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DETERMINATION OF HEAVY METALS IN TOMATO (*SOLANUM LYCOPERSICUM*) LEAVES, FRUITS AND SOIL SAMPLES COLLECTED FROM ASABA METROPOLIS, SOUTHERN NIGERIA

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ABSTRACT

Soil, tomato leaves and tomato fruits collected from Asaba metropolis were digested and analyzed for metals such as lead, copper, cadmium, nickel, zinc, chromium, manganese, arsenic, iron, selenium and cobalt. The aforementioned metals were determined using atomic absorption spectrophotometry (AAS). The results obtained revealed that all the metals were detected and there were metal variations. Metal concentration in soil samples exceeded those of tomato leaves. Also, tomato leaves metals were higher than those values obtained in tomato fruits. This is an indication that the soil was pollution to the tomato leaves and fruits. The highest concentrations were found to lead and iron.

Keyword: Heavy metal, contamination, concentration, environment, vegetation, bioaccumulation.

INTRODUCTION

The environment is a natural system that encompasses the relationship between relief, vegetation, plant, animal, man and the physical world (Robinson, 1998). Another study, Konz-Lisi and Friebele (1998) discussed that the environment is constantly being spoiled and rendered very unsafe for human habitation and other organism. This unhealthy environment is brought about through the various activities of man such as mineral exploitation, agricultural practice, industrial production, food processing, social, domestic and commercial activities. All these lead to pressure on the commercial environment. However, the misleading of these activities result in environmental pollution. Heavy metal as defined by Yang and Zhang (2003) are metals having a density greater than $5g/cm^3$. They are inorganic element found in plant and animal growth in trace or very minute quantities, toxic and poisonous in relatively higher concentration, biologically undegradeable but easily assimilable and bioaccumulated in the protoplasm of living organism. Advance in technology has led to high levels of industrialization and urban migration leading to the discharge of effluents containing heavy metals in our environment. The various activities of man in recent years have increased the quantity and distribution of heavy metals in the atmosphere, land and water bodies (Zurera-cosano, 2008).

Heavy metals are usually present at level as low as ppb in a polluted or moderately polluted natural source but biological system accumulate these metals by factor as high as 1000 times more (Ademorati, 1996). This accumulation is passed on to the food chain in ppm (part per million) or higher concentration in soil, consumed by man in very much accumulated amounts and will continue to build up. The most dangerous and serious implication of these bioaccumulation is that symptoms of heavy metals poisoning may not appear or may not be identified until several years of continuous exposures and intake (Edward and Kuo, 2006). On appearance of these symptoms, they will not easily be traced back to the correct and original cause or source. The said source may have been a regular and delicious diet such as vegetables, fish or drinking water. Therefore, communities relying greatly on a contaminated diet become particularly exposed to the danger of long term chronic heavy metal poisoning.

Vegetables constitute an essential dietary component by contributing protein, vitamins, iron, calcium and other nutrients, which are usually in short supply (Thompson and Kelly, 2000). They also act as buffering agents for acidic substances produced during the digestion process. However, they contain both essential and toxic elements over a wide range of concentrations. Metal accumulation in vegetables may pose a direct threat to human health (Turkdogan *et al*., 2003; Damek-porawa and Sawicka-kapusta, 2003). Vegetables take 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 (Zurera-cosano *et al*., 2008). It has been reported that nearly half of the mean ingestion of lead, cadmium and mercury through food is due to plant

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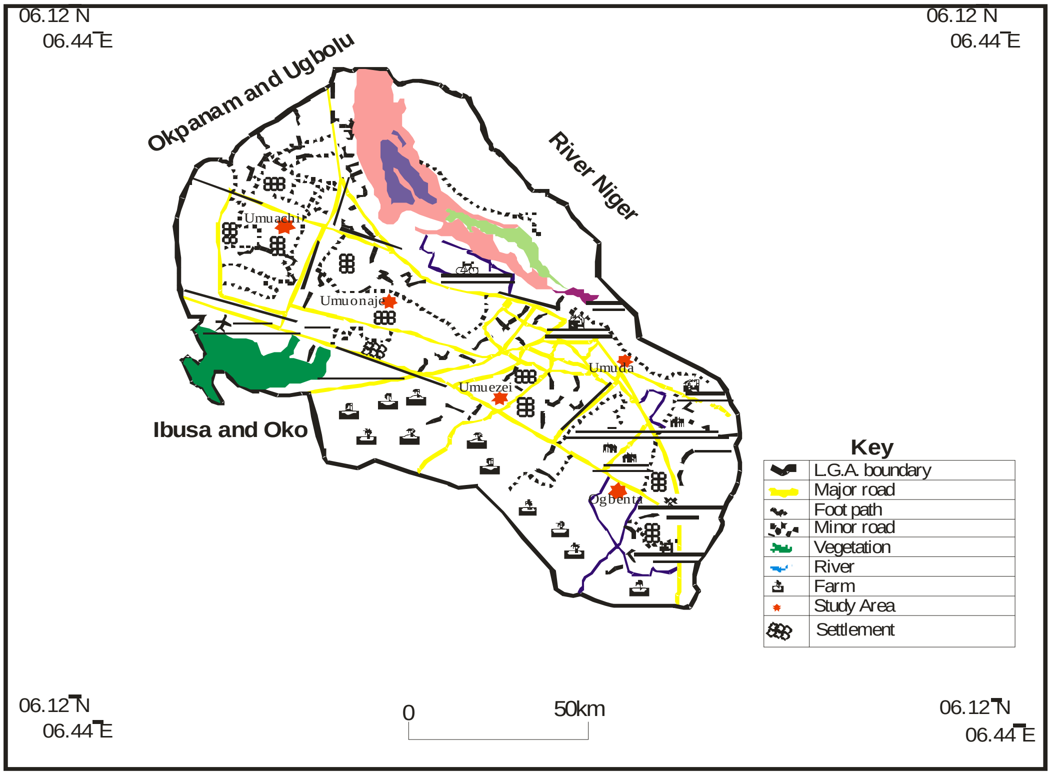

Fig. 1. Map of Asaba showing the study area.

origin. Moreover, some population groups seem to be more exposed, especially vegetarians, since they absorb more frequently "tolerable daily doses".

This study aims to (i) determine the levels of metals in tomato fruit, leaves and soil (ii) determine the sources of heavy metals in tomato fruit, leaves and soil and (iii) determine the pollution status, if any.

MATERIALS AND METHODS

Materials

Soil, tomato leaves and fruit were collected in Asaba metropolis from three different farms along Asaba-Benin expressway. The soil samples were stored in polyethylene bags and taken to Mail–In Laboratory in Warri Metropolis. The wet soil samples were dried under sunlight and later kept at room temperature at 25^{o}C free from moisture. The tomato leaves and fruit samples were collected from the same site at 10m, 50m and 100m. Samples were air dried, grinded and sieved.

Study site

Asaba is a town in Oshimili South Local Government Area and also the capital territory of Delta State situated in the Niger Delta region of the Southern part of Nigeria (Fig. 1). It lies between latitude 6^{0}12'N and longitude 6^{0}44'E of the equator. It is bounded on the east by Onitsha, in Anambra State, on the west by Ibusa, on the north by Asako and Ugbolu, while on the south by Oko. The town also has a lot of registered and unregistered small and large industries. This includes block industry, Asaba Aluminium Company, borehole, sales of cements/depot, bakeries, Eternite roofing sheet company, sales of timber, plywood industry, commercial banks and poultry/animal farms.

Apparatus

The apparatus used in this study included: measuring cylinder (100ml), funnel, volumetric flask (500ml), pyrex bottom flask (25ml) hot plate, beam balance (electrical digital), wattman's filter paper, masking tape, sampling bottles (plastics) and atomic absorption spectrophotometer (AAS).

Determination of Metal in Soil Sample

The loamy sand texture was 99% sand and 1% silt and clay. Soil samples were taken at the three randomly replicated plots in three different quarters. 20g of soil was weighed into acid washed platinum crucible. 20ml of concentrated HNO_3 was added and left for 20 minutes (it is imperative that this step be carried out before the

Table 1. Heavy metal in soil obtained from Asaba metropolis.

Sample Code	Metals in mg/kg dry weight										
	Pb	Cu	Cd	Ni	Zn	Cr	Mn	As	Fe	Se	Co
SSA (O_1)	10.14	2.28	0.01	3.96	7.88	0.15	14.53	0.01	66.00	0.01	0.01
SSB (O_2)	7.01	2.01	0.01	2.03	5.53	0.16	12.15	0.01	70.12	0.01	0.01
SSC (O_3)	9.12	2.24	0.01	3.01	4.35	0.01	11.52	0.01	61.22	0.01	0.01

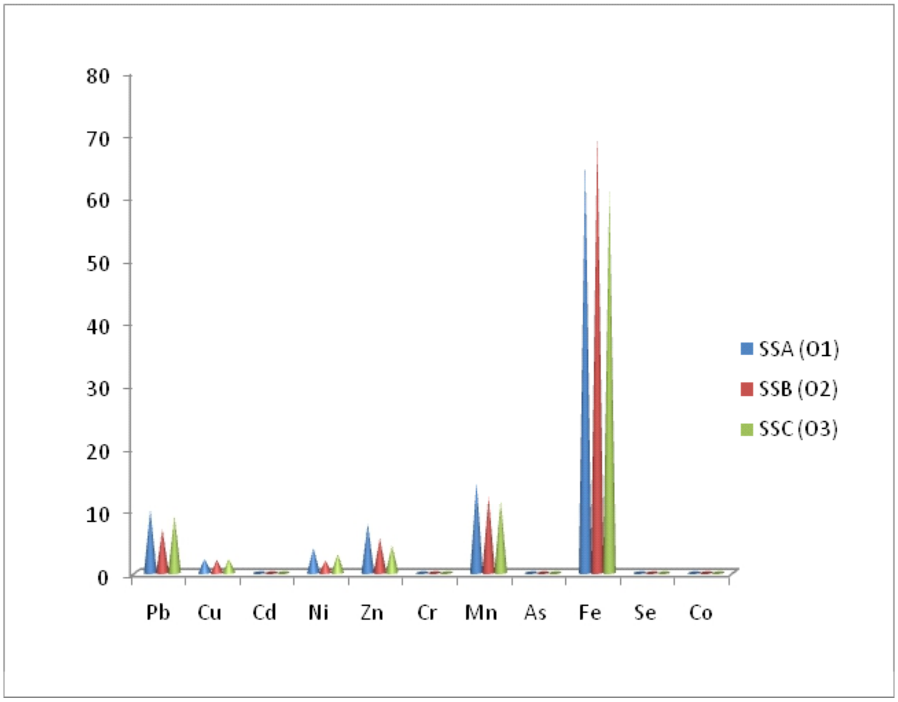

Fig. 2. The concentration of heavy metals in soil collected from Asaba metropolis.

addition of perchloric acid otherwise, explosion may occur). 2ml each of $HClO_4$ and HCl in the ratio of 10:1 was added and left for about 10 minutes. Heat the sample in the crucible in a hot plate from 135–180^{0}C and evaporate the content almost to dryness. 10ml of deionised water was added and boil gently to dissolve the residue. Cool and filter through No. 42 wattman filter paper into 100ml volumetric flask and make to mark with deionised water. The soil extracts and the standard solutions were aspirated into the air-acetylene flame of Varian 220 (*fast sequential*) Atomic Absorption Spectrometer. A blank sample was also prepared and analyzed along the sample.

Determination of Metal in Tomato Leaves and Fruits Samples

20g each of tomato leaves and fruits were weighed into two acid washed platinum crucible. 20ml of concentrated HNO_3 was added to each of the containers and leave for 20 minutes (it is imperative that this step be carried out before the addition of perchloric acid otherwise, explosion may occur). 2ml each of $HClO_4$ and HCl in the ratio of 10:1 was added and left for about 10 minutes. The samples were heated in the crucible in a hot plate from 135–180^{0}c and evaporate the content almost to dryness. 10ml of deionised water was added and boil gently to dissolve the residue. Cool and filter through No. 42 wattman filter paper into 100ml volumetric flask and make to mark with deionised water. The tomato leaves and fruits extract and the standard solutions were aspirated into the air-acetylene flame of Varian 220 (*fast sequential*) Atomic Absorption Spectrometer. A blank sample was also prepared and analyzed along the sample.

Determination of plant biomass

The weight of the vegetables or plant species was determined in two phases (the wet weight WW and the dry weight DW) at the end of the study by the method of Edwin-wosu and Kinako (2004). The wet weights were obtained using a weighing balance. The entire plant leaves and fruits of known fresh weights were dried under the sun for 10 days to constant weight. The dried plants were reweighed to obtain the dry weight.

Table 2. Heavy metal in tomato leaves obtained from Asaba metropolis.

Sample Code	Metals in mg/kg dry weight										
	Pb	Cu	Cd	Ni	Zn	Cr	Mn	As	Fe	Se	Co
TLSA (O_1)	4.01	1.19	0.01	1.83	4.89	0.16	4.51	0.01	7.13	0.01	0.15
TLSB (O_2)	3.84	1.56	0.01	2.07	4.00	0.41	4.48	0.01	8.15	0.01	0.4
TLSC (O_3)	4.03	1.75	0.01	2.01	4.52	0.01	4.42	0.01	8.11	0.01	0.01

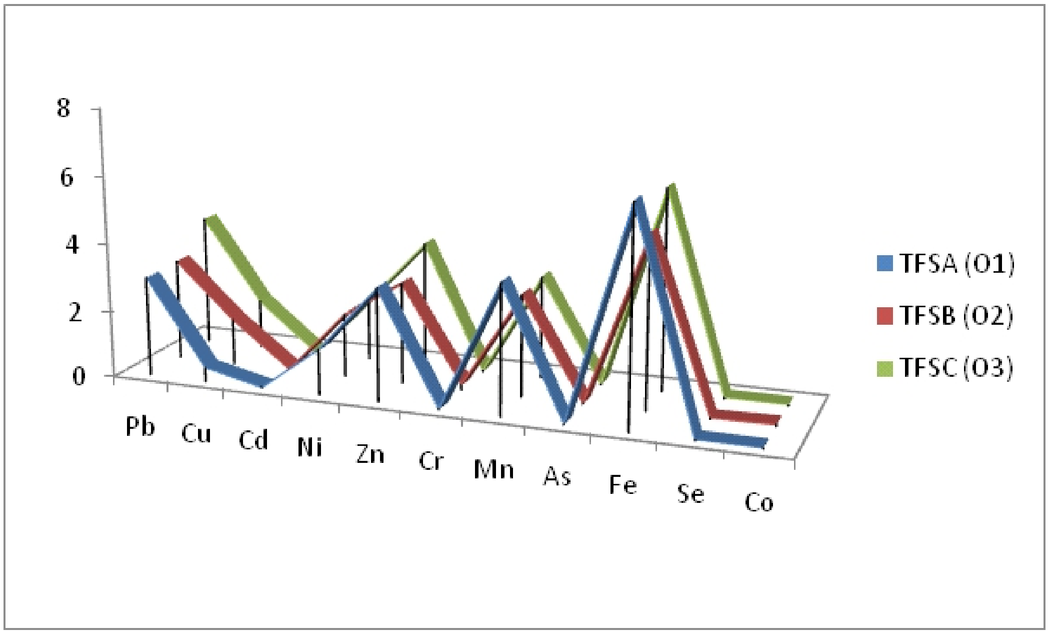

Fig. 3. The concentration of heavy metals in tomato leaves obtained from Asaba metropolis.

Quality Control

Quality control was assumed from the use of analytical blank and spike. The blank were prepared in a similar manner like the same. All instrument reading was corrected with the blank. A recovery test of the entire procedure was carried out by a spike and already analyzed with known standard of the metal of interest. An acceptable recovery of 92% and 93.4% was achieved for chromium and nickel.

$$\frac{\text{Concentration of the spike} - \text{Concentration of the unspiked}}{\text{Concentration of the unspiked sample}} \times \frac{100}{1}$$

RESULTS AND DISCUSSION

Soil, tomato fruits and tomato leaves collected in Asaba metropolis were digested and analyzed for heavy metals. The results obtained revealed that all the metals analyzed were detected and there were variation in the values obtained in soil, tomato fruits and tomato leaves respectively. The metal concentrations obtained in the aforementioned samples are presented in table 1, 2, and 3 respectively.

The results of the analysis as displayed in the various tables and figures show the concentrations of heavy metals in the samples. Table 1 and figure 2 shows the concentration of heavy metals in the soil sample. Table 2 and figure 3 show the concentration of heavy metals in tomato leaves samples and table 3 and figure 4 shows the concentration of heavy metals in tomato fruit samples. A look at the three soil samples location revealed that metal concentrations in samples SSO_1, SSO_2 and SSO_3 were higher than those values obtained in samples $TLSO_1$, $TLSO_2$ and $TLSO_3$ (tomato leaves). Also, the tomato leaves metal values exceeded those of $TFSO_1$, $TFSO_2$ and $TFSO_3$ (tomato fruits). Although, metals such as copper, nickel, zinc, manganese and cobalt, concentrations in this study are not considered dangerous when compared with other studies with similar areas. Whereas metals such as lead, cadmium, chromium, arsenic, iron and selenium are considered to be dangerous on long-term basis. The contamination of the tomato leaves and tomato fruits is an indication that the soil is polluting the vegetables. The elevated concentrations of metals in soil samples are traceable to the activities of various industries in Asaba

Table 3. Heavy metal in tomato fruits obtained from Asaba metropolis.

Sample Code	Metals in mg/kg dry weight										
	Pb	Cu	Cd	Ni	Zn	Cr	Mn	As	Fe	Se	Co
TFSA (O_1)	2.96	0.41	0.01	1.35	3.33	0.01	3.83	0.01	6.38	0.01	0.01
TFSB (O_2)	3.01	1.35	0.01	1.88	2.98	0.15	3.01	0.01	5.09	0.01	0.05
TFSC (O_3)	3.92	1.44	0.01	1.82	3.73	0.01	3.05	0.01	6.00	0.01	0.01

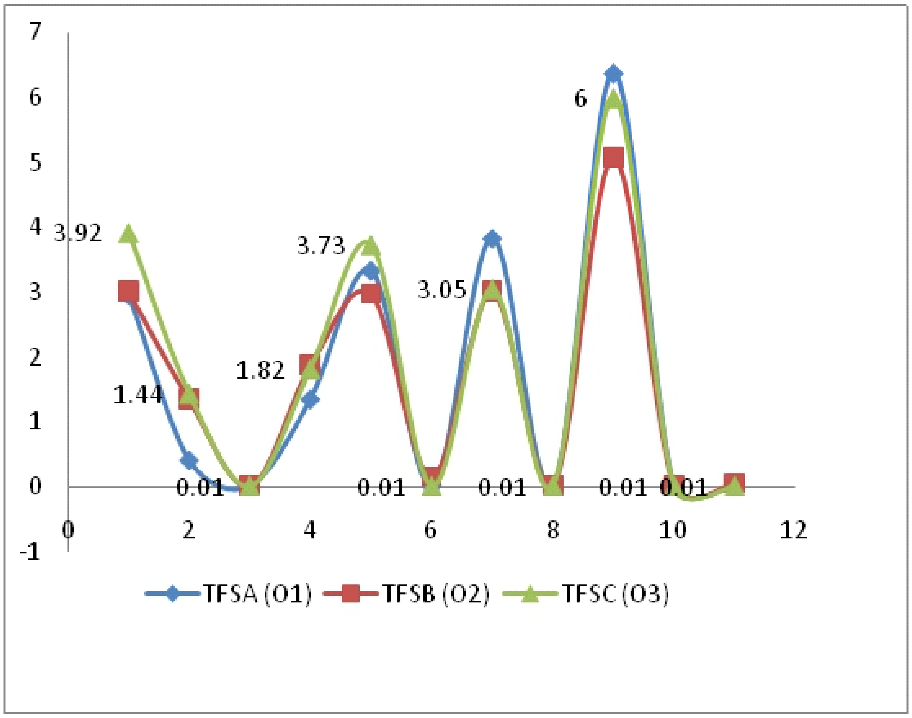

Fig. 4. The concentration of heavy metals in tomato fruits obtained from Asaba metropolis.

and its environs. Lead and iron concentrations in this study are highly elevated. Especially, lead values in all the sample can lead to health problems on long-term basis. Mental retardation and brain damage especially in children could occur, if no urgent measure is taken.

This study had revealed that metal concentrations in tomato leaves are higher than those of the fruits indicating that it is safer to consume the tomato fruits. The increase in metal values in leaves of tomato plants is as a result of the uptake rate of the soil nutrient.

Metal such as cadmium, arsenic, selenium and cobalt in soil, tomato leaves and tomato fruits did not indicate variations in terms of metal values. However, the presence of the aforementioned trace metals in tomato fruits could lead to metal poison. Urbanization and anthropogenic wastes normally found in urban towns could account for vegetable contamination via the soil.

CONCLUSION

Soil, tomato leaves and tomato fruits were collected in Asaba metropolis. These samples were analyzed for metals such as lead, copper, cadmium, nickel, zinc, chromium, manganese, arsenic, iron, selenium and cobalt respectively. Metal levels in soils were considered to be higher than those of the tomato leaves and tomato fruits. This is an indication that the contamination of the vegetables was through the soil. These elevated concentrations of metals were attributed to the activities of industries and anthropogenic wastes around Asaba and its environs. Lead and iron concentrations in all the samples determined were highly elevated indicating pollution.

RECOMMENDATIONS

This study has some recommendations towards reducing the level of environmental pollution in the study area.

- The Delta State Environmental Protection Agency (DELSEPA) should live up to their expectation in monitoring environmental pollution in the state.
- DELSEPA should set up a guideline and published same to the public for proper monitoring of pollution in urban and rural area of the state
- A central laboratory should be established in the major cities of the state for effective monitoring of soil pollution
- Any company which gaseous emission and/or discharged effluent are detected to be above the set limit for air and water should be penalized for non-compliance by paying any applicable fine.

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