PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
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Pakistan Journal of Nutrition 7 (3): 418-420, 2008
ISSN 1680-5194

Lead, Zinc and Cadmium in Root Crops from Mineralized Galena-Sphalerite Mining Areas and Environment

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Abstract: Concentrations of the metals leads, cadmium and zinc were estimated in root crops: Cassava (*Manihot esculenta crantz*), yam (*Dioscorea rotundata*), potato (*Ipomea batatas*) and cocoyam (*Colocosia esculenta*) harvested in some mineralized areas of galena and sphalerite deposits using atomic absorption spectrophotometer. The Investigation showed that the sample analyzed contained lead concentration ranging from 0.030-0.190 mg/kg. Cadmium levels were in the concentration range of 0.136-2.633 mg/kg in all crops, while zinc concentration ranged from 0.340-3.890 mg/kg. There was no significance difference observed between the levels of contamination of the different crops, while high variation in concentration was observed in the level of predominance of heavy metals in different location. These results reflected higher concentration of metals in selected crops from these zone.

Key words: Lead, cadmium, zinc, root crops, mineralized area, galena and sphalerite

Introduction

Uncontrolled mining activities and illegal mining in developing countries has left a lot of environmental hazards and enormous amount of wastes and different types of pollutants are generated.

Adverse environmental and ecological changes as a result of anthropogenic input has become more tangible and menacing (Tomov and Kouzmova, 2005). There exist concerns and question on the state of the soil and quality of food crops, fruits and vegetables cultivated and grown in areas where heavy mining and exploration are carried out.

Some heavy metals such as lead, zinc and cadmium in crops are studied because they are related to environmental problems and also have accumulative properties. Traces of these metals can be found naturally in the environment but industrial activities increase their level so lead to pollution (Adediran *et al.*, 1990). In mineralized areas such as Ishiagu, Nigeria, one of the major sources of lead and associated cadmium to the environment arise from lead and zinc mining activities by industrial and local miners.

Heavy metals such as lead (Pb) is mainly absorbed through leaves, roots and aerial deposition (Flam, 1978). Cadmium accumulation by plants are greatly influenced by the supply of zinc to the plant (Abbdel-Sabour and Mortvedt, 1998; Honma and Hirata, 1978; Haghiri, 1974). However high level of heavy metals in the soil could indicate similar concentration in plant by accumulation at concentration causing serious risk to human health when consumed (Vousta *et al.,* 1996). Moreso, constant exposure to very low levels of elements such as lead (Pb), cadmium (Cd) and mercury (Hg) have been shown to have cumulative effects since there is no homeostatic mechanism which can operate to regulate their toxicity (Carter and Fernando, 1979; Yeast and Brewers, 1983). Recent work has shown the study of heavy metals (Pb, Cd, As and Hg) in edible grains grown and marketed (Osu and Odoemelam, 2007), trace metal (Pd, Fe, Cu and Zn) in crops harvested in some oil prospecting locations (Hart *et al.*, 2005), bio-accumulation of heavy metals in Periwinkle and Oyster (Fubara and Christian, 2006) and the uptake of Cu, Pd, Cd, As and DDT by vegetables grown in urban environments has been reported.

This study therefore, is designed to investigate the concentration of heavy metals lead(Pb), zinc(Zn) and cadmium (Cd) in root crops namely cassava (*Manihot esculenta crantz*), yam (*Dioscorea rotundata*), potato (*Ipomea batatas*) and cocoyam (*Colocosia esculenta*) cultivated and harvested in the galena - sphalerite rich zone of Ishiagu, Nigeria. This will also ascertain the effect of mining activities on these areas in relation to agricultural produce.

Materials and Methods

Study locations: The study areas were, Amita, Amagu, Amaeze, Amaonye, Amaeke and Ihetutu, all in Ishiagu community in Ebonyi State, Nigeria. These sites where chosen because they are rich in lead and zinc minerals and mining activities are carried out in these area. The crops from Federal University of Technology, Owerri, farm was used as the control site for the experiment.

Sample Collection: Food crops used for the study were root tubers; cassava, yam, potato and cocoyam. These crops were harvested at peak of the harvest. By arrangement with the respective farm owners, the

Table 1: Mean values of lead, zinc and cadmium in crops in relation to environment.

Crops	Metal in mg/Kg	Replications Ihetutu	Amita	Amaeke	Amagu	Amaonye	Amaeze
CASSAVA	Lead	0.140	0.030	0.080	0.000	0.080	0.080
	Zinc	1.020	0.340	1.520	1.760	1.890	0.700
	Cadmium	0.993	0.666	1.035	1.285	1.070	0.000
YAM	Lead	0.080	0.000	0.020	0.000	0.100	0.040
	Zinc	1.240	1.700	2.620	1.050	1.460	3.890
	Cadmium	0.136	0.917	1.265	0.017	0.000	0.019
COCOYAM	Lead	0.030	0.000	0.160	0.000	0.000	0.190
	Zinc	0.590	2.950	1.050	2.430	1.890	1.080
	Cadmium	0.258	2.633	0.751	0.804	1.470	2.032
POTATO	Lead	0.050	0.020	0.040	0.030	0.140	0.090
	Zinc	0.820	2.140	1.230	2.840	1.860	2.620
	Cadmium	0.817	0.907	0.000	0.455	1.496	1.910

Table 2: Variance among metals, locations and crops.

	Locations	Crops	Metals	Crop X Metal
$F_{CAL\ 0.05}$	$0.71^{N.S}$	$1.93^{N.S}$	17.120**	$1.330^{N.S}$
	3.03 **	$0.059^{N.S}$	26.970**	$0.970^{N.S}$
$LSD_{0.05}$	N.S	N.S	0.550	0.760
	N.S	N.S	0.492	0.692

various crops were randomly harvested from two or three farms within each location. There was no history of fertilizer and other agro-chemicals used in the farms studied. Samples of each crops collection were wrapped in black calico bags properly labeled and taken to the laboratory for analysis. Each sample removed from calico bags were washed in distilled water to remove soil and dirt, then placed in labeled envelops and were oven dried at 105^{o}C for 2hrs. The dried samples were then milled into powder using Author Thomas Milling Machine and stored in an airtight container until required for analysis.

Determination of metals: 1g of the ground samples was homogenized and was digested with 20ml of 1:1 (v/v) concentrated HNO_3 and HCl (Analar grade) in 100ml beaker. The flask was swirled gently and heated in an electrothemal heater until evolution of white fumes marking the end of the digestion process. The digest was then cooled and filtered through whatman No.1 filter paper into 50ml volumetric flask and diluted to 50ml mark with distilled water. The resulting solutions were subsequently analyzed for lead, zinc and cadmium concentration by an air-acetylene flame atomic absorption spectrophotometry (Apha-4-model) by the standard calibration techniques.

All reagents used in the analysis were of analytical grade. Analysis were done in duplicates. In all determinations, blanks were included.

Results and Discussion

The mean level of lead (Pb), cadmium (Cd) and zinc (Zn) concentration obtained was subjected to statistical analysis. Using analysis of variance (ANOVA). The least significance difference (LSD) was applied to show the mean difference at 5% level of significance.

The mean levels of lead, zinc and cadmium in crops; cassava, yam, cocoyam and potato and with respect to the six locations namely; Ihetutu, Amita, Ameke, Amagu, Amaonye and Amaeze in Ishiagu communities are shown in Table 1. The relatively high concentration of these metals occurring in crops from these areas strongly indicate the presence of heavy metal pollution due to the deposits of lead-zinc minerals and the mining activities in these areas. Previous work on trace metals levels of soils and crop around Ishiagu rock mining site had also shown lead concentration 6mg to 32mg/100g (Ehosum, 2002). The relatively higher level of lead in crops from Ihetutu, Amaeze and Amaeke with values 0.140mg/Kg, 0.0190mg/Kg and 0.160mg/Kg, all were due to the nearness of these villages to the mining sites (1-2 Km) compared to those harvested from villages far away from the mining site. Highest value of zinc concentration was obtained in yam from Amaeze with the values 3.890mg/Kg with associated high concentration of cadmium. This is explained by the reports of Abbdel-Sabour and Mortvedt, 1998.

Table 2 shows the analysis of variance of the crops with respect to the concentration level of heavy metals in different locations. No significant difference was observed between the levels of contamination of the different tubers in question within each environment. No significant difference was observed between the level at which cassava was contaminated with heavy metals and the level at which yam was contaminated. High variation in concentration was observed in the level of predominance of metal in different locations.

Table 2 also shows the least significance difference test on crops with respect to the contamination and levels of metals in different locations. The results obtained were in consonance with that obtained in the analysis of variance except for the interaction of crops with the metals which showed a significant difference between crop contamination with different metals.

Generally, there was high levels of cadmium in crops from these mineral rich lead-zinc zones. This result could be due to the rate with which cadmium is taken up from the soil through the roots and more so, cadmium occurs in association with lead and zinc.

It has been reported that in industrial societies, up to 0.2-0.4mg lead may be ingested in the food daily and 90% of this excreted in the faces. From Table 1, the values of cadmium are above normal range of metal concentration daily intake, which is 0.018mg/kg (Okoronkwo *et al.,* 2005). The values were relatively high compared to the crops from the university farm which has the following values for lead, cadmium and zinc in cassava, yam, cocoyam and potato as 0.000, 0.002, 0.001 and 0.008 all in mg/Kg respectively.

Conclusion: This study has revealed the various concentrations of metal lead (Pb), cadmium (Cd) and zinc (Zn), in cassava, yam, cocoyam and potato tubers harvested at areas of high mining activities in Ishiagu community. These findings are indicative of pollution due to mining activities. The values of these metals are within acceptable range. These crops are stable foods in Ishiagu, consequently people depending on these crops as source of stable food are indirectly ingesting heavy metals into their body system. In view of these findings, there is need to monitor more closely the environment under review and to ensure appropriate mining technology in order to reduce the availability of these metals (Pb, Zn and Cd) in agricultural crops and also preserve the health of communities within the vicinity of the mineralized area, particularly as the effects of heavy metals are bio-accumulative.

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