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Heavy Metal in Cassava Roots (Manihot esculenta) Harvested from Farm Land along Ilaro-Ibese Road, Ogun State Nigeria

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Abstract – Heavy metal concentrations (Cu, Pb, Zn, Ni, Cd) in cassava roots cultivated on farmlands along the Ilaro-Ibese road were studied. Cassava root samples were collected from cassava farms in three different spots within the farmland. The concentration of these metals was determined using ICP-OES (Agilent 720-ES). Cu (5.1883 mg/kg), Ni (0.1552 mg/kg) Zn (0.1204 mg/kg), Pb (0.0581 mg/kg), and Cd (0.0432 mg/kg) had significant metal concentrations in cassava root. Heavy metal concentrations in cassava roots were in the following order: Cu > Ni > Zn > Pb > Cd. In comparison to other spots (i.e., 10 and 15 m distances), the concentration of heavy metals in cassava roots planted at 5 meters away from the major road is high. The bioaccumulation of heavy metals in cassava roots observed in this study is generally lower than the WHO/FAO acceptable limit (2001). For all metals, the soil plant transfer factor values at all sites indicated medium accumulation.

Keywords – Cassava roots, Heavy metals, Ogun State, Health effects, Ilaro-Ibese,

I. INTRODUCTION

One of the most significant parts of food quality assurance is heavy metal contamination [1]. Heavy metals are defined as elements in the periodic table with a densities greater than 5 grams per cubic centimeter or atomic number greater than 20. Heavy metals have a negative impact on the environment because they are not biodegradable and, when present in high concentrations in water, soil, or food, they are hazardous to living beings [2]. Plants cultivated in polluted soil have been extensively investigated for heavy metal uptake. The outcomes suggest that increased metal levels in soil may lead to greater metal uptake by plants growing in soils with higher metal concentrations and ion content. Long-term waste water application can cause heavy metals to accumulate to dangerous levels in the soil. As a result of soil and air pollution, metal contamination of vegetables poses a risk to their quality and safety. Because heavy metals have the ability to accumulate in soil for a long time, their levels in agricultural soil are extremely important (Iwegbue, Egobueze, and Opuene 2006). Metal ions in high concentrations in soil can harm natural streams and human health (Wu and Zhang, 2010). Excessive heavy metal deposition in agricultural soils can lead to contamination of the soil, as well as food quality and public health concerns.

Food is an essential part of human nutrition, and it is mostly derived from plants. Plants have an innate ability to absorb hazardous chemicals, such as heavy metals, which are then passed through the food chain (Singh, Sharma, Agrawal and Marshall 2010).

Cassava plants contribute glucose, vitamins, iron, calcium, and other nutrients to the diet, all of which have significant health benefits (Thompson and Kelly, 1990; Arai, 2002). Cassava is a resilient crop that can withstand harsh environmental conditions and even grow in poor soils. Cassava's growth media (soil, air, nutrient solutions) are the main sources of heavy metals, which are absorbed by the roots or foliage [3]. Heavy metal build up in crops may lead to the lowering, destruction, and altering of animal or human physiological functioning through the food chain, making research into the mechanism of heavy metal uptake by crops or plants from polluted soils increasingly important [4]. Heavy metal poisoning of soil, wastewater, and air pollution are all threats to cassava plants. Because of this, heavy metal levels in cassava plants must be measured on a regular basis to verify that they meet internationally agreed-upon requirements for protecting public health. Heavy metals enter human tissues through a variety of routes, including the cassava plant and other foods, causing health problems. Heavy metals can also cause cassava and other crop plants to lose their root weight. According to Padmaja et al. (1990), persistent application of Cd, Ni, or Pb might result in a reduction in cassava stem girth, which is partly due to the metals' restrictions on chlorophyll production and photosynthesis. The impact of heavy metals on cassava stem girth varies by cassava species. Cassava leaves are also a heavy metal target since they reduce the quantity of leaves, according to Mbong et al. (2013).

Heavy metal contamination has caused an upsurge in environmental hazards over the last decade. This sort of pollution is becoming increasingly visible in the way it affects plant, human, and animal resources. Therefore, the goal of this research is to look into the levels of heavy metals such as Cu, Cd, Pb, Zn, and Ni in the Ilaro-Ibese road.

II. MATERIALS AND METHOD

Study Area: The sampling locations were chosen to span a wide range of traffic density and to give a good geographical coverage of the Ilaro-Ibeshe area of Ogun State. Ilaro-Ibeshe is under Yewa (Egbado) South Local Government areas in Ogun State. It has an estimated population of more than 59,098 as of 2015 and is approximately 8.8 square kilometers in area. Ilaro-Ibese is located at 6° 53' 20" north latitude and 3° 00' 50" east longitude. It has a tropical wet climate with an average rainfall of 7.3 inches and an average daily temperature of 23°C. The major occupation of the Yewa (Egbado) people is mostly farming of arable crops and cash crops like cassava, yam, cocoa, coffee, kola nuts, oranges, and pineapples.

Sample Collection

On a farm located along the busy Ilaro-Ibeshe road, cassava roots were collected at random from three locations (10, 15, and 20 meters away from the roadside). Control samples were taken from another cassava farm in the Gbokoto village in Ilaro. The samples were gathered in a polythene bag, labeled by distance from the road, and taken to the science laboratory technology department, Federal Polytechnic Ilaro for analysis. Analytical grade chemicals and reagents were employed throughout.

Sample Preparation

To eliminate dirt, bug pieces, surface acids, and other contaminants, the cassava rooys were properly washed with clean portable water. They were then peeled to remove their coats and cuticles, and the edible parts were sliced into pieces of around 10 cm^3 to improve their surface area for easy drying. They were then placed on aluminum trays and dried to a consistent weight in electric ovens at 120 °C. Prior to digestion, the dry samples were pulverized with a mortar and pestle and stored in desiccators.

Sample Digestion

Adedeji and Ajibode (2005) techniques were used to digest the materials. 1 g of cassava samples were weighed into a 50ml digestion tube, and 1 ml of hydrogen peroxide (H_2O_2) solution, 2 ml of concentrated hydrochloric acid (HCL), 5 ml of concentrated nitric acid (HNO_3), hypochlorate (1:1), and 2 ml of concentrated sulphuric acid (H_2SO_4) were added. The solution was heated to 120 ºC until it turned transparent. After that, the sample was coded and filtered into a volumetric flask. For comparison, a blank digestion was performed. After that, a standard solution for each element was created and used in the calibrations. The ICP-OES (Agilent 720-ES) was used to measure metals.

Statistical Analysis

The results were calculated as the mean standard deviation of triplicate determinations. At a significance level of $P < 0.05$, Duncan's multiple range test in conjunction with one way analysis of variance (ANOVA) was used to determine significant differences among the means at a significance level of $P < 0.05$ using Sigma Plot 14.0 (Systat Software Incorporation).

Table 1. Mean concentration of heavy metals in cassava roots in distances away from road

Metal	Control	5 m Away	10 m Away	15 m Away
Zn	0.0621±0.0064	0.1204±0.0091	0.0862±0.0102	0.0741±0.0060
Cu	0.1062±0.0050	0.1883±0.0020	0.1611±0.0202	0.1043±0.0445
Ni	0.0683±0.0090	0.1552±0.0223	0.1444±0.1830	0.1414±0.0256
Pb	0.0404±0.0712	0.0581±0.0301	0.0361±0.0281	0.0092±0.0122
Cd	0.0213±0.0086	0.0432±0.0035	0.0301±0.0293	0.0112±0.0421

Table 2: Plant transfer factor (Tf) of mean of metal

Metals	Control	5 m Away	10 m Away	15 m Away
Zn	1.32	1.41	0.99	1.01
Cu	0.46	0.92	0.56	0.75
Ni	0.23	0.43	0.32	0.57
Pb	0.20	0.54	0.23	0.42
Cd	0.12	0.25	0.10	0.08

III. DISCUSSION

The bioaccumulation of heavy metals in cassava root observed in the present study is substantially lower than the WHO/FAO acceptable limit (2001). At each site, there was also an indication of a drop in concentration as distance increased. Cd bio-accumulates in cassava roots, possibly due to low pH. Cadmium is a highly mobile metal that is quickly absorbed by plants through the root surface, goes through wood tissue, and then transfers to the higher portions [5], which is consistent with the findings of our study. The nickel content at 5 meters away from the roadside was found to be higher than at 10 and 15 meters. According to Yassoglou et al. (1987), this could be owing to nickel added to gasoline and Ni-containing parts of automobiles, or the widespread use of various pesticides and fertilizers in that area, all of which contributed to increased Ni availability in the soil. The copper levels found in cassava plants in three different spots were within safe limits and were highest in the root of cassava planted 5m away from the road side (0.1883±0.0020 mg/L). According to Muhammad et al. (2008), who studied the responses of three vegetables to Cu toxicity and found that Cu levels in both root and shoot increased, but root Cu concentration increased more sharply than shoot with increasing Cu levels in growth media. Cu was primarily accumulated in the roots, with only a small percentage (10%) of absorbed Cu being transported to the shoot. Moshen and Moshen (2008) found that the Cu concentration in the shoots was significantly influenced by the Cu concentration in the dirt. The statistical analysis result showed that there was no significant difference in the bioaccumulation of heavy metals in the different parts of the cassava crop, which implies that the cassava crop is not a hyper-accumulator plant. The content of nickel at 5m away from the roadside in this study was found to be higher compared to 10m and 15m. According to Yassoglou et al. (1987), this may be due to emissions from the nickel added to gasoline and Ni-containing parts of automobiles or the wide application of various types of pesticides and fertilizers in that location, which contributed to the increased availability of Ni in the soil. Amusan, Bada, and Salami (2003) studied heavy metal uptake by plants and found that Pb uptake by water leaves (Talinum traingulare) and Okra (Abelmoschus esculentus) increased by 200% and 733%, respectively, in leaves and by 126% in the fruit of Okra relative to the control. There are reports of a direct relationship between levels of lead in plants and traffic density [6]. One possible explanation for this situation is that the pH of the soil and the levels of organic matter can promote Pb uptake.According to Sharma and Prasade (2010), only 3% of Pb in soil is translocated through the root to the shoot of plants, while the rest is through foliage. The values of heavy metal transfer recorded are considere high because values close to or above 1 (one) are considered high Tf values [7]. The high Tf value may be due to its weak adsorption onto the organic matter which renders it more bio-available to plants [8]. Pb showed low Tf values with the highest being 0.52, indicating that cassava plants from the study area did not have a high Pb contamination. From the results obtained, the highest transfer factor recorded was in Zn, with all values above 0.5, indicating that cassava plants were contaminated with Zn probably from anthropogenic sources, and this is based on the suggestion that the greater the transfer coefficient value above 0.50, the greater the chances of plant-metal contamination [9]. Chiroma et al. (2003) showed that Zn accumulates in roots and translocates gradually to the leaves. This means that Zn poisoning can cause hypertension, arthritis, diabetes, anemia, cancer, cardiovascular disease, cirrhosis, and impaired fertility; hypoglycemia, headaches, osteoporosis, renal disease, and stroke [10].

IV. Conclusion

The overall findings revealed heavy metal bio-accumulation in cassava plants from farm lands bordering the Ilaro-Ibese road. In control samples, the amounts of heavy metals tended to be lower. The concentration of heavy metals in cassava plants at 5 m distance to the main road is higher compared to other spots (i.e., 10 and 15 m distances). This can be linked to emissions from vehicles (fuel combustion, road abrasion, lubricating oil, tire and break wear) or through the atmospheric deposit or road runoff along the road. Due to higher Tf value (> 0.5) of zinc, it indicated that cassava plants from the study area have a high Zn contamination.

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