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Toxicity of copper to tropical freshwater snail (*Pila ovata*)

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ABSTRACT:

The potential toxicity of copper to freshwater snail (*Pila ovata*) was investigated in a static renewal bioassay for 96 hours. Chemically pure salts of copper sulphate ($CuSO_4$. $5H_2O$) dissolved in distilled water was used as toxicant. Five copper ion concentrations with a control group were prepared. The LC_{50} at 24 h, 48 h, 72 h and 96 h was 4.67, 2.12, 1.64 and 0.59 mg/l respectively. The LT_{50} of copper concentrations of 0.05 mg/l, 0.1 mg/l, 0.5 mg/l, 1.0 mg/l and 2.0 mg/l were 123.86 h, 97.20 h, 83.33 h, 75.32 h and 60.04 h respectively. No death was recorded in the controls. Survival time decreased with increasing concentrations of copper ion. The results showed that copper is toxic to *Pila ovata* and could pose serious threat to their survival in natural environment.

Keywords:
Copper toxicity, freshwater snail, median lethal concentration, median lethal time.

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INTRODUCTION

Freshwater molluscs play an important role in aquatic ecosystems, providing food for many fish species and vertebrates (Maltchik, *et al*., 2010). *Pila ovata*, a tropical freshwater snail, is among the molluscan seafoods that are widely distributed in streams, lakes and rivers across the southern rain forests in Nigeria (Ariole and Ezevununwo, 2013). It serves as a major source of protein as well as generating income to the people.

The contamination of freshwater with a wide range of pollutants has become a matter of concern over the last few decades (Vutukuru, 2005). Chemicals derived from agricultural operations (pesticides and herbicides) and industrial effluents, such as metals, ultimately find their way into a variety of different water bodies and can produce a range of toxic effects in aquatic organisms (Al-Kahtani, 2009).

Copper salts (copper hydroxide, copper carbonate and copper sulphate) are widely used in agriculture as fungicide, algaecide and nutritional supplement in fertilizers. They are also used in veterinary practices and industrial applications. Copper sulphate is released to water as a result of natural weathering of soil and discharge from industries, sewage treatment plants and agricultural runoff. Copper sulphate is also intensively introduced in water reservoirs to kill algae. Thus, excessive amount of copper accumulates in water bodies and cause toxicity of aquatic fauna and flora (Kaoud, 2013). Copper is essential for the normal growth and metabolism of nearly all organisms including mollusc. However, when biological requirements are exceeded, this metal can become harmful to aquatic biota (Hall *et al*., 1997).

Acute toxicity bioassay are widely used to assess the effects of pollutants on one or more organisms usually based on the determination of acute lethal toxicity and sub-lethal toxicity test using sensitive species or organisms based on their economic and ecological importance, availability and ease of handling (Fuller *et al*., 2004). Although the tests are laboratory based, simple, of single variable and do not necessarily simulate the field situations, they nonetheless provide useful information on the potential of the pollutant to harm the biota (Akbari *et al*., 2004).

The toxicity of copper to aquatic organisms such as tropical freshwater prawn (Kaoud, 2013) and fish (Olaifa *et al*., 2004; Abou El-Naga *et al*., 2005; Stasiūnaitė, 2005; Mickėniėnė *et al*., 2007) have been reported. There is dearth of information on the toxicity of copper to mollusc, *Pila ovata*.

Therefore, the present study aimed to evaluate the potential toxicity of copper to freshwater snail (*Pila ovata*) so as to ascertain its level of tolerance and its suitability as bio-indicator in freshwater environment.

MATERIALS AND METHODS

Pila ovata was collected from Okpuhur Creek in Ahoada, Rivers State, Nigeria. The snails were handpicked and placed in a plastic bucket containing habitat water. On reaching the laboratory, active snails were selected for acclimatization for 10days at room temperature (APHA, 1998) in a vessel containing habitat water.

Chemically pure copper sulphate ($CuSO_4 \cdot 5H_2O$) dissolved in distilled water was used as a stock solution. The required concentration was calculated according to the amount of copper ions. Five concentrations (0.0 mg/l), 0.05 mg/l, 0.1 mg/l, 0.5 mg/l, 1.0 mg/l and 2.0 mg/l) were prepared using water from the habitat of the snail as diluent. The control was dilution water without toxicant. A preliminary range finding test (Rahman *et al*., 2002) was first performed to determine the concentrations used in the definitive tests. The 96 h acute toxicity bioassay was carried out using the procedure of APHA (1998). Triplicate sets of glass tanks (29 x 29 x 30 cm) for each copper concentration were employed. Ten snails of fairly equal sizes were

handpicked and carefully transferred into each test tanks. Mortality was recorded at 24, 48, 72 and 96 hours of exposure time as described by Odiete (1999). Dead snails were removed at each observation and the test solution in each tank was renewed every 24 h. The test was terminated after 96 h and repeated three times to confirm the data.

Data analysis

Probit analysis (Sprague, 1973) was used to transform each test concentration and the corresponding percentage mortality. The method described by Finney (1971) was used to determine the median lethal concentration (LC_{50}) and median lethal time (LT_{50}). The number of survivors in different concentrations of copper was tested for significant differences using one way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The probit mortality rate increased with increasing copper ion concentrations as shown in Figure 1. No mortality occurred in the control group. The relationships between copper concentrations and probit mortality were analysed. The results in basic correlation analysis illustrated a positive linear relationship (Figure 1). The 24, 48, 72 and 96 h LC_{50} of copper to *Pila ovata* were 4.67, 2.12, 1.64 and 0.59 respectively (Table 1). The result showed that the LC_{50} value of copper ion to *Pila ovata* decreased as the exposure time increased. The LT_{50} for freshwater snail in different copper ion concentrations are shown in Table 2 and Figure 2. There is negative correlation between the LT_{50} values and copper ion concentrations; when the copper ion concentrations levels decrease, LT_{50} values increased (Table 2 and Figure 2). The survival percentages were found to be significantly different from each other as shown in Table 3.

The LC_{50} of copper vary considerably when previous reports on fish species are compared and also with LC_{50} values obtained in this study. The 96 hr LC_{50} values of copper ions for rainbow trout (Gündoğdu, 2008), *Mugil seheli* (Abou El-Naga, 2005) and *Macrobrachium rosenbergii* (Kaoud, 2013) were 0.094 mg/l, 1.64 mg/l and 0.35 mg/l respectively. The variation in the LC_{50} values for the same metal may be due to species type, chemical structure of metal compound, the conditions of the experiment (water temperature, salinity, oxygen content and pH) and geographical regions. 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 results of this study indicated that mortality and time were influenced by the concentration levels of copper and that copper is toxic to *Pila ovata*. It has been reported that *Pila ovata* is capable of bioaccumulating

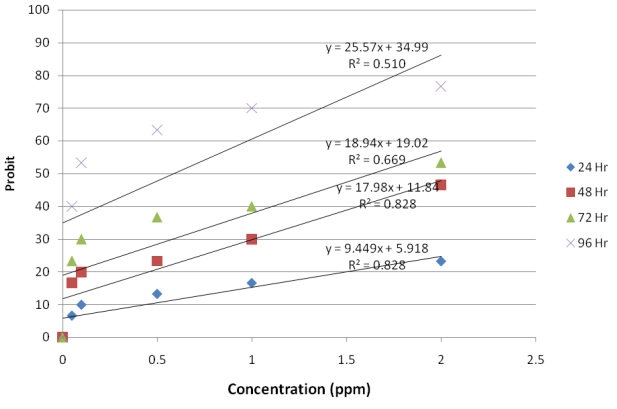

Figure 1: Median Lethal Concentration (LC_{50}) of Copper to *Pila ovata*

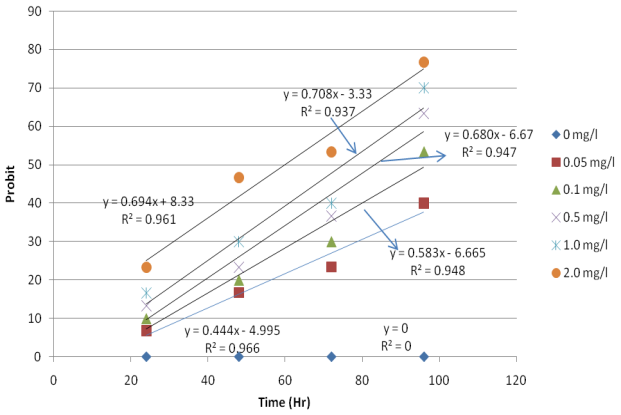

Figure 2: Median Lethal Time (LT_{50}) of Copper to *Pila ovata*

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

Time (hr)	LC_{50} (mg/l)
24	4.67
48	2.12
72	1.64
96	0.59

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

Concentration (mg/l)	Time (hr)
0.05	123.86
0.1	97.20
0.5	83.33
1.0	75.32
2.0	60.04

trace metals (Ezemonye *et al*., 2006). This poses health issue when consumed by human. Therefore, caution should be exercised against water source contamination and exposure to fertilizer and industrial pollution which could pose serious threat to their survival in natural environment.

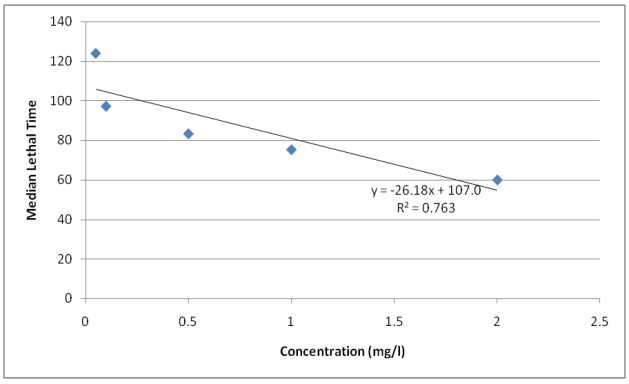

Figure 3: Minimum lethal concentration and minimum lethal time of copper to *Pila ovata*

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

Concentration (mg/l)	Survival (%) (Mean ±S.D)
Control (0)	$100^{a} \pm 0.00$
0.05	$60^{b} \pm 0.67$
0.1	$46.67^{c} \pm 0.67$
0.5	$36.67^{d} \pm 0.67$
1.0	$30^{e} \pm 0.67$
2.0	$23.33^{f} \pm 0.67$

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

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