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Accumulation of lead, cadmium and chromium in some plants cultivated along the bank of river Ribila at Odo-nla area of Ikorodu, Lagos state, Nigeria

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Abstract: *Heavy metal in soil samples and in washed and unwashed samples of Telfaria occidentalis (ugwu) and Talinum triangulare (waterleaf) cultivated on the bank of river Ribila in Odo-nla village were determined. The soil was moderately polluted with cadmium when compared with Federal Environmental Protection Agency standards. The difference between the unwashed and washed plant samples revealed that metal pollutants exist as superficial contaminants on the foliage surface which is the edible portion and if the foliage portion is washed thoroughly it may be safe for dietary consumption. There is no doubt that continuous discharge of effluent and gaseous emissions from the industries located in this area and dumping of domestic wastes into the river may lead to higher concentrations of these heavy metals in the soil and in the tissue of the leafy vegetables cultivated on the river bank over time. This can eventually lead to pollution of the soil and the cultivated plants, which are ready source of food for the people and other organisms in the food chain.*

Key words: *Heavy metals, Cultivated plants, Soil, River-bank.*

Introduction

Quite a large amount of waste substances, effluents and energy are introduced into the environment through several sources (Andersen *et al.,* 1978; Kabata-Pendias and Pendias, 1992; Ademoroti, 1996; Turick *et al.,* 1996, Paivoke, 2002). When these substances make their way into the aquatic ecosystem, the activities of lifeforms in water bodies are hindered and furthermore, they may also reduce the quality of water. Water from such polluted water bodies becomes unavailable for human use and dangerous to organisms that inhabit the water bodies and even those organisms outside this type of habitat.

In the last couple of years, quite a number of industries has located their production plants around Odo-nla village in Ikorodu area. These industries produce soap, textiles, iron and steel and various other products. River Ribila flows through the village and receives effluent discharges and gaseous emissions from the industries and domestic wastes from the community.

The bank of the river on both sides is cultivated throughout the year with different crops, particularly two types of leafy vegetables. These are *Talinum traingulare* and *Telfaria occidentalis* which the villagers depend on as source of food and money. It therefore became imperative to carry out a study to know the levels of certain heavy metals which are lethal to organisms including humans when present in high concentrations. Lead, cadmium and chromium were investigated since they are constituents of effluents, gaseous emissions and domestic wastes. These substances can be accumulated in the shoot and roots of plants at low, medium or high levels (Baker and Brooks, 1989; Verma and Dubey, 2003; Yang, *et al.,* 2003; Chandra and Kulshrestha, 2004; Adeyeye, 2005). The study aims at determining the concentrations of lead, cadmium and chromium in the soil and the two types of leafy vegetables commonly cultivated at the riverbank.

Materials and Methods

Study-site description: River Ribila is located in Odo-nla village off Sagamu road, Ikorodu, Lagos State. The river flows from Oke-Gbegu through Abule-Oloja to Odo-nla village with a maximum length of about 100km and a width of 5m at the widest point. The riverbank covers an area of about 20 acres most part of which is cropped with leafy vegetables and other crops by small scale farmers. Effluents from soap, textile, iron and steel industries are discharged directly into the river. Domestic wastes of Odo-nla village and surrounding village residents are dumped into the river. The river during the rainy season overflows its banks to form floodplains. These floodplains dry up during the dry season to form mudflats on which the farmers cultivate leafy vegetables and other crops.

Collection of samples: Plant samples of *Talinum triangulare* and *Telfaria occidentalis,* which are the main leafy vegetables cultivated along the riverbank, were collected. Three plant samples each of the two leafy vegetables were collected from the farms.

Soil samples from the mudflats were collected using a hand trowel. Three soil samples were randomly collected by scooping the soil from surface to 15cm depth into the soil. The quantity of the soil scooped from each point was about 250g.

Determination of heavy metals: The 3 digested samples each of soil and plants were analysed for lead, chromium and cadmium by Atomic Absorption Spectrophotometer (AAS) (Buck Scientific Model 200A). The magnification coefficient which is the concentration of the heavy metals in the plant roots in relation to the concentration in the soil samples was calculated. This was done by dividing the concentration in the root by

Table – 1: Concentrations of heavy metal (µg/g) in the soil sample of the cultivated bank of river Ribila.

Soil pH	Pb	Cd	Cr
6.83±0.02	62.17±0.024	2.43±0.002	36.74±0.033

Table – 2: Concentrations of heavy metal (µg/g) (Pb, Cd, and Cr) in two vegetable plants cultivated on the bank of river Ribila

Plant species	Plant parts	Lead		Cadmium		Chromium	
		Washed	Unwashed	Washed	Unwashed	Washed	Unwashed
Telfaria occidentalis	Root	72.25±0.05	242.30±.21	0.00	25.40±0.5	10.63±0.63	47.40±0.21
	Foliage	102.25±0.25	125.05±0.05	0.00	0.00	0.00	2.60±0.10
Talimum traingulare	Root	25.05±0.05	132.3±0.10	2.34±0.01	7.70±0.05	7.51±0.01	17.40±0.01
	Foliage	0.00	30.25±0.05	4.10±0.01	13.63±0.11	0.00	12.50±0.01

Table – 3: Total percentage (%) of heavy metals removed from plant parts when thoroughly washed.

Plant species	Plant parts	Lead	Cadmium	Chromium
Telfaria occidentalis	Root	70.11±0.05	100.00	78.47±0.42
	Foliage	18.13±0.125	0.00	100.00
Talimum traingulare	Root	81.20±0.016	70.92±0.064	57.14±0.05
	Foliage	100.00	70.90±0.01	100.00

Table – 4: Relationship of heavy metal in unwashed root tissues with the concentration in the soil, showing multiplication factor.

Plant species		Lead	Cadmium	Chromium
Telfaria occidentalis	Soil	62.17±0.024	2.43±0.002	36.74±0.033
	Root	242.3±0.02	25.38±0.05	47.38±0.05
	Magnification coefficient	3.90	10.45	1.29
Talimum traingulare	Soil	62.17±0.024	2.43±0.002	36.74±0.033
	Root	132.3±0.05	7.70±0.03	17.38±0.06
	Magnification coefficient	2.13	3.18	0.41

concentration of heavy metal in the soil sample. This indeed shows the rate of uptake of the heavy metal by the plants. The results on the AAS were converted to actual concentration of the metals in the samples.

Soil pH determination: The pH of the bulked soil was determined in water using the electronic method.

Results and Discussion

The concentrations of the heavy metals in the soil as shown in Table 1 indicated that the soil is moderately or slightly polluted with cadmium. The concentration of Cd was (2.43µg/g) below intervention value of (12µg/g) of Federal Environmental Protection Agency (FEPA, 1991) and that of 1µg/g or less specified by John *et al.,* (1972) for agricultural soils. The concentration of lead and chromium in the soil are within safe limits for agricultural soils (FEPA, 1991). Low concentration of chromium, cadmium and lead have also been reported in agricultural soils of Fadama farms in Nigeria (Adeyeye, 2005).

Tables 2 and 3 show the concentrations of metals in the washed and unwashed samples of the leafy vegetables and the total percentage of heavy metals removed from the plants when thoroughly washed respectively.

The unwashed samples contained the heavy metals except for the foliage of *T, occidentalis* in which cadmium was not detected (Table 2). Moreover, the roots of the plants contained higher concentrations of the heavy metals than the foliage except for *T. traingulare.* Zaranyika and Ndapwadza (1995) and Yang *et al.,* (2003) reported this same trend of roots having higher concentration of heavy metals than shoot while in some plant species there was higher concentration in the shoot than the roots as shown in *T. triangulare* (Yang *et al.,* 2003). Futhermore, lead is easily absorbed and accumulated in different plant parts (Sharma and Dubey, 2005). The roots are indeed the primary site for absorption of water and minerals including heavy metals (Richards, 1969). The root will thus contain more heavy metal load than the shoot and acts as a source of storage organ in this case. Lead has also been found at lower concentration in foliage of barley than the root as observed for *T. Triangulare* in this study (Keaton, 1973). The danger in the high concentration of these heavy metals in the root may be two folds. Though humans do not normally eat roots of these vegetables but they can be eaten by livestock and other animals which are fed upon by humans. There are other plants in the site whose roots and shoots are utilized by herbalists for herbal medicine. In these ways, these heavy metals contained in the shoots and roots of the plants can get into the food chain.

The unwashed parts contained higher concentrations of heavy metals than the washed parts (Table 2). However, a high percentage of these was washed off as shown in Table 3. This shows that the amount washed off did not actually get into the plant tissues. This is an indication that quite a large amount of atmospheric emissions from machines or vehicles deposit on the plant as surface contaminants. Thus the usual practice of thoroughly washing vegetables before consumption is indeed good and can help to remove a substantial quantity of the contaminants from getting to the body of their consumers.

Table 4 shows the relationship of the concentration of heavy metals in the root with the concentration in the soil. The trend of concentrations of heavy metals in plants being higher than that of the soil has been observed in several studies of Motto *et al.,* (1970) and Rolfe (1973) on lead. Page *et al.,* (1972) has noted bioaccommulation of cadmium in the roots of lettuce, barley, cabbage and pepper. Turner (1973) equally recorded accumulation of cadmium in tomato roots. More recent study has also shown high level of chromium in roots of *Brassica campestris* and emergent species like *Cyperus esculentus* (Gosh and Singh, 2005, Chandra and Kulshreshtha, 2004).

However, the concentration of chromium in the root of *T. triangulare* was lower than the concentration in the soil sample. This observation conforms with that of Elliot (1983) in which he found that at pH as low as 2-3, more heavy metals can be absorbed by plants and indeed absorption of lead can increase with increasing pH between 3-8.5 (Lee *et al.,* 1998).

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