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Correlation between concentrations of heavy metal ions in snail and prawn from Fresh water swamps Otuoke Bayelsa State, Nigeria.

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Abstract

The relationship between concentrations of heavy metals in dominant aquatic fresh water swamp organisms (snails and prawns), Otuoke Bayelsa state Nigeria was investigated. The samples collected from similar locations within the study area were analyzed for the present of nickel, cobalt, lead, chromium and cadmium. The results obtained indicated that mean concentrations of nickel, cobalt, lead, chromium and cadmium in snail were 1.88, 0.44, 1.42, 0.728 and 0.008 mg/g while the corresponding mean concentrations in prawn were 1.96, 0.44, 1.12, 0.719 and 0.008 mg/g. Strong correlation ($R^2 = 0.9624$) was obtained for the concentration of these heavy metals in snails and prawns which indicates that these organisms have common sources of heavy metals. However, concentrations of the study heavy metals in prawn and snail were within the permissible tolerance limit.

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Introduction

Heavy metals are those metals whose density is greater than 5 g/dm^3. The presence of heavy metals in the various components of the environment has been extensively documented (Tchounwou *et al*., 2012). In the land, heavy metal accumulation could arise through waste decomposition (Eddy *et al*., 2007). In the air, heavy metals accumulate through natural processes (such as volcano eruption, earth quake) and from anthropogenic sources including industrial sources. However, several concerns have been concentrated on the enrichment of aquatic environments by heavy metal ions because most of these metal ions generated through anthropogenic and natural sources terminate in the aquatic environment (*Gevorgyan et al., 2015*). Consequently, the water, aquatic plants and animal (such as fish, flora and fauna, etc) sediment are common indicators for heavy metal pollutions. According to Jakimska *et al*. (2011), accumulation of heavy metals in tissues of snail, prawn, sea turtle and fish has significant impact on man because they are essential components of the food chain.

Levels of concentration of heavy metals in a given environment depend on level of generation of heavy metal ions, industrial activities, human activities and other factors. Bayelsa is located within the Niger Delta zone, the zone whose activities is dominated by crude oil exploration and related activities. The area is predominantly swampy and is located within the rain forest zone. Several studies have reported high concentrations of heavy metals in plants and some animals within the region. However, in spite of their dominant presence coupled with the high rate of consumption of snails and other soft tissue animals, researches on the concentration of heavy metal ions in these lower trophic animals is scanty.

Results obtained by Gbarulo and Friday (2007) observed that molluscs and crustacean obtained in some parts of the Niger Delta region accumulated considerable amounts of heavy metals and that higher levels of all the metals determined (Hg, Pb, Cr, Cu, Ni, and Zn) were observed in the shells than in the fleshly tissues. Karadede-Akin and Unlu (2007) investigated the accumulation of Cd, Co, Cu, Fe, Mn, Ni, Pb and Zn in water, sediment, muscle, liver and gill of fish (*Silurus triostegus*, *Mastacembelus simack*, *Mystus halepensis*, *Orthrias euphraticus*) the muscle and liver of crab (*Potamon fluviatilis*), the internal organs of fresh water snail (*Physa acuta*), and mussel *(Unio elongatulus*), and in whole biomass of green algae (*Spirogyra* sp.) obtained from Tigris River and from a reference site on Resan Creek. Elevated concentration of these metal ions was observed in the soft tissues of the studied animals. Ogundiran and Fasakin (2015) found that mulusca and crustacean obtained from some Nigerian cities are enriched by heavy metals at a level that affects their protein content. Adedeji *et al* (2011) also

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reported significant concentration of heavy metals in snail and water samples from Alaro River in Oluyole Industrial area of Ibadan Southwestern Nigeria. Other studies on heavy metal content of snail are those reported by Zhang *et al* (2016), Fatima *et al*. (2014) and Prosi (1998). The present study is aimed at investigating the levels of concentrations of some heavy metal ions in snail and prawn obtained from Otuoke in Bayelsa State, Nigeria.

Materials and methods

Snail and prawn samples were simultaneously (and from the same location) collected from muddy environment in Otuoke. Otuoke is a suburb in Ogbia local government *area* of Bayelsa State in the Niger Delta region of Nigeria. Majority of its inhabitants are farmers and fishermen. Fig. 1 shows the map of the studied area. The site is geographical located at *Latitude* N040 47' 32.7" and *Longitude* E0060 19' 31.4". The samples were dried, ashed and digested with nitric acid. The digested sample was used for metal determination using atomic absorption spectrophotometer as described by Sneddon *et al*. (2006).

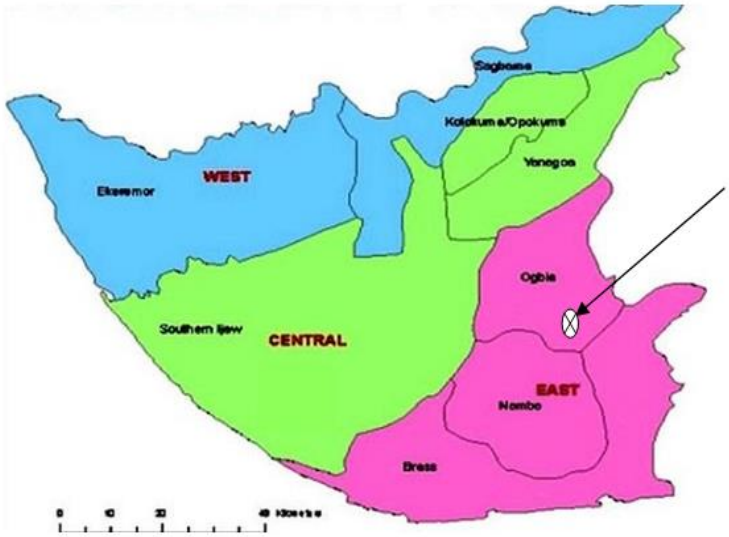

Fig.1: Map of Bayelsa state showing Otuoke

Results and discussion

Mean concentrations of the studied heavy metal ions (including nickel, cobalt, lead, chromium and cadmium) in snail and prawn are presented in Tables 1 and 2 respectively. From the results obtained, mean concentration of nickel ions in snail samples was 1.88 mg/g. The standard deviation for this concentration was 0.03. The low variability indicates that nickel ion concentration in the snail is in low concentration range. On the other hand, prawn samples taken from the same aquatic environment, had mean nickel concentration value of 1.96 mg/g and standard deviation of 0.085. This concentration is higher than the mean concentration in snail suggesting that prawn has better capacity to accumulate nickel ions than prawn or that prawn might have shown better migration from one aquatic environment to another. Also, within the aquatic environment, snail feed on prawn indicating that concentration of nickel in snail can be traced to its source of feeding, which is mostly prawn. On the course of such migration, the organisms will accumulate heavy metal ions, including nickel ions through the food chain. Available literature reveals that nickel ion does not bioaccumulate to a great extent in animals but evidence of significant nickel uptake of nickel ion in plant has been reported (Eddy and Ukpong (2005). Also, nickel is an essential trace element in animals and its deficiency is manifested in the liver, which could lead to abnormal cellular morphology, oxidative metabolism, alteration in lipid levels, decrease in growth and hemoglobin concentration as well as impaired glucose metabolism. However, the essentiality of nickel in humans has not been fully established and yet nickel dietary recommendation has not been established for humans. Therefore, the

observed levels of concentrations of nickel in snail and prawn samples are within safety levels. However, controlled level of nickel ion intake for humans is recommended.

Adverse respiratory effects have been reported in humans and animals exposed to nickel compounds at concentrations much higher than typically found in the environment.

Mean concentration of cobalt ion in snail samples was 0.44 g/g while the standard deviation was 0.010. In prawn, the mean concentration was also 0.44 g/g but the standard deviation was 0.03. The similarity in mean concentration of cobalt ion in prawn and snail clearly suggest that bioaccumulation of cobalt ion by prawn and snail is evidence and the extent of accumulation is comparable. According to Shuhaimi-Othman *et al*. (2012), metals bioconcentration in snail increases with exposure to increasing concentrations and Cu has the highest accumulation (concentration factor) in soft tissues. Therefore, although the observed concentration of chromium ion in snail and prawn are below values reported elsewhere and also below permissible limit, there is a future danger than uncontrolled and continuous release of chromium rich wastes into the aquatic environment may lead to significant concentration of the ion in snail and prawn and eventually on man, through the food chain.

Lead is a heavy metal that is toxic at low concentration. Mean concentration of lead ions in snail was 1.42 g/g (standard deviation = 0.091) while the mean concentration in prawn was 1.12 g/g (standard deviation = 0.086). The higher concentration of lead recorded in snail than prawn may be due to bioaccumulation. According to Aebayo-Tayo *et al*. (2011), lead concentration in snail samples from aquatic environment within the Niger Delta ranged from 0.03 to 0.24 mg/kg, which are lower than the concentrations obtained for prawn and snail in the present study. Therefore, there is significant evidence of bioaccumulation of lead ions in snail. Studies conducted by Ottoloju *et al*. (2009) reveals that continuous exposure of snail to lead will exert toxic impact on the animal and ingestion by man could lead to liver infection and blood poisoning. Therefore, although the present concentration levels of lead in snail and prawn are below toxic limit, continuous exposure may establish toxic impart on exposed animals and the entire component of the food chain (including man).

Chromium ion concentration in snail samples exhibited mean value of 1.42 mg/g with standard deviation of 0.076. In prawn, the mean concentration was 0.719 mg/g (standard deviation = 0.025). This indicates that prawn may not be the major source of cadmium ion contamination in snail but other food sources of snail might have contributed to the elevated background concentration of chromium found in snail. Also, the elevated concentration maybe attributed to bioaccumulation, a biological process that defines continuous enrichment of a given biota by heavy metal ion. Elevated concentration of chromium ions in snail and prawn has been reported around a landfill by Sriuttha *et al*. (2017). The recorded concentration was above permissible limit. However, concentrations of chromium ions in snail and prawn samples obtained in this study are below permissible limit.

Mean cadmium concentration in snail was 0.008 mg/g while the calculated standard deviation was 0.001. In prawn samples, mean cadmium concentration was 0.008 mg/g while the calculated standard deviation was 0.00. The constancy of cadmium concentration in both snail and prawn perhaps suggests constant addition of cadmium to the environment. Cadmium ion is a toxic heavy metal ion. Its toxicity is closely related to that of lead. However, the present study reveals levels of concentration of cadmium ions in snail and prawn sample to be below the permissible limit.

Nickel is the most abundant element among all and its highest concentration was found in prawn. Cadmium is the least abundant and maintains concentration similar in both snail and prawn. Lead ion is more concentrated in snail while concentration of chromium and cadmium in both snail and prawn were significantly comparable.

Fig. 2 shows a plot for the variation of concentration of the studied metal ions in snail and prawn samples. High degree of linearity (96.21 %) was observed as shown by calculated value of R^2. This indicates that the concentration of heavy metal ions in snail increases as the concentration of heavy metals in prawn increases.

Table 1: Concentration of heavy metals ions in snail

Heavy metal ion	Mean ± SD (mg/g)	%RSD
Ni	1.88 ± 0.03	1.58
Co	0.44 ± 0.01	2.28
Pb	1.42 ± 0.09	6.41
Cr	0.73 ± 0.08	10.38
Cd	0.008 ± 0.001	18.78

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Table 2: Concentration of heavy metals ions in prawn

Heavy metal ion	Mean ± SD (mg/g)	%RSD
Ni	1.96 ± 0.085	4.33
Co	0.44 ± 0.030	2.87
Pb	1.12 ± 0.086	7.62
Cr	0.72 ± 0.025	3.54
Cd	0.008 ± 0.000	2.17

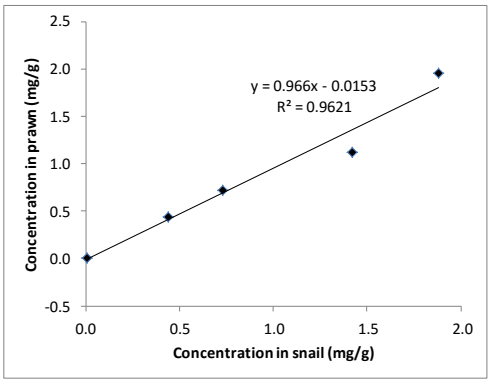

Fig. 2: Variation of concentrations of heavy metal ions in snail with their concentration in prawn

The fact remains that the major source of heavy metal ions in snail in the study area is prawn. There was no significant difference between the distribution of heavy metal ions in snail and prawn (t_{cal} = 0.2617) at 95
% level of confidence.

Conclusion

The present study reveals that concentrations of nickel, cobalt, lead. chromium and cadmium ions in snail and prawn samples are relatively below the permissible limit but with strong tendency to increase if the discharge of these heavy metal ions to the environment is not controlled. Strong correlation exists between the concentrations of the studied heavy metal ions in snail and prawn. Nickel is the most concentrated heavy metal while cobalt is the least concentrated heavy metal ion in both snail and prawn.

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Appendix 1: Levels of concentration of heavy metals in snail and prawn