**RESEARCH ARTICLE**

# Effects of Selected Pollutants on the growth and survival of *Clarias gariepinus* (Burchell, 1822)

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**ABSTRACT**

Spent engine oil, NPK fertilizer (15:15:15) and sewage effluent pollutants on growth and survival of *Clarias gariepinus* catfish were investigated for 70 days. Juvenile fish of length range 7.5cm to 10.6cm; and weight range 4.00g to 8.20g were used; and fish fed 5% body weight of conventional floating feed on daily basis. Temperature ($^0$C), pH and dissolved oxygen (mg/l), mortality and growth rate were monitored. 35% mortality was experienced in NPK media; and 15% mortality was experienced in control experimental tanks. Specimens in control and NPK tanks survived to end of experimental period (70 days) with highest mean weight control tank (51.9g) and length (9.6cm); NPK specimen had mean weight 35.0g and length 8.4cm. Condition factor 'K' in control tank and NPK tank were: 0.98 and 0.93. Food Conversion Ratio (FCR) of control and NPK tanks were: 2.00 and 1.51. Food Conversion Efficiency (FCE) in control and NPK tanks were: 50.11% and 66.35%. Specific growth rate (SGR) {%/day} in control water tank was 1.47% per day, and NPK was 1.29% per day. Test statistic indicated there was no significant difference in growth/survival rate within surviving specimens of NPK and control environmental tanks.

**Keywords:** *Clarias gariepinus*, growth, mortality, pollutants, survival.

## INTRODUCTION

*Clarias gariepinus* is one of the most highly valued freshwater fishes of Africa, and among the most highly prized food fishes of West Africa. *C. gariepinus* fish had been used in fundamental research work for the improvement of science of fisheries (Nguyen *et.al.,* 1999). The fish occur in brackish and fresh waters, flood plains, lakes, and creeks of Nigeria.

Adebiyi (1991) reported that pollution in the inland and fresh water areas in Nigeria has been a major hindrance to enhanced fish production, hence the need to control all pollutants in our water bodies. (Otitoloju (2006) reported that Nigeria accounts for more than 8.7 million liters of spent lubricant oil annually, of which about 80 – 90 % is disposed into the environment, causing pollution.

According to International Center for Aquaculture and Aquatic environment, (ICAAE (1998), most fish species are found only in well aerated aquatic water and may not survive any form of pollution in their water bodies. Moreover spillage or erosion of inorganic fertilizer into aquatic environment can result in toxicity (ICAAE, 1998). (Luger and Brown (2004) reported that, treated sewage effluent is one of the most common types of pollution found in urban rivers, and its persistent discharge results in pollution of the freshwater systems which causes reduction in oxygen concentration through microbial overload, and contamination of fishery resources. The objective of this study was to investigate the effect of selected sources of pollution: spent engine oil, inorganic fertilizer, sewage effluent, on the growth and survival of *Clarias gariepinus.*

## MATERIALS AND METHODS

Several *Clarias gariepinus* post-juvenile fish of length range between 7.50 – 10.60 cm and weight range between 4.00g – 8.20g were collected from a private aquaculture farm in Egbeda, Lagos; in a 25 liters plastic container with water from the farm; and transported during early hours between 8am – 10am to research laboratory of Marine Sciences Department, University of Lagos. Fish were acclimatized for three days and fed fortified floating feed at 5% body weight in the laboratory environment to allow them adapt to laboratory conditions.

### Test chemicals and water supply

Two liters spent engine oil was collected in a mechanic work station in Shomolu, Lagos; NPK (15:15:15) inorganic fertilizer was obtained from a sales outlet in Agege, Lagos; sewage effluents was collected in 50 liters plastic container from the discharge outlet of sewage treatment plant in University of Lagos; and Fresh water used was collected from Marine Sciences laboratory.

### Experiment set-up

Experimental tanks A, B, C, and D (Table 1) in plastic material dimension [50x30x34] cm (L x B x H) were set up in replicates for the three pollutants and control experimental condition which were filled with 30 liters fresh water. Spent engine oil (30 ml) was introduced into bioassay tanks for spent engine oil polluted enclosure (tanks $A_1$, $A_2$) and 30g NPK fertilizer in 30 litres fresh water (tanks $B_1$, $B_2$), 30 liters fresh water control experiment (tanks $C_1$, $C_2$), and 30 liters sewage effluents for the sewage effluent condition (tanks $D_1$, $D_2$). Ten specimens each of *Clarias gariepinus* specimens of initial length range between 7.50 – 10.60 cm and initial weight range between 4.00g and 8.20g were randomly introduced into the experimental tanks respectively to test the effect of pollutants on the growth and survival of *Clarias gariepinus*. Experimental tanks were covered with 4mm mesh size net to prevent the specimens from jumping out of the tanks and proper aeration of tanks were ensured using Boyu silent air pumps (Model No SA- 1500) with air stones inserted into the end of the tube from the pumps for agitation of the water.

The experiment was carried out for a period of ten weeks; during which specimens were fed 5% body weight fortified pelleted feed (Table 2) daily, every 0900 hours and 1600 hours. Concentrations of pollutants media and fresh water in the experimental tanks were freshened every three days to avoid deterioration. Daily monitoring of the fish specimens were carried out to assess the state of being and behavioral attitude of fish within the pollutant media; and mortality were monitored and recorded daily throughout experimental period. Physico-Chemical parameters of experimental media were carried out between 0900 hours and 0930 hours weekly. Air and water temperature were obtained using mercury in glass thermometer and Hydrogen – ion concentration were obtained using pH-009IIATC (High Accuracy Pen Type Portable pH meter), Dissolved oxygen was determined by the use of Extech direct reading dissolved oxygen meter.

Growth measurement and monitoring were carried out between 0900 hours and 1000 hours fortnightly throughout the ten weeks experiment-tal period on any five surviving randomly selected specimens from each experimental media. Morphometric measurements on total length (cm), standard length (cm) were carried out using graduated board; and weight (g) gained by specimen were measured using digital measuring scale. Mean length and weight measurement were determined by dividing the sum of the totality of the standard length of the fish by the number of the specimen per tank throughout the experimental period.

Condition factor (K) {equation 1} of survived fish specimens from the experimental media were determined to assess the state of well-being of the fish; Food Conversion Ratio {equation 2} and Food Conversion Efficiency {equation 3} were determined to assess the behavioral disposition of fish to feeding within the pollution media; and Specific Growth Rate (SGR) {equation 4} of survived specimens within experimental tanks were calculated. Statistical package for social sciences (Pasw statistics 18) was used to assess significant difference in growth among the survived fish specimens in the polluted experimental media and control experiments.

$$\text{Condition Factor (K)} = \frac{100W}{L^b} \quad \text{... (Bannioter, 1976) (eqn. 1)}$$

Where K = Condition factor
W = Weight of specimen in cm
L = Length of specimen in cm
b = Regression coefficient

$$\text{Food Conversion Ratio(FCR)} = \frac{\text{Dry food fed (g)}}{\text{Live Weight gained (g)}} \quad \text{...(Goddard,1996) (eqn. 2).}$$

$$\text{Food Conversion Efficiency(FCE)} = \frac{\text{Mean Weight gained}}{\text{Feed in-take}} \times 100 \quad \text{... (Goddard, 1996)(eqn. 3).}$$

$$\text{Specific Growth Rate (SGR)} = \frac{\text{Log final body weight} - \text{Log initial body Weight}}{\text{Time (in days)}} \times 100 \quad \text{... (Goddard, 1996) (eqn. 4)}$$

**RESULTS**

Mean physico-chemical parameters assessed on the experimental media over the period of the experiment indicated a condusive parameters range (Table 1).

Behavioral observations of fish at introduction into the pollutant experimental media and throughout the experimental period show irrational reactions and adaptation to environmental condition in survived fish. Specimens introduced into spent oil (tank A) had erratic movement on introduction with increase in breathing shown by increase in rate of opercula flap. Feeding activity was closed to none due to the polluted environment, and further behavioral observation were: settling down at the base of the tank with increase panting, hanging and dangling within the environment and incident of blood from the urinary system and followed by death of the fish. Erratic movements were observed in fish exposed to NPK 15:15:15 fertilizer (Tank B), followed by settling down at the bottom of the tank; and increase in respiration observed by increase in rate of opercula flapped. The coloration of fish bleached, and the fish drag around the environment and later adjust to the environmental condition and feeding activity increase with increase in rate of adjustment of the fish and adapted to the environmental condition. Fish subjected to sewage effluents (Tank C) were observed to experience irrational and erratic movement, followed by settling down at the bottom of the tank with increase opercula flap which indicated increased breathing, hanging and dangling. Little or no feeding activity was observed, and specimen death. Specimen in the control experiment (tank D) performed normally with little or no irrational movement and carryout feeding activities.

**Table 1:** Mean physico-chemical parameters of the experimental media

| Tanks | Air temperature ($^0$C) | Water temperature ($^0$C) | pH | Dissolved Oxygen (mg/l) |
|---|---|---|---|---|
| A | 29.80 ± 1.20 | 28.60 ± 0.70 | 6.90 ± 0.20 | 2.80 ± 0.50 |
| B | 29.70 ± 1.00 | 28.50 ± 0.60 | 6.00 ± 0.60 | 3.70 ± 0.50 |
| C | 29.60 ± 1.20 | 28.10 ± 0.70 | 6.30 ± 0.60 | 3.70 ± 0.50 |
| D | 29.70 ± 1.00 | 28.50 ± 0.30 | 6.20 ± 0.40 | 3.50 ± 0.70 |

**Table 2:** Survival and Mortality recorded for *Clarias gariepinus* specimens in the experimental tanks

| **Tanks↓** | **Weeks→** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A | A1 | 1 | 0 | 8 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | A2 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | B1 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | B2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| C | C1 | 6 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| | C2 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | D2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

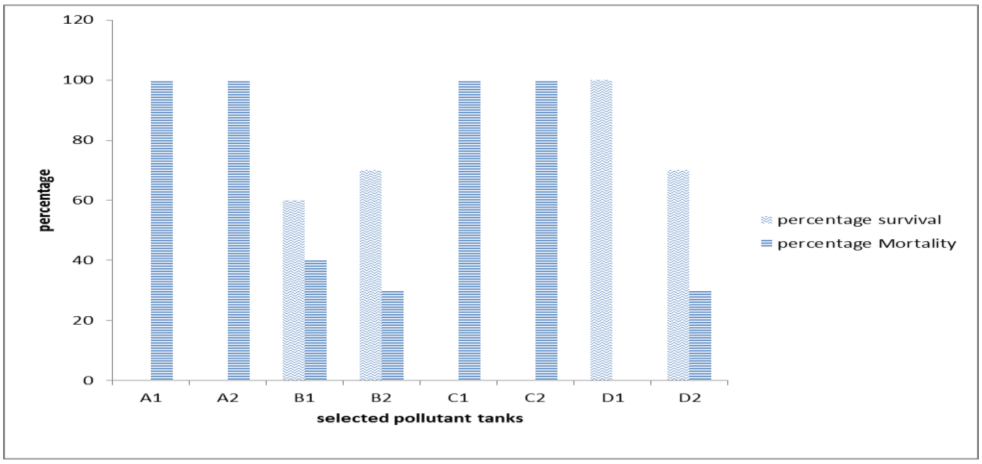


**Fig.1:** Percentage Mortality/ Survival of *Clarias gariepinus* in Experimental media

**Table 3**: Mean Weight Gain / Loss of Clarias gariepinus Specimens with Time under Different Environmental Conditions

| Treatments | Initial mean weight (g) | Mean weight (g) at 2 weeks | Fortnight mean weight (g) gain/loss | Mean weight at 4 weeks | Fortnight mean weight (g) gain/loss | Mean weight (g) at 6 weeks | Fortnight mean weight (g) gain/loss | Mean weight (g) at 8 weeks | Fortnight mean weight gain/loss | Mean weight (g) at 10 weeks | Fortnight mean weight (g) gain/loss |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Spent oil | 8.20 | 10.50 | 2.30 | 3.20 | -7.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| NPK fertilizer | 5.10 | 10.50 | 5.40 | 21.10 | 10.60 | 19.90 | -1.20 | 34.64 | 14.74 | 40.10 | 5.46 |
| Sewage effluent | 4.00 | 5.00 | 1.50 | 0.00 | -1.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Control | 5.30 | 10.10 | 4.80 | 17.40 | 7.30 | 25.70 | 8.30 | 45.53 | 19.83 | 39.20 | -6.33 |

**Table 4:** Percentage Mean Length, Weight Gain, Food Conversion Ratio, Food Conversion Efficiency, Specific Growth Rate and Condition factor of Clarias gariepinus fish in Different Experimental Media

| **Treatment** | **Initial mean length (cm)** | **Initial mean weight (g)** | **Final mean length (cm)** | **Final mean weight (g)** | **Mean length gained (cm)** | **Mean weight gained (g)** | **% length gained** | **% weight gained** | **Food conversion Ratio (g)** | **Food conversion Efficiency** | **Specific Growth Rate** | **Initial Condition Factor (F)** | **Final Condition Factor (F)** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spent oil | 10.60 | 8.20 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| NPK fertilizer | 7.90 | 5.10 | 16.30 | 40.10 | 8.40 | 35.00 | 106.30 | 686.30 | 1.5 | 66.40 | 1.3 | 1.03 | 0.93 |
| Sewage effluent | 7.50 | 4.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Control | 8.40 | 5.30 | 18.00 | 57.20 | 9.60 | 51.90 | 114.30 | 979.30 | 2.0 | 50.10 | 1.5 | 0.89 | 0.98 |

Mortality data from the four experimental media indicated that specimens in the spent engine oil (tank A) and sewage effluent (tank C) media suffered highest mortalities within two week of pollutants assessment. Spent engine oil media recorded 55% mortality within two weeks and the remaining 45% mortality before the end of the fifth week of the experiments. There was 95% mortality within two weeks in the sewage effluent media, and the surviving 5% specimen died before the end of the sixth week. Totality of 35% mortality was recorded in the NPK inorganic fertilizer media (tank B) while control experiment (tank D) experienced 15% mortalities throughout the experimental period. Dead specimens were removed from tanks to prevent deterioration of the experimental media and mortalities were recorded (Table 2). Survival rate of fish in the experimental media was 65% for NPK fertilizer media and 85% for the control experiment void of pollutant. Spent engine oil and sewage effluent experimental media had zero survival rates (0%) respectively at the end of the experimental period (Fig. 1).

Table 3 shows the mean weight measurement with time and mean weight gain/loss fortnightly for the experimental specimens. The mean weight gained in survived fish specimens indicated that specimens in the NPK experimental media were the survivors of the three pollutants experimental media; and 35.0 g mean weight gain was recorded from it at the end of the 10 weeks experiments; while mean gain in weight calculated for control experiment was 51.9 g.

**Growth Assessment of Survived Clarias gariepinus in Experimental Media**

Mean length gained in specimens in control experiment (9.60 cm) was 1.20 cm more than mean length gained in specimens from NPK polluted media (8.40 cm); and percentage mean length and weight gained were indicated in table 4. Fish from control experiment showed a better food conversion ratio (2.0g) to the survivor from the polluted media (1.5g) which yielded higher food conversion efficiency (66.40%) above the control experiment (50.10%). Specific growth rate of survived fish in the control experiment was higher (1.5%) than survived fish in NPK fertilizer polluted environment (1.3%). And Condition factors 'K' of the specimens in the different tanks indicated a range from 0.69 to 1.03 for initial condition factor of the fish in all experimental media, and 0.93 to 0.98 for final condition factor in fish from NPK fertilizer-polluted and control experiments respectively (Table 4).

**Result of Statistical Analysis**

Chi- square used to analyze significant difference in the survival/mortality of *Clarias gariepinus* fish in control and NPK fertilizer experimental media indicated acceptance of null hypothesis of value: (2.133) at 0.05 significant level; and it was concluded that there was no significant different in the survival / mortality rate between specimens in the control and NPK experimental media respectively. T-test was used to assess level of significant difference in growth rate of survived specimens in control and NPK fertilizer-polluted experimental media; and result obtained indicated the acceptance of the null hypothesis with fortnight growth rates values: (0.881, 0.522, 0.215, 0.314 and 0.107) at 0.05 significant level; and it was concluded that growth rate of specimens in control and NPK experimental media shows no significant difference.

## DISCUSSION

Physico-chemical parameters monitored in experimental media indicated fairly conducive aquatic environmental conditions. However, total mortality was experienced in *Clarias gariepinus* specimens exposed to sewage effluent-polluted and spent oil-polluted experimental media; as experienced by (Soyinka and kusemiju, (2004), which reported highest mortality in specimens exposed to diesel oil-polluted water and untreated sewage water. And survival rate of fish in the experimental media was 65% for NPK fertilizer-polluted media and 85% for the control experiment void of pollutant.

Luger and Brown, (2004) reported that, treated sewage effluent is one of the most common types of pollution found in urban rivers in which both the quality and quantity of effluent result in various impacts on the receiving freshwater as well as estuaries and near shore marine environment. Discharge into aquatic systems results in reduction in species diversity and degradation of aquatic environment which can have negative impacts on human health, primarily from bacteriological and other forms of pathogens that survive the biological treatment process and inadequate disinfection of the effluent. Breakdown of ammonium ($NH_4^+$), into its un-ionised form ($NH_3$) which is toxic to many forms of aquatic life and increases in relative proportion to $NH_4^+$ as pH and temperature increase, becoming a serious threat in alkaline conditions (pH > 8) is of ecological implication. Nonetheless, conferment within a small enclosure without access to escape enhanced complete mortality within a short period. This investigation may be the case especially at area of discharge of sewage effluent (introduction area) as well as aquatic environments exposed to constant or continual sewage effluent. (Ajao (1990) in (Soyinka and Kusemiju, (2004), also reported the effects of untreated sewage and sludge in the Lagos lagoon to included aesthetic nuisance, nauseating odor and human health hazard.

Pollution of commercial petroleum fuels (CPF) is one of the environmental constrains that produces aqua-toxicological effects, which affect growth performance and survival; and are deleterious to aquatic life (Safaa and Mohsen, 2011). According to Otitoloju and Okusada (2003), spent oil has negative impacts on aquatic organisms because it acts more as a physical poison forming a barrier on the water surface which reduces the rate of oxygen diffusion into water; and in such event leading to soon used up of available dissolved oxygen by the animals which slowly die from asphyxiation. This supported the experience studied from exposure of *C. gariepinus* to spent oil whereby fish became agitated, imbalanced, gasping for air with increased opercula movement and unable to feed, thereby resulted in total kill of the specimen within a short time. This is because the fish are in a confined environment, but in natural environment, high kill rate will occur at instant of high discharge especially in low mobility organisms, and moving away of fish from such environment will result in lesser impact or survival. This is supported by the report of Soyinka and Kusemiju, (2004) which stated that, in a natural aquatic condition, oil spillage into the aquatic environment might not have high mortality effect due to high mobility rate of organism.

Reduced percentage (35%) mortality experienced in NPK fertilizer-polluted experimental media resulted after the fish experienced changes in behavioral response of physiological condition to the environment pollution, which was observed through the loss of equilibrium, erratic swimming, sudden swimming motion reduced feeding and excessive mucus secretion. Skins of the survivors were observed to have bleached out as they adjusted to the polluted environment. These responses and results obtained indicated similarities to the observed responses of fish under various stress conditions studied by (Erol *et al*. (2010). The result is an indicative that nitrogen fertilizers can increase ammonium concentrations in the water which might positively or negatively affect the ecosystem quality to the benefit or detriment of live aquatic organisms including fish; and the effects for aquatic organisms is ability to movement away from toxic effects of pollutant which may be deadly or quick recovery as reported by (Yaro *et al*. (2005) as supported the observed results of the present study. None-the-less, continuous exposure of *C. gariepinus* to the inorganic fertilizer may continue to impair physiological formation of the fish and death will continue to increase when physiological sustainability is reduced. Prediction of water quality impacts of fertilizer and related land management practices is an essential element of site-specific control options and for the development of generic approaches for fertilizer control, (Quirós, 1993).

## CONCLUSION

Sewage effluents, spent engine oil and NPK fertilizer (15:15:15) were toxic for *Clarias gariepinus*. Impact of sewage effluent and spent engine oil was highest for mortality than the inorganic fertilizer within the confined environment, but likelihood of survival in open water will be high due to means of escape and leaching of toxic with time from the body of the fish. Fish exposed to fertilizers recover quickly when they were moved to freshwater. It is concluded that the sewage effluents, spent engine oil and NPK fertilizer may have toxic potentials in the shallow water and enclosed waters; and therefore environmental impact of release or introduction of such substances should be carefully assessed in areas closed to waterside.

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