Direct RESEARCH JOURNALS

Vol. 4 (12), pp. 351-360, December 2016
ISSN 2354-4147
International Standard Journal Number (ISJN) e-ISJN: A4372-2604
Article Number: DRJA337510907

Direct Research Journal of Agriculture and Food Science
http://directresearchpublisher.org/aboutjournal/drjafs

ISJN

Research Paper

Effect of detergent on the growth of African catfish *(Clarias gariepinus)*

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Received 4 October 2016; Accepted 28 November, 2016

The effect of detergent on the growth rate of *C.gariepinus* was undertaken for a period of 2 month (May-June 2006). The result showed that detergent reduces the growth of the African catfish. The mean growth rate of *Clarias gariepinus* (control) was 42.2 g while that of 9 m1, 5 m1 and 1 ml concentrations of detergent were -12.7g , - 1.7 g and - 0.8 g respectively. The relative growth rate after 35 days of exposure was -30.0,-4.13 and -1.9 for 9 m1, 5 m1 and 1 ml concentration respectively. While the control had 1.02. The results showed that detergent had detrimental effect on the growth and survival of the African catfish *(C. gariepinus)*.

Key words: Detergents, *Clarias gariepinus and* alkylbenzenc, sulfonates

INTRODUCTION

Every day large amount of detergents cleaning agents and cosmetics are used containing substances that affect the environment irritate the skin and even causes allergy (Hellmann, 1981). More recently in Nigeria, and other developing nations, pollution of water resources has become a serious problem. One of the principal reasons for this is that many toxic and bio accumulative chemicals such as detergent have contaminated freshwater bodies (Esenowo and Ugwunba, 2010). Water pollution is the contamination of water bodies, it occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds (EPA, 2007). Apparently, human and ecological disorder experienced in industrial settlements as a result of improper disposal of chemicals such as detergent effluent calls for careful surveillance on the state of the environment (Ogundiran *et al.,* 2010). Only few chemicals have been ecologically tested in Nigeria for safety in spite of their environmental and ecological impact. Recently, the Federal Government of Nigeria is emphasizing the need for adequate environmental protection in any technological and socioeconomic development or endeavours by strictly asking industrial operators to manage the disposal of chemical into natural environment (DPR, 2002).

Detergents are cleaning products derived from synthetic organic chemicals. The cheapness of detergent production from petrochemical sources with its ability to foam when used in acid or hard water gives it an advantage over soaps (Okpokwasili and Nwabuzor, 1988). Surfactants are the components mainly responsible for the cleaning action of detergents. The other components include bleach, filler, foam stabilizer, builders, perfume, soil-suspending agents, enzymes, dyes, optical brighteners and other materials designed to enhance the action of the surfactant. Generally, detergents are xenobiotic compounds which are usually washed into water bodies and are made up of several compounds of which the active components are the surface-active agents or surfactants (Ruiswell *et al.*, 1992).

Detergent surfactants are complex organic chemicals where hydrophilic and hydrophobic groups are joined together in the same molecules (Huang *et al.*, 2000). There are various types of surfactants used in detergents formulations; the linear alkylbenzene sulfonate (LAS)-ionic surfactants is the most widely used. It was introduced as biodegradable alternatives to the non-biodegradable branched- chained alkylbenzenc sulfonates. Linear alkylbenzene sulfonate has been reported to have a high solid adsorption coefficient, which is attributed to the physicochemical properties of the surfactants (WHO, 1996). The Linear alkylbenzene sulfonate molecules adsorb to the suspended solid in water bodies and hence end up in sediments along the water course or sludge in treatment plants (Cavalli *et al.*, 2000).The recommended Linear alkylbenzene sulfonate that was claimed by some researcher to biodegrade perfectly (Gledhill, 1974; WHO, 1996; McAvoy *et al.*,1997) have also been reported to poorly degrade in rivers, lakes, ponds and even in soils and this may be toxic to Aquatic faunas and bras and can also induce severe damage to vital organs and even haematological, hormonal and enzyme disturbances (Lightowlers, 2004; Ogundiran *et al.*, 2007 and Ogundiran *et al.*, 2009). Also the nonylphenol, chemical used in production of detergent have been detected widely in waste water streams across the globe which is a concern due to its toxicity to many aquatic organisms.

Also surfactant increases microbial populations especially those that are able to use it as their basic source of carbon or phosphate or both. Some of these microorganisms stands as an ectoparasites or endoparasites that causes histological degradation in fish species (Eniola and Olayemi, 2002; Adewoye and Lateef, 2004). Detergent is a persistent environmental contaminant probably due to its use in the formulation of cleaning agents, pesticides and for dispersing oil spills at seas; so the use, production and exposure, of detergents is unavoidable. Xenobiotics compounds usually concentrate in the tissues of Aquatic biotas and are known to produce cumulative deleterious effects (Abbas and Mahmood, 2003, 2004).

Indiscriminate discharge of such compounds that contains mixtures of heavy metals such as herbicide, pesticides, detergent etc, their careless handling, accidental spillage or discharged of treated effluents into natural waterway shave harmful effects on the African catfish population and other forms of aquatic life and may contribute long term effects in the environment (Olojo *et al.*,2005 and Ayoola, 2008). Toxic chemicals cause tissues damage and histopathological degradations as the catfish show Hernatological responses to toxicants; and generally, such degradation of histological origin occurs in the gills, livers, heart, kidney and epidermis of animals. Diethyl phthalate (DEP) is an industrial chemical used in products of detergent, bathing soap, after shave-lotion etc. (Kamrin and Mayor, 1991). The indiscriminate disposal of DEP made products and careless handling have harmful effect on the fish. Detergents when leached into water bodies fish gills are the primary target for toxicant that are dissolved in water. Also fish liver can be considered a target organ which alters its structure and is significant in the evaluation of fish health (Ogundiran *et al.*, 2010) Fishes are widely used to evaluate the health of aquatic ecosystem. Physiological changes serves as biomarkers of environmental pollution (Kock *et al.*, 1996). *Clarias gariepinus* is used as biological indicators of ecotoxicological studies. The aim of the study is to determine the effect detergent on the growth performance of African catfish (*Clarias gariepinus*).

Classification /Type of detergent

Detergents are classified depending on the electrical charge of the surfactants. There are four (4) main classes of detergent; these are Anionic detergent, Cationic detergent, Non-ionic detergent and amphoteric detergent. Anionic means a negatively charged molecule. Anionic detergent is used extensively in most detergent systems, such as dish wash liquids, laundry liquid detergents, carwash detergent etc. It is commonly known as neutral detergent. Cationic detergents have poor detergency and are used more for germicides, fabric softener and specialist emulsifiers. Cationic means positively charged. Non-ionic detergents do not ionize or carry a charge when dissolved in water. As the name implies, no ionic constituents are present. Amphoteric detergents possess a net zero charge arising from the presence of equal number of +1 and -ve charge chemical group. They are found in shampoos, skin cleaners and carpet shampoo. There are different types of detergent such as laundry detergent, dish wash liquid, biological detergent etc.

Occurrence of detergent in freshwater

All detergents destroy the external mucus layers that protect the fish from bacteria and parasites; plus they can cause severe damage to the gills (Ikele *et al.*, 2011). Most fish will die when detergent concentrations approach 15 parts per million (Alaa Eldin *et al.*, 2012). Detergent concentrations as low as 5 destroy fish eggs. Surfactant detergents are implicated in decreasing the breeding ability of aquatic organisms. They also lower surface tension of water. Organic chemicals such as pesticides and phenols are much more absorbed by fishes. A detergent concentration of only 2 ppm can cause fish to absorb double the amount of chemicals they would have normally absorbed, although that concentration itself is not high enough to affect fish directly. Phosphates in detergents can lead to freshwater algal blooms that release toxins and deplete oxygen in waterways. When the algae decompose, they use up the oxygen available for aquatic life (Demand, 2012).The potential for acute aquatic toxic effects are the release of secondary or tertiary sewage effluents containing the products of laundry detergents which may is low.The major entry point into water is via sewage works into surface water.

African catfish

African catfish *(Clarias gariepinus)* is a typical air-breathing catfish with a scale less, elongated body with long dorsal and anal fins and a helmet like head. Color varies dorsally from dark to light brown and is often molted with shades of olive and grey while the underside is pale cream to white (Skelton, 2001). It can grow very large with a maximum reported length of 170 cm (IGFA, 2001) and weight of 60 kg (Robins *et al.* 1991).

Taxonomy

Species: *Clarias gariepinus*; Family: Clariidae; Order: Siluriform; Class: Actinopterygii

A genus *Clarias* was reviewed in the 1980s, which resulted in several widespread species being synonymized (*Clarias copensis* of southern Africa, *C.mossambicus* of central Africa and *C. lazera* of West and North Africa) under name *Clarias gariepinus* (Teugels, 1986).

Natural distribution and habitat

It can tolerate water high in turbidity and low in dissolved oxygen and is often the last or only fish species found in remnant pools of drying rivers (Safriel and Bruton, 1984; Van der Waal, 1998).

Environmental tolerance ranges

Clarias gariepinus can endure extremely harsh conditions (Skelton 2001). It can tolerate very low oxygen concentrations and survives for considerable periods out of water, via the use of a specialized suprabran organ (Safried and Bruton, 1984, Hecht *et al.*, 1988). This organ is a large paired chamber with branches above the gill arches specifically adapted for air breathing (Mama and Maloiy, 1986) and allows it to move over land even when not forced to do so by drought (Welman ,1948; Johnels, 1957). Water temperatures between 8 and 35%, salinities of 0 to l0% and a wide p1-I range are all tolerated (Safried and Bruton, 1984). *C. gariepinus* exhibits high growth recorded at 30°c (Britz and Hecht, 1987). The ability of the fish to be able to tolerate these extreme conditions allows it to survive even in moist sand or in borrows with an air-water interface (Bruton, 1979, and Van der Waal, 1998).

MATERIALS AND METHODS

Fish Samples

150 healthy catfish juveniles of mean weight 5.l g and length of 9.4 cm were transported in a container to the laboratory. The fishes were acclimatized for 14 days and their water was changed every two days r to remove faecal, and unconsumed feeds. The fish were fed 5% of their gross body weight with 2mm coppens fed twice daily (Ogundiran *et al.*, 2010).

Preparation of test media

50 g of detergent was mixed with 5 L of water to get the stock solution needed for the experiment (Esenowo and Ugwumba,2010). The mixture was divided into three concentrations.

Exposure of test organism

Ten (10) juveniles were exposed each to three detergents concentrations (namely 9, 5 and 1 ml) in 40 L capacity plastic containers. Feeding was discontinued 24 h before the start of the experiment. Control fishes were in de-chiorinated tap water. Their length and weight of were taken 4 days after acclimation.

Long-term renewal toxicity test

Renewal toxicity test was conducted for a period of 35 days to study the effect of detergent (concentration) on the growth and survival of the juveniles *Clarias gariepinus*. Their weights and lengths were taken every 2 day. The juveniles were observed for behavioural changes while mortality was recorded and growth were calculated according to Esenowo and Ugwumba, (2010) using the formula as follows:

$$RGR\ (\%) = \frac{Wf - W1 \times 100}{Time}$$

Where:

RGR =relative growth rate
W=total body weight of the fish in gram
Wf=final weight
WI =initial weight m
T=time

Physio-chemical parameters

Records of temperature, pH and dissolved oxygen will be taken during the experimental period.

Temperature

Temperature using Mercury- in- glass thermometer was measured to the nearest 0.1 degree and readings described by Benneth and David (1974).

pH

Each concentration of detergent's water will be tested for hydrogen ion concentration using p1-I meter by EXTECH instrument.

Dissolve Oxygen

Winkler's titrimeter method was used to measure dissolved oxygen (Taylor *et al.*, 1998). The method is as follows: Two (2) millimeters of Winkler's solution I ($MnSO_4$) and another 2 m1 of Winkler's solution II (KI + NaOH solution) were added to the water sample using a syringe. The bottle was closed carefully to avoid air bubbles and thoroughly shaken to ensure proper mixing. A brown fiocculent precipitate forms at the bottle after this process.

The bottle was then, transported to the laboratory for further analysis.The cover was removed and 1ml if conc. H_2SO_4 was added to the sample, then replaced carefully not to trap any air bubbles in the bottle and inverted several times to mix.

The flocculent then dissolved leaving the water sample yellow in colour.The burette was filed with O.025N of sodium thiosulphate solution to zero mark, 100 ml of the prepared solution was measured into a 250 m1 conical flask, and then titrated against $Na_2S_2O_3$ to pale yellow colour, thereafter 2 drops of starch indicator solution was added which made the sample turn blue, titration was then continued until the blue colour just disappeared (end-point).

The initial and final burette readings were taken and the volume of $Na_2S_2O_3$ used was noted. From these, volume of dissolved oxygen was calculated.

Calculation

$$DO\ mg/l = \frac{N \times X \times 1000}{V}$$

Where:

X =Mean of the readings

N =Normality

V = Volume of sample

1000= Standard value of equation

Statistical analysis

All the data generated during the field work were analyzed using statistical package for social science (SPSS) 19.0 versions on the independent sample. ANOVA was used to test the significance of the means of the parameters at 5% significance level.

RESULTS

The result on the effect of detergent on growth of African catfish is as shown in (Table 1).

The growth increase in weight of the control catfish was 42.2 g at 1.027 g growth rate per day while the growth increase in weight of the catfish that were exposed to 9 m1 concentration of the detergent was -12.7 g at -O.309 g growth rate per day, those exposed to 5 m1 concentration of detergent had -1.7 g at -O.041 g growth rate per day while catfish exposed to 1ml concentration of

Also the relative growth rate of the control catfish in percentage was 102.7 while the relative growth rate of the catfish exposed to 9m1, 5m1 and 1ml of detergent concentration were -30.0,-4.13 and -1.9 respectively.

There was significant difference between the growth rate of catfish exposed to each concentrations (p<O.05).

The overall mortality rate of *C. gariepinus* exposed to detergent is shown in (Table 2).

The highest mortality rate (43.3%) was observed in catfish exposed to 9m1 concentration of detergent, while the lowest mortality rate (23.3%) was observed in catfish exposed to 1 ml concentration of detergent. Catfish exposed to 5m1 concentration of detergent had mortality rate of (26.6%).

The exposure of *C. gariepinus* to detergent showed mortality even at low concentration.

The rate of mortality became greatly increased with increased in the concentration of detergent. There is no mortality recorded in the control catfish.

The result of physiochemical parameters is shown in (Table 3), temperature ranged from 29-30°C during the study period and the mean was 29.5°C.

The highest temperature observed was in 5 m1 concentration of detergent which is 29.8°C while the lowest temperature observed was in 5 m1 and 1ml concentration of detergent which is 29.2°C.

Dissolved oxygen content was maintained at 1.43 -2.10 mg/l. pH readings was between 7.20 7.35°C. The lowest pH value was in 9 m1 concentration of detergent which is 7.20°C while highest pH value was observed in 1 ml concentration of detergent which is 7.35°C.

Table 1. Effect of detergent on the growth of *C. gariepinus.*

CONC (ml)	Initial weight before exposure	Final weight after exposure	Growth increase in weight	Growth rate (g/day)	Relative growth rate (RGR)
9	60.4	47.7	-12.7	-0.309	-30
5	55.4	53.7	-1.7	-0.041	-4.13
1	52.03	51.2	-0.8	-0.019	-1.9
Control	66.3	108.4	42.2	1.027	102.7

Table 2. Mortality rate of *Clarias gariepinus* exposed to different concentration of detergent.

Day/conc.	9ml			5ml			1ml		
	1	2	3	1	2	3	1	2	3
1									
2									
3									
4							01	01	
5									
6									
7									
8									
9							01	01	
10							01		
11								01	01
12					01				
13									
14			02						
15		01	02	01					01
16									
17									
18									
19									
20			01						
21					02				
22				01					
23		01	01	02					
24						01			
25				01					
26									
27									
28									
29						01			
30									
31									
32									
33									
34									
35									
Total Mortality	00	02	06	05	03	02	03	03	02
%Mortality	0	20	60	50	30	20	30	30	20

DISCUSSION

Detergent have been discovered to induces poisonous effects; such xenobiotic compounds could be persistence and more mobile in soil and water, hence it is known to be one of the most common terrestrial and aquatic contaminants. The result obtained from the studies shows that there was significant difference between the growth rate of African catfish exposed to each concentrations of detergent ($p<0.05$). The reduction in the relative growth rates of catfish exposed to 9ml,rnl and 1ml concentrations of detergent were -30.0, -4.13 and -1.90. Catfish exposed to 9 m1 concentration of detergent had the highest reduction while Catfish exposed to 1 ml

Table 3. Mean of physiochemical parameters.

Conc. (ml)	Samples	Temperature (°C)	PH (°C)	DO(mg/l
9	1	29.3	7.2	1.43
	2	9.5	7.31	1.93
	3	29.6	7.29	1.9
5	1	29.8	7.21	2.05
	2	29.2	7.31	1.45
	3	29.7	7.21	2.1
1	1	29.7	7.26	1.72
	2	29.2	7.35	1.49
	3	29.6	7.24	1.89

concentration of detergent had lowest reduction. The reduction in the growth rates of the exposed catfish supports the findings of Esenowo and Ugumba, (2010) who reported that sub-lethal concentration of a detergent in an aquarium tank reduce the weights of catfish *(Clarias gariepinus)* exposed. The most likely explanation for the growth reduction in this study is increase in metabolism due to detoxification and impaired health which lead to loss of appetite during the exposure. Growth reduction cannot be explained entirely by lack of food, it may be due to energy loss also.

At higher concentrations the behavioral activities of the organism is disrupted. Detergent effect is however noted to be increased with increased concentration. Ayoola, (2008) reported that the level of toxicity of any toxicant depends on its bioaccumulation. No adverse behavioral changes or any mortality were recorded in the control experiment throughout the practical period. While in the exposed fishes, several abnormal behavioral responses were observed such as pronounced gasping for breath, restlessly, frequent surface to bottom movement, and sudden change of direction during movement, resting at the bottom, loss of skin colouration ,loss of equilibrium and stagnant in length. The observation was similar to the observation of Aguigwo, (2002), Ogundiran *et al*., (2010), Esenowo and Uwumba, (2010) . Loss of the equilibrium observed may be due to depletion of energy in the body of the exposed catfish.The catfish that cannot tolerate the change of the environment died. Also the rate of mortality became greatly increased with increased in the concentration of the detergent.

The temperature reading fell between 29-30°C which was within the limit for fishes. Baden, (1982) showed that toxicity increased with temperature thus the overall toxicity recorded for detergent was not influenced by temperature which was within the normal range. Dissolved oxygen content was maintained at 1.43-2.l0 mgl^{-1} by changing the water. The oxygen stress encountered by the catfish that is responsible for the respiratory distress and death was due to their inability to withstand the oxygen depletion of the water induced by the active organic compound in the detergent. Adewoye and Fawole, (2002) and Adewoye *et al*., (2005) had earlier reported that indiscriminate deposition of effluent into an aquatic system might decrease the dissolved oxygen concentration, which stand to impair respiration leading to asphyxiation (which is an indication of unconsciousness or death produced by failure of the blood to become properly oxygenated in the lungs) and may ultimately result into organ architectural degradation such as liver dysfunction.

Conclusion

It is clear from the research that exposure of *C. gariepinus* juvenile to even low concentrations of detergent lead to significant reduction in the growth rate, which dependent on the period of exposure and concentration of toxicant. In view of the toxicity effect of this detergent, it can be inferred that, indiscriminate discharge of detergent effluents can affect growth of African catfish. This might make all the• living entities in polluted environment vulnerable to diseases, and eventually leads to death. This study establishes that Growth performance of African catfish *(Clarias gariepinus)* is invariably affected by detergent.

Recommendation

More research still need to be done to ascertain further effects of detergent on gonad, skin, heart, kidney and epidermis as this will allow us to draw certain conclusions on the impacts of detergent in our environment. There is need for the adoption of proper effluent treatment technology which would ensure proper treatment of industrial effluents prior to their discharge into the environment. Although, in a developing country like the Nation Nigeria, several numbers of legislations exist on the quality assurances of water resources but such legislations are rarely followed and yet Industrial. Growth and its associated environmental problems such as water and sediment contamination are fast increasing. So there is the need for us to imbibe from such developed nations where environmental monitoring agencies are more effective and environmental laws and legislations are strictly followed. General environmental quality monitoring is compulsory and the monitoring of the quality of water resources is done on a regular basis and as a result, any abnormal changes in the water quality can easily be detected and appropriate action is taken before the outbreak of epidemics. Moreover assessment should be made to determine the toxicity of the active ingredient of detergent for safer use.

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Appendix 1. Initial Reading of Weights of African Catfish.

9ml			5ml			1ml			Control
1	2	3	1	2	3	1	2	3	
60	60	60	55	55	55	55	50	50	65
60	60	60	55	55	55	55	50	50	65
60	60	60	55	55	55	55	50	50	67
62	62	61	57	57	56	57	51	50	68
242/4	242/4	241/4	222/4	222/4	221/4	222/4	201/4	200/4	265/4
60.5	60.5	60.3	55.5	55.5	55.3	55.5	50.3	50.0	66.3

Appendix 2. Final readings of weights of african catfish.

9ml			5ml			1ml			Control
1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	
65	65	65	61	60	60	60	55	52	73
65	65	65	61	60	55	57	55	52	75
65	65	65	61	60	55	57	55	52	75
63	62	63	60	60	55	57	55	52	80
60	62	61	62	60	52	55	53	52	84
57	60	58	61	62	50	48	50	50	87
55	60	55	62	62	47	45	50	48	102
50	35	47	60	60	45	46	48	45	105
51	35	48	60	60	46	49	50	48	110
53	36	47	60	62	47	47	53	50	115
55	33	48	55	60	45	47	55	55	117
53	31	40	50	57	45	45	55	57	120
53	30	36	50	57	43	45	54	55	125
50	29	35	51	51	42	42	54	55	126
50	27	31	50	51	42	42	55	52	128
52	25	32	51	51	42	43	55	52	130
53	25	32	50	51	42	45	55	52	130
51	25	30	51	60	43	42	55	53	135
936/17	705/17	793/17	955/17	984/17	801/17	813/17	907/17	880/17	1842/17

Appendix 3. Effect of detergent on the growth of African catfish.

Conc.(ml)	**Replicate**	**Before Exposure Initial Weight**	**After Exposure Final Weight**	**Growth Increase in weight**	**Growth Rate (g/Day)**	**Relative Growth Rate (RGR)**
9	1	60.5	55.1	-5.4	-0.13	-13
	2	60.5	41.5	-19	-0.463	-46.3
	3	60.3	46.6	-13.7	-0.334	-33.4
Mean		60.4	47.7	-12.7	-0.309	-30.0
5	1	55.5	56.2	0.7	0.017	1.7
	2	55.5	57.9	2.4	0.059	5.9
	3	55.3	47.1	-8.2	-0.20	-20
Mean		55.4	53.7	-1.7	-0.041	-4.13
1	1	55.5	47.8	-7.7	-0.187	-18.7
	2	50.3	53.9	3.6	0.087	8.7
	3	50.0	51.8	1.8	0.043	4.3
Mean		52.03	51.2	-0.8	-0.019	-1.9
Control		66.3	108.4	42.2	1.027	102.7

Appendix 4. Analysis of variance (ANOVA).

Source	Type III sum of squares	Df	Mean square	F	p-value	F crit
9ml	773.73	23	33.64	3.962	0.068511517	1.401159333
5ml	102438.519	1	102438.519	12064.733	4.89E-10	9.131671971
1ml	773.73	23	33.64	3.962	0.068511517	1.401159333
Error	229.25	27	8.941			
total	133552	51				
Corrected Total	1002.98	50				

Where

SS=Sum of square
Df=Degree of freedom
MS=Mean square
F=F-test
P-value =Probability value
F-crit=F-Critical