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Heavy Metals Concentration in Cassava Tubers and Leaves froma Galena Mining Area inIshiagu, IVO L.G.A ofEbonyi State Nigeria

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Abstract:*Cassava leaf and tuber samples were collected from four different farmlands around galena mining site in Ishiagu, Ebonyi state, Nigeria. These samples were monitored for heavy metals using atomic absorption spectrometer. Metals studied were Pb, Mn, Ni, Fe, Cr, Cd, Zn, and Cu. The concentration range of these metals in cassava tubers were found to be 10-27mg/kg Cu, 86-93mg/kg Zn, 0.1-0.43mg/kg Cd, 0.012-0.036mg/kg Cr, 35-70mg/kg Ni, 98-130mg/kg Mn, 11.50-16mg/kg Fe, and 0.6-1.2mg/kg Pb. Cd, Ni and Pb concentrations were found to be above WHO standard of 0.20mg/kg, 67.90mg/kg and 0.30mg/kg respectively. Maximum concentrations of the metals in leaf samples were found to be 15mg/kg, 97mg/kg, 0.40mg/kg and 0.086mg/kg for Cu, Zn, Cd and Cr respectively. Cd, Cr and Pb concentrations in cassava leaf samples were found to be above WHO standard of 0.20mg/kg,0,05mg/kg and 0.30mg/kg respectively. The variation in parameters determined for the samples (cassava leaf and crop samples) were all found to be statistically significant ($p<0.05$). The results of the analysis showed that there were significant accumulations of these metals studied in cassava leaves and tubers.*

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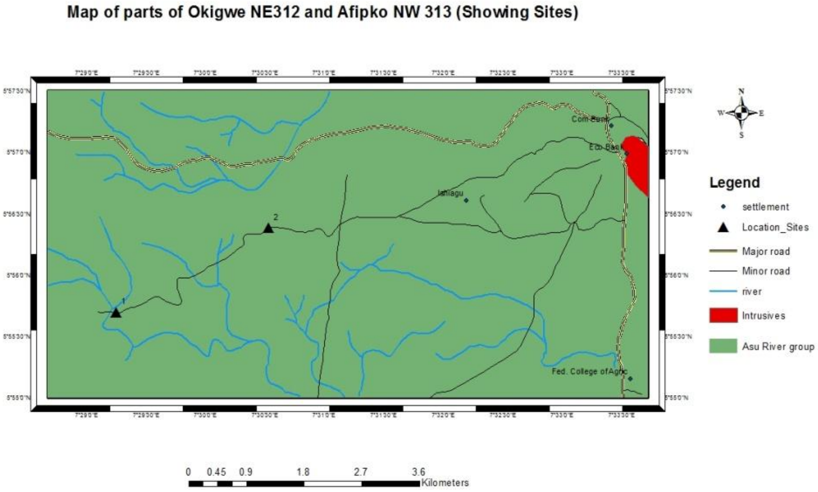
I. Introduction

Nigeria has varieties of mineral resources both taped and untapped, mining has been listed as one of the ways of generating revenue for the government. The impact of mining activities in an area can persist over a long period of time, usually long after mining operations may have ceased[1]. The largest deposit of galena has been documented for Abakiliki in Ebonyi state [2]. Galena is the natural mineral form of Lead (II) Sulphide. Heavy metals refers to any metallic element that has a relatively high density and are toxic at low concentration[3]. Plant roots are the important site for uptake of chemicals from soil[4]. At varying levels, dependent on specie, plants can extract or remediate toxins from soil through their root systems[4]. Plants grown in Zn and Cu polluted soils store abundant portion of metals in roots[5]. The high level of heavy metal in the soil could indicate similar concentration in plant by accumulation at a concentration that causes serious risk to human health when consumed[6]. Heavy metals are dangerous[7], and are considered environmental pollutants because they are non-biodegradable and toxic in nature, their degree of toxicity varies from metal to metal and from organism to organism[8]. Heavy metal accumulation in plants, especially consumable vegetables is really of great concern as their concentration may exceed recommended safety levels thereby posing health hazards to man and environment. Some studies have related heavy metals to mining activities. A study on the environmental health impact of potentially harmful element discharges from mining operations in Nigeria, established that artisanal\ small scale mining of Lead sulfides in Anka and Zurak, Nigeria has led to pervasive contamination of the environment by potentially harmful elements[9] especially Pb, Cd, As and Hg. Elevated concentration of heavy metals were recorded in all vegetable samples collected from EnyigbaPb mine in Nigeria as recorded in the analysis done by Oti[10]. The distribution of Pb, Zn, Cu and Cd in agricultural soils in Ishiagu, Ebonyi state Nigeria, showed that Pb, Zn and Cd attained toxic limit of 100, 300 and 5 mg\kg respectively in the soil samples and mining of Pb-Zn ores in this community was agreed to be responsible for the mobilization of these metals into the soil[11].



II. Material And Methods

Cassava samples (tubers and leaves) were collected in triplicates and randomly from four different farmlands near galena mining sites (farm N, S, E and W). Control samples were taken from a cassava farm located at Nchatancha village in Enugu state. The samples were identified and packed into polyethylene bags. In the laboratory, they were washed to remove any surface deposits (dust and other particles that may act as contaminants).

1g of each ground sample (cassava tubers and leaves) was put into separate beakers, digested with 15ml tri acid mixture (conc HNO_3, conc $HClO_4$, and conc H_2SO_4 in the ratio of 5:1:1) at 80^{o}C in a water bath until a transparent solution appeared[12]. After cooling, the digested samples were filtered using whatman No1 filter paper. The filtrates were made up to 100mls mark in volumetric flasks with distilled water. Heavy metals were analyzed in the digested samples using atomic absorption spectrophotometer (Buck Scientific 210 VGP). Atomic absorption spectrophotometer analysis was done by selection of various units of the instrument; the lamp selection, wavelength selection, silt adjustment and flame adjustment. All reagents used were of analytical grade, analysis was done in triplicates. In all determinations, blanks were included.

Statistical analysis

The variations of the level of heavy metals in cassava tubers and leaves were analyzed using the analysis of variance (ANOVA) in excel, at 0.05 significance levels.

III. Result

The concentrations of heavy metals in cassava tubers from farmlands near galena mining site are shown in Table1. The standard deviations of the values were also shown. Figure 1 shows the level of increases of various heavy metals at different locations from the control. Cassava tubers from the E has the highest concentration of copper while those from N, S and W has the same values of 10.00 mg/kg. The highest concentration of zinc was found in cassava tubers from the E while those from the N have the least values. Nickel and iron concentration ranged from 35-70 mg/kg and 18-76mg/kg respectively in the tubers while manganese concentration in tubers was found to be between 98-130 mg/kg. Values of lead were found to be high in cassava tubers from all the farmlands with the highest value of 1.2 mg/kg for N.

Table 1: Heavy metal content of cassava tubers (mg/kg)

Location		Cu	Zn	Cd	Cr	Fe	Ni	Mn	Pb
S	Mean	10.00	90.00	0.20	0.03	11.50	36.00	130.00	0.60
	SD±	2.01	2.00	0.03	0.01	1.50	2.65	1.73	0.02
W	mean	10.00	87.00	0.43	0.04	16.00	70.00	130.00	0.60
	SD±	3.00	2.65	0.13	0.00	0.96	2.65	1.00	0.02
E	mean	27.00	93.00	0.10	0.02	15.40	40.00	130.00	0.90
	SD±	5.77	1.00	0.06	0.06	4.05	2.00	1.00	0.07
N	mean	10.00	86.00	0.20	0.01	12.00	35.00	98.00	1.20
	SD±	1.14	1.50	0.06	0.00	6.39	2.00	1.50	0.08
Average		14.25	89.00	0.23	0.05	13.73	45.25	122.00	0.83

Control	mean	2.50	22.00	0.09	0.01	6.30	15.00	46.00	0.09
	SD±	0.26	2.65	0.01	0.00	1.31	1.73	1.77	0.07

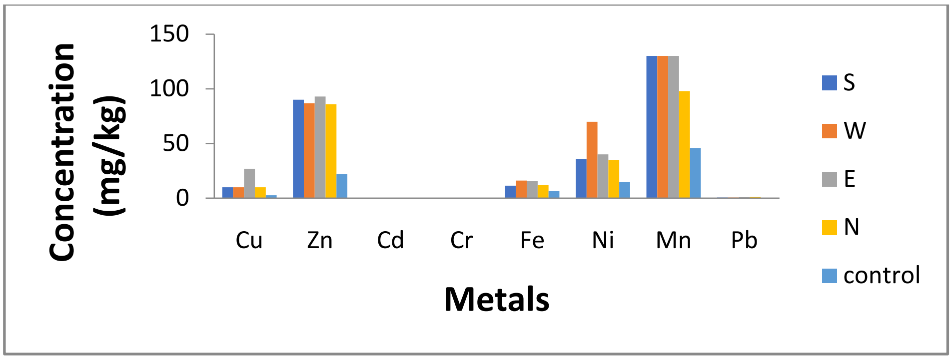


Fig 1: The concentration levels of heavy metals in cassava tubers

The concentration of heavy metals in cassava leaves across different locations of the galena mining site is shown in Table 2: The increase in the level of heavy metals from the control for cassava leaves is shown in Figure 2. In S, N and W cadmium levels in leaves were found to be high, with range value of 0.10mg/kg to 0.40 mg/kg. Concentration of zinc was more in cassava leaves from E and least in those from W. Lead concentration was also more in samples from E and least in those from S. Range concentrations of nickel and manganese were found to be 15mg/kg-30mg/kg and 31mg/kg-91mg/kg respectively. Iron concentration was observed to be between 12.00mg\kg and 20.10mg\kg while that of chromium was between 0.01mg/kg-0.09mg/kg. In S, N and W cadmium levels in leaves were found to be high, with range of 0.10mg/kg to 0.40 mg/kg. Concentration of zinc was more in cassava leaves from E and least in those from W. Lead concentration was also more in samples from east and least in those from south. Range concentrations of nickel and manganese were found to be 15mg/kg-30mg/kg and 31mg/kg-91mg/kg respectively. Iron concentration was observed to be between 12.00mg\kg and 20.10mg\kg while that of chromium was between 0.01mg/kg-0.09mg/kg.

Table 2: Heavy metal content of Cassava leaves (mg/kg)

Location		Cu	Zn	Cd	Cr	Fe	Ni	Mn	Pb
S	Mean	8.00	40.00	0.20	0.09	12.00	20.00	91.00	0.21
	SD±	0.66	2.65	0.16	0.04	2.23	0.40	6.56	0.08
W	mean	9.00	34.00	0.40	0.02	20.01	30.00	79.00	0.29
	SD±	0.98	1.00	0.07	0.05	4.10	1.35	5.29	0.13
E	mean	11.00	97.00	0.10	0.06	16.00	16.00	87.00	0.51
	SD±	0.82	2.00	0.13	0.01	7.14	0.96	5.57	0.14
N	mean	15.00	39.00	0.30	0.01	17.00	15.00	31.00	0.46
	SD±	1.74	2.00	0.02	0.00	4.60	1.95	1.05	0.05
Average		10.75	52.50	0.25	0.04	16.25	20.25	72.00	0.37
Control	mean	3.00	10.00	0.09	0.01	10.00	7.00	23.00	0.01
	SD±	0.35	1.00	0.14	0.04	0.26	0.17	2.65	0.04

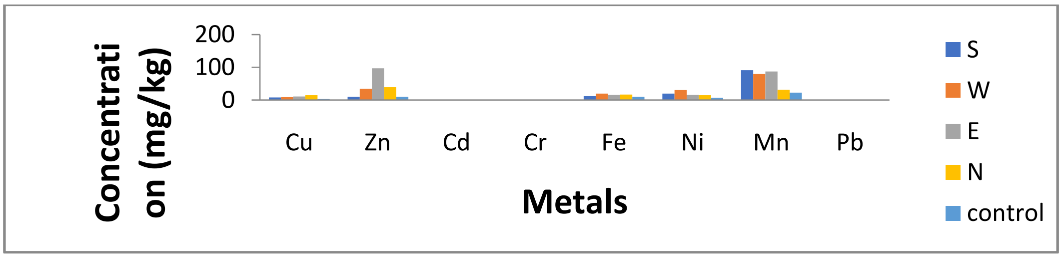


Fig 2: The concentration levels of heavy metals in cassava leaves

IV. Discussion

The values of cadmium in cassava tubers were all on the high level, except for those tubers from farm E. General high level of cadmium in these cassava samples from different farmlands could be due to the rate with which cadmium is taken up from polluted soil through roots, since this metal occurs in association with Pb-Zn[13]. Fig 1 showed that lead had a slight increase from the control while increase in iron was even at different locations with farm W and E having the highest values. The chart also reveals that increase in cadmium and chromium was less than others. The increase in zinc, manganese and nickel from control were also high and it can be seen that the level of zinc was evenly distributed across the various locations. The variation in concentration of these heavy metals in cassava tubers from different farm locations could have been influenced by soil (soil type and soil pH which has been made acidic by pollution). Acidity of a soil increases the rate in which nutrients and also metals are taken up from soil to plants. Topography of the area might also be attributed to the high concentration of lead and zinc in most of the tubers especially those samples obtained from N and E locations. The copper concentration in cassava leaves from N has the highest concentration while those from S were the lowest. Copper was found to be more in tubers than in leaves as shown in Tables 1 and 2. The levels of heavy metals in cassava leaves across various farm locations at the mining site are much higher than the control values showing that mining increased the levels of heavy metals in the cassava leaves as seen in Fig 2. The level of zinc in farm E is very high compared to the level at other farm locations. The mining activities highly increased the level of manganese and zinc at all farm locations. High increase in concentration of heavy metals from control was also seen in nickel, iron and copper. High values of theses metals in cassava leaves could be due to their high concentration in the cassava tubers. High values of lead were recorded for both cassava leaves and tubers, they were all above the WHO permissible limits of 0.30mg\kg for lead. This agrees with work of Ogbonna[14]. The high concentration of lead in both leaves and tubers strongly indicated the presence of heavy metal pollution due to the deposits of Pb-Zn minerals and the mining activities in these areas. Lead pollution in these farmlands was attributed to releases from the mines dumps and asu river shale[11.] Previous work on heavy metals content in soils near Pb-Zn mines district done by Nnabo had shown high concentration of heavy metals in these soils also[15]. There is a strong relationship between metals concentration in soils and vegetables/plants[16]. Mining of Pb-Zn ores is responsible for mobilization of heavy metals into the soil, which is at the same time absorbed by plants. It can be deduced that galena mining increases the level of the heavy metals in these cassava tubers and leaves.

V. Conclusion

This study revealed the various concentrations of some metals: Pb, Cd, Zn, Cu, Fe, Mn, Ni, and Cr in cassava leaves and tubers collected from different farmlands near galena mining site in Ishiagu, Ebonyi state, Nigeria. Cassava tubers and leaves from a non-mining community were also used as control. It was seen from the results obtained, that the cassava tubers and leaves from four different farmlands were polluted as a result of galena mining in Ishiagu, this was shown by the concentration values of these heavy metals and their levels of percentage increase from the control samples. The major pollutants for cassava tubers and leaves were Pb, Zn, Cd and Ni. The concentrations of these heavy metals were all statistically significant at 0.05 significantvaluethere is need to monitor more closely the mining environment under study, to ensure the use of appropriate mining technology and proper mining waste disposal in order to reduce the availability of these heavy metals in consumable crops consumed by inhabitants of these mining communities thereby preserving the health of these inhabitants.

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