Toxicity of Zinc to Tropical Freshwater Snail (*Pila ovata*)

Caroline Nchedo Ariole[1] and Chiamaka Ukeje[2]

[1]Department of Microbiology, University of Port Harcourt, P.M.B. 5323, Port Harcourt, Nigeria
cnariole@yahoo.com
[2] School of Science Laboratory Technology, University of Port Harcourt, P.M.B 5323, Port Harcourt, Nigeria.

Abstract: The potential toxicity of zinc to freshwater snail (*Pila ovata*) was evaluated by static renewal bioassay for 96 hours. There was an initial range finding test to determine the concentration of zinc to be administered on the test organisms in the definitive test. Five concentrations of zinc were prepared in the definitive test as 5, 10, 20, 30 and 40mg/l and a control experiment (0.0mg/l). The median lethal concentration (LC_{50}) at 24hr, 48hr, 72hr and 96hr were 138.48, 61.33, 27.57 and 21.20mg/l respectively. The median lethal time (LT_{50}) of zinc concentrations of 5, 10, 20, 30, and 40mg/l were 111.66hrs, 100.49hrs, 86.45hrs, 77.78hrs and 67.17hrs respectively. Mortality increased with increase in zinc concentration and the number of survivors in each concentration differ significantly ($p<0.05$) from others. No death was recorded in the controls. The results indicate that zinc has mortality effect on *Pila ovata* and could pose serious threat to their survival in natural environment.
[Caroline Nchedo Ariole and Chiamaka Ukeje. **Caroline Nchedo Ariole and Chiamaka Ukeje. Toxicity of Zinc to Tropical Freshwater Snail (*Pila ovata*).** *Researcher* 2013;5(2):70-74]. (ISSN: 1545-0740). http://www.sciencepub.net/researcher. 14

Keywords: zinc toxicity; freshwater snail; median lethal concentration; median lethal time

1. Introduction

Heavy metals enter aquatic systems through natural and anthropogenic sources such as domestic, industrial, agricultural and other man made activities. The aquatic environment is more susceptible to the harmful effects of heavy metal pollution because aquatic organisms are in close and prolonged contact with the soluble metals (Kaoud, 2013). Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and the diversity of aquatic organisms (Farombi *et al*., 2007).

The fate of heavy metals introduced by human activities into aquatic ecosystems have recently become the subject of wide spread concern, since beyond the tolerable limits they become toxic (Koller *et al*., 2004). The most hazardous toxic heavy metals are lead (Pb), manganese (Mn), chromium (Cr), copper (Cu), nickel (Ni), zinc (Zn) and their soluble compounds (Navas and Lindhotfer, 2005). Zinc ion is important in cellular metabolism, acting as co-factor in a number of important enzymes. However, it becomes toxic when elevated concentration is introduced into the environment (McGeer *et al*., 2000). The discharge of toxic elements into the rivers, estuaries and coastal waters poses serious pollution problems and consequently affects the flora and fauna such as snail.

Freshwater molluscs play important role in aquatic ecosystems, providing food for many fish species and vertebrates (Maltchik, *et al*., 2010). *Pila ovata* which generates income to the people is an essential source of protein among Nigerians and it is widely distributed in streams, lakes and rivers across the southern rain forests (Ariole and Ezevununwo, 2013).

The toxicity of zinc to various fish species has been studied (Svecevičius, 1999; McGeer *et al*., 2000; Syvokiene *et al*., 2006; Gioda *et al*., 2007; Gündoğdu, 2008). There is dearth of information on the toxicity of zinc to other aquatic organisms such as mollusc, *Pila ovata.*

Due to the persistence and toxic nature of the metals, knowledge on the toxicity of different metals is important for evaluating tolerable levels of the metal to various types of biological components. Therefore, the present study aimed to evaluate the potential toxicity of zinc to freshwater snail (*Pila ovata*) so as to ascertain its level of tolerance and its suitability as bio-indicator in freshwater environment.

2. Materials and Methods

2.1. Collection and acclimatization of test organisms

The specimens of *Pila ovata* were collected from Okpuhur Creek in Odhieke Community in Ahoada West Local Government Area, of Rivers State, Nigeria. The specimens were brought to the laboratory in plastic container filled with oxygenated and cool habitat water to reduce their activity and stress before reaching the laboratory. Active and healthy organisms were selected for acclimatization. Acclimatization was for 10days at room temperature according to the static test procedure (APHA, 1998) in dilution water obtained from organism's habitat.

2.2. Bioassay

Chemically pure zinc sulphate ($ZnSO_4 \cdot 5H_2O$) dissolved in distilled water was used as a stock solution. The required concentration was calculated according to the amount of zinc. A range finding test was carried out as described by Rahman *et al*., (2002) to determine the concentrations of zinc used in the definitive test. The following concentrations of zinc were used for the definitive test- control (0.0mg/l), 5 mg/l, 10mg/l, 20mg/l, 30mg/l and 40mg/l. Sixty (60) specimens of juvenile *Pila ovata* of fairly equal size were randomly assigned in equal number (10) into six test tanks (29cm by 29cm by 30cm) separately containing the definitive concentrations of zinc. Each of these test tanks was replicated thrice to give a total of eighteen (18) experimental units (test tanks) containing 180 specimens of *Pila ovata*. The control (0.0 mg/l) contained only 10 individuals of *Pila ovata* without zinc. During the bioassay, the test solution in each tank was renewed every 24hours. Dead snails were promptly removed and mortality was specifically recorded at 24, 48, 72 and 96 hours of exposure time as described by Odiete (1999).

2.3. Data analysis

Each test concentration and the corresponding percentage mortality were transformed into probit (Sprague, 1973). The median lethal concentration (LC_{50}) and median lethal time (LT_{50}) were determined according to the method described by Finney (1971). Analysis of variance (ANOVA) was used to test for significant differences in the number of survivors in different concentrations of the toxicant (zinc).

3. Results Analysis

The results obtained showed that, generally, percentaged mortality increased with increasing concentration of zinc (Fig.1) and with increase in exposure time (Fig. 2). The 24, 48, 72 and 96hr median lethal concentration (LC_{50}) of zinc to *Pila ovata* were 138.48, 61.33, 27.57 and 21.20mg/l respectively (Table1).

Table 1: Median lethal concentration (LC_{50}) of zinc to *Pila ovata*

Time (hr)	LC_{50} (mg/l)
24	138.48
48	61.33
72	27.57
96	21.20

The correlation coefficient (r^2) between concentration of the zinc and probit mortality showed that there were strong and positive correlations between concentration and mortality values for 24, 48, 72 and 96hr (Fig.1).

The median lethal time (LT_{50}) of zinc to *Pila ovata* at zinc concentrations of 5, 10, 20, 30 and 40mg/l were 111.66hr, 100.49hr, 86.45hr, 77.78hr and 67.17hr respectively (Fig. 2 and Table 2).

Table 2: Median lethal time (LT_{50}) of zinc to *Pila ovata*

Concentration (mg/l)	Time (hr)
5	111.66
10	100.49
20	86.45
30	77.78
40	67.17

The number of survivors of *Pila ovata* exposed to different concentrations of zinc differ significantly ($p<0.05$) from others (Table 3). There is negative correlation between the LT_{50} values and the zinc ion concentrations; when the zinc ion concentration levels decreased, LT_{50} values increased (Fig. 3).

Table 3: Survivors of *Pila ovata* exposed to different concentrations of zinc

Concentration (mg/l)	Survival (%) (mean ±S.D)
Control (0)	$100^a \pm 0.00$
5	$60^b \pm 0.63$
10	$53.33^c \pm 0.33$
20	$46.67^d \pm 0.33$
30	$40^e \pm 0.63$
40	$30^f \pm 0.33$

Mean values which do not have the same superscript letter are significantly different ($p<0.05$)

4. Discussion

The result showed that the LC_{50} value of zinc ion to *Pila ovata* decreased as the exposure time increased (Fig. 1). Exposition duration evidently influenced the value of LC_{50}. The LC_{50} of zinc vary considerably when previous reports on fish species are compared and also with LC_{50} values obtained in this study. The calculated 96-hr LC_{50} of five fish species vary within the range of 3.79-11.37mg Zn/litre. The lowest 96hr LC_{50} was found for rainbow trout and the highest one for roach (Svecevičius, 1999). The 96hr LC_{50} value of zinc ions for rainbow trout was found to be 12.88 mg/l by Gündoğdu, 2008.

The differential toxicity of zinc to freshwater organisms can be attributed to the differences in species susceptibility or metabolic activities, geographical regions and physicochemical composition of water (Svecevičius, 1999). That is why the data obtained in different countries can hardly be extrapolated to local conditions. Therefore, experimental work is needed to obtain the data corresponding to the conditions of the given region.

The dead organisms were exposed to dilution water (no toxicant added) and observed for 1 hour. None of the dead organisms revived. This is evidence that death was irreversible. The mode of toxicity was not evaluated at this stage. It is likely that the absorption of the toxicant molecules on the respiratory tract reduced the oxygen uptake rate which invariable affected metabolic activity.

The levels of zinc in the environment may be lower than the concentrations tested in this study. However, the results show the potential toxicity of zinc to the organism. This will result in reduced catch and economic loss to the local baiters. Consumption of the dead snails is an indirect route of accumulation of this toxicant by humans, this poses health risk. It has been reported that *Pila ovata* is capable of bioaccumulating trace metals especially Zn and Fe (Ezemonye *et al*., 2006). Therefore, caution should be exercised against water source contamination and exposure to fertilizer and industrial pollution. Currently work is continuing in our laboratory on the potential toxicity of other heavy metals on the organism.

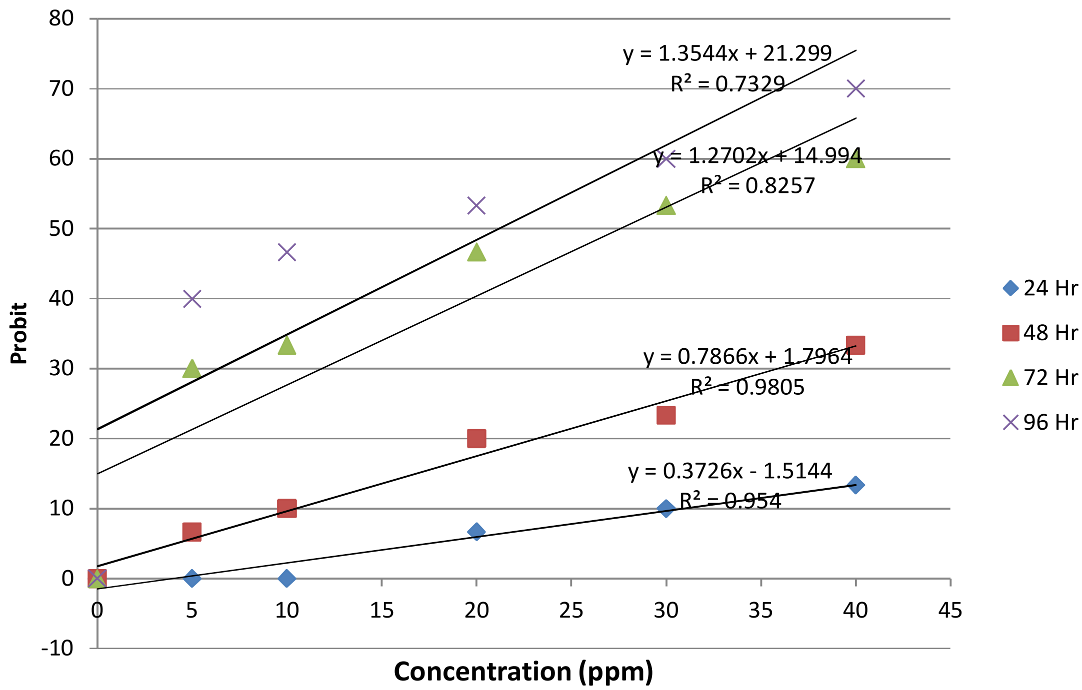

Figure 1: Median Lethal Concentration (LC_{50}) of Zinc to *Pila ovata*

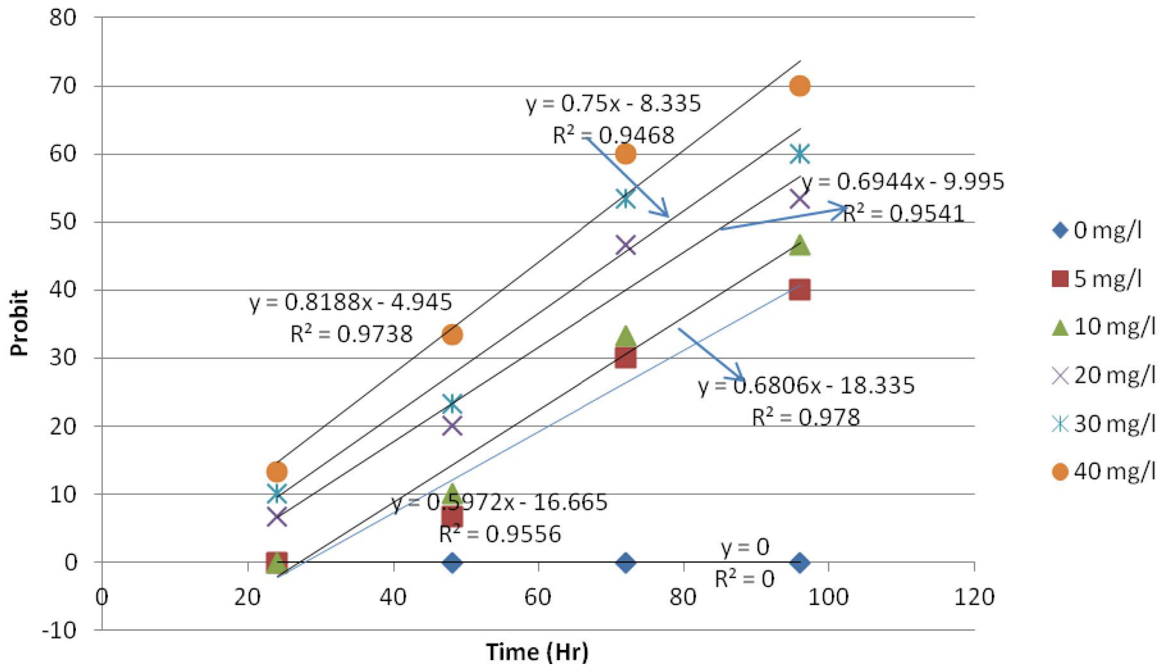

Figure 2: Median Lethal Time (LT_{50}) of Zinc to *Pila ovate*

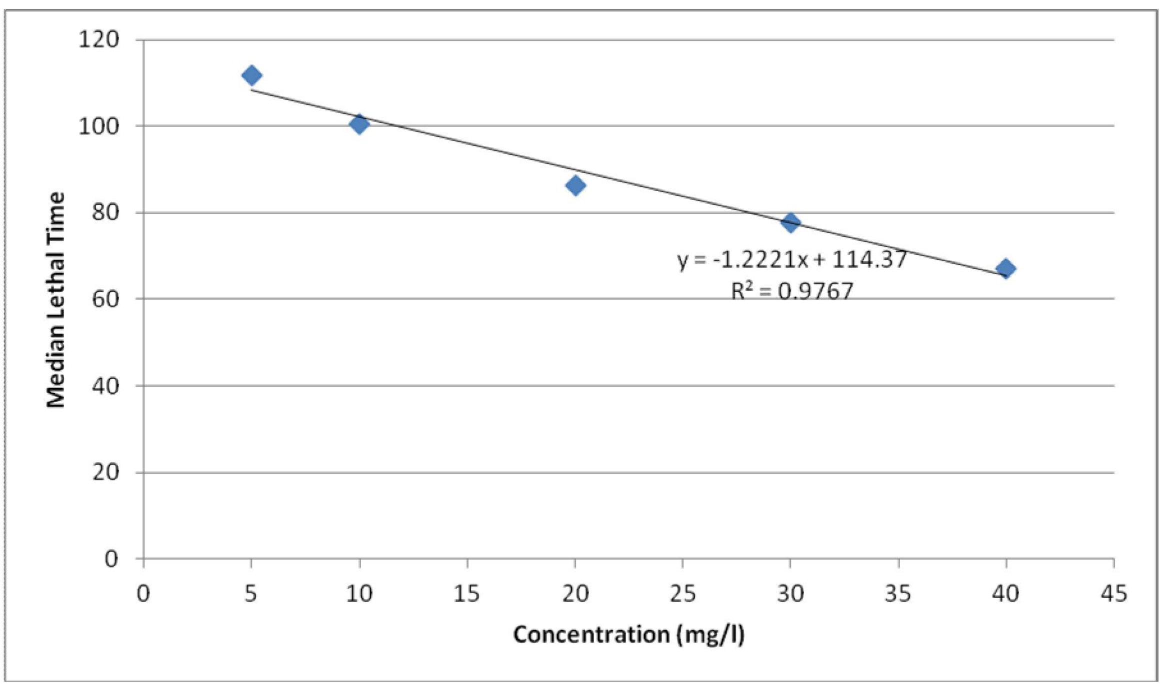

Figure 3: Minimum lethal concentration and minimum lethal time of zinc to *Pila ovata*

References

1. Kaoud HA. Histopathological alterations and bioaccumulation of heavy metals in *Oreochromis niloticus* fish In: Eds. Bhartis, P.K., Chauhan, A., Kaoud, H.A. Aquatic Biodiversity and Pollution, Discovery Publishing House PVT. LTD., New Delhi, 2013;70-89.
2. Farombi EO, Adelowo OA, Ajimoko YR. Biomarkers of oxidative stress and heavy metal levels as indicator of environmental pollution in African catfish (*Clarias gariepinus*) from Nigeria Ogun River. International Journal of Environmental Research and Public Health 2007; 4:158-165.
3. Koller K, Brown T, Spurgeon A, Levy L. Recent development in low level exposure and intellectual impairment in children. Environmental Health Perspective 2004; 112 (9): 987-994.
4. Navas A, Lindhotfer H. Chemical partitioning of Fe, Mn, Zn and Cr in mountain soils of the lberia and Pyrenean Ranges (NE Spain). Soil and Sediment Contamination 2005; 14 (3): 249-260.
5. McGeer JC, Szebednszky C, McDonald DG, Wood CM. Effects of chronic sublethal exposure to water borne Cu, Cd or Zn in rainbow trout 1: Lono-regulatory disturbance and metabolic costs. Aquatic Toxicology 2000; 50: 231-243.
6.. Maltchik L, Stenert C, Kotzian CB, Pereira D. Responses of freshwater molluscs to environmental factors in southern Brazil wetland. Brazilian Journal of Biology 2010; 70 (3): 473-482.
7. Ariole CN, Ezevununwo O. Acute toxicity of dichlorvos on tropical freshwater snail (*Pila ovata*). International Journal of Biosciences 2013; 3 (1): 70-75.
8. Svecevičius G. Acute toxicity of zinc to common freshwater fishes of Lithuania. Acta zoologica Lithuanica. Hydrobiologia 1999; 9 (2): 114-118.
9. Šyvokiéné J, Mickeniéné L, Svecevičus G. Acute toxicity of copper- zinc mixture to rainbow trout *(Oncorhynchus mykiss*) and its impact on the bacterial flora of the digestive tract. Acta Zoologica Lithuanica 2006; 16 (3):235-240.
10. Vosyliene MZ, Jankaite A. Effect of heavy metal model mixture on rainbow trout biological parameters. Ekologija 2006; 4: 12-17.
11. Gioda. C R, Lissner LA, Pretto A, da Rocha JBT, Schetinger MRS, Neto JR, Morsch VM, Loro VL. Exposure to sublethal concentrations of Zn (II) and Cu (II) changes biochemical parameters in *Leporinus obtusidens*. Chemosphere 2007; 69 (1): 170-175.
12. Gündoğdu A. Acute toxicity of zinc and copper for rainbow trout (*Onchorhyncus mykiss*). Journal of Fisheries Sciences. com 2008; 2 (5): 711-721.
13. APHA. Standard Methods for the Examination of Water and Wastewater 20th ed. American Public Health Association, Washington, D.C., 1998.
14. Rahman MZ, Hossain Z, Mollah MFA, Ahmed GU. Effect of diazinum 60EC on *Anabas testudineus*, *Channa punctatus* and *Barbodes gonionotus* “Naga’’.The ICLARM Quarterly 2002; 25: 8-12.
15. Odiete WO. Environmental Physiology of Animals and Pollution. Diversified Resources, Ltd., Lagos, Nigeria, 1999.
16. Sprague JB. The ABCs of pollutants bioassay using fish. In: Biological methods for assessment of water quality. J. Jr. Cairns and K. L. Dickson (eds.), ASTM Special Tech. Public 1973; 528: 6-30.
17. Finney DJ. Probit Analysis. 3rd edition Cambridge University Press, London 1971; 333.
18. Ezemonye LIN, Enobakhare V, Ilechie I. Bioaccumulation of heavy metals (Cu, Zn, Fe) in freshwater snail (*Pila ovata;* Oliver 1804) from Ikpoba River of Southern Nigeria. Journal of Aquatic Sciences 2006; 21 (1): 23-28.

1/12/2013