Research Journal of Applied Sciences 1 (1-4): 16-18, 2006

Characterization of Heavy Metal Pollutant Around Cassava Processing Factory Using Atomic Absorption Spectrophotometer

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Abstract: The physico-chemical properties of soils and trace metal contents of plants around ten sites of cassava processing factories in Akure, Nigeria were determined using standard methods of analyses. The results revealed that there were no significant differences ($p = 0.05$) in the soil compositions between the control and the test locations. The soils in the vicinities were sandy in texture, slightly acidic and have low organic matter. Concentrations of Fe and Zn were relatively high (>200 mg kg^{-1}) in the soil samples. High transfer factors were obtained for the vegetables. There were high variations in metals of plants in test and control areas. This was depicted with coefficient of variations (%) between 10.10 and 42.04. Trace heavy metals concentrations of the test samples exceeded those of the control area.

Key words: Cassava processing, factories, trace heavy metals, soils, plants

INTRODUCTION

Trace heavy metals distribution between the soil and the vegetation is a key issue in assessing the environmental effect of metals in the environment. These metals contamination is of concern due to their effect as carcinogen. Understanding the distribution of trace heavy metals in soils is important for establishing baseline concentrations from which anthropogenic effects can be measured.

Akure is one of the urban cities in Nigeria. This urbanization trend continues to increase. The inhabitants engage in farming among other activities. Cassava processing factories are sited in different areas. This human activity is dated back to the early days. In these areas, agricultural crops are planted, harvested and consumed. In Nigeria, several workers have investigated trace metals in soil and vegetation around industries described by Oluwole *et al.*[1]; Oyedele *et al.*[2], Adeyeye and Ayejuyo,[3]; Asubiojo *et al.*[4], but no report from cassava processing vicinity. The aim of this study was to determine the distribution of soil and plant trace metals from this vicinity.

Experimental: Ten sites on the cassava processing vicinity were selected, vegetables and soils were collected from the centre of each site in March 2005. The control sites were 750 m away from the test sites. The vegetables were cleaned and then washed with tap water, drained and dried in an oven (100°C) for 24 h, ground, sieved (2 mm mesh) and stored prior to analysis. A 5 cm core of soil sample close to where the vegetables were planted was collected with soil auger, ground with mortal and pastle, sieved (100 mesh) and stored prior to analysis.

Two grams of each plant was wet ashed using 20 cm^3 of 1:1 HNO_3 / $HCLO_4$ mixture the cool clear soil was made up to 50 cm^3 with distilled water. One gram of the soil sample was ashed with 20 cm^3 of 1:1 HCL/HNO_3 mixture and heated to dryness. The residue was extracted using 2M HCL and made up to 50 cm^3 with distilled water. An SP 1900 Pye Unicam atomic absorption spectrophotometer was used for the determination of the heavy metals.

Results were statistically analyzed using SPSS for window 10.

RESULTS AND DISCUSSION

Table 1 contains the soil composition. There were no significance differences ($p = 0.05$) between the control and test locations. The soils in the sampled areas were sandy in texture, slightly acidic and have a low organic matter.

The mean distributions of the element in control and test areas are shown in Table 2. The distribution diagram of each metal was prepared to evaluate the variability of the metal contents (Fig. 1 and 2) in both sets of samples. The concentrations of Fe and Zn were relatively

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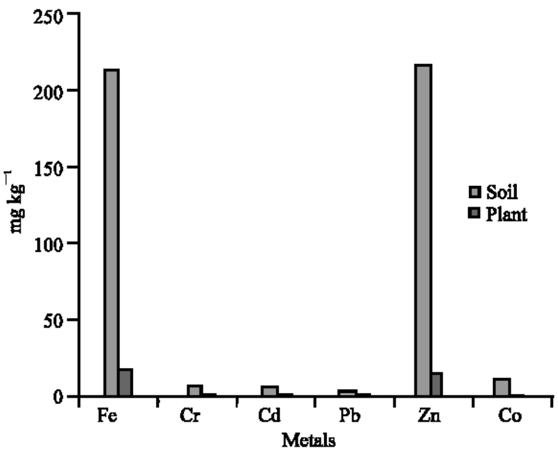

Fig. 1: Variation of metals in samples around cassava processing factory (Test)

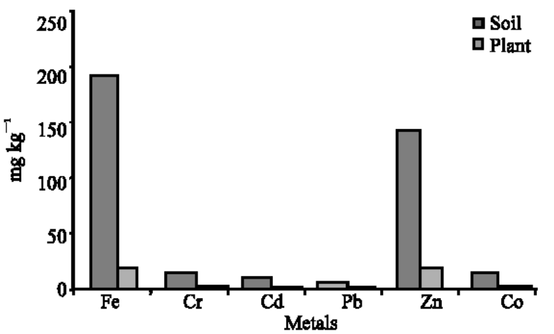

Fig. 2: Variation of metals in samples around cassava processing factory (Control)

Table 1: The soil chemical composition of soil samples

Soil properties	Test location	Control location
pH	5.3	5.1
Sand (%)	70	71
Salt (%)	19	20
Clay (%)	11	19
Textural grade	1.54	1.24
Organic matter (%)	0.49	0.44
Exchangeable bases		
Ca^{+} mmol kg^{-1}	0.10	0.09
N^{+} mmol kg^{-1}	0.18	0.12
K^{+}mmol kg^{-1}	0.10	0.08
Mg^{2+} mmol kg^{-1}	0.21	0.12
Exchangeable acidity		
H^{+} mmol kg^{-1}	3.72	2.72
Al^{3+}mmol kg^{-1}	0.10	0.10
Available P (mg kg^{-1})	6.21	5.24

Table 2: Mean metal content around the cassava processing factories

	Test		Control				
Parameter	Soil	Plant	Soil	Plant	Mean	SD	CV (%)
Fe	220.0	20.35	192.5	17.93	112	108.6	96.4
Cr	10.0	1.0	8.3	1.30	5.15	4.67	90.7
Cd	9.0	0.76	6.0	0.90	4.17	4.04	97.0
Pb	6.0	0.80	4.0	0.60	2.85	2.62	91.7
Zn	223.0	19.90	140.0	16.40	99.83	100.22	100.4
Co	15.0	0.83	13.0	1.00	7.46	7.60	101.9

Table 3: Factor of plants from the vicinity

Metals	Test	Control	Mean	SD	CV (%)
Fe	0.09	0.09	0.09	0.0	0.00
Cr	0.10	0.16	0.13	0.04	32.64
Cd	0.08	0.15	0.12	0.05	42.04
Pb	0.13	0.15	0.14	0.01	10.10
Zn	0.09	0.12	0.11	0.02	20.20
Co	0.06	0.08	0.07	0.01	20.20

high (>200 mg kg^{-1}), while levels of the other elements were generally low (<6.5 mg kg^{-1}). The mean concentration of Pb in the soils from test areas was 6 mg kg^{-1} that of control was 4 mg kg^{-1}. This indicated that the test soils could be polluted. The total Pb concentration of soil ranged between 172-220 mg kg^{-1} while that of vegetables ranged between 0.5 and 0.8 mg kg^{-1}. From the mean results it could be deduced that apart from the deposition of participation dust on foliage of vegetables, cassava effluents could be the cause for the difference obtained in the results. Similar observation had earlier been reported for soils and vegetation from neighborhood of cement, lead and tin mining and livestock by Asubiojo *et al.*[1]; Oluwole *et al*,[2]; Oyedele[4]; Abulude[5].

High transfer factor values were obtained for the vegetables (Table 3). Statistical analyses showed that there were large variations in the trace elements compositions of both the control and test samples. Trace metals concentrations and distributions in soils and vegetables were generally influenced by contamination of natural and anthropogenic activities.

CONCLUSION

Trace heavy metal concentrations of the test sample (vicinity of cassava processing factory in soils and plants) exceeded those of the control area. This study is the first to provide information on trace heavy metal distribution in soils and plants within these areas. The data would be useful for assessing trace heavy metals contamination and determining the uses for remediation.

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