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HEAVY METAL CONCENTRATIONS IN SOME SELECTED VEGETABLES FROM THE VICINITY OF KAOLIN MILLING PLANT IN ALKALERI, BAUCHI STATE-NIGERIA

A.O. ABDULLAHI[1]*, A.B.MOHAMMED[1] AND M.J YELWA[1]
[1] *Department of Chemistry, Gombe State University, P.M.B. 127 T/Wada, Gombe State. Nigeria.*

*Corresponding author: latyph2k@yahoo.com

ABSTRACT

Heavy metals in tomato and okro vegetables from the vicinity of kaolin milling plant in Alkaleri, Bauchi state were determined. Simple random sampling method was used in sample collection. Sample collection was done three times in interval of one month. Samples were then air dried and digested using hot HCl, H_2SO_4 and HNO_3 in the ration of 1:5:1. Elemental analysis was carried out using Atomic Absorption Spectrophotometry. The result of this study showed that the average concentration of zinc detected ranged from 9.33 to 13.20ppm in Tomato and 2.76 to 5.30ppm in Okro while cadmium varied from 1.11 to 3.17ppm and 0.59 to 1.58 in tomato and okro respectively. Chromium ranged from 0.96 to 1.48ppm (Tomato) and 1.42 to 1.98ppm (Okro), Lead detected ranged from 0.91 to 2.21ppm (Tomato) and 1.24 to 1.85ppm (Okro), Iron ranged from 33.61 to 40.0ppm(Tomato) and 12.71 to 14.99ppm (Okro) and Cobalt ranged between 3.06 to 6.46ppm (Tomato) and 1.55 to 4.42ppm (Okro). The result showed that the concentration of heavy metals varied in order of Fe> Zn> Co> Cd > Pb > Cr. All but the level of Zn and Fe were above the safe limits established by FAO and WHO.

Keywords- Heavy metals, vegetable, kaolin, milling plant, Alkaleri

INTRODUCTION

Crops and vegetables grown in soil contaminated with heavy metals have greater accumulation of heavy metals than those grown in uncontaminated soil (Sharma *et al*.., 2007). Heavy metals accumulation varies from one plant to another, one heavy metal to another and the plant parts (Leita, 1998).

Pollution in plants is of concern for two major reasons. Firstly, pollutants may have direct phytotoxic impact on the plants themselves, leading to a decline in crop yield and threatening food supplies and secondly, the plants may act as a vehicle for transferring pollutants into the food chain (Owosu-Donkor, 2011). Since crops take up nutrients from the soil, the presence of heavy metals in high concentrations is expected to correspond to high concentrations in agricultural produce from these affected soils. Agricultural products have their permissible levels for heavy metals upon which consumption will be harmless, especially for edible fruits. Extensive long term studies on the uptake of soil metals by plants illustrate that metals can accumulate in edible tissues of plants (Owosu-Donkor, 2011).

Heavy metals may enter human body through food, water, air or absorption through the skin when they come in contact with human in agriculture, manufacturing, pharmaceutical, industrial, or residential settings (Robert, 1999). Plants growing in polluted environment can accumulate the toxic metal at high concentration causing serious risk to human health when consumed (Oti and Nwabue, 2011).

MATERIALS AND METHODS Study area

The study area covers about 9Km^2 around the kaolin milling plant located at Alkaleri local government area of Bauchi State in the North-Eastern Nigeria. Alkaleri is located at the coordinates: 9^{0}53'N 10^{0}30'E / 9.883^{0}N 10.500^{0}E.

Sampling

The samples were collected from a distance of 500m, 1000m and 1500m away from the factory in the directions of North, South and West. The controls were collected at the interval of 2km, 3km and 4km east away from the factory. Simple random sampling method was adopted in the sample collection. The samples were then air dried in the laboratory. The dried samples were kept in a clean dried polyethylene bag. The sample collection was done over a period of three month, at the interval of one month each.

Sample preparation

2g each of the vegetable samples and control were weighed and transferred into separate clean 250ml beaker and digested using a mixture of Perchloric, Nitric and Sulphuric acids in the ratio 1:5:1 (Bonglaisin et al, 2011). The mixture was heated for an hour and allowed to cool at room temperature. This was then filtered into a 50ml volumetric flask through acid wash filter paper (Whatman 24) and made up to mark with distilled water. Similarly blank was prepared in the same manner but in the absence of the sample. Standard solutions of each of the metal: copper, iron, zinc, chromium, cadmium and lead were prepared and run using Atomic Absorption Spectrophotometer (AAS) Buck Scientific, model VGP at various wave lengths to prepare a standard calibration curve. The heavy metals concentrations in the vegetable samples and the control were determined using AAS Buck Scientific, model VGP by extrapolation.

RESULTS AND DISCUSSION

Table 1: Heavy metals concentrations (ppm) in the vegetable samples

Parameters	Samples (Mean concentration)		Control	
	Tomato	Okro	Tomato	Okro
Zinc	13.2±3.87	5.30±2.54	1.06±0.41	2.65±0.50
Cadmium	3.17±2.06	1.58.±0.99	1.06±0.42	1.06±0.42
Chromium	1.48±0.52	1.98±0.56	0.99±0.24	0.99±0.24
Lead	2.11±1.20	1.85±0.61	1.58±0.70	1.06±0.46
Iron	40.0±6.39	14.99±2.28	26.66±4.56	13.33±2.13
Cobalt	6.46±3.40	4.42±2.87	5.00±2.74	0.96±0.21

Values are mean± standard deviations for triplicate determinations**.**

The concentrations of heavy metals found in the vegetables based on sample dry weight were summarized in the table 1 above.

The zinc concentration in the tomato samples ranged between 9.33 to 13.20ppm and this is higher than that found in the tomato control which ranges between 0.65 to 1.06ppm. In okro samples, the concentrations were found to be between 2.76 to 5.30ppm which are higher than that okro control which ranges between 2.15 to 2.65ppm. This concentration is lower than that reported by Oviasogie *et al*. (2007) and Sani *et al*. (2011) whose values falls between 3.20 to 23.80mg/kg and 20.4 in spinach and 24.21µg/g in lettuce respectively. It was reported by Jabeen *et al*. (2010) that the permissible limit set by FAO/WHO in edible plants was 27.4 ppm. Dietary limit of Zn is 100 ppm as reported by Jabeen *et al*. (2010). Zinc is an essential trace element and plays an important role in various cell processes including normal growth, brain development, behavioral response, bone formation and wound healing (Moses *et al*. 2012).

Cadmium content in the tomato samples ranged from 1.11 to 3.17ppm which was higher than that in the tomato control that ranges between 0.64 to 1.06ppm. Cadmium in the okro samples also between 0.59 to 1.58ppm which is higher than that in okro control which falls between 0.64 to 1.06ppm. These values are higher than the 0.01µg/g for toxic metal uptake by spinach and lettuce reported by Sani *et al*. (2011). FAO and WHO, (2004) maximum limits for Cadmium is 0.5 and 0.2ppm respectively. It was found that all studied samples have cadmium above the permissible limit set by FAO/WHO. Cadmium causes both acute and chronic poisoning, adverse effect on kidney, liver, vascular and immune system (Jabeen *et al*. 2010).

Concentrations of chromium found in the tomato samples analyzed were between 0.96 to 1.48ppm which are higher than that of tomato control that ranges from 0.75 to 0.99ppm. Chromium in okro samples ranged from 1.42 to 1.98ppm and it is higher than that in okro control which ranges from 0.75 to 0.99ppm. The values are higher than those earlier reported by Khan *et al*. (2008). Omogbehin and Osesua (2011), also reported a value lower than that obtained in this study. The values compared well with the daily intake estimated by (USEPA, 2010) which is 105mg per day. Chromium is an important element for the insulin activity and DNA transcription (Fernando *et al*. 2012). However, an intake below 0.02ppm per day could reduce cellular responses to insulin (Kohlmeier, 2003). Chromium is one of the known environmental toxic pollutants in the world (McGrath and Smith, 1990). An elevated concentration between 5-30 mg kg^{-1} is considered critical for plants and could cause yield reduction (Kabata-Pendias and Pendias, 1992).

High concentrations of lead found in the tomato samples were between 0.91 to 2.11ppm which are higher than that of tomato as control that ranges from 0.88 to 1.58ppm. Lead in Okro samples ranged from 1.24 to 1.85ppm and it is higher than that in Okro as control which ranges from 0.60 to 1.06ppm. This concentration is lower than the values reported by Naser *et al*. (2012) which ranged 1.65 to 4.76µg/g. Also, Fawotade *et al*. (2012) reported a value ranged 0.16 – 0.39mg/kg which is lower than the one analyzed in this research. FAO and WHO, (2004) maximum limits for lead is 0.5 and 1.5 respectively. The toxicity effects of lead focus on several organs, such as liver, kidneys, spleen and lung, causing a variety of biochemical defects (Fernando *et al*. 2012). The nervous system of infants and children is particularly affected by the toxicity of lead.

The vegetable samples collected from the vicinity of the milling plant area showed high amount of iron in tomato samples (33.61 to 40.0ppm), followed by control of Tomato which is between 22.1 to 26.66ppm. Okro samples ranged between 12.71 to 14.99ppm and control has 11.2 to 13.33ppm. Oviasogie et al. (2007) reports a value ranged 21.20 to 142.50 mg/kg which is higher than that in this study. The vegetables showed a lower concentration when compared with the analysis reported by Sani *et al*. (2011) who reported 357.78µg/g in lettuce and 211µg/g in spinach. The high iron amount in the aerial parts is also due to the foliar absorption from the surrounding air. Iron deficiency in plants produces chlorosis, however its high concentration also affects plant growth (Sakolnik, 1984). Iron together with haemoglobin and ferridoxin plays a central role in metabolism (Khan *et al*. 2008). FAO and WHO maximum limits for iron is 450 and 425ppm respectively.

Cobalt was found in the vegetables from the kaolin milling plant area, where its concentrations in tomato samples were between 3.06 to 6.46ppm which is higher than that in tomato control that was between 2.26 to 5.00ppm. Cobalt in Okro samples have concentrations of 1.55 to 4.42ppm and it is more than Okro control which was from 0.75 to 0.96ppm. This concentration is higher than that reported by Murtaza *et al*. (2003). Cobalt is a constituent of vitamin B12. The estimated daily intake of cobalt was 0.040mg equals to 3mg per day established by (Food and Nutrition Board, 2004). It is very essential to provide 2.0μg per day in the form of vitamin B12 for a diabetic individual (Khan *et al*. 2008). High intake of cobalt causes vomiting, nausea, vision and heart problems and also damage of thyroid (Bethesda 1993, Smith 1990).

CONCLUSION

The results reported here confirm that the vegetables collected from the vicinity of kaolin milling plant in Alkaleri, Bauchi state of Nigeria contained measured metals contents within and/or outside the safe limit prescribed by the FAO/WHO. The result showed the concentration of heavy metals were in the order of Fe> Zn> Co> Cd > Pb > Cr. All the metals investigated except Zn and Fe were above the safe limits established by FAO and WHO. This result is important as human health is directly affected by ingestion of vegetables.

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