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ASSESSMENT OF THE TOXICITY OF RADIOGRAPHIC DEVELOPER EFFLUENT ON CATFISH (*HETEROBRANCHUS LONGIFILIS)*

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ABSTRACT

Toxicity of radiographic developer effluent on catfish juveniles (*H. longfilis*) from the Institute of Oceanography fish farm, University of Calabar was assessed. Seventy five (75) juveniles of *H. longifilis* were acclimated in about 5 litres of habitat water for 48 hours with minimum feeding. Range finding test was conducted at effluent concentration of 100%, 50%, 25%, 12.5%, 6.25%, 3.125%, 1.0% and control (0%) in 200ml of habitat water. After, the acclimated juveniles were introduced into the standard solution. They were observed for behavioural changes and/or mortality. Behavioural changes such as hyperactivity, increased number and length of gills on the anterior fontenelle, restlessness and loss of balance of test organisms occurred at 100%, 50% and 25% effluent concentration. Mortality of organisms occurred at 5, 8, 15, 25 and 51 minutes respectively in the test solutions. The control contained only habitat water. The test solution which resulted in 100% mortality within 96 hours (1.0%) was taken as highest test dose for toxicity testing. Other concentration used for toxicity testing were 0.8%, 0.6%, 0.4%, 0.4%, 0.2%m 0% (control) respectively. Toxicity testing showed that there was increased death of catfishes as effluent concentration increased from 0.8% to 1.0% with increased duration of the exposure. Nine (9) juveniles of average length 36cm each were exposed to the test solutions. Maximum exposure time was 96 hours while estimated 96 hours LD_{50} is 0.32 of which safe disposal of 1 limit (approximate is 0.032 (1/10 or 10% of LD_{50}). Resultantly, considering the importance of catfishes as a source of food (protein), sporting tools for anglers; and a vital part of the ecosystem (tertiary consumers), it is pertinent therefore, that legislations, policies and sanctions be put in place to ensure safe disposal limit and adherence to laws on radiographic developer effluent disposal in Nigeria.

KEYWORDS: Toxicity, Radiographic developer, Effluent, Juveniles, Heterobranchus longifilis

INTRODUCTION

Catfish (*Heterobranchus longifilis*) plays an important role as a primary or secondary consumer in the ecosystem (Ramlingam, 2001). They lay their eggs in the benthic zones of water bodies. The major concerns therefore arises from potential mortality to eggs, larva, juveniles, fry, (many of which can be found in estuaries and coastal waters which because of the abundance of food supply serve as spawning and or feeding ground for many species including (*H. longifilis*). The mortality of adults or tainting of commercial species which renders the catch very unpleasant and discouraging. Larval stages have been proven to be particularly vulnerable (Dicks, 1983; Health 1987).

USEPA (1987) had shown how toxic developer effluents are to aquatic biota. 20% mortality was recorded for *Doroceras reticultum* species of molluscs exposed to 0.02mg/litre of Hydroquinone developer effluent within 4 days (Briggs and Henderson, 1987) while *Artemia salina, Crangon septemspinosa, Daphnia magma* and *Gammarus*, all different species of crustaceans had lethal threshold for morbidity at effluent concentrations of 312mg/litre, 0.83mg/litre, 0.60mg/litre and 1.5mg/litre respectively (Devillers *et al.*, 1987; McLeese *et al.*, 1979; Stom *et al.*, 1986). When *Brachydanio rerio* and *Carassius auratus*, both species of fishes were exposed to the same Hydroquinone, over 100% mortality was recorded for a concentration of 5mg/litre for 22 hours (USEPA, 1987) while having a LC 100 for 0.25mg/litre concentration on the *Brachydanio nerio* (Wellens, 1982).

Considering that some fish species including *H. longifilis* in Nigeria fresh and coastal waters are said to be under serious threat of extinction (Nwigwe, 2001) with the attendant lack of data on the impact of radiography developer effluents on these species, and the absence of a regulatory/legal framework for its control, this paper intends to be very useful in providing toxicity data for the development of safe discharge limits of radiographer developer effluent in Nigeria.

MATERIALS AND METHODS

Seventy five (75), juveniles of *H. longifilis* purchased from the Institute of Oceanography Fish Farm, University of Calabar were acclimatized in approximately 5 litres of habitat water for 48 hours.

Range finding test

This was performed on the organism to

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determine the approximate range of concentrations (radiographic effluent) for the toxicity test. Toxicant concentrations of 100%, 50%, 25%, 12.5%, 6.25%, 3.125% down to 1.0% and control (0%) were prepared in 200mls of habitat water. After swirling to mix, juveniles of *H. longifilis* were introduced into the standard solutions. The organisms were observed for behavioural changes and / or mortality. Mortality of test organisms occurred at 5, 8, 15, 25, and 51 minutes respectively in the test solutions. The control (0%) contained only habitat water. The test solution which gave 100% mortality within 96 hours was taken as the highest test dose for toxicity testing. From the range finding test, the 1% dose was selected as the highest dose for the toxicity test.

Toxicity test

The toxicity test was conducted as earlier described for the range finding test using concentrations 0% (control), 0.2%, 0.4%, 0.6%, 0.8% and 1% respectively.

Estimation of mean effective lethal dose

Estimation of the mean effective lethal dose was performed using Spearman Karber method (Sachs, 1984). Effective lethal dose for 96 hours was calculated using the formula.

96hrsLD_{50} M= xk – d(S- ½)

LD_{50} or M - Mean Effective lethal dose

xk - largest test dose which produces 100% mortality (reaction)

d - difference between adjacent doses

S1 - Sum of the relative portions of each reacting organisms

S2 - Sum of the cumulative added portions of the reacting doses.

Calculation of 96hr LD50

M = xk – d(S - 0.5)

M = 1-0.2(3.889-0.5)

M = 0.32

Calculating the standard deviation associated with this 96hrLD_{50}

SLD_{50} sm= $d\sqrt{2(S_2) - S_1 - S_1^2} - \frac{1}{12}$

$= 0.2\sqrt{2(10.555) - 3.889 - 3.889^2 - 0.08333}$

= 0.28

Thus, the 96hrLD_{50} = 0.32±0.28

RESULTS

Table 1: Toxicity test relative to controls (%) during 96hr exposure to different radiographic effluent concentrations.

Duration% conc.	24 hours	48 hours	72 hours	96 hours
Control (0%)	0	0	0	0
(0.2%)	11.11	22.22	44.44	55.56
(0.4%)	11.11	33.33	55.56	66.67
(0.6%)	11.11	33.33	66.67	77.78
(0.8%)	22.22	55.56	77.78	88.89
(1.0%)	77.78	88.89	100	100

Table 4.2: Values for the calculation of 96hrLD50

Concentration %	% dead catfishes	Relative portions of % dead catfishes	Cumulative portions of % dead catfishes
0	0	0	0
0.2	55.56	0.5556	0.5556
0.4	66.67	0.6667	1.2223
0.6	77.78	0.7778	2.0001
0.8	88.89	0.8889	2.8890
1.0	100	1.0000	3.8890

The results obtained from the experiment (table 4.1) indicate that the percentage mortality of *Heterobranchus longifilis* is not very conspicuous at exposure duration and effluent concentration of 24-48 hours and 0 – 0.6% respectively. At a higher effluent concentration of 0.8-1.0% there existed a marked difference in the percentage mortality between 24-96 hours i.e. 22.22-88.89% and 77.78 - 100% respectively. From table 4.2, the value for 96 hours LD_{50} on this study was 0.32 ±0.28. This implies that 50% mortality of *H. longifilis* was recorded as 0.32 effluent concentrations.

DISCUSSION/CONCLUSION

It could be deduced that the potential for harm is more at higher concentrations of toxicant. Hence, toxicant concentration below 0.2% may have little or no effect on the test organism (catfish) while beyond 1.0%

will produce very lethal effects within a short duration. Existing literature on the toxicity of fresh radiographic developer on frog tadpole *Rana subsigillata species* was given as 0.46±0.22 that is, the LD_{50} lies between the range of 0.24 to 0.68 (Chiaghanam et. al. 2010). Studies, on the effect of water soluble fraction (WSF) of crude oil on development and hatching success of *H. longifilis* eggs showed mean fertilization failure at 10.00ppm, 15ppm and 20ppm respectively (Dicks, 1983). WSF of crude oil shows that within the limit of experimental error, incubation of eggs in concentration of WSF of crude oil reduced fertilization success. Past fertilization death with increased larval deformity as well as egg death also occurred (Dicks, 1983; Health, 1987).

Based on the observations and results obtained from the experiment, it was deduced that radiographic developer effluent is toxic to catfishes. According to Ouano (1988) and Maxey (1987), the estimated safe discharge limit of the effluent is therefore $1/10^{th}$ or 10% of the LD_{50} (0.032).

Consequently, there is need for adequate legislations on radiographic effluent disposal stating clearly the safe discharge limits.

REFERENCES

Briggs, G. G and Henderson, I. F., 1987. Some factors affecting the toxicity of poisons to the slug Deracerous reticulatum (Muller) (Pulmonata Limacidae) Crap Prot. (6): 342-346.

Chiaghanam, N. O., Egbe, N. O., Nzotta, C. C., Aina, D. S and Akpan, E. R., 2010. Toxicity of fresh Radiographic Developer on Tadpole of *Rana subsigillata species.* Afr. J. Med. Phy. Biomed Engr & Sci, 2, 3-5.

Devillers, J., Chambon, P., Zakarya, D., Chastrette, M and Chambon, R., 1987. A predictive structure-toxicity model with Daphnia magna Chemosphere (16): 1149-1163.

Dicks, B., 1983. Methods for Petroleum related pollution monitoring, evaluation and assessment. Oil Pollution Research Unit, Field Studies Council, Orientation Field Centre, Rembroke Dyfed U. K. 6-11.

Health, A. G., 1987. Water pollution and fish physiology. C.R.C Press, Florida, 248pp.

Maxey, M. N., 1987. Managing toxic materials: A bioethical perspective. Toxic materials and methods for control, edited by N. E. Armstrong and A. Kudo. Water resources symposium No. 10 Bureau of Engineering Research, College of Engineering, University of Texas, Austin. Pp 149-161.

McLeese, D. W., Zitko, V and Peterson, M. R., 1979. Structure-lathality relationships for phenols, anilines and other aromatic compounds in shrimp and clams, Chemosphere, (2): 53-57.

Nwigwe, H. C., 2001. Effect of drilling mud on the plankton community of an experimental lacustrine system. In: Proceedings of the 16^{th} annual conference/international workshop of Nigerian Association of Aquatic Sciences, 3^{rd} – 6^{th} October, 2001 held at Michael Okpara University, Umudike. Pp 134-144.

Ouano, E. A., 1988. Training manual: Assessment of the quality and type of land based pollutant discharges into the marine and coastal environment. Pp. 54-55.

Ramlingam, S.., 2001. Modern Biology for Senior Secondary Schools, Nigeria: Africana-Feb Publishers Limited.

Sachs, L., 1984. Applied statistics “A handbook of techniques” 2^{nd} ed Springer – Verlag, New York.

Stom, D. J., Geel, T. A and Balayan, A. E., 1986. Effect of individual phenolic compounds and their mixtures as luminous bacterial part 1: Use of bacterial luminescience extinguishing for biotesting of phenols. Acta.

U. S. Environmental Protection Agency., 1987. Health and environment effects document for hydroquinone. Environmental criteria and assessment office, Office of Health and Environmental Assessment.

US EPA., 1987. The toxicity of 3400 chemicals to fish part 2: The toxicity of 1085 chemicals to fish, Washington, DC, US Environmental Protection Agency, Office of Toxic Substances (EPA) 560/6-87-002

Wellens, H., 1982. Comparison of the sensitivity of Brachydonio rerio and Leuciscus idus by testing the fish toxicity of chemicals and wastewaters. JZ Wasser Abwasser Forsch, (15): 49-52.