Short Communication

Evaluation of environmental lead exposure in snails from four contaminated sites at abandoned battery factory in Niger Delta, Nigeria

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Abstract

*The evaluation of environmental lead exposure in snails from four contaminated sites of entrance, storage, dried effluent and waste dump respectively, at abandoned battery factory (Niger Delta, Nigeria) were investigated. Results indicated significant ($P < 0.05$) depressed weights of foot, shell, and offal at elevated lead contamination. The exposure of *Achatina achatina* snail to lead pollution indicates a pollution warning signal. Contaminated snails are critical pathway for transport of lead along the food chain.*

Keywords Niger delta, edible snail, lead accumulation, battery factory

Introduction

Contamination of animal feed materials with lead (Pb) cannot be entirely avoided given its prevalent occurrence in the environment. Environmental exposure to Pb is a continuous source of mortality and morbidity throughout the world (Adebamowo *et al.*, 2006). Human exposure to Pb results from various sources, of which food is one of the major routes of exposure in non-occupationally exposed persons.

In Nigeria, snails are eaten as a delicacy that supplement low protein diets (Ebenso and Okafor, 2002). The low fat content makes it

useful for hypertensive patients (Omole *et al.*, 2000). Studies of Dallinger *et al.*, (2004) have clearly demonstrated that the value of terrestrial snails as biological indicators for metal pollution is irrefutable, as trace elements are primarily accumulated in soft tissues. The common garden snail has been proposed as a sentinel species for mapping environmental concentrations of toxic metals, since it accumulates high levels in its soft tissues (Bebby and Richmond, 2003). The risk of secondary poisoning should also be considered since snails are prey for many invertebrates and vertebrate predators (Scheifler *et al.*, 2000).

Previous studies indicate that as bioindicator organisms (Ebenso, *et al.*, 2006; Ebenso and Ologhobo 2007, 2008ab, 2009ab), edible snails are prone to bioaccumulation of contaminants. While prevention is acknowledged as the best public health option, the level of knowledge about Pb exposure in many developing countries is unknown (Adebamowo *et al.*, 2006). This study determined the toxic exposure levels of Pb on sentinel snails at abandoned battery factory sites and to provide information on the awareness of the hazards associated with Pb exposure in Nigeria.

Materials and Methods

The samples were from previous study (Ebenso and Ologhobo 2009a), of 4 soil sites namely entrance as control, storage dump, dried effluent, and waste dump, respectively. Experimental area was the abandoned Sunshine Batteries Limited (SBL), Ukana within latitude 5° 80' N and longitude 7° 41' E of Essien Udim Local Government Area of Akwa Ibom State, Niger Delta, Nigeria.

All sites were sampled three times, the top 15cm of soil, excluding the litter layer, as well as samples of the predominant vegetation (*Raphanus sativus*), was hand searched randomly and cut at 3cm above the soil and taken to laboratory and dried to constant weight.

Live snail samples collected were put into clean, labeled cellophane bags and taken to the laboratory for further analyses. Five samples from 3 replicates per site were collected. Live weights of snails were measured using electronic balance, then killed by immersing in boiling hot

water, shocked, with weights of shell, foot, and offal recorded. The ratios of carcass weights to live weights were expressed as percentages.

Chemical properties of soil, plant and snail samples were undertaken as outlined in previous study of Ebenso and Ologhobo (2009 a).

All data collected from each treatment for all parameters considered were subjected to ANOVA using SAS (1999). The means were separated using Duncan Multiple Range Test.

Results and Discussion

Elevated soil Pb pollution was associated with increasing values of clay content (Table 1). This observation is supported by reports of Chapman *et al.*, (2003). Soil Pb at the sites in this study, may have been in ionic forms in wet soil conditions (experimental period was during rainy season). Ge *et al.*, (2000) concluded that, soluble forms of metals in soil solution are only present at low concentrations; hence metal bioavailability in soil is low.

With uptake of Pb by *R. sativus* (Table 2) from polluted sites (Table 1), Clark *et al.*, (2000) would classify *R. sativus* in the present study as an "indicator" due to its proportional uptake of Pb. Further, these authors reported that bioindicator can act as early warning systems of pollution whose effects are possibly irreversible. Therefore, plant is able to access the non-labile soil Pb pool, which is usually thought to be low bioavailable according to Ge *et al.*, (2000).

The carcass analyses of sentinel juvenile *A. achatina* at SBL sites are shown in Table 3. All parameters measured differed significantly ($P < 0.05$) among the sites. Only offal/live weight with 25.57% at control was lowest compared with values at polluted sites. Other parameters

Table 1 Physico-chemical properties of soil at contaminated sites

PARAMETER	CONTROL	STORAGE DUMP	DRIED EFFLUENT	WASTE DUMP	SEM
Sand (%)	85.50 b	79.41 d	84.17 c	88.59 a	0.20
Silt (%)	6.19 c	8.29 a	6.81 b	6.39 c	1.10
Clay (%)	8.27 c	9.21 b	14.29 a	14.59 a	0.09
Bulk Density (g/cm ³)	1.25 c	1.68 b	1.59 b	2.20 a	0.07
pH (H ₂ O)	6.29 a	5.38 b	5.21 b	4.42 c	0.09
Organic Carbon (%)	3.45 a	1.84 b	1.49 c	1.39 d	0.02
Total Nitrogen (%)	0.29 a	0.17 b	0.13 b	0.06 c	0.02
Av. Phosphorus (µg/g)	172.65 a	102.38 c	122.26 b	120.45 b	0.01
Ex. Calcium (cmol/kg)	0.83 a	0.82 a	0.74 b	0.55 c	0.03
CEC (cmol/kg)	3.32 c	4.41 b	5.33 a	5.37 a	0.07
Base Saturation (%)	68.01 a	56.61 b	55.72 c	38.45 d	0.23
Mg (µg/g)	1.03 d	1.21 c	2.45 b	3.57 a	0.11
Fe (µg/g)	102.43 d	128.35 c	141.49 b	174.53 a	0.10
Cd (µg/g)	0.03 d	0.05 c	0.08 b	1.10 a	0.004
Ni (µg/g)	0.08 b	0.06 b	0.09 b	1.20 a	0.01
Cu (µg/g)	0.62 d	0.71 c	1.10 b	1.31 a	0.01
Zn (µg/g)	1.24 d	1.39 c	1.56 b	1.91 a	0.01
Pb (µg/g)	0.56 d	20.37 c	200.42 b	1200.30 a	0.04

abc... means followed by different letters are significantly different $\alpha = 0.05$

Source: Ebenso and Ologhobo (2009a)

Table 2 Chemical properties of plant *Raphanus sativus* at contaminated sites

PARAMETER	CONTROL	STORAGE DUMP	DRIED EFFLUENT	WASTE DUMP	SEM
Dry Matter (%)	83.67 d	84.15 c	86.15 b	88.32 a	0.05
Crude Protein (%)	10.36 a	10.34 a	10.23 a	9.35 b	0.04
Crude Fiber (%)	14.43 d	15.60 c	17.14 b	18.37 a	0.10
Ether Extracts (%)	6.67 b	6.25 c	6.87 b	7.51 a	0.04
Ash (%)	3.18 d	4.32 c	6.27 b	9.38 a	0.04
NFE (%)	52.14 a	48.61 b	44.57 c	43.24 d	0.08
Calcium (%)	0.64 a	0.55 b	0.48 c	0.39 d	0.02
Pb (µg/g)	0.45 d	7.07 c	29.87 b	68.35 a	0.04

abc... means followed by different letters are significantly different $\alpha = 0.05$

Source: Ebenso and Ologhobo (2009a)

showed depressed values at increasing Pb pollution. Decreasing weights were recorded at elevated levels of Pb pollution in Table 3. According to Notten *et al.*, (2006) studying *Capaea nemoralis* agreed that elevated Pb concentration affect general snail fitness, hence depressed weight. Snails at control site were heavier than snails at polluted sites (Ebenso and Ologhobo 2008a) which are comparable to present study.

Carcass results in Table 3 are similar to values of *Archachatina marginata* as reported by Omole *et al.*, (2000). The range of 44.63 to 46.73% dressing is higher than values by Oredein *et al.*, (1999) who observed 38.10%. In addition, the results of the present study are contrary to report of Omole *et al.*, (2000). These authors observed that snail with high shell to live weight % indicates low dressing %, but compares with report of Odunaiya and Akinyemi (2008) that shell to live weight % is inversely proportional to the dressing %.

The Pb accumulated in snail foot tissue (Table 3) is above the maximum permissible level (MPL) of 1.5 µg/g in bivalval molluscs, oyster shells and clams as defined in European Commission Regulation (EC 2004).

According to Adebamowo *et al.*, (2006) using questionnaire survey of communities exposed to Pb, their study showed that there was poor knowledge about preventive efforts, particularly the role of diet and there was not evidence of any specific Pb awareness programme in the affected communities. Tong *et al.*, (2000) reported that minimizing human exposure to Pb can be achieved by improving identification of population at high risks of exposure on the basis of monitoring systems and, awareness through public health education.

Conclusion

It can be suggested from the results of this study that snails picked around the abandoned battery factory sites and consumed indicates *A. achatina* as a pollution warning signal of toxic lead

Table 3 *Achatina achatina* from battery factory sites

PARAMETER	CONTROL	STORAGE DUMP	DRIED EFFLUENT	WASTE DUMP	SEM
CARCASS ANALYSIS					
Live weight g/s	83.54 a	80.29 b	79.85 b	72.49 c	0.47
Foot weight g	37.23 a	36.46 b	35.63 c	32.46 d	0.01
Offal weight g	21.12 a	20.95 b	20.57 b	20.16 c	0.01
Shell weight g	24.34 a	22.93 b	21.34 c	19.47 d	0.01
Dressing %	46.37 a	45.45 b	45.06 c	44.63 d	0.01
Shell weight/ Live weight %	28.04 a	28.52 a	26.72 b	26.99 b	0.01
Offal weight/ Live weight %	24.57 d	26.07 c	25.76 b	27.98 a	0.01
LEAD ACCUMULATION IN SNAIL MEAT					
Pb µg/g	1.76 d	12.20 c	91.38 b	468.50 a	0.13

abcd. means followed by different letters are significantly different $\alpha = 0.05$

exposure, which is of public health concern, especially as Pb values in Table 2 are above EC's MPL. This study stimulates the development of multi-disciplinary research integrating ecotoxicological and epidemiological studies as it concerns human food safety dangers of Pb and pollutants mediated disease incidences and advocates for increased proactive awareness.

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