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TEMPORAL HEAVY METALS VARIATION IN VEGETABLES SAMPLED AT KASUWAN MATA, KADUNA METROPOLIS, NIGERIA.

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ABSTRACT The study is aimed at assessing monthly heavy metals variation in some selected vegetables sampled from Kasuwan Mata, Igabi Local Government Kaduna. Vegetables samples were collected and analysed for Pb, Cu, Zn, Ni, Mn Cr and Cd using Atomic Absorption Spectrophotometric techniques for the period of 4 month. Results show high heavy metal concentration in the month of november when compared to the month of august, September and October, all the heavy metal concentration in the vegetables were within WHO/FAO permissible limits but these can cause hazardous health effects in people, who are ingesting these vegetables for long period of time due to magnification of these heavy metals in their body. It is thereby recommended that KEPA should serve as references laboratory for the approval of farmers that intend to undertake dry farming.

Keywords: AAS, Heavy Metals, Water Pollution, Irrigration, Seasonal Variation

INTRODUCTION

Industrial and sewage wastewater are disposed in open drains whose water is used for irrigation (Su *et al.* 2014; Sharma *et al*., 2016). These wastes contain huge amount of heavy metals e.g. Fe, Mn, Pb, Cu, Zn, Cr, Co, Ni, and Cd along with organic matter and nutrients. Crops irrigated by wastewater store and secrete these heavy metals through various parts. These heavy metals cause serious health effects when taken up with food. Plants and leafy vegetables have high capacity to accumulate these heavy metals when grown in soil irrigated by wastewater (Li *et al*., 2016). Irrigation can impact potential yield by affecting morphological and physiological traits. Irrigation of crops by wastewater for long time cause high concentration of heavy metals in plants and vegetables (Rana *et al*., 2014; Pan *et al*., 2016).

Toxic metals accumulated in all parts of vegetables but few metals like Zn, Ni, Cu are More essential for body at low concentration but Zn in higher concentrations results abnormal functions of reproductive activities (Siegel *et al*., 2014; Zhong *et al*., 2017; Ogunkunle *et al*., 2017). Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, as well as vitamins, minerals and heavy metals. Heavy metals are one of a range of important types of contaminants that can be found on the surface and in the tissue of fresh vegetables (Mafuyai *et al*., 2015; Ojo, 2017). A number of elements, such as lead (Pb), cadmium (Cd), nickel (Ni), cobalt (Co), chromium (Cr), Copper (Cu) and Selenium (Se) (IV)

can be harmful to plants and humans even at quite low concentrations (Usman and Kolo, 2015). Soil pollution is caused by misuse of the soil, such as poor agricultural practices, disposal of industrial and urban wastes, etc. (Usman et al., 2015). Soil is also polluted through application of chemical fertilizers (like phosphate and Zn fertilizers), and herbicides (Liu *et al*., 2015). Heavy metal accumulation in soils is of concern in agricultural production due to the adverse effects on food quality, crop growth (Akan *et al*., 2013) and environmental health. Plant species have a variety of capacities in removing and accumulating heavy metals. So there are reports indicating that some plant species may accumulate specific heavy metals (Sultana *et al*., 2017). The uptake of metals from the soil depends on different factors, such as their soluble content in it, soil pH, plant species, fertilizers, and soil type (Michael *et al.,* 2015). Vegetables, especially leafy vegetables, accumulate higher amounts of heavy metals (Ogwok *et al.,* 2014). Roots and leaves of herbaceous plants retain higher concentration of heavy metal than stems and fruits (Mahfuza *et al*., 2014). There are limited studies on heavy metal content at different growth stages of vegetables, the most studies focused on the status of metal content in edible parts of vegetables. And an investigation of the literature also shows a scarcity of data on comparison of metal content at different leafy vegetable species in Hawul (Usman and Kolo, 2015).

Potentially harmful metal contents in soils may come not only from the bedrock itself, but also from anthropogenic sources like solid or liquid waste deposits, agricultural inputs, and fallout of industrial and urban emissions (Hu *et al*., 2017). Excessive accumulation in agricultural soils may result not only in soil contamination, but has also consequences for food quality and safety. So, it is essential to monitor food quality, given that plant uptake is one of the main pathways through which heavy metals (HMs) enter the food chain (Yu *et al.,* 2016).

Vegetables are very important because they contain essential components of protein, vitamins, iron, calcium and other nutrients (Bahemuka and Mubofu, 2015)..However, their nutritional value and consumer acceptance as food must be taken into consideration, because vegetables can contain both essential and nonessential elements over a wide range of concentrations (Chien *et al*., 2015; Gupta *et al*., 2015).It is well established that the daily intake of heavy metal contaminated vegetables may pose a risk to human health. This is because heavy metals can accumulate in living organisms and at elevated levels, they can be toxic. It has been reported that prolonged consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of metals in the kidney and liver of humans, causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney, and bone diseases (Jarup, 2003; Ugya and Ahmad, 2016).

Absorption and accumulation of heavy metals in vegetables and fruits are

influenced by many factors, including: concentration of heavy metals in soil, composition and intensity of atmospheric deposition, including precipitations, phase of plant vegetation (Pan *et al*., 2016). To all of these, can be added other sources generated by agricultural technologies such as: irrigation with wastewater, the administration of organic and mineral fertilizers with the load of heavy metals, or application of pesticides, which contain in their structure such chemical elements (Musilova*et al.,* 2017). Urban, industrial and household activities, traffic, contribute significantly to increasing the load degree with heavy metals containing particles of inferior atmosphere (Pan *et al.,* 2017), from where these particles will settle on the plants foliage system and soil. Many times, the plant foliage system is representing the edible part of vegetables (lettuce, parsley, dill, lovage etc.). The heavy metals are overtaking in the edible parts of vegetables and fruits by physiological path, either from soil, from leaves surface or with these kinds of chemicals loaded from irrigation water. The intake of heavy metals can lead to altering of humans and animals healthiness state. Thus, the carcinogenic effects generated by continuous consumption of fruits and vegetables loaded with heavy metals such as Cd, Pb or even Cu and Zn are known. There are already published works related to the incidence of gastrointestinal cancer (Gupta *et al*., 2015), and cancer of the pancreas, urinary bladder or prostate (Sharma *et al*., 2016). There are, in Romania, three areas (CopşaMică-Sibiu County, Zlatna – Alba County and Baia Mare – Maramures County) very strongly polluted with heavy metals, caused by nonferrous ores extraction and metallurgical processing. The contents of heavy metals in the soils around these localities are higher than the maximum allowable limits. As a result, the plants, including vegetables, accumulated high quantities of such chemical elements (Usman and Kolo, 2015; Usman *et al*., 2016), This research thereby determine concentrations of heavy metals in sample vegetables collected from Kasuwan Mata which is a market in which vegetable irrigated by waste water and domestic water from river Kaduna and Other streams in Kaduna Metropolis are sold and to evaluate the potential health risks to local consumers.

MATERIALS AND METHODS

Sample Collection

Vegetable samples were collected from Kasuwan Mata located within Igabi Local Government Area, Kaduna State, Nigeria locations from August to November, 2016 to provide replicate samples of each plant. Vegetable samples were divided into fruit, leaf, stem and root. Vegetable samples include Okra, tomato and garden egg.

Preparation and digestion of samples for heavy metal analysis

Vegetables samples collected were thoroughly washed with water, cut and separated into different parts (root, stem, leave and fruits) and dried in an oven at 80^{o}C for 72 hours. The dried samples were

crushed in a mortar and the resulting powder was digested by weighing 1.0 g of the dried grounded sample into 250 mL beaker. 20 mL of HNO_3 was added and heated on a hot plate until no brown fumes was giving off. 10 mL of H_2O_2 was added in small portions to avoid any possible overflow leading to loss of material and the heating continue until the volume was reduced. 10 mL of HCl was finally added and evaporated to dryness. The mixture was cooled and then filtered through a Whatman No. 41 filter paper into a 100mL volumetric flask and made up to mark with distilled water (USEPA 3050b) (Radojevic and Bashkin, 1999).

Elemental Analysis of Samples

Determination of Pb, Fe, Cu, Zn, Cd, Ni, Mn and Cr as well as were made directly on each final solution using Perkin-Elmer Analyst 300 Atomic Absorption Spectroscopy (AAS).

Statistical Analysis

One-way analysis of variance (One-way ANOVA) was used to test for significant difference between the variables (samples) at $P<0.05$.

RESULT AND DISCUSSION

RESULT

The results obtained shows that tomato has the highest concentrations of Cu, Cd, Pb, Mn and Zn in August (Fig 1), and okra recorded the highest concentrations of Ni and Cr .While in the month of September, highest concentrations of Cu, Mn and Zn was observed in garden egg, and highest concentrations of Cd, Pb and Ni were recorded in okra samples (Fig 2). In the case of October, highest concentrations of Cd, Pb, Mn, Ni and Zn were recorded in garden egg, and highest Cu concentration was observed in okra (Fig 3). The result recorded in November reveals highest concentrations of cd, Cr and Zn in okra, with the highest concentrations of Cu and Mn in garden egg (Fig 4). There was no significant difference in the concentrations between samples at $P<0.05$.

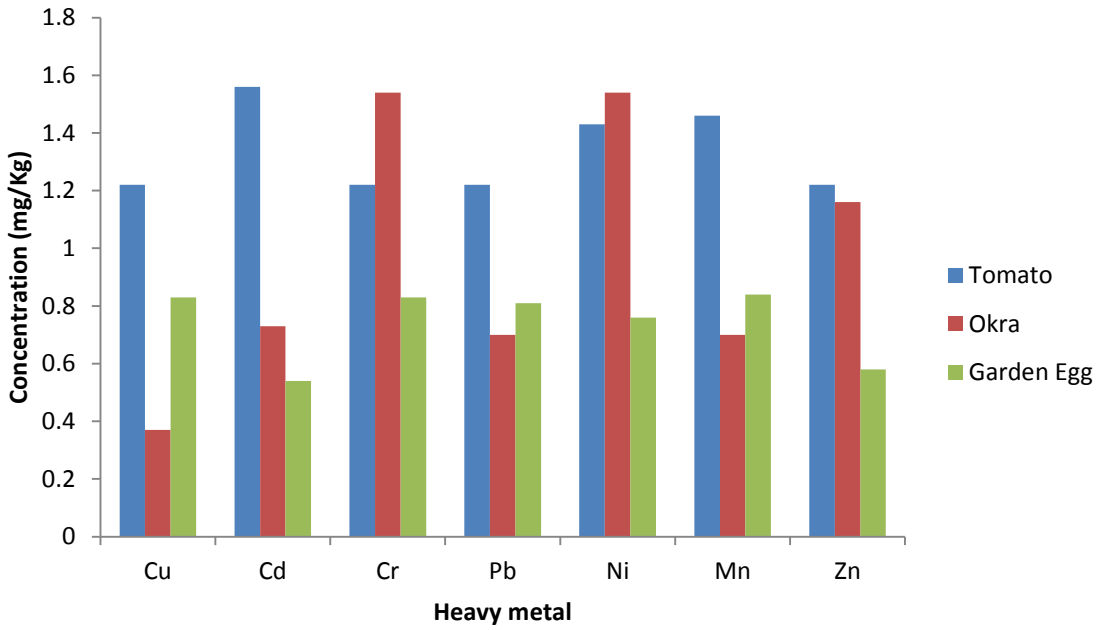

Figure 1: Heavy metal concentration in Vegetables during the month of August, 2016.

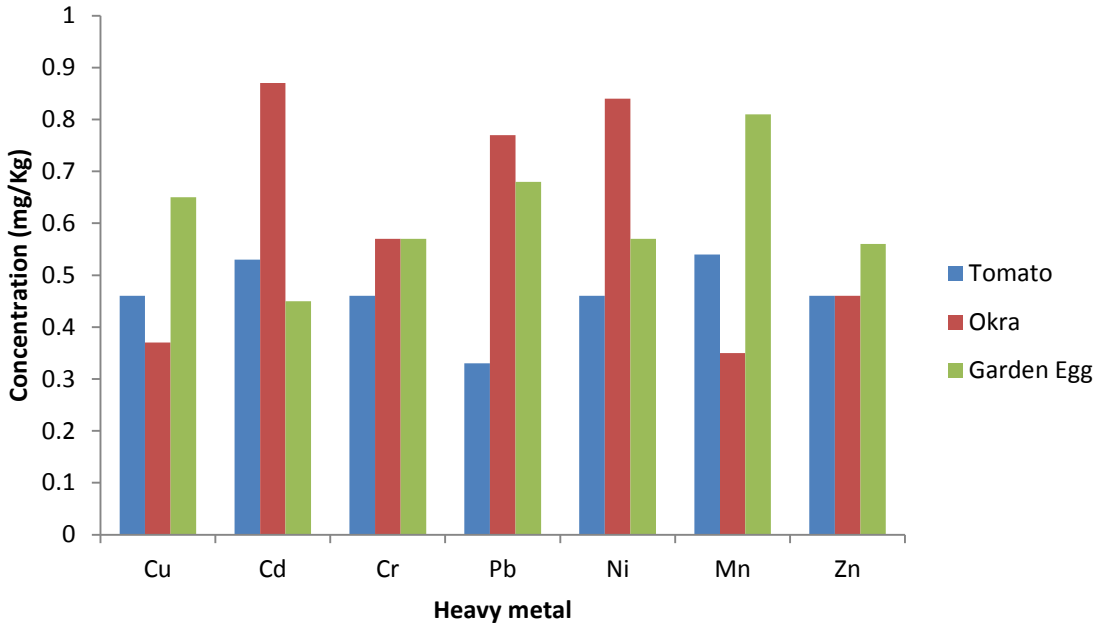

Figure 2: Heavy metal concentration in Vegetables during the month of September, 2016.

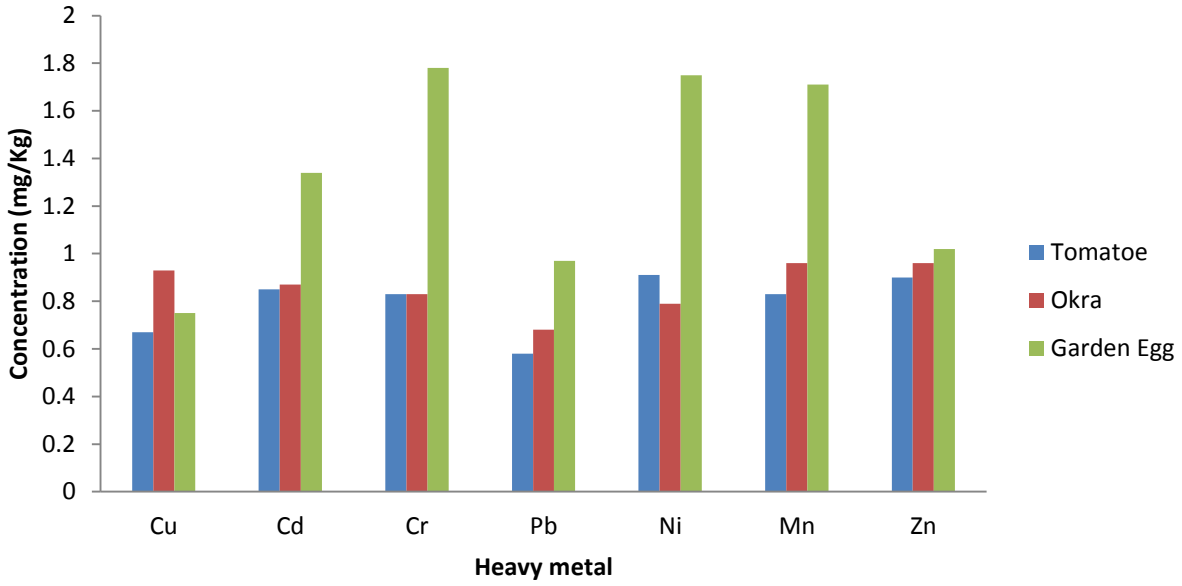

Figure 3: Heavy metal concentration in Vegetables during the month of October, 2016.

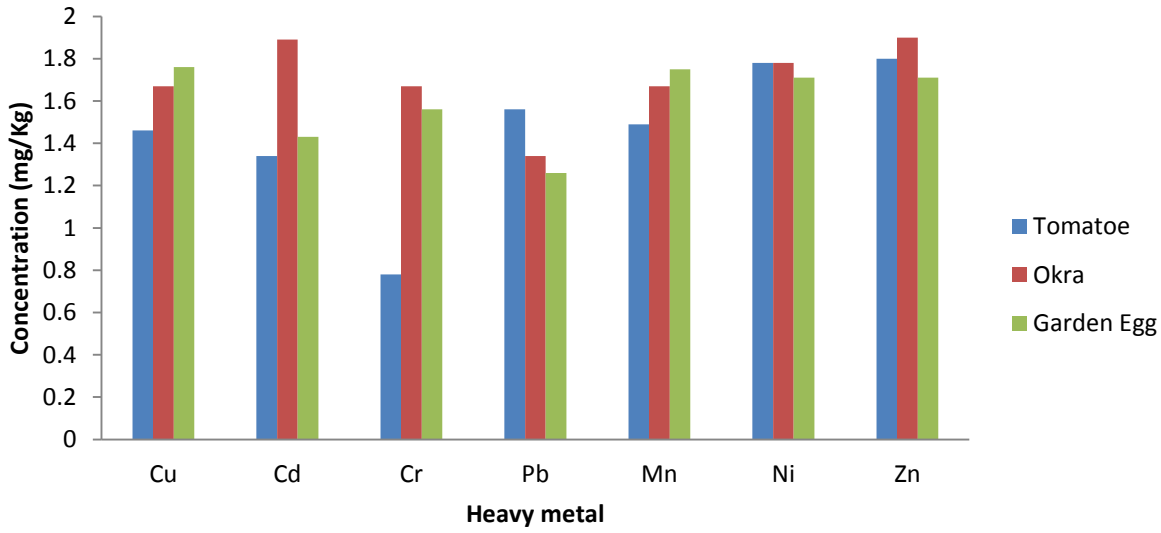

Figure 4: Heavy metal concentration in Vegetables during the month of November, 2016.

DISCUSSION

The high heavy metals concentration recorded in the month of November and October could be attributed to the fact that the vegetables were irrigated with water contaminated with the said heavy metals as a result of domestic and industrial runoff into river Kaduna and his tributary stream. This is because various sources of environmental contamination have been implicated as route for heavy metals in food. Waste water irrigation, air deposition, spillage are major pathway to heavy metals bioaccumulation in vegetables and plants (Imam, 2014; Arantes *et al*., 2016; Izah *et al*., 2016; Yu *et al.,* 2016; Bhatti *et al*., 2016;Vaikosen and Alade, 2017). This finding agrees with the findings of previous studies with regard to heavy metal contamination in the edible parts of vegetables produced in waste water irrigated sites. Studies conducted by Muchuweti *et al.* (2015), Sharma *et al.,* (2015) and Liu *et al.* (2005) also demonstrated that plants grown on wastewater-irrigated soils are generally contaminated with heavy metals, which pose a major health concern (Muchuweti *et al.*, 2015; Sharma et al., 2015; Liu *et al*., 2015; Hossain *et al.,* 2015). Rana *et al*., (2014) during a study on the determination of heavy metals content in vegetables irrigated by Hudiara drain water shows that vegetable samples contain some amount of heavy metals. The lowest concentration of heavy metals recorded was in the month of September and could be attributed to the fact that irrigation is not the only water source of irrigating the vegetables during rainy season. Although, all the heavy metal concentration in the vegetables were within WHO/FAO permissible limits but these can cause hazardous health effects in people, who are ingesting these vegetables for long period of time due magnification of these heavy metals in their body (Li and Qian, 2011; Rana *et al*., 2014; Hossain *et al.,* 2015; Ugya, 2015; Ugya and Imam, 2015, Ugya *et al*., 2015a; Ugya *et al*., 2015b; Ugya *et al*., 2015c; Ugya *et al*., 2015d; Ugya *et al*., 2016; Ugya, 2016; Hannah *et al*., 2016; Usman *et al*., 2016: Ugya *et al*., 2016b; Ugya and Imam, 2016).

CONCLUSION

The concentration of heavy metals in the vegetables decreased at month of August but increased from September, October and November. The ability for heavy metal uptake and accumulation by vegetables was highest during the month of November signifying that irrigation plays a major role in the contribution of heavy metals to the food chain of vegetable. This research further shows that the residents of Igabi local Government Area may be facing health risks due to vegetable consumption, and that children will be particularly vulnerable to the adverse effects of ingestion of heavy metals. It is thereby recommended that dry season farming of vegetables should be subjected to KEPA.

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