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Determination of Heavy Metal Contaminants in Leafy Vegetables Cultivated By the Road Side

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Abstract:- A study was conducted to analyze the heavy metals in some leafy vegetable cultivated by roadside including *Talium triangulare, Amaranthus hybridus* and *Telfairia occidentalis*. The vegetables were sampled from different areas of Ojo local goverment. The vegetables were digested using 98% nitric acid ($HN0_3$) and analyzed with the aid of Atomic Absorption Spectrophotometer(AAS) to determine heavy metals. The mean concentration for each heavy metal in the samples gotten from each sites were calculated and the comparison of these data was done amongst the three differnt locations. These were compared with the permissible levels set by the FAO and WHO. Results showed that the levels of Copper and Cadmium for the leafy vegetables ranged from 0.3944 ± 0.159 to 1.6559 ± 0.919 and from 0.0854 ± 0.043 to 0.2563 ± 0.249mg/kg dry weight respectively. While that of Zinc and Lead was 1.8028 ± 0.111 to 6.2267 ± 1.572 and 0.0856 ± 0.040 to 2.104 ± 1.490mg/kg . When compared with standards, heavy metal levels were found to be within safe limit which is an indicator that the leafy vegetable in Ojo local government area are safe for consumption without the risk of environmental toxicants.
Keywords:- Heavy metals, Leafy vegetables, Environmental pollutants, Road side, Atomic absorption spectrometer

I. INTRODUCTION

Air pollution of the natural environment by heavy metals is a universal problem because these metals are indestructible and most of them have toxic effect on living organisms, when permissible concentration levels are exceeded. Heavy metals frequently reported in literature with regards to potential hazards and occurrences in contaminated soil are cadmium, copper, zinc and lead (Akoto *et al*., 2008., Alloway, 1995). The vehicular exhausts, as well as several industrial activities emit these heavy metals so that soils, plants and even residents along roads with heavy traffic loads are subjected to increasing levels of contamination with heavy metals (Ghrefat and Yusuf, 2006). However, heavy metals are natural components of the earth's crust and cannot be degraded nor destroyed. They enter the human body through food, water and air. Heavy metals are ubiquitous; therefore they tend to bio accumulate, thus causing an increase in their concentration in a biological system. Chronic heavy metal toxicity has been the result of long term low level exposure to pollutants and is associated with many chronic diseases. Heavy metals are given significant interest throughout the globe due to their toxic, mutagenic and teratogenic effects even at very low concentrations.

Vegetables constitute an important part of the human diet since they are rich in carbohydrates, proteins as well as vitamins, minerals and trace elements however; they contain both essential and toxic elements over a wide range of concentrations. Metals accumulation in vegetables may pose a direct threat to human health. Heavy metals are one of a range of important types of contaminants that can be found on the surface and in tissue of dry vegetables. Vegetables are also part of daily diets in many households forming an important source of vitamins and minerals required for human health. They are made up of chiefly cellulose, hemi-cellulose and pectin substances that give them their texture and firmness (Sobukola and Sairo 2007). Vegetables takes up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments (Sobukola *et al.,* 2010). Vegetable plants growing on heavy metal contaminated medium can accumulate high concentrations of trace elements to cause serious health risk of consumers. Regular monitoring of these heavy metals from effluents, sewage, in vegetables and in other food materials is essential for preventing excessive buildup of the metals in the food chain. Heavy metals depositions are associated with a wide range of sources such as small scale industries (including battery production, metal products, metal smelting and cable coating industries); brick kilns; vehicular emissions; re-suspended road dust and diesel generator sets. These can be important contributors to the contamination found in vegetables. Heavy metals, such as cadmium, copper, lead and zinc are important environmental pollutants, particularly in areas under irrigated with waste water. Metals such as lead, zinc, copper and cadmium are cumulative poisons. These metals cause environmental hazards and are reported to be exceptionally toxic. Heavy metals may enter the human body through inhalation of dust, direct ingestion of soil and consumption of food plants grown in metal contaminated soil, indicated that the cadmium concentrations in shoots and roots varied both with different cadmium levels and type of vegetable crop was increased with the increasing cadmium concentrations in the growth medium.

Telfairia occidentalis (fluted pumpkin) is one of the commonly consumed leafy vegetables in Nigeria. It is used in herbal preparations in African traditional medicine; it has the ability to attenuate hypercholesterolemia. The vegetable is cultivated in various parts of southern Nigeria. It is widely cultivated for its palatable and nutritious leaves which are used mainly as vegetable. The seeds are also nutritious and rich in an oil which may be used for cooking and soap manufacture. Its taxonomy, morphology and potential uses are discussed in relation to its economic importance as a tropical crop. (Berti *et al.*, 1996).

Amaranthus hybridus also known as "Amaranth or pigweed", is an annual herbaceous plant of 1- 6 feet high. The leaves are alternate petioled, 3 – 6 inches long, dull green, and rough, hairy, ovate or rhombic with wavy margins. They have small flowers, with greenish or red terminal panicles. Taproot is long, fleshy red or pink. The seeds are small and lenticellular in shape; with each seed and average of 1 – 1.5 mm in diameter and 1000 seeds weighing 0.6 – 1.2 g. It is rather a common species in waste places, cultivated fields and barnyards. In West African, *A. hybridus* leaves are normally used to prepare soup (Oke, 1983; Mepha *et al.*, 2007). They leaves are eaten as spinach or green vegetables (Dhellot et al., 2006).

Talinum triangulare (water leaf) is an herbaceous perennial leaf, caules cent and glabrous plant widely grown in tropical regions as a leaf vegetable (Ezekwe et al., 2001). It is consumed as a vegetable and constituent of a sauce and soups in Nigeria. Nutritionally, water leaf has been shown to possess the essential nutrients like Beta carotene, minerals (such as calcium, potassium and magnesium), pectin, protein and vitamins (Ezekwe *et al.*, 2001). Water leaf has been also found to be used medically in the management of cardiovascular diseases like stroke, obesity, etc. (Adewunmi and Sofowora, 1980) and traditionally culinary as a softener of other vegetable species (Anete and 2006).

The objective of this research work is to determine the suitability of the leafy vegetable consumed in the Ojo Local government Area of Lagos Metropolitan area and viz a viz the heavy metal contaminants of the three leafy vegetable used as a delicacy in this area.

II. MATERIALS AND METHODS

2.1 *Experimental plants*

Three vegetable species were selected for the purpose of the experiment based on their availability. These vegetable leaves were *Telfairia occidentalis, Amaranthus hybridus* (Green) and *Talinum triangulare*. The vegetable leaves used for the experiment were harvested fresh or purchased directly from local farmers at the sites located in Lasu Iyana-Iba road, Iyana-Iba Market and LASU Campus (This serves as a control experiment, It was planted in the green house of Botany Department of Lagos State University Ojo). The freshly harvested vegetable leaves were immediately subjected to dry oven and was done by constantly exposing the plants to oven for 3-4 days at 70c. Sample collections were carried out according to the methods described by Udosen *et al.*, 2006. The samples were analyzed for heavy metal contents: Cadmium (Cd), Copper (Cu), Lead (Pb) and Zinc (Zn).

2.2 *Determination of heavy metal content in plants*

The whole plants where dried in an oven at 70^oC for 3 days. The dry samples were crushed in a mortal and the resulting powder was packaged for analysis of the heavy metals copper, cadmium, zinc and lead. Approximately 5g of the powder was transferred to a 25ml conical flask; 5ml of concentrated H_2SO_4 was added followed by 25ml of concentrated HNO_3 and 5ml of concentrated HCL. The contents of the tube were heated at 200^oC for 2 hour in a fuming hood, and then cooled to room temperature. Then, 20ml of distilled water was added and the mixture was filtered using filter paper to complete the digestion of organic matter. Finally, the mixture was transferred to a 50ml volumetric flask, filled to the mark, and allowed to settle for at least 15 hours. The resulted filtrate was analyzed for total Cd, Zn, Cu and Pb by Atomic Absorption Spectrometer. This sample procedure was carried out for each plant sample (Jones, 1984).

2.3 *Metal analysis*

All plants samples were analyzed using Atomic Absorption Spectrophotometer (AAS) model for determination of lead, cadmium, zinc and copper. The method used was by direct aspiration of sample digest, using air acetylene flame. The calculating of metal is based on the comparison of absorbance of samples against standard known concentration, and all results are converted to mg kg^{-1}.

III RESULTS

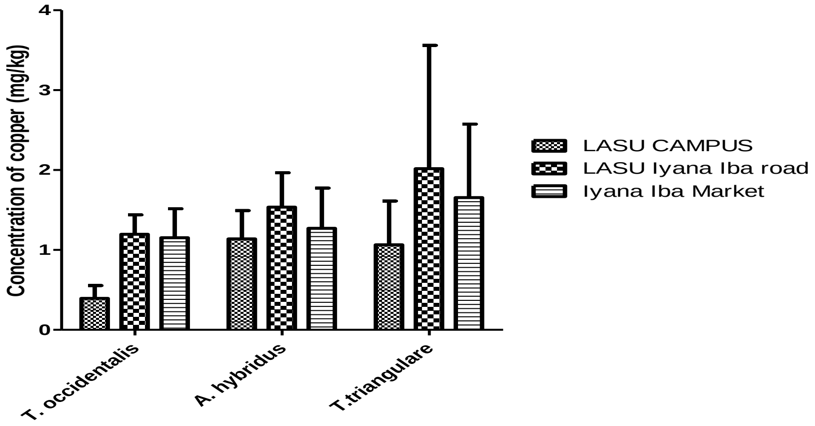

Figure 1: Amount of heavy metal Copper (Cu) in different plant collected at different location for period of three weeks

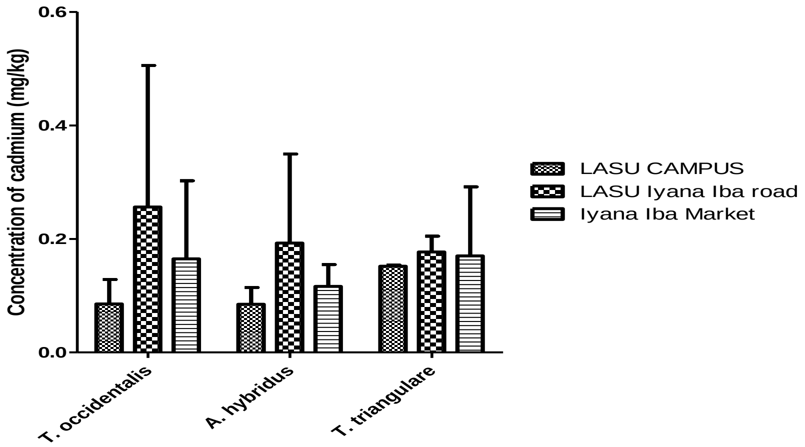

Figure 2: Amount of heavy metal cadmium (Cd) in different plant collected at different location for period of three weeks

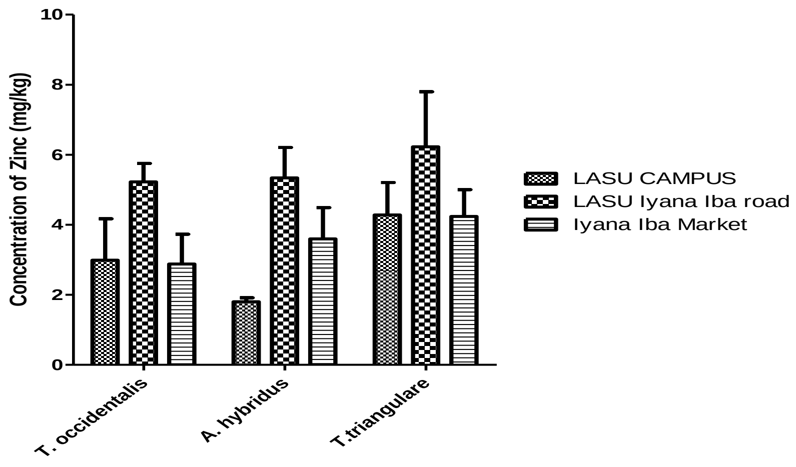

Figure 3: Amount of heavy metal Zinc (Zn) in different plant collected at different location for period of three weeks

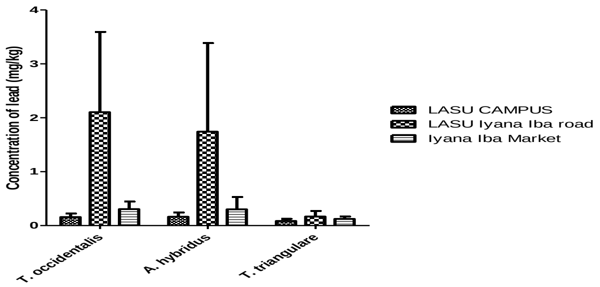

Figure 4: Amount of heavy metal lead (Pb) in different plant collected at different location for period of three weeks

IV. DISCUSSION

Pollution is a major urban problem and its direct or indirect effect is hazardous to human life and organisms. Vegetable is a major part of Nigerian diet and is very susceptible to environmental pollution due to the activity practice in the area where it is gotten from. Copper is a component of other proteins associated with the processing of oxygen. In cytochrome oxidase, which is required for aerobic respiration, copper and iron cooperate in the reduction of oxygen. Copper is also found in many superoxide dismutases, proteins that detoxify superoxides, by converting it (by disproportionation) to oxygen and hydrogen peroxide. (Jones, 2009).
From the result (Figure 1) the concentration of copper in *T.occidentalis* is quite low in Iyana Iba market compared to the other sites although the result is not statistically significant, on the other hand *A. hybridus* in LASU Campus that serves as the control is very low compared to the other two sources, the concentration is 1.1392 ± 0.353 while the other from LASU Iyana Iba road and Iyana Iba Market are 1.2215 ± 0.502 and 1.5368 ± 0.429. On the other hand the *T.triangulare* has a lower concentration of copper than the other vegetable gotten from LASU Campus. This shows that the level of heavy metal pollution in LASU campus site is very low and minimal compare to other sources.

Cadmium is a heavy metal with high poisonous ability and it is a non-essential element in foods and natural waters and it accumulates principally in the kidneys and liver (Divrikli *et al.*, 2006). Various sources of environmental contamination have been implicated for its presence in foods (Adriano, 1984). Various values have been previously reported for leafy vegetables which include 0.090 mg/kg for fluted pumpkin by Sobukola *et al* (2010), 0.049 mg/kg (Muhammed and Umer, 2008). According to FAO/WHO, the safe limit for Cd consumption in vegetables is 0.2mg/kg**.** The contents of both Cadmium and Zinc reported in this study are within the permissible levels by FAO/WHO in vegetables. Among all heavy metals, Zinc is the least toxic and essential elements in human diet as it require maintaining the functioning of the immune system. Zinc deficiency in the diet may be highly detrimental to human health than too much Zinc in the diet. The recommended dietary allowance for Zinc is 15mg/day for men and 12mg/day for women (ATSDR 1994a) but high concentration of Zinc in vegetables may cause vomiting, renal damage, cramps.

In this study, the concentration of Zinc was high in the LASU campus, while low concentration of Zinc was observed in vegetable sample from LASU Iyana Iba road and Iyana Iba Market, the concentration of zinc in LASU campus compared to that of other site is statistically significant ($P<0.05$). Lead is a serious cumulative body poison which enters into the body system through air, water and food and cannot be removed by washing fruits and vegetables. The high levels of Lead in some plants may probably be attributed to pollutants in irrigation water, farm soil or due to pollution from the highways traffic (Qui et al., 2000). Chinese cabbage has been reported to accumulate higher Lead concentrations compared to Pumpkin leaves from Mazimbu and Towelo (Chove *et al.*, 2006). Wong *et al.*, (1996) also reported that Chinese cabbage picks up Lead more readily compared to other heavy metals such as Cadmium, Copper, Zinc and Lead. In contrast, lower level of Lead has been reported with *Telfaria* (Akinola and Ekiyoyo, 2006). *Talinum,* and *Amaranthus* (Afolami et al 2010) similar to the result of this study is the result of Ladipo and Doherty, 2011.

Lead pollution has been shown to be commensurate with population/vehicular density (Afolami *et al.*, 2010). It can be stated that the site of growth noticeably influences the heavy metal uptake by vegetables. Generally, lead contaminations occur in vegetables grown on contaminated soils. Lead poisoning is a global reality, and fortunately is not a very common clinical diagnosis yet in Nigeria except for few occupational exposures (Anetor *et al.*, 1999). Low levels of heavy metals were observed in the markets because most of the markets are located away from source of contamination which includes: tire wear, motor oil, grease, brake emissions, corrosion of galvanized parts, fuel burning, and batteries and so on. It may also be attributed to the soil on which the vegetables were grown. Such soil may be sited in rural areas which may be related and not contaminated. Although the concentrations of the Cadmium and Zinc established for the vegetables are lower than those permitted by FAO/WHO, what matters in the long run is the quantities consumed and the frequency of intake. There is a cumulative effect on sustained intake of heavy metals, as they are not easily removed from the body. *Telfaria occidentalis* has a low level of lead and it is not statistically significant and also falls below the permissible limit. It is advisable that for consumption purposes, regular monitoring should be conducted to detect increasing levels of Lead in vegetables. Many rural and urban low-income families in Nigeria consume large quantities of vegetables on a daily basis and this exposes them to the health risks associated with heavy metals ingestion.

V. CONCLUSION

However, the levels of heavy metals were observed to be lower than those of previous published works and regulatory standards. This may be in due partly to the low level of pollution in the area under investigation and the season of the year in which the sample is harvested. Further works should be carried out in the soil samples were the vegetables are grown as the pollution of these soils may cause a serious pollution on the plants.

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