Analysis of Heavy Metals Content of Leafy Vegetable (Celosia Argentea) and Soil from a Dumpsite in Offa, Kwara State, Nigeria

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ABSTRACT

Heavy metals are required in micro-level for optimum crop growth and plant performance, however, bioaccumulation of metals in tissues and on leafs of edible vegetable plants posses serious health risks especially now that there has been increased awareness of the nutritive and medicinal value of leafy vegetables, therefore this study assess the level of heavy metal (Fe, Mn, Zn, Cu, Cd, and Pb) content of commonly consumed Lagos spinach leaves (Celosia argentea) which were locally sourced from a dumpsite in Offa, Kwara State, North Central Nigeria, and the soil samples using Atomic Absorption Spectrophotometry (AAS). The result obtained showed the range of heavy metal concentration in Celosia argentea leaves as: Fe (0.10-0.30mg/kg), Zn (0.09-0.29mg/kg), Mn (21.50-21.70mg/kg), Cu (0.05-0.09mg/kg), Cr (0.011-0.019 mg/kg), Pb (ND). The average range of heavy metals concentration in soil samples from dumpsite were Fe (3.70-3.90), Zn (0.06-0.26mg/kg), Mn (0.83-1.03mg/kg), Cu (0.05-0.14mg/kg), Cr (0.018-0.023mg/kg), Pb (ND). The load of heavy metals in Lagos spinach leaves' samples increased in the order Pb<Cr<Cu<Zn<Fe<Mn which correlates with the trend of observed heavy metals content in the dump soil samples (Pb<Cr<Cu<Zn<Mn<Fe). however, the heavy metal concentrations obtained from this study were below the recommended dietary intake limit by World Health Organization (WHO) and National Agency for Food and Drug Administration and Control (NAFDAC) limits except for Manganese and thus recommended safe for human consumption irrespective of the source.

Keywords: Lagos spinach (Celosia argentea), Atomic Absorption Spectrophotometry, Heavy metals, Offa.

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1. INTRODUCTION

Land is vast and valuable natural resources which sustained the agricultural activities and civilization of mankind. This has gradually been degraded in an attempt by man to explore and exploit the natural resources endowed in it. The soil is the major reservoir for heavy metal released as a result of vehicular exhaust emission, solid discharge and industrial effluent, gas, flaring, insecticides and pesticides, municipal wastes and practices of fertilizer application, spillage of petrochemical and combustion of coal (Singh *et al*., 2001). They can also act as toxicant to soil and crops at elevated concentrations. Heavy metals such as Mn, Ni, Cd, etc are required in micro-level for optimum crop growth and plant performance (Singh *et al*., 2001). In most cases, they play key roles in development and growth of crop plants (Mustapha *et al*., 2005).

Vegetables are good sources of Fibres, Carbohydrates, Vitamins, Fats, Proteins, Minerals, vital Amino acids, Carotene, Saponins, Arscorbic acids, Steroids, Riboflavin, Folic acid, Iron, Calcium, and Phosphorus (Raghervendra, 2013). Likewise, some African leafy vegetables have medicinal values and are potent enough to cure more than one disease. This curative values are thought to be correlated to their phytochemical and other chemical constituents (Fallah, 2005). More so, studies have shown that high intake of vegetables reduces the risk of ageing disease due to the presence of sufficient levels of antioxidants as well as phytochemicals in them (Elias *et al*., 2012). The major pathways of heavy metals into the soil are mainly through application of compost and chemical fertilizers (Kaonga *et al*., 2010). Likewise, the two main routes of toxic heavy metals exposure to human and other animals are inhalation and ingestion of leafy vegetable, fruits and other food items (Ramesa *et al*., 2014).

Accumulation of heavy metals in the soil over a period of time may lead to excessive uptake of these elements by plants. Bioaccumulation of metals in tissues and on leafs of edible vegetable plants posses serious health risks especially now that there has been increased awareness of the nutritive and medicinal value of leafy vegetables (Sajjad *et al*., 2009).

The presence of elevated levels of these metals in plant tissue has detrimental toxic effect on animals especially on consumption causing phytotoxicity and zootoxicity (Osundiya *et al*., 2014). For instance, elevated dose of copper is linked to liver and kidney damage, as well as irritation of intestine and stomach, Arsenic toxicity is linked to skin damage, circulatory system disorder and high risk of cancer. likewise, mercury is associated with brain, lung and kidney damage whereas bioaccumulation of Cadmium in the kidneys cause permanently damage to the kidney (Ogoko, 2014).

Fig. 1: Dumpsites Scenario in Nigeria

2. MATERIALS AND METHODS

Sample collection and preparation

Offa is a town in Kwara State in the North central Nigeria with a population of about 90,000 inhabitants. The town is located between longitude 8^o 9N to 4^{o}43E and latitude 8.15^{o}N to 4.717^{o}E with GPRS of 100DFT. Soil sample at depth level (0-30cm) was collected with the aid of soil augar from dump soil within the vicinity of "NASFAT village" in Kwara State. *Celosia argentea* is predominantly grown in south-western part of Nigeria owning to its characteristic taste and aroma as soup for pounded yam. this plant is well known for it medicinal and nutritive properties. Also, it is believed that any Nigeria woman from southwest part must know how to prepare the vegetable soup as it opens her husband's heart to meet her needs. These plant is scarce during the dry season except when I is cultivated near riverside , but its abundant, expensive and rare during raining season (April to July) but it is perishable and has to be consumed fresh, hence its hard to find Plant sample of *Celosia argentea* "*Efo Soko*" was also collected at strategic locations i.e. the upper., middle and base of the dumpsite. This dumpsite is predominately covered with waste from farmlands, poutry, kitchen and market to sand fill the site from nearby towns and villages as it is located in the outskate of the town.
The soil samples were labeled SS I, SS II and SS III depending on the location of the dumpsite, air-dried, ground to powder using pestle, mortar and two (2) mm mesh sized sieved. Likewise, the plant samples (Vegetable leaf) were labeled SD 1, SD2, SD3 and sourced from the top, middle and base of the dumpsite they were thoroughly washed with water and then rinsed with distilled water in order to get rid of contaminant on the surface of the leaves, oven dried at 70^{o}C. The dry leaves were weighed and ground into powder, kept in air tight cellophane bags for further use

Heavy metal analysis of the plant samples

The powdered plant samples were digested and analyzed using AAS according to the method described by Rasaq *et al*. (2015). The plant samples were extracted by acid digestion using HNO_3/H_2SO_4: $HClO_4$ (10:1:4 v/v). The filtrate obtained was diluted to 50ml with distilled water infused into Atomic Absorption Spectrophotometer (FS240) with detection limit of 0.001 ppm for desired metal ions. The spectrophotometer was operated under optimal conditions as follows. Measurement mode (integrated), slit (0.5nm), gain (79%), lamp current (4.0mA), flame type (Air/Acetylene), air flow (13.0L/nm), Acetylene flow (2.0L/nm).

Heavy metal analysis of the soil samples

Total concentration of some heavy metals of interest was determined according to the method of Lokeshwary and Chandrappa, (2006). 2g each of soil samples were weighed into 250ml glass beaker followed by digestion with 8ml of aqua regia on a sand bath for 120 minutes. The sample was evaporated to dryness and then dissolved with 10ml of 2% nitric acid. Filtered and diluted to 50ml with de-ionized water. The filtrate obtained was then analysed for total concentration of the heavy metals of interest using Atomic Absorption Spectophotometer (FS240).

3. RESULTS AND DISCUSSION

Heavy metals concentrations in soil samples were all below the recommended USEPA and WHO limits. Iron (Fe) is an essential element in man and plays vital role in the formation of haemoglobin, oxygen and element transport in human body (Kakugbor and Din, 2014). Iron concentration found in the vegetable and soil samples were 0.25 mg/kg and 3.81mg/kg respectively which was far lesser than the maximum limit permitted by WHO (425 mg/kg). Zinc (Zn), an Essential nutrient to all organisms and has an important role in metabolism, growth, development and general well-being. It is an essential co-factor for a large number of enzymes in the body.

It was found to have the value of 0.16 mg/kg, and 0.14mg/kg in both the vegetable leaf and soil sample respectively. Thereby fallen within the maximum limit provided by WHO and NAFDAC which are 99.4 mg/kg and 50 mg/kg respectively. Magnesium is an important Nutrient that is needed for more than 300 biochemical reactions in the body. It helps to maintain normal nerve and muscle function, supports a healthily immune system, keeps the heart beat steady and helps bone remain strong it also helps regulate body glucose levels and aid in the production of co-energy and protein. In this research its concentrations in the vegetable and dumpsite soil samples were found to be 21.43mg/kg and 0.93 mg/kg respectively. Both concentrations were above the recommended maximum value by WHO (2.5 mg/L).

Although, it is plays an important role in a number of physiological processes as a constituent of multiple enzymes and an activator of other enzymes, Manganese deficiency results in abnormal skeletal frame, impaired growth, impaired reproductive functions, altered carbohydrate and lipid metabolism, decrease serum-cholesterol levels and a transient skin rashes in man and animal. Chromium (Cr) is one of the essential elements required for normal sugar and fat metabolism. It is effective for the management of diabetes and it is a co-factor with insulin. The concentrations of Chromium obtained were 0.01mg/kg and 0.02 mg/kg for vegetable leaf and dumpsite soil samples respectively as indicated in tables 1 and 2 below. These concentrations fall within the recommended limit by WHO (2.3 mg/kg).

Table 1: Heavy metals (Fe, Zn, Mg, Cu, Cr and Pb) in vegetable leaf (*Celosia argentea*) "Efo Soko"

	Heavy metals (mg/kg)					
Sample	Fe	Zn	Mn	Cu	Cr	Pb
SD1	0.10	0.09	21.70	0.05	0.01	ND
SD3	0.30	0.29	21.09	0.08	0.02	ND
SD2	0.25	0.09	21.50	0.09	0.01	ND

Values are means of triplicate determinations rounded up to the nearest 2 decimal places.

KEY:
ND means not detected.
SD1: Vegetable samples from top upper part of dumpsite
SD2: Vegetable samples from top middle part of dumpsite
SD3: Vegetable samples from top lower part of dumpsite

Table 2: Heavy metals (Fe, Zn, Mg, Cu, Cr and Pb) present in dumpsite soil sample.

	Heavy metals (mg/kg)					
Sample	Fe	Zn	Mn	Cu	Cr	Pb
SS I	3.90	0.06	0.83	0.05	0.02	ND
SSIII	3.84	0.29	1.03	0.12	0.02	ND
SS II	3.70	0.06	0.92	0.14	0.01	ND

Values are means of triplicate determination. Values are rounded up to the nearest 2 decimal places

KEY
ND means not detected..
SS I: Soil samples from top upper part of dumpsite
SS II: Soil samples from top middle part of dumpsite
SS III: Soil samples from top lower part of dumpsite.

4. CONCLUSION AND RECOMMENDATION

Concentrations of metals in vegetables will provide baseline data for further research. Heavy metals have toxic impact on humans however, its detrimental impact becomes apparent only when long term consumption of contaminated vegetables occur. The result of this study revealed the presence of various heavy metals (Cu, Cr, Zn, Fe and Zn) in the plant and soil samples at levels which does not pose any health risk to the unsuspecting consumers except for manganese whose concentration were above the recommended value (2.5mg/kg) by WHO and FAO. Metals with high concentration always have low transfer factor, hence, greater retention of metals in the soil.

The plant, "Efo soko" observed show high phytoremediation properties i.e. greater efficiency of vegetables to absorb metals, hence, to avoid entrance of metals into food chain, it is suggested that regular monitoring of heavy metals in vegetables and other food items should be performed in order to prevent heavy build ups in the human food chain. However, Reduced crop contamination and improved safe food quality can be achieved through reducing pollution at source, improved vegetable production and post harvest handling and using support of vegetable trading system to improve safety.

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