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Effects of Varied Concentrations of Automotive Gas Oil Pollution on Performance of *Clarias gariepinus*

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ABSTRACT
Water pollution, which is sometimes caused by the spilling of commercial petroleum fuels (CPFs), is a major environmental problem that causes toxic effects in aquatic ecosystems. Hence the effect of varied concentrations of Automotive Gas Oil (AGO) pollution on *Clarias gariepinus* was investigated. 210 juveniles of C. *gariepinus* (mean juvenile weight of 3.3g) were divided into five treatment groups of 42 each and assigned to different pollution levels (treatments) of AGO in a laboratory condition for a period of 14 days. Each treatment was replicated three times composed of 14 juveniles of *C. gariepinus* in each replicate. 20 liters de –chlorinated bore hole water was poured into the each of the 15 plastic aquaria (experimental units) and AGO was introduced to the water at 0mg/l (control), 5mg/l, 10mg/l, 15mg/l, or 20mg/l, as single treatments. The effect of exposure to AGO pollution levels on rate of survival/mortality, growth rate and nutrient utilization of juveniles were investigated. Data collected were subjected to analysis of variance (ANOVA) and test of significance was by Duncan Multiple Range Test. From the results there was no mortality recorded for fish exposed to all treatments regardless of pollution levels; but AGO pollution levels, significantly affected fish growth and nutrient utilization ($P<0.05$). Fish growth reduced with increased AGO pollution level. The study concluded that *C. gariepinus* is an effective bio-indicator for AGO polluted aquatic environment; Maximum Admissible Concentration (MAC) of AGO in water bodies for optimal performance of *C. gariepinus* is less than 5mg/l, yet the study showed that even 5mg/l AGO pollution negatively affected growth of the specie.
Keywords: Clarias gariepinus, mortality, pollutant, growth, fingerlings.

INTRODUCTION

Damaging effects of oil toxicity on various ecosystem elements have been increasingly reported since 1960s. A variety of pollutants including petroleum products are known to induce stress conditions, which impair the health of aquatic life (Kori-Siakpere, 2000; Agbogidi et al, 2005). The growing demand for oil products has increased the amount of petroleum products entering to the aquatic environment caused by the leakage of oil transport pipelines, storage tanks, and accidents involving petroleum transport vehicles (Abdel-Tawwab, 2012). The mining of oil shale reserves may also pose a risk to freshwater ecosystems (Abdel-Tawwab, 2012; Lennuk, et. al, 2015). Oil spill is a type of pollution that occurs mostly on water as well as on land and can have devastating effects on plant and animal life, and the environment. It occurs mainly as a result of human activity (exploration and transport of oil) and is the release of oil/liquid petroleum hydrocarbon into the aquatic environment such as oceans and coastal waters and on land. Spills may occur of crude oil

(unrefined oil) from tankers, oil rigs and platforms and oil wells as well as during the transport of refined petroleum products in vessels and tankers.

Reports show that oil spills cause substantial mortality among fish, amphibians and invertebrates. Other effects include changes in species composition, low abundance, loss of species and tainting (Bellona, 2007). Consequently, these reports confirm that oil pollution impacts negatively on fishery resources. Frequent spillage of crude oil and its products in creeks and rivers may have resulted in a marked reduction in the number of both freshwater and marine organisms (Abdel-Tawwab, 2012). Azad (2005) observed that eggs and young fishes are especially vulnerable to the toxic effects of crude oil and its refined products. It has been found that as little as 0.1ppm of oil can seriously affect fish, amphibians, crustaceans and plankton. Oils float and coat things and have the potential to kill quickly by coating aquatic lives, forming an oil film on the surface of water bodies and interfering with gas exchange necessary for life.

To date, some studies have been carried out to assess impact of petroleum products on fish species. Nevertheless, most of these studies have correlative nature and the reported oil spill effects are likely compounded by other environmental variables that are not covered by sampling design. As a consequence, the adverse effect of petroleum products alone cannot often be distinguished (Batten et al., 1998 and Hu et al., 2011). Hence, in order to understand the effects of oil pollution to the whole ecosystem devoid of environmental interaction effects, it is crucial to engage studies also on smaller unit using a rigorous experimental frame and conducted under controlled conditions. Consequently, this study examined the effects of varied concentrations of automotive gas oil pollution on performance of *Clarias gariepinus*.

MATERIALS AND METHODS

250 *Clarias gariepinus* juviniles (mean weight 3.3g) were collected from a concrete tanks fish farm, close to Alvan Ikoku Federal College of Education, Owerri and transported in two plastic containers (50L) to the Department of Agricultural Science Laboratory, Alvan Ikoku Federal College of Education, Owerri, Nigeria. The fish were kept in the laboratory for 7 days in laboratory tap water having pH of 6.78 and dissolved oxygen of 5.2 mg/l and temperature of 26^{o}C, to acclimatize to the tap water. During acclimatization, the fish were fed on diet of 36%crude protein at 1% body weight per day (bw/d) (Obasoshan et al., 2011). Automotive gas oil (AGO) that was used for the experiment was obtained from NNPC mega fuel station, Onitsha road, Owerri, Imo State

Experimental Set-up

The toxicity methods employed were similar to those of Figueiredo-Fernandes et al, (2007), Ugwu et al, (2011) and Obasohan, et al., (2011). A completely Randomized Design (CRD) was adopted. Fifteen (15) plastic aquaria were used in all, with 3 plastic aquaria (as replicates) assigned to each of the 5 treatments of various concentrations of AGO. Twenty (20) litres of water was poured into each of the 15 plastic aquaria and various concentrations of AGO at 0mg/l (control), 5mg/l, 10mg/l, 15mg/l, or 20mg/l introduced. The mixture was vigorously shaken (AGO was not added to the control). Average body weights of the juveniles were taken using sensitive electronic scale. Fourteen (14) *C. gariepinus* juveniles were introduced to each of the experimental units (aquarium).

Experimental Period

The duration of the AGO for the toxicity test on *Clarias gariepinus* juveniles experiment was 14 days. The distress behaviour and the deaths were closely monitored and recorded from the onset of the experiment. The initial water parameter and daily water parameter: dissolved oxygen, temperature; pH, were monitored using mercury – in – glass thermometer, and Lurton DO and pH meters. The battery-operated meters were calibrated according to manufacturer's instructions before being used for measurement. During the toxicity test, fish were fed on formulated 36%CP feed twice daily at 9:00 and 15:00 h, at 2% body weight per day. Fish were also weighed weekly and the weight gain used to determine growth and nutrient utilization.

Fish performance

At the end of the experiment, the fish were collected, counted, and weighed. Growth performance was determined, and feed utilization was calculated as following:

(a) specific growth rate (SGR; percentage per day) = 100 (Ln W_2– Ln W_1)/T, where W_1 and W_2 are the initial and final weights, respectively, and T is the number of days in the experimental period;
(b) feed conversion ratio (FCR) = feed intake (g)/weight gain (g)
(c) Protein Efficiency Ratio (PER) = weight gain (g) /amount of protein (g)
(d) Productive Protein Value (PPV), PPV = Daily weight gain (g) / daily protein intake (g) x body protein of fish.

Statistical Analyses

Data were analyzed using a one-way ANOVA. Statistical significance was set at the 5% probability level, and means were separated using Duncan's new multiple range test. The software SPSS version 20 was used.

RESULTS AND DISCUSSION

Table 1: Water pH and Temperature Range during Experiment

AGO Pollution levels	Temperature range °C	Average temperature °C	pH range	Average pH
Control	24- 26	24.7	6.8-7.0	6.88
5mg/l	24-26	24.8	6.7-7.0	6.81
10mg/l	24-26	24.6	6.7-7.0	6.83
15mg/l	24-26	25.1	6.8-7.1	6.98
20mg/l	24-26	25.2	6.8-7.2	6.99

Source: Laboratory Analysis, 2018

From Table 1 above, temperature and pH of the treatments varied slightly throughout the experimental period.

Table 2: Effect of Varied Levels AGO pollution on Survival of Fish

AGO Pollution levels	Mortality (Numbers) Week one	Week two	Survival (%)
Control	Nil	Nil	100
5mg/l	Nil	Nil	100
10mg/l	Nil	Nil	100
15mg/l	Nil	Nil	100
20mg/l	Nil	Nil	100

Source: Experimental Result, 2018

From Table 2 above, mortality was not recorded throughout the period of exposure of test organism to AGO pollution levels. The fish had 100% survival for all pollution levels (treatments).

Table 3: Growth Rate and Nutrient Utilization of Fish Exposed to Levels of AGO Pollution

Pollution Levels	Growth and Nutrient Utilization Parameters (Per Fish)						
	IBW(g)	FBW(g)	BWG(g)	FCR	SGR	PER	PPV
Control	3.22	3.71	0.49^{a}	1.84^{a}	3.50^{a}	0.016^{a}	0.642^{a}
5mg/l	3.41	3.79	0.38^{ab}	2.51^{ab}	2.71^{ab}	0.011^{ab}	0.428^{b}
10mg/l	3.32	3.41	0.09^{b}	10.32^{b}	0.64^{b}	0.0028^{b}	0.110^{bc}
15mg/l	2.85	2.92	0.07^{bc}	11.40^{bc}	0.50^{bc}	0.0025^{bc}	0.113^{bc}
20mg/l	3.46	3.47	0.01^{c}	96.88^{c}	0.071^{c}	0.0003^{c}	0.016^{c}

Source: Experimental Result, 2018. ^{abc} Means with same superscript are not (P>0.05) significantly different
IBW = Initial body weight (g)
FBW = Final body weight (g)
BWG = Body weight gain (g)
FCR = Feed conversion ratio
SGR = Specific growth rate
PER = Protein efficiency ratio

PPV = Productive protein value.
Growth rate and nutrients utilization of fish was significantly (P =0.000) adversely affected by AGO pollution levels (Table 3). Fish in the control treatment gained more weight and had better nutrient utilization than fish exposed to levels of AGO pollution. For all the growth and nutrient utilization parameters measured, the trend showed that the more the AGO concentration, the less the growth response. Fish exposed to 20mg/l had least growth rate and nutrient utilization although the difference was not significantly lower than for fish exposed to 15mg/l of AGO. Fig 1-3 below show the trend in the response of fish to AGO pollution levels in terms of body weight gain, feed conversion ratio, specific growth rate, and productive protein value.

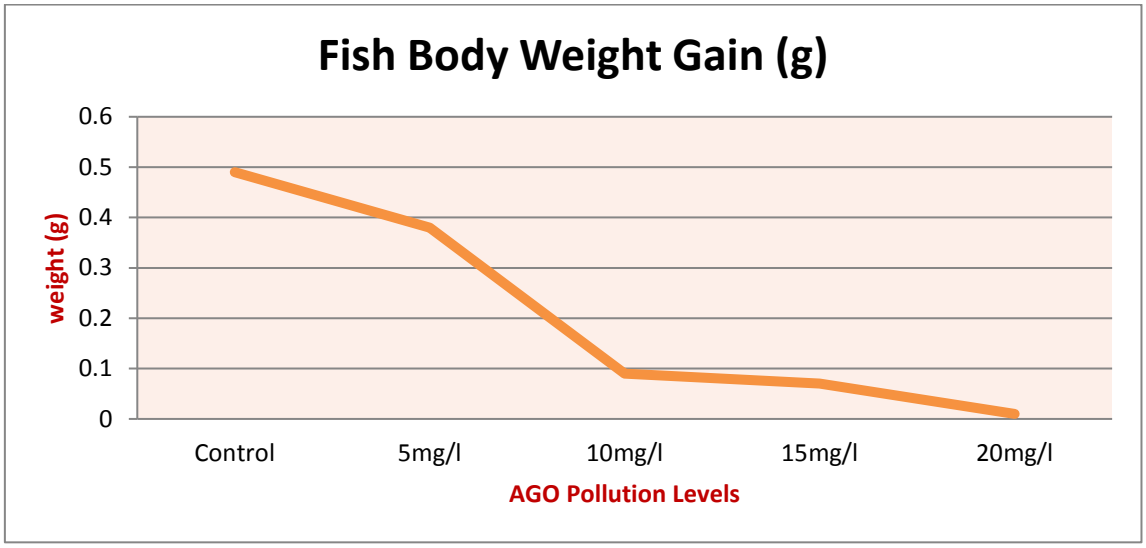

Fig 1: Effect of AGO on fish body weight gain over two weeks period.
Source: Experimental Result, 2018

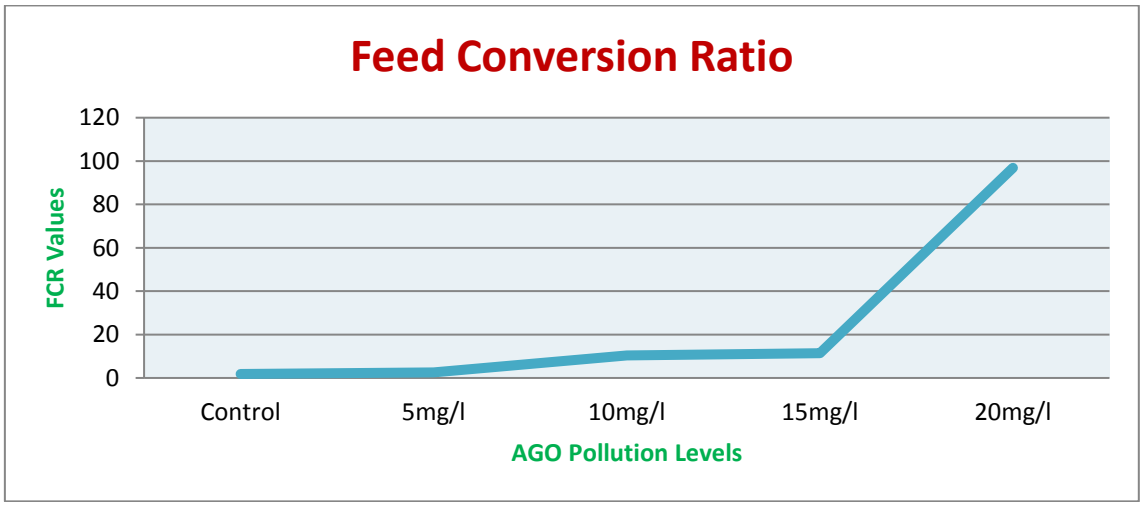

Fig 2: Effect of AGO pollution on fish feed conversion ratio (FCR)
Source: Experimental Result, 2018

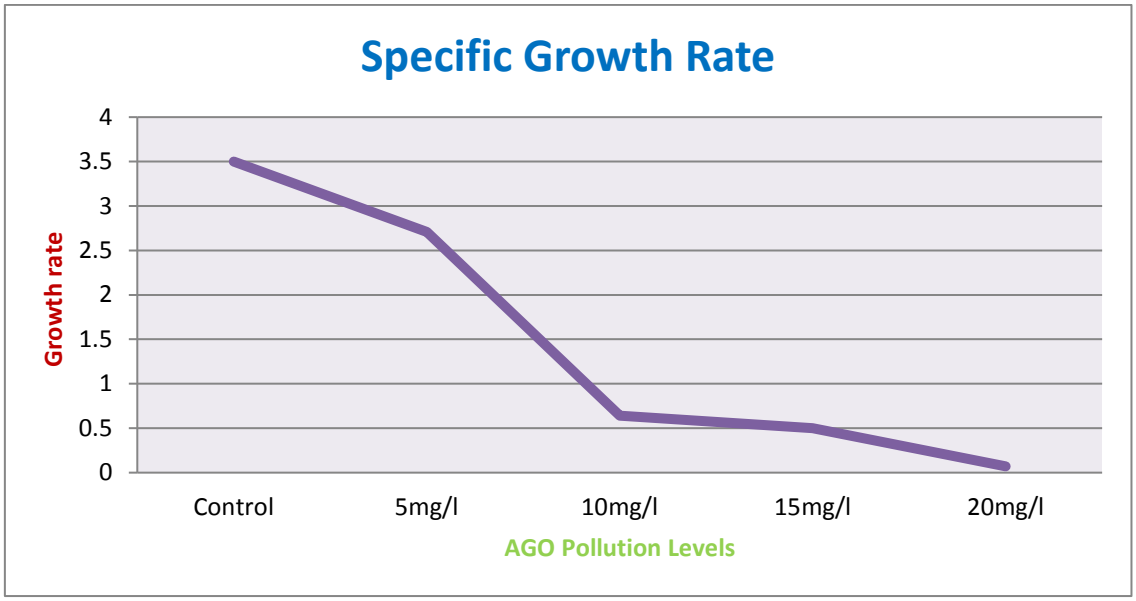

Fig 3: Effect of AGO Pollution on fish Specific Growth Rate (SGR)
Source: Experimental Result, 2018

Discussion of Findings

From the results, mortality was not recorded in any of the pollution levels throughout the period of 14days; hence mortality rate was 0% while survival rate was 100%. Olaifa (2012) also record 0% fish mortality rate for a pollution study with crude oil up to 100ppm for 96hours while George et al (2014), had same result with crude oil pollution up to 20mg/l for a period of 96hourrs. This indicates that fish, especially *Clarias gariepinus,* can survive in AGO polluted water at concentration up to 20mg/l for 14 days. At higher concentrations of oil pollution, mortalities have been reported. Lennuk, et al, (2015) reported high mortality rate at above 100mg/l of crude oil pollution, 100% mortality rate was recorded within 96hrs when pollution concentration increased to 400mg/l. Oil depletes the oxygen level of water and could lead to fish death.

Growth rate and nutrient utilization of fish were affected by AGO pollution levels. There was decrease in growth rate and all nutrient utilization parameters with increasing AGO pollution levels. This was similar to the result of Nwabueze and Agbogidi (2010), in which increased concentration in crude oil pollution led to decrease in growth rate and nutrient utilization. Feed conversion ratio increased in values with increase in AGO pollution levels. This indicated a decrease in feed conversion efficiency. Higher values of FCR imply poorer feed conversion efficiency (Hasan and Soto, 2017). Abdehel-Tawwab (2012) reported decrease in growth rate of fish after exposing them to oils for 5 minutes and allowing them to recover in unpolluted water for 4 weeks. Sharaf and Abdel-Tawwab (2015) also reported decrease in growth rate of fish exposed to commercial petroleum fuels for 5 minutes and allowed to recover in unpolluted water for 4 weeks. The reduction in fish growth while in oil polluted water is attributed to some factors which include: reduction in dissolved oxygen caused by the oil pollution, increased stress on the fish, and reduction in feed intake. Ugwu et al (2011) reported that petroleum fractions cause the blockage of atmospheric oxygen from dissolving in water thereby limiting the supply of oxygen to fish resulting to incidence of excretory waste products (carbon dioxide, ammonia) in the ambient water environment. Increases in the free carbon dioxide concentration as the exposure period increases could be synonymous with decreases in dissolved oxygen (D.O) concentration thereby subjecting the fish to stress, which affect feed intake and growth.

CONCLUSION AND RECOMMENDATION

The responses (survival/ mortality, growth and nutrient utilization) of *C. gariepinus* in this study provided basis for predicting the overall impact of Nigerian oil spills on fish populations. The study has also showed that *C. gariepinus* can serve as effective bio-indicator of AGO contaminated water bodies. Since there is a likelihood of continuous transportation, and exploitation of petroleum products in Nigeria, further studies to ascertain the tolerance limit of every bio-indicator to environmental pollution should be conducted. Particular attention should also be given to AGO production and transportation process aimed at minimizing the environmental hazards due to oil spillage.

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