Concentrations of Hg, Pb, and Cd o*n Telfairia Occidentalis* Leaves grown under Sewage Sludge Dumpsites in Owerri Imo State

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ABSTRACT

Telfairia occidentalis planted in abandoned sewage sludge dumpsite were analyzed for Mercury (Hg), Lead (Pb) and Cadmium (Cd) levels. The dumpsite was partitioned into A, B and C. Ten (10) soil samples were collected from each partition at a depth of 0-30 cm and bucked for 3 composite replicates. Fallow lands of about 100 meters away from the dumps were also sampled for reference. The fallow land had no influence of dumpsite and it acts as control. Sixty (60) representative leaves samples were also randomly collected from the three partitions (A, B and C). The samples were air dried and routinely analyzed, and heavy metals were determined using Atomic Absorption Spectrophotometer (AAS). The result showed that sewage sludge deposit increased the heavy metals levels significantly when compare with control and permissible limits. The concentrations were (3.360 Hg, 73.63 Pb, and 5.10 Cd Mg/Kg-^{1}) when compared with control (0.056 Hg, 21.04 Pb, and 1.03 Cd Mg/Kg^{1}) respectively. The mean values for Mercury were well above permissible limits of 0.190 mg/kg-^{1} for soil and 1.012 mg/kg-^{1} for telfaira leaves. For Lead, the mean values of 73.63 mg/kg-^{1} in soil samples and 29.27 mg/kg-^{1} leaves concentration respectively were also above the permissible limits of 50.02 mg/kg-^{1} and 1.00 mg/kg-^{1} respectively. Cadmium permissive limit of 2.00 mg/kg-^{1} and 0.30 mg/kg-^{1} for soil and leaves respectively, were well below the soil sample (5.10 mg/kg-^{1}) concentration and 0.83 mg/kg-^{1} leaves concentrations respectively. Sewage Sludge also increased N, P, K, Ca, Mg, K and ECEC and this may have contributed to the continuous cultivation of Telfaira by farmers due to the fact that sewage sludge increase the nutrient content of soil by improves its physical and chemical properties as reported by researchers. Organic matter contents was increased by the sewage sludge deposit. Sewage sludge significantly increased the concentration of Hg, Cd and Pd above permissible limits in both soil and *occidentalis* leaves. This showed high uptake of heavy metals by *telfaira occidentalis*. These concentrations were high to cause health challenges. Lead been a bioaccumulative metal like mercury, will be extremely dangerous for repeated ingestion through the telfaira leaves. Cultivation and harvesting of *telfaira* occidentalis from the dumpsites should be discontinued immediately because, plants under these concentrations are toxic to man through food chain. If sewage sludge dumpsites are to be used for agricultural purposes, heavy metal concentrations must be determined, as well as other health challenging factors. The result was discussed in-line with heavy metals in questions and permissible limits.

Keywords- *dumpsites, heavy metals, pollution index, proximate analysis*

INTRODUCTION

The benefits of amending soils with sewage biosolids are well documented, primarily linked to the fact that sewage biosolids return nutrients and organic matter to the soil through their effects on soil physical and chemical properties (Bamka *et al*., 1999). McGrath and Jane (1989) reported that organic matter additions from sludge application may still be significant ten years after application. Consequently, these wastes enhances soil fertility and improves yield capacity (Anikwe and Nwobodo, 2002; Krogmann and Chiang, 2002). However, Harrison (1999) reported that many trace organic elements can be found in this organic waste. Stehouwer (1998) added that some of these compounds are toxic, carcinogenic or cause reproductive or developmental defects in mammals. And according to (Krogmann and Boyles, 1999). there maybe also, disease-causing organisms in these wastes.

Sewage is the by-product(s) of domestic and, or municipal waste-water. Sewage sludge is the solid of the by-product (Brandy and Weil, 1999). Heavy metals are metals that have high specific gravity or densities of 5.0 mg/m or greater. Heavy Metals in the soil includes Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Pb, and Zn. According to Krogmann (2002), not all sewage sludges contains high concentrations of heavy metals, but toxicity to both plants and mammals may occur upon repeated application of the biosolids. Some reports (Helmore and Ratta, 1995) showed that farmers are known to produce vegetables and other crops in old garbage dumps in small and large cities around the world where improper management of municipal waste and sewage sludge exists. Farmers in the study area planted cassava (*Manihot esculanta*) and Pumpkin *telfaira occidentalis* in some abandoned sewage sludge dump sites, and at the edges of some current sewage sludge dump sites.

Ademoroti (1996) and Jimoh (2001) stressed the need for documentations of adverse impact of heavy metals to humans because when heavy metals are absorbed by plants which may serve as food and medicine to man, and as forage to animals, they find their ways into the body system and pose serious health problems ranging from cancer to heart disease. The study was carried out to determine the concentrations of Mercury, Lead and Cadmium in *telfaira occindentalis* planted in abandoned sewage sludge dumpsite, and make recommendation based on findings.

MATERIALS AND METHOD

Study Area.

Sewage Sludge dump sites behind Nigeria Custom Service Training Ground along Owerri – Onitsha Road Imo State Nigeria was used in 2009. Owerri is located geographically at latitude 5.5720° N and longitude 7.0588° E. and falls within the tropical rainforest zone of Nigeria. The site consist of area under continuous dumping for four (4) years before abandoned. Some part of the site was covered by a degraded secondary low-land rainforest and some voluntary trees and water-leaf etc.

Sample collection

The dump site was partitioned into A, B and C. Soil samples were randomly collected with the aid of spade (Brown, 1987) from thirty (30) spots, and each 10 spots bucked for composite replicate, and three (3) composite replicates of top-soil (0 – 15 cm) was realized. Nyanagababo and Hamya (1986) emphasized that surface soils are better indicators for metallic burdens. Sixty (60) representative leaves from actively growing *telfaira occidentalis* were also collected randomly from the partitions A, B and C. Twenty 20 leaves from each partition were bucked for 3 composite leaf replicates. The plant samples were stored in a paper envelop and labeled while soil sample were stored in a polyethene bag.

Sample preparation and laboratory analysis

Sample Analyses

Both soil and plant samples were dried on clean and dry paper sheet followed by routine analysis. For soil. a 10g of soil sample was mixed with 20 ml DTPA (0.05 M – adjusted to pH 7.3 with TEA), then shaken for 30 – 45 minutes before filtering through Whatman No 1 filter.

The filtrate were analyzed for heavy metals (Pb, Cd and Hg) on Atomic Absorption Spectrophotometer (AAS). Physico-Chemical properties of the soil were determined routinely. For soil pH: This was determined in distilled (deionised) water (1:2.5 soil-water ratio) using glass electrode pH meter (Dewer model). Organic carbon was determined by the Walkley-Black wet oxidation method (Heanes, 1984). Exchangeable acidity was determined by the titration method (Westerman, 1990). CEC was determined by summation method etc. *Telfaira occidentalis* leaves were analyzed for nutrient concentrations, and heavy metals determined using AAS after wet digestion.

Data analysis

Simple descriptive statistical method were used. The mean of the data collected were compared with control and already established permissible limits.

RESULTS AND DISCUSSION

Effects of sewage sludge on heavy metal contents in soil and leaves

Telfaira Occidentalis heavy metal levels and the physico-chemical properties of the soil were displayed in Tables 1 and 2. The results showed high levels of heavy metals in both soil sample and telfaira leaves. The Physical and chemical properties of the soil showed that the soil textural class is loam, with slight acidic characteristics, but rich in organic matter. The macronutrients were also high, as well as the percentage Base Saturation.

Table 1. Heavy metal contents in soil and *Telfaira Occidentalis* leaves as influenced by sewage sludge

Table 2. Physicochemical properties of the studied locations

		pH	OM	TEA	TN	Ca	Mg	K	P	Na	CEC	BS
Sources	**Txt**	**pH**	**%**	**gkg^{-1}**	**gkg^{-1}**	**gkg^{-1}**	**Cmolkg^{-1}**	**Cmolkg^{-1}**	**mgkg^{-1}**	**Cmolkg^{-1}**	**Cmolkg^{-1}**	**%**
A	L	5.86	3.16	1.2	0.28	2.61	2.81	0.52	15.12	0.25	7.39	83.76
B	L	5.91	3.52	1.1	0.31	2.39	2.21	0.52	12.65	0.24	6.46	82.97
C	L	5.94	3.37	1.6	0.27	3.38	2.84	0.59	18.35	0.26	8.68	81.56
Mean		5.9	3.35	1.45	0.28	2.79	2.62	0.54	15.35	0.25	7.51	82.76

Sewage sludge deposit increased significantly the heavy metals studied when compared with control and permissible limits in the soil and the leaves. According to Krogmann (2002), high concentrations of heavy metals and toxicity to plants may occur upon repeated application. This was supported by (Alloway, 1995), who reported that some sewage sludge contains high concentrations of heavy metals and their repeated application can increase levels beyond

Sources	**Hg**		**Pb**		**Cd**	
	……..mg/kg^{-1}……					
	Soil	**Leaf**	**Soil**	**Leaf**	**Soil**	**Leaf**
A	4.271	2.136	78.37	30.06	5.22	0.83
B	2.542	2.189	81.62	35.02	4.39	0.97
C	3.259	2.074	60.91	22.73	5.70	0.71
Control	0.056		21.04		1.03	

permissible limits.

For environmental protection and for agricultural purposes, there are limits at which heavy metals do not exceed in the soil and edible plant parts to avoid bioavailability and accumulation in plant tissue (Bragato*et al*., 1998).

The fertility indices of the soil reflects a fertile soil. McGrath and Jane (1989) reported that organic matter additions from sludge application may still be significant ten years after application. In addition, Bamka *et al*. (1999) posited that biosolids return nutrients and organic matter to the soil through their effects on soil physical and chemical properties. To this end, farmers tend to increase yield using dump sites. However, according to Ademoroti (1996) and Jimoh (2001) these farmers do not know the concentrations of deadly metals like heavy metals and the adverse impact to humans health when ingested through food chain. The permissible limits for metal exposure, though slightly different from country to country indicated adherence especially with infant exposure. The mean values for Mercury in the soil and leave were 3.360 mg/kg^{-1} and 2.133 mg/kg^{-1} respectively. These were well above permissible limits of 0.190 mg/kg^{-1} for soil and 1.012 mg/kg^{-1} for telfaira leave concentrations. For Lead, the mean values of 73.63 mg/kg^{-1} in soil samples and 29.27 mg/kg^{-1} for leaves respectively were above the permissible limits of 50.02 mg/kg^{-1} and 1.00 mg/kg^{-1} respectively. Lead being a bioaccumulative metal like mercury, will be extremely dangerous for repeated ingestion of high levels. Cadmium permissive limit of 2.00 mg/kg^{-1} and 0.30 mg/kg^{-1} for soil and leave concentrations respectively, were well below the soil sample (5.10 mg/kg^{-1}) concentration and 0.83 mg/kg^{-1} leave concentrations respectively.

Mercury health effect impacts on cognitive thinking, memory, attention, language, and fine motor and visual spatial skills in children. For Foetus, infants, and children, impaired neurological development cause by methyl mercury. Impairment of the peripheral vision, lack of coordination of movements disturbances in sensations may also occur (Brady and Weil, 1999).

Environmental contamination with lead causes foe toxicity of serious congenital malfunctions in human stunted growth and abnormal infants (USEPA, 1997). Spontaneous abortions in woman, and brain damage may also occur (Mulchi*et al*., 1987**). Lead toxicity** causes memory problems, infertility, abdominal pain, breathing problems and lung cancer including heart and kidney disease, and bone embrittlement with numbness and tingling in hands and feet.

Cadmium exposure can cause damage to reproductive system, damage to bone, kidneys and lungs as well as cardiovascular problems (Mulchi*et al*., 1987**).**

CONCLUSION

While uptake of heavy metals and translocation differs from plant to plant, much concern must be emphasized when edible parts of the plant forms part of the accumulation and chemical reactions. Sewage sludge significantly increased the concentration of Hg, Cd and Pd above permissible limits in both soil and *occidentalis* leaves. This showed high uptake of heavy metals by *telfaira occidentalis*. Cultivation in this site should be discontinued and the *telfaira* leaves harvesting abandoned because plants under these conditions are toxic to man through food chain (Walker, 1989).

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