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ACUTE TOXICITY OF TWO SELECTED DETERGENTS TO AFRICAN CATFISH (CLARIAS GARIEPINUS) JUVENILE

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The efforts of fishermen fishing in lower River Benue in Makurdi, Benue State, Nigeria was employed to collect samples of Clarias gariepinus juveniles with length range of 14.20cm to 16.50cm and weight range of 28.40g to 32.20g. After proper acclimatization and trials, the fish samples were exposed to varying concentrations of two detergents , Omo and Klin. The concentrations of klin used were 12, 16, 20, 24 and 28mg/L while that of Omo were 16, 20, 24, 28 and 32mg/L. A control experiment was also set up. After static renewal bioassay and observations at 24, 48, 72 and 96 hours, the 96 hour LC_{50} of Klin on Clarias gariepinus was determined to be 18.28mg/L (upper and lower limits of 20.60mg/L and 16.22mg/L respectively) while that of Omo was 23.69mg/L (upper and lower 26.16mg/L and 21.46mg/L respectively). There was no mortality in the control. It was concluded that Klin is more toxic in the aquatic environment than Omo and that detergents should not be released indiscriminately into the environment.

Key Word: Acute, Toxicity, Detergent, Mortality, Clarias gariepinus.

INTRODUCTION

Aquatic ecosystem is a significant environment for bio-productivity through the interaction between the various physico-chemical parameters. However, the environment has been a victim of human activities like urbanization, industrialization, agricultural and other activities. These activities has exploited the environment and disturbed the delicate ecological balance between living and non-living components of the wetlands.

Over the years, rivers have turned murky, fishes rotting on sea shores, trees withering, cities choking up with foul air, toxic chemicals being cycled into food stuffs and epidemic diseases appearing so frequently. This has been as a result of heavy pollution of the waters of the world from domestic, industrial discharge and detergents (Topale, 2013).

Use of detergents is indiscreetly increased daily by human through washing of cloth, vehicles, vessels and most of the detergents used does not degrade easily or they degrade very slowly in water body. This means they remain in the aquatic system for longer time. Consequently, they enter the aquatic food chain and food web through uptake by vegetation, planktons, fishes and zooplanktons or absorbed through the gills or through the skin of the aquatic animals (Eknath, 2013).

Detergents are organic compounds, which affects both chemical and biological characteristics of receiving water bodies. They are of three types- anionic, cationic and non–ionic detergents (Walker et al., 2001). Detergents, which are discharged in the water bodies, may affect the pH, total alkalinity, free CO_2, dissolved oxygen and also affect the rate of photosynthesis and lead to eutrophication (Najam et al., 2010). Thus, detergents have toxic effects on aquatic animals like fishes, thereby causing mortality of animals. The main contributors to the toxicity of detergents are the sodium silicate solution and the surfactants with less and indirect toxic effects from constituents like phosphate (Lenntech, 2003).

Surfactants are the components mainly responsible for the cleaning action of detergents. Surfactants of various detergents having benzene ring, branched alkyl chain or ethoxylate chain are resistant to anaerobic biodegradation. In the course of biodegradation, H_2, H_2S, CO_2 and CH_4 are produced. The final products of biodegradation are CO_2 and CH_4 (Itoch et al., 1987). Excessive amount of phosphate in detergents are responsible for eutrophication of natural waters and brunt the diversity of plankton.

Detergents also have effect on biochemical aspects of the animals and change the concentration of proteins, fats and carbohydrates (Najam et al., 2010). Hence, the interaction between detergents and proteins, and their influence on membrane permeability may be the basis of the biological action of detergents.

Of all the freshwater fishes whose food materials, ecosystem, eggs and survival are affected by the presence of detergent in the water bodies, African catfish (Clarias gariepinus) is not an exception. The African catfish (Clarias gariepinus) is a common freshwater species, which are endemic to Africa and widely distributed in Nigerian waters except Cross River (Olaosebikan & Raji, 2013). They are hardy and adaptable to stay out of water for hours due to the presence of assessory breathing organs (Idodo-Umeh, 2003).

LC_{50} is a concentration in which 50% of the experimental animals survive. Estimation of LC_{50} by interpolation involving plotting of data in a graph with concentration on X-axis, while percentage on Y-axis. A straight line is drawn between maximum points representing survival at maximum successive concentrations that were lethal to more and less than of the total number of test animals exposed to the toxicant. The concentration at which this crosses the 50% survival line is the LC_{50} value.

Hence, an attempt is made in the present investigation to determine the acute toxicity (LC_{50}) of two household detergents (Klin and Omo) to the freshwater fish, African catfish (Clarias gariepinus).

MATERIALS AND METHODS

The samples of Clarias gariepinus juveniles were collected by the fisherman from Lower River Benue in Makurdi, Benue State, Nigeria and were used for bioassay studies. The fish were brought into the laboratory for the acclimation by providing sufficient aeration in plastic bowls.

The fish were selected irrespective of sex for experiments. The size or length ranged from 14.20cm to 16.50cm and weight ranging from 28.40g to 32.20g. Fishes were acclimated in glass tank in the Aquatic Toxicology Laboratory of the Department of Fisheries and Aquaculture, University of Agriculture, Makurdi for seven days according to the method in APHA (2005). Two brands of commonly used detergents for both domestic and industrial cleaning, Omo and Klin were purchased from a reputable supermarket (NOBIS) in Makurdi. These were used for the toxicity experiment.

A trial test was done for 96 hours to determine the actual concentrations used for the experiment and the fish to be used for the bioassay were starved 24 hours before and during exposure to the detergents (toxicants).

After appropriate toxicity range of the test solutions were determined by preliminary testing, ten (10) fish were randomly selected and exposed to the following concentrations of Klin: 12mg/L, 16mg/L, 20mg/L, 24mg/L and 28mg/L as well as 16mg/L, 20mg/L, 24mg/L, 28mg/L and 32mg/L for Omo for a period of 96 hours. The experiment was replicated as described by Rahman et al. (2002). A control experiment (0mg/L) was also set up.

The method of bioassay used was static renewal, using well-aerated borehole water. Observations on survival were made after 24, 48, 72 and 96 hours.

LC_{50} (concentration required for 50% mortality) values are calculated by graphical method. The bioassay water was analyzed for five physico-chemical parameters (pH, temperature, dissolved oxygen, electrical conductivity and total dissolved solid). Dissolved oxygen was determined in the laboratory using a HANNA DO meter model HI9142, while temperature, pH, dissolved oxygen, electrical conductivity and total dissolved solid were also determined in the laboratory using a multi parameter water checker Model HI98129.

Results obtained were subjected to statistical analysis.

RESULTS

During the period of acute toxicity tests, no mortality was observed in control group. The behavioral pattern observed in Clarias gariepinus juveniles, during the acute toxicity bioassay included erratic swimming, gasping for air and restlessness, incessant jumping, frequent surface to bottom movement and resting at the bottom.

The mortality records obtained during the exposure of Clarias gariepinus juveniles to the various concentrations of toxicants (Klin and Omo) are as shown in Tables 1 and 2. The tables show the highest mortality (85%) observed in Klin solution and the highest mortality (80%) observed in Omo solution. The tables also show that the mortality increased with increase in the concentration of the toxicants.

TABLE 1: MORTALITY RECORD OF CLARIAS GARIEPINUS JUVENILES EXPOSED TO KLIN FOR 96 HOURS

S/NO	CONC. (mg/L)	MORTALITY IN 96 HOURS		TOTAL MORTALITY (20 FISH)	% MORTALITY	LOG CONC.	PROBIT
Control	0.00	0	0	0	0	0	0
1	12.00	1	2	3	15	1.0792	3.96
2	16.00	4	4	8	40	1.2041	4.75
3	20.00	5	6	11	55	1.3010	5.13

Continuation of Table 1

4	24.00	7	7	14	70	1.3802	5.52
5	28.00	9	8	17	85	1.4472	6.04

TABLE 2: MORTALITY RECORD OF CLARIAS GARIEPINUS JUVENILES EXPOSED TO OMO FOR 96 HOURS

TREATMENT	CONC. (mg/L)	MORTALITY IN 96 HOURS		TOTAL MORTALITY (20 FISH)	% MORTALITY	LOG CONC.	PROBIT
Control	0.00	0	0	0	0	0	0
1	12.00	1	2	3	15	1.2041	3.96
2	16.00	3	3	6	30	1.3010	4.48
3	20.00	5	4	9	45	1.3802	4.87
4	24.00	7	5	12	60	1.4472	5.25
5	28.00	8	8	16	80	1.5051	5.84

The linear relationship between probit mortality and logarithm of concentration of the detergents' solutions are as shown in Figures 1 and 2 below. Figure 3 represents the combined linear relationships between probit mortality and the logarithm of concentration for both detergents' solutions.
The LC_{50} of both Klin and Omo were calculated to be 18.28mg/L (upper and lower limits of 20.60mg/L and 16.22mg/L respectively) and 23.69mg/L (upper and lower limits of 26.16mg/L and 21.46mg/L respectively) respectively.
The R^2 value for Klin (0.978) shows it to be more toxic compared to Omo with R_2 value of 0.944.

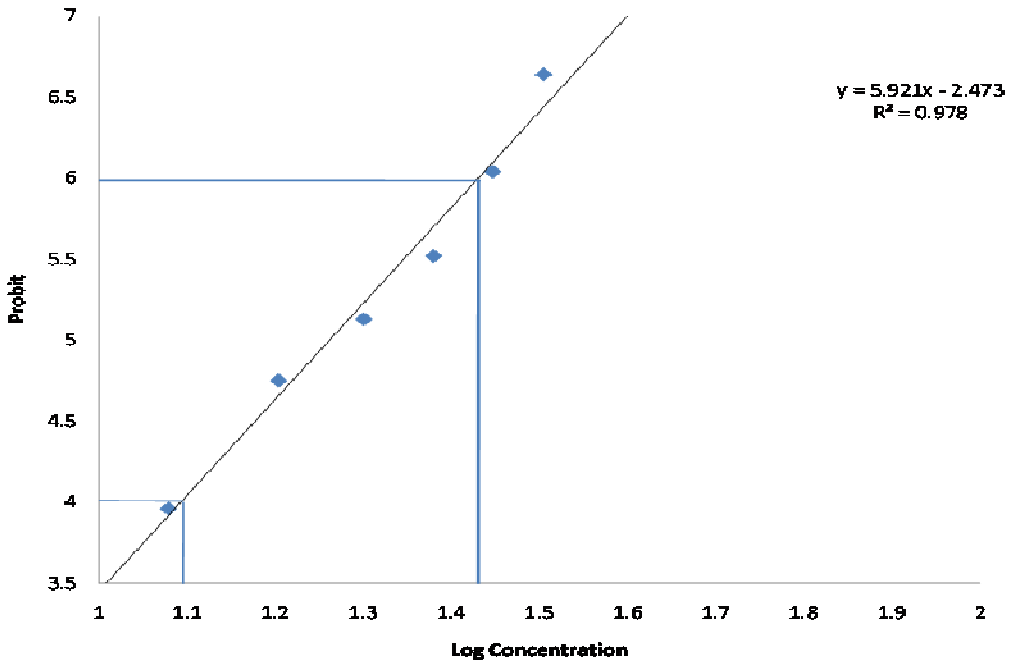

Fig 1 : Linear Relationship between Probit Mortality and Log Concentration of Acute Toxicity of Klin on Clarias gariepinus juveniles.

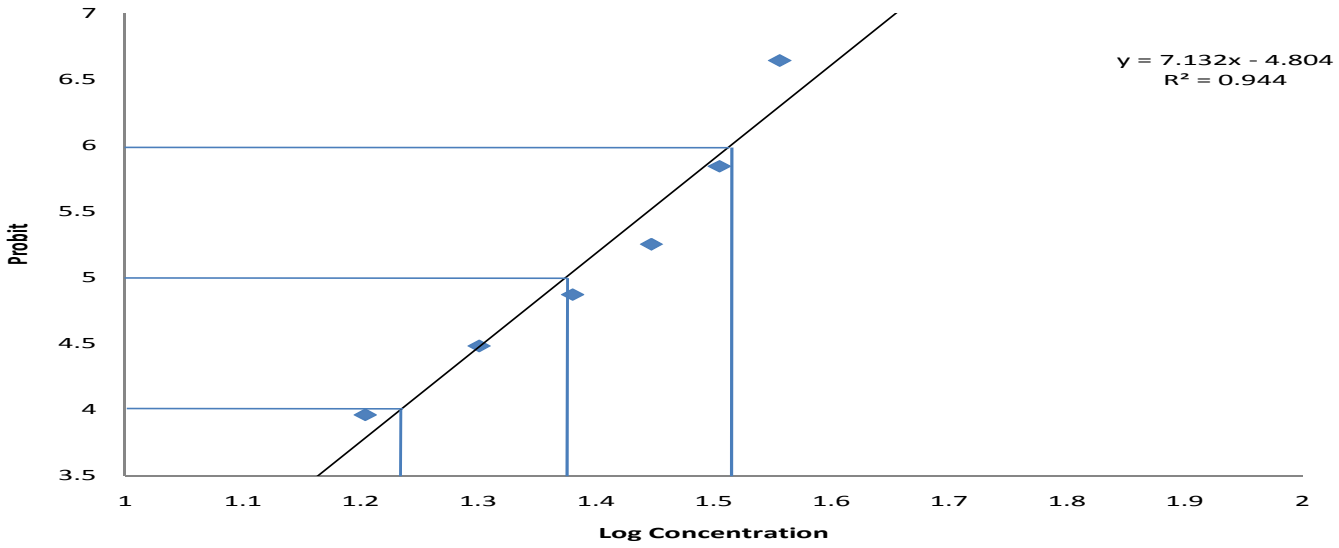

Fig 2: Linear Relationship between Probit Mortality and Log Concentration of Acute Toxicity of Omo on Clarias gariepinus juveniles.

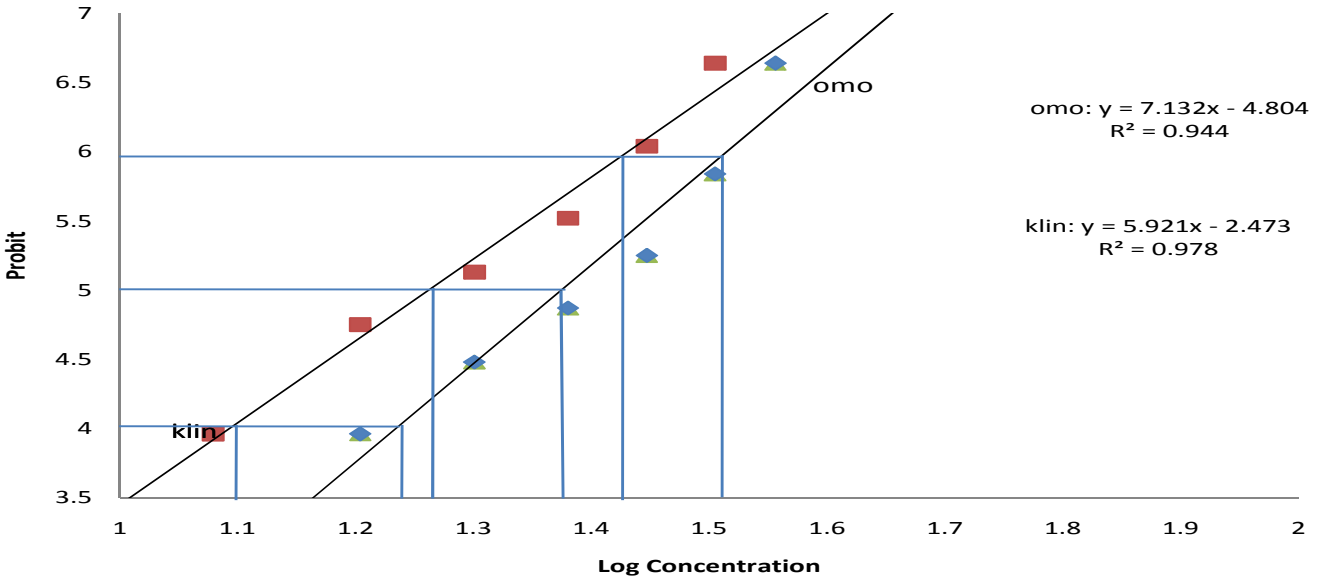

Fig3: Combined Linear Relationships between Probit Mortality and Log Concentration of Acute Toxicity of Klin and Omo on Clarias gariepinus juveniles

The water quality parameter of the bioassay media are as shown in the Tables 3 and 4 below. The tables show that there is no significant differences in the pH, temperature and dissolved oxygen while total dissolved oxygen and conductivity showed slight variations down the dilution concentration.

TABLE 3: WATER QUALITY PARAMETER OF THE TEST MEDIUM FOR KLIN

TREATMENT	pH	TEMP (°C)	DISSOLVED OXYGEN (mg/L)	TOTAL DISSOLVED SOLIDS	CONDUCTIVITY
1	8.67±0.01^{a}	26.27±0.07^{a}	4.77±0.03^{a}	305.33±0.33^{b}	611.33±0.33^{b}
2	8.69±0.01^{a}	26.37±0.09^{a}	4.73±0.03^{a}	305.33±0.33^{b}	611.33±0.33^{b}
3	8.76±0.00^{a}	26.40±0.10b^{a}	4.57±0.03^{a}	305.67±0.33^{b}	612.33±0.33^{b}
4	8.79±0.00^{a}	26.60±0.10^{a}	4.53±0.03^{a}	308.33±0.33^{c}	616.67±0.66^{c}
5	8.81±0.01^{a}	26.83±0.09^{a}	4.47±0.03^{a}	310.33±0.33^{a}	621.33±0.33^{d}
Control	8.68±0.00^{a}	26.07±0.07^{a}	4.80±0.00^{a}	296.00±1.00^{a}	594.00±1.00^{a}

Means in the same Column with different superscripts differ significantly ($p<0.05$)

TABLE 4: WATER QUALITY PARAMETER OF THE TEST MEDIUM FOR OMO

TREATMENT	pH	TEMP (^oC)	DISSOLVED OXYGEN (mg/L)	TOTAL DISSOLVED SOLIDS	CONDUCTIVITY
1	8.78 ± 0.03^a	25.37 ± 0.09^a	4.80 ± 0.00^a	306.00 ± 0.33^b	614.00 ± 1.00^b
2	8.77 ± 0.00^a	25.33 ± 0.03^a	4.77 ± 0.03^a	308.67 ± 0.67^b	618.33 ± 1.33^{bc}
3	8.79 ± 0.00^a	25.43 ± 0.03^a	4.73 ± 0.03^a	310.33 ± 0.33^b	621.67 ± 0.67^c
4	8.79 ± 0.00^a	25.67 ± 0.03^a	4.60 ± 0.00^a	311.33 ± 0.33^c	623.33 ± 0.33^c
5	8.81 ± 0.07^a	25.77 ± 0.03^a	4.53 ± 0.03^a	314.67 ± 0.67^c	629.33 ± 1.33^d
Control	8.69 ± 0.01^a	25.17 ± 0.17^a	4.83 ± 0.03^a	296.00 ± 1.00^a	594.00 ± 1.00^a

Means in the same Column with different superscripts differ significantly ($p<0.05$)

DISCUSSION

Various chemical substances represent point and non-point sources of pollution in our water bodies. As seen in the results of the acute toxicity of Klin and Omo shown in the tables and figures above, the detergents are potent toxicants in our water bodies.

There was no mortality recorded in the control set up which showed that all the mortality cases recorded in the experimental set up were due to the toxicants, Klin and Omo detergents. However, the experimental fish exhibited various signs of discomfort as a result of the toxicants. Among these is loss of balance, rapid opercula movement, respiratory disorder, loss of nervous control, erratic swimming as well as frequent surfacing. These suggested various nervous disorders and haemorrhaging of the gills when the test fish were exposed to the detergents. These show that the two detergents at different concentrations are toxic at different levels to the various parts of the body. The disruption of activities of mucus secreting gland is a clear indication of the poisoning effect of the detergent on organs glands and tissue.

Okoli Anunobi et al. (2002) also reported similar observation in their investigation on glands, organs and tissues of Oreochrotnis niloticus fingerlings. This has also been confirmed by the work of Ogeleke et al. (2010) who exposed Tilapia guineensis to two different concentrations of two industrial chemicals, Norust and Neatex. He observed that tissue, guts and the gills accumulated increasing levels surfactants. However, the immediate cause of death may be asphyxiation, as the interaction between detergents and proteins, and their influence on membrane permeability may be the basis of the biological toxicity of detergents (Topale, 2013).

Also, results obtained from this experiment showed that the percentage mortality of Clarias gariepinus juveniles increased significantly ($P<0.05$) from 15% to 85% for Klin and 15% to 80% for Omo respectively with increase in the concentrations of both klin and Omo from 12mg/L to 28mg/L. The R^2 value of 0.978 for Klin and 0.944 for Omo showed that the increase of the concentration of Klin has more toxic effects on the juveniles of Clarias gariepinus than Omo. (complete this sentence). This is in agreement with similar observations by Eknath (2013) who worked on the toxicity of detergents to Mystus montanus and change in behaviour of fish.

The values of 18.28mg/L (upper and lower limits of 20.60mg/L and 16.22mg/L respectively) for Klin and 23.69mg/L (upper and lower limits of 26.16mg/L and 21.46mg/L respectively) as the 96 hours LC_{50} recorded in this investigation presents the toxicant as highly lethal for fish, with Klin as more toxic than Omo. These values are within the range of 0.4 to 40.00mg/L reported by Abel (2006) on synthetic detergents to be acutely toxic to fish. The 96-hour LC_{50} has earlier been reported for Clarias gariepinus by Ayuba and Ofojeku (2002) to be 204.17mg/l for Datura innoxia root extract, while Ayotunde et al. (2010) reported the 96-hour LC_{50} of Clarias gariepinus fingerlings exposed to Carica papaya seed powder to be 12.9mg/l. Abalaka and Auta (2010) also recorded 296.14 and 225.48mg/l for aqueous and ethanol extracts of Parkia biglobosa pod respectively for Clarias gariepinus.

Fafioye and Adebisi (2010) who worked on the toxicity of aqueous ethanol extracts of Parkia biglobosa and Raphia vinifera on Clarias gariepinus reported that the 96-hour $LC_{50}$for aqueous and ethanol extracts of parkia biglobosa to be 2.8ppm and 2.4ppm respectively. While for R.vinifera aqueous and ethanol extract, the values were 3.4ppm and 3.2ppm respectively.

The difference in the result of the study and those of these researchers may be due to the difference in toxicants, their concentration, environmental conditions, age and size of Clarias gariepinus.

CONCLUSION

The use of detergents cannot be discontinued however, better methods of disposing the
'after wash' needs to be worked out. If the present rate at which they are introduced into our aquatic environment is not checked, the continuous existence of aquatic fauna including many important aquacultural fish species such as Clarias griepinus would be seriously threatened.

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