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GROWTH AND SURVIVAL OF *Clarias gariepinus* (BURCHELL, 1822) FINGERLINGS IN DIFFERENT CONCENTRATIONS OF DOMESTIC LEACHATE

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ABSTRACT

Growth and survival of *Clarias gariepinus* in different concentrations of domestic leachate were investigated. Leachate collected from Ogbeogonogo market dumpsite in Asaba was analyzed for its physico-chemical parameters. Leachate was diluted with borehole water to give - 0%, 20%, 40%, 60%, 80% and 100% strength. Ten four weeks old fingerlings each of *C. gariepinus* were cultured in the different concentrations of leachate-borehole water in a static renewal bioassay system. Poor growth of *C. gariepinus* was observed in the treatment tanks compared with growth of fish in the control tank which was progressive as indicated by the higher value of condition factor. Leachate had significantly ($P < 0.05$) higher BOD, COD, alkalinity and significantly ($P <0.05$) lower dissolved oxygen than culture water in control tank. All fish in control tank survived till the end of the study while 100% mortality was recorded for fish in 100% leachate concentration by the end of the second week of the study. Slight growth was recorded for fish in the other treatment tanks until the fourth week when drop in fish weight was observed. The poor growth and survival of fish in the treatment tanks may be due to the high levels of BOD, COD, alkalinity and the low level of dissolved oxygen observed in the tanks. The higher the concentration of leachate, the lower the survival of fish with time of exposure. The longer the exposure time in leachate the lower the survival of fish with increasing concentration. This study has shown that leachate can reduce growth rate and survival of *C. gariepinus.* An urgent need for strict legislation regarding waste dumps located close to water bodies is recommended to forestall fish stress and kills.

Keywords: growth, survival, clarias gariepinus, leachate.

INTRODUCTION

Leachate is any liquid that in passing through matter, extracts solutes, suspended solids or any other component of material through which it has passed, introducing environmentally harmful substances which may enter the environment (Wikipedia, 2010). Leachates normally enter the environment from waste disposal sites. The lack of proper management of solid waste has been a major environmental issue in Nigeria. Solid wastes are often disposed off in uncontrolled and undesignated public places rather than in the few and probably inadequate designated dump sites. Increase in urbanization and population growth are likely to increase the annual generation of municipal solid waste estimated at 29.78 x 10^9kg (Ojolo *et al*., 2004). Leachate contains a range of chemical compounds, which may leach into the environment particularly into nearby water sources (Christensen *et al*., 2001). Leachate may also contain pathogenic microbes some of which are capable of producing toxins that may have public health implications (Donnelly *et al*., 1988).

Studies on the possible hazards of solid waste leachate and its effects on aquatic organisms have been reported (Wong, 1989, Wick and Dave, 2006, Koshy *et al*., 2007). Leachate has been reported to impact negatively on water quality parameters of the aquatic ecosystem. Leachate contamination of water bodies can result in increase of water turbidity, limiting the amount of light penetration which reduces photosynthesis and production of dissolved oxygen (Pillay, 1992). Leachate has also been reported to increase water alkalinity and hardness (Dupree and Huner, 1984). Leachate may clog fish gills reducing resistance to diseases, lowering growth rate and affecting egg and larval developments (Ovre and Adeniyi, 1990).

Few reports are available on the effect of leachate-contaminated water on tropical fish species especially cat fish which are hardy and can withstand more stress than other tropical fish species (Holden and Reed, 1978). This study investigates the growth and survival of *Clarias gariepinus* cat fish in different concentrations of domestic leachate.

MATERIALS AND METHODS

The study which was carried out in the Department of Fisheries using concrete tanks measuring (4ft x 4ft x 6ft) lasted 14 weeks in 2009. Two hundred (200) four week old fingerlings of *Clarias gariepinus* ranging in total length 8.5 cm to 12.5 cm and weight 5.4 g to 11.6 g were used. Fingerlings were kept in stock tank containing borehole water to acclimate for a period of 7 days, during which time fingerlings were fed twice daily (10.00 am and 6.00 pm) with commercially available feed. Leachate for this study was collected in clean 10 litre plastic buckets at the Ogbeogonogo Market dump site in Asaba, which is close to the River Niger. Leachate was transported to the laboratory for physico-chemical analysis. Ten fingerlings each were randomly distributed from the stock tank into six different duplicate tanks labelled: tanks A_1 and A_2 (control) with only borehole

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water, B_1 and B_2, C_1 and C_2, D_1 and D_2, E_1 and E_2 and F_1 and F_2, having 0%, 20%, 40%, 60%, 80% and 100% strength of leachate and borehole water mixture respectively. Both treatment and stock tanks were held in a static renewal bioassay system. Weekly measurement of fish growth in length and weight were taken and used to calculate the condition factor (K) of the fish. Behaviour of fish in the different treatments and control were observed. Water quality parameters of the treatment and control tanks were analyzed weekly according to APHA (1985) and data obtained analyzed using paired student t test statistics at $P < 0.05$. Significant means were separated with Duncan multiple range test (DMRT).

RESULTS AND DISCUSSIONS

Growth of *C. gariepinus* was observed to reduce in the treatment tanks compared with the control tank which had progressive growth of fish. Weight of fish in treatment tanks with 20%, 40% and 60% concentration of leachate increased slightly until the forth week when a reduction in weight was observed. There was a progressive growth in weight and total length of fish in the control tank (0%) while in treatment tanks with 80% and 100% leachate strength, no growth in weight and total length was noticed. The condition factors (K) of fish in the different concentrations of leachate show that fish in control tank had increase in K indicating good well being of fish whereas fish in the treatment tanks had lower condition factors implying that fish were not doing well. According to Bagenel and Tesch (1978) the condition factor is a length-weight relationship that indicates the well-being of the fish. The lower the condition factors the poorer the well being of the fish. The growth in weight/length and condition factor (K) of fish in treatment and control tanks are presented in Table-1.

Table-1. Mean growth and condition factor (K) of *Clarias gariepinus* exposed to different concentration of leachate for 14 weeks.

Conc. of Leachate (%)	**Fish weight** (g)		**Weight gain** (g)	**Fish length** (cm)		**Length gain** (cm)	**Condition factor** (K)	
	Initial	**Final**		**Initial**	**Final**		**Initial**	**Final**
0 %	5.8	48.6	42.8	8.1	15.4	8.3	1.1	1.3
20 %	8.2	19.4	11.2	10.1	13.3	3.2	0.8	0.8
40 %	5.4	5.6	0.2	6.9	7.8	0.9	1.6	1.1
60 %	13.4	13.8	0.4	11.2	11.7	0.5	1.0	0.8
80 %	11.1	10.9	-0.2	10.3	10.4	0.1	1.0	0.8
100 %	9.6	9.1	-0.5	9.8	9.8	0	1.0	0.9

The physico-chemical parameters of domestic leachate (Table-2) shows that leachate had significantly higher ($P < 0.05$) biochemical oxygen demand (BOD), Chemical oxygen demand (COD) and alkalinity than the control tank water sample. Ehrig (1983) observed higher BOD and COD of water due to anaerobic acetic production induced by leachate contamination of water. Dissolved oxygen (DO) levels were significantly ($P <0.05$) lower in leachate water than in control. Also, DO in treatment tanks were reduced though not significantly ($P >0.05$) when compared with the control except for treatment tanks with 80% and 100% leachate concentration. Dupree and Huner (1984) also reported that alkalinities of 30 to 150mg were preferred in fish culture. The alkalinities observed were slightly higher than 150mg/l and this may have contributed to stress in fish in treatment tanks and control tank water sample. Growth of fish was found to be highest in control tank and least in the 100% concentration of leachate. Slight increase in growth was observed for fish in the other treatment tanks. The high levels of BOD, COD, alkalinity and the low level of DO observed may have been responsible for the poor growth rate recorded in the treatment tanks. Boyd and Lichtkoppler (1979) reported that fish may survive but have slower growth rate with low dissolved oxygen. Okaeme (1990) also noted that low dissolved oxygen level can be lethal, resulting in acute fish anoxia leading to retarded growth of embryo, juveniles and eventual mortality. Leachate has been reported to clog fish gills reducing resistance to diseases, lowering growth rate and affecting egg and larval development (Ovre and Adeniyi, 1990).

All fish in control tank survived throughout the period of study. However, there was 100% mortality in 100% leachate concentration by the second week of the study. Leachate concentrations and time of exposure were observed to have significant effect on the survival of fish in treatment tanks. Table-3 shows the mean survival of *C. gariepinus* in different concentration of leachate in relation to time of exposure. The higher the concentration of leachate, the lower the survival of fish with time of exposure. The longer the exposure time in leachate, the lower the survival of the fish with increasing concentration. Figures 1 and 2 show the percentage survival of *C. gariepinus* in relation to concentration and duration of exposure.

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Table-2. Physicochemical parameters of domestic leachate and control tank.

Parameter	Leachate	Control tank
Temperature (^{0}C)	31.1	28.3
BOD(mg/l)	360.0	35.4
COD (mg/l)	680.13	50.8
DO (mg/l)	0.35	7.2
pH	8.1	6.9
Alkalinity (mg/l)	218	72

Table-3. Mean survival of *C. gariepinus* in different concentrations of leachate in relation to time of exposure.

Weeks	Concentration of leachate (%)					
	0	20	40	60	80	100
1	10.0000^a	10.0000^a	10.0000^a	10.0000^a	8.3333^b	3.0000^c
2	10.0000^a	10.0000^a	7.3333^b	5.6667^c	2.6667^d	0.0000^e
3	10.0000^a	10.0000^a	5.3333^b	4.6667^b	1.3333^c	0.0000^d
4	10.0000^a	8.3333^b	4.0000^c	3.3333^d	0.0000^e	0.0000^e
5	10.0000^a	7.0000^b	3.3333^c	2.3333^d	0.0000^e	0.0000^e
6	10.0000^a	5.3333^b	1.0000^c	1.0000^c	0.0000^d	0.0000^d
7	10.0000^a	4.3333^b	0.0000^c	0.0000^c	0.0000^c	0.0000^c
8	10.0000^a	3.0000^b	0.0000^c	0.0000^c	0.0000^c	0.0000^c
9	10.0000^a	2.0000^b	0.0000^c	0.0000^c	0.0000^c	0.0000^c
10	10.0000^a	2.0000^b	0.0000^c	0.0000^c	0.0000^c	0.0000^c
11	10.0000^a	1.6667^b	0.0000^c	0.0000^c	0.0000^c	0.0000^c
12	10.0000^a	1.0000^b	0.0000^c	0.0000^c	0.0000^c	0.0000^c
13	10.0000^a	0.3333^b	0.0000^b	0.0000^b	0.0000^b	0.0000^b
14	10.0000^a	0.0000^b	0.0000^b	0.0000^b	0.0000^b	0.0000^b

mean with different superscripts are significantly different.

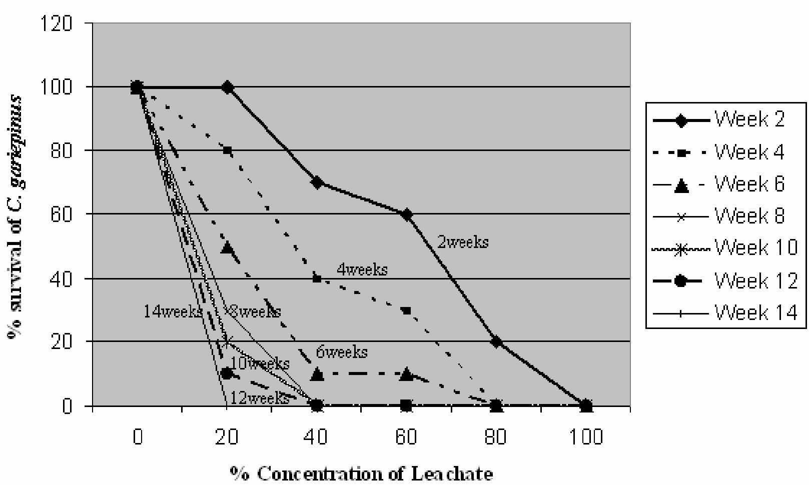

Figure-1. Percentage survival of *C. gariepinus* in relation to concentration of leachate.

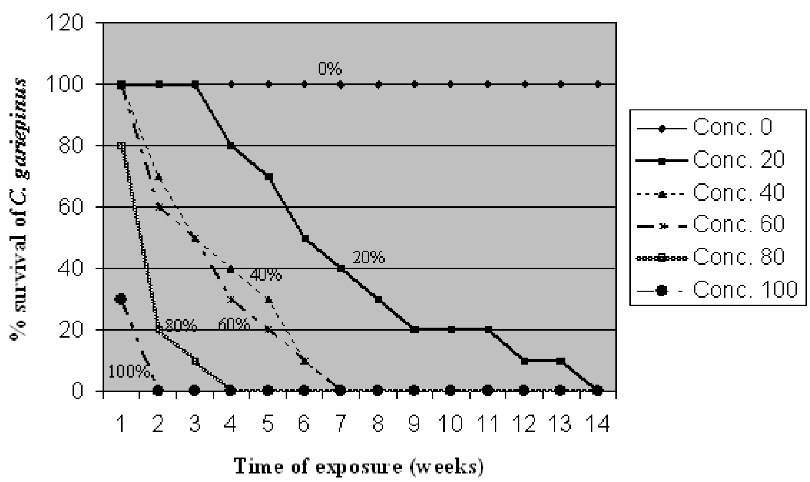

Figure-2. Percentage survival of C. gariepinus in relation to time of exposure to leachate.

Leachate being a complex mixture of organic, inorganic and many unidentified toxicants may pose risk of unknown magnitude to aquatic life. The presence of illegal waste dump sites in public places and the lack of proper management of solid waste have serious health implications. Leachate from waste dump sites leaching into nearby water bodies may have adverse effect on aquatic organisms particularly fish. Though, the effect of leachate may be reduced in flowing water than in pond system, and also with distance from the source of generation, leachate can still contaminate water bodies. Robinson (1983) reported that even when leachate is weakened by distance; it can still result in pollution of surface and ground water by causing eutrophication and high nitrates in drinking water and toxic heavy metals in ground and surface water.

This study has shown that leachate can reduce growth rate and survival of *C. gariepinus.* In view of the possible health hazard of domestic leachate and its effect on fish, there is an urgent need for strict legislation on environmental waste management against the siting of waste dumps in public places especially close to water bodies to forestall fish stress and kills.

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