxicity effects of cassava mill effluents on *Heterobranchus bidorsalis* is scanty in literature. Therefore, this study assessed the mortality rate of *Heterobranchus bidorsalis* fingerlings exposed to cassava mill effluents.

**Materials and Methods**

**Fish Procurement and source of the cassava mill effluents**

A total of two hundred and sixty healthy fingerlings of *Heterobranchus bidorsalis* with mean length 4.00cm were purchased from a private fish farm in Yenagoa metropolis, Bayelsa state. The fish samples were transported to the laboratory in 20liter rubber cans with their natural water. The cassava mill effluents used for the study were obtained from a small scale cassava processing mill in Ndemili, Delta state, Nigeria. The effluents were transported to the laboratory in an ice pack.

**Acclimation of the fish samples**

In the laboratory the fishes were allowed to acclimatize in circular rubber aquaria for 7days. During the period, the fishes fed with their normal coupon fish diet. The test water was renewed daily. During the acclimatization period mortality rate were less than 1%.

**Trial test**

During the trial test, 10mls, 30mls, 50mls and 70mls of the effluents were pipetted into 4litre of water in the aquarium. The effluents were renewed every 24hours for 48hours. This was carried out to determine the sub-lethal concentration for the main experimental run.

**Main experiment**

Six concentration of the effluents viz: 0.000ml/L, 0.003ml/L, 0.006ml/L, 0.009ml/L, 0.012ml/L and 0.015ml/L were made

**Table1:** Some in-situ parameters tested during the bioassay.

Concentration, ml/L	TDS, mg/L	Temperature, °C	Salinity, mg/L	Conductivity, µS/cm	pH	Turbidity, NTU
0.000	22.77±0.25a	28.30±0.26a	16.13±0.15a	32.43±0.25a	7.03±0.06f	0.42±0.11a
0.003	72.97±0.40b	28.33±0.21a	46.20±0.20b	88.80±0.10b	6.87±0.03e	5.58±0.50b
0.006	123.50±0.10c	28.17±0.15a	76.40±0.10c	143.87±1.19c	6.61±0.01d	9.50±0.08c
0.009	173.63±0.12d	28.17±0.21a	116.40±0.00d	192.70±1.40d	6.39±0.07c	13.58±0.50d
0.012	223.93±0.06e	28.27±0.15a	156.63±0.06e	263.47±0.67e	6.14±0.04b	17.55±0.02e
0.015	281.67±3.65f	28.40±0.36a	187.63±15.79d	314.23±0.06f	5.72±0.18a	21.58±0.50±f

Each data is expressed as mean± standard deviation (n=3); Different alphabets along the column indicate significant difference (P<0.05) according to Waller Duncan test statistics.

**Table2:** Mortality rate of *Heterobranchus bidorsalis* fingerlings exposed to cassava mill effluents.

Concentration, ml/L	Hours				
	0	24	48	72	96
0.000	0.00±0.00	0.00±0.00a	0.00±0.00a	2.77±4.81a	5.55±4.81a
0.003	0.00±0.00	8.33±0.00ab	19.45±4.81b	27.78±4.81b	41.67±0.00b

based on the result of the range finding test. 12 fishes were introduced into the aquarium containing the effluents. The effluents were renewed every 24hours. Borehole water was used as diluents and control.

**Mortality determination**

The fish samples were confirmed dead when they did not respond to repeated prodding [35]. Mortality rate of the fish samples were calculated as:

$$\text{Mortality rate} = \frac{\text{Number of dead fish}}{\text{Total number of fish exposed to the cassava mill effluents}} \times 100$$

**In-situ analysis of the effluents**

The various concentration of the effluents made during the experiment was analyzed for pH, temperature, conductivity, salinity, total dissolved solid and turbidity using portable meter.

**Statistical analysis**

Statistical package for social sciences version 20 was used for the statistical analysis. Mortality data was expressed as mean ± standard error. One-way analysis of variance was used to show significant difference at P=0.05, and Waller Duncan statistics was used to showed the source of the observed variation.

**Results and Discussion**

Table1 presents the in-situ characteristics of the aquarium medium during the bioassay. Total dissolved solid, salinity, conductivity and turbidity concentration increased in concentration dose dependent manner which was significantly different among the various concentrations. Furthermore, the pH of the aquarium also showed significant variation (P<0.05) which declines (tending toward) acidity as the concentration of the effluents increased. Temperature were not significantly different (P>0.05) among the various concentration. The temperature of the aquarium water is within the values previously reported to support fish life.

0.006	0.00±0.00	13.89±4.82b	19.45±4.81b	44.45±4.81c	58.33±0.00c
0.009	0.00±0.00	16.67±8.34b	25.00±0.00b	52.78±4.81c	69.45±4.81d
0.012	0.00±0.00	27.78±4.81c	41.67±8.34c	63.89±4.82d	77.78±4.81d
0.015	0.00±0.00	30.55±4.81c	50.00±8.33c	75.00±8.33e	91.68±8.34e

Each data is expressed as mean± standard deviation (n=3); Different alphabets along the column indicate significant difference (P<0.05) according to Waller Duncan test statistics.

Table 2 presents mortality rate in *Heterobranchus bidorsalis* fingerlings exposed to cassava mill effluents. There was no mortality at 0 hours of exposure. Mortality were in dose depended manner. There was significant variations (P<0.05) among the various concentration for each of the time interval. At 96 hours the mortality rate were 39.55%, 50.00%, 75.00% and 91.68% for 0.000ml/L, 0.003ml/L, 0.006ml/L, 0.012ml/L and 0.015ml/L. The findings of this study showed that the cassava mill effluents are toxic to the fishes. Several factors such as acidity and cyanide content of cassava may have contributed to the toxicity level [13]. Studies have shown that pH of 6.5 – 9.0 [37-39] is ideal for aquaculture. Bhatnagar and Devi (2013) also provided a stricter limit of 7.0 – 8.5. Due to the effects of the effluents the acidity of the aquarium water decreased (tending toward acidity). This therefore suggests the effect of acidification on the *Heterobranchus bidorsalis* fingerlings.

Adeyemo (2005) described cyanide as a potent respiratory poison that has adverse effect on aquatic organisms such as fishes. The author also reported that cyanide at even low concentration could elicit physiological and pathological effects in fishes. Therefore, cyanide causes stress in fishes. Cassava mill effluents in aquatic ecosystem could affect oxygen content in the water which therefore affects the rate of respiration among fishes, and ultimately contributing to mortality rate [40,13]. In addition, Olufayo and David (2016) reported that variation in the oxygen consumption due to the effect of cassava mill effluents on exposed fishes is associated with impaired oxidative metabolism and respiratory stress.

## Conclusion

In some coastal areas in Bayelsa state, cassava processing mill are found close to the aquatic ecosystem. The wastewater often drains into nearby pit and surface water itself. The results of this study showed that cassava mill effluents induce mortality in fingerlings of *Heterobranchus bidorsalis* even at low concentration. Therefore, there is the need to located cassava processing mills far from surface water resources.

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