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Original Research

Determination of heavy metal (zinc, Zn, Iron, Fe and Lead, Pb) concentrations in some selected food crops (yam, cassava, and potato)

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ABSTRACT: The analysis of heavy metals (Zn, Fe and Pb) concentration of selected food crops namely yam, cassava and potato sourced from Aluu market a close agrarian community to Port Harcourt in Rivers State was carried out. Samples were powdered before digesting with aqua ragia solution. Various filtrate from the digested samples were sent for instrumental analysis for cations using atomic absorption spectrophotometer (AAS). The results showed that the concentrations of zinc (Zn) in yam, cassava and potato were 92.39, 69.42 and 11.04mg/kg respectively. The concentrations of iron (Fe) in the same crops sample were 24.78, 30.50 and 33.87mg/kg. Lead (Pb) concentrations in the same crops sample were 2.57, 3.26 and 1.83mg/kg respectively. The variations in the concentrations of the metals ions in crops samples may be attributed to the nature of the soil, the use of fertilizers and closeness of the farmlands to areas having high industrial activities. The high zinc and iron concentrations in yam and cassava show that these plants can serve as good sources of these metals. The potato with the highest iron concentration could also be a better source of iron than sweet potato and cassava. However, the high lead concentrations in cassava and yam, which are above the levels recommended by WHO /NAFDAC, mean that although they are good sources of iron and zinc, they can also be dangerous to humans if these plants, which come from the same source, are consumed continuously.

Keywords: Heavy metals (zinc, iron, lead) , Food crops (yam, cassava, potato)
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INTRODUCTION

The awareness about the safety of foods is increasing in several parts of the world. The wellbeing of humans are majorly dependent on the types of foods they consume. Tropical roots and tuber crops including cassava, yam and potato are consumed as staple foods and also used as raw materials for small scale industries, especially in less developed countries. Cassava, yam and potato are very important staple foods in almost all communities in Nigeria. These food crops when planted acquire their nutrients from the soil and probably incorporate heavy metals in their roots and tubers through assimilation (Lovet and Kaplan, 2014). Hence, there is a probability that roots and tubers of crops may contain certain concentrations of beneficial and hazardous heavy metals. Metal elements that possess specific gravity of more than 5g/cm^3 are referred to as heavy metals. Examples of some heavy metals mercury, zinc, copper, gold, lead, iron, arsenic selenium etc. Most of them are natural components of the earth crust and cannot be degraded nor destroyed. Many of them are beneficial to humans, and animals when they are accumulated in their systems at certain concentrations while some are toxic when they exceed certain levels in human and animals.

Heavy metals can enter into the bodies of animals and humans through foods, water and air when they occur as particular matter. Human beings require the presence of

heavy metals such as zinc and iron for their healthy living even though at higher concentrations, become harmful. Heavy metals such as lead and mercury are considered as toxic contaminants when they occur at certain in foods.

The increase in heavy metals concentrations in foods over the allowed limits by World Health Organization (WHO) may cause toxic effects in individuals consuming them. These effects are more in children and older people than middle aged people (Shaid and Omar, 2015). Zinc is an essential nutrient in humans and animals. It is necessary for the function of a large number of metallo-enzymes. These enzymes include alcohol dehydrogenase, deoxyribonucleic acid (DNA, ribonucleic acid (RNA), polymerase etc. The deficiency of zinc has been associated with poor wound healing, impaired immune functions and depressed metal functions. Excess of zinc can result in a decreased availability of dietary copper and the development of copper deficiency.

Iron is an essential constituent of certain biological molecules in humans and animals such as haemoglobin that regulates oxygen distribution in human and animals systems. The deficiency of iron includes symptoms such as reduced resistance to infections, work productivity, weakness and fatigue.

Lead is an extremely toxic heavy metal that disturbs various physiological processes and does not play any biological function but interferes with numerous enzymes activities in cells of humans. The effect of high concentration of lead in humans includes muscle and joint aches, constipation and overall fatigue. Excess of lead in humans can cause death by damaging the brain as a result of oxygen deficiency.

White yam (*Dioscorearotundata*) is a food crop cultivated in Africa. It is one of the most cultivated staple food crops in African countries. The mode of cultivation is by seedlings which mature after about nine (9) months before harvesting yam tubers grow and absorb their nutrients, including heavy metals from the soil.

Lovet and Kaplan (2014) in their studies on heavy metal absorption in individual plants, suggested that individual plants have different capacities to absorb and accumulate heavy metals which can lead to contamination of the food chain.

In a research carried out by Ihesinachi (2015) to determine the presence of heavy metals in white yam from farms in Khana, Rivers State, he suggested that the continuous consumption of white yam from farms in Khana will have adverse effects on consumers as a result of high concentrations of harmful heavy metals.

Cassava (manehotspp) is the most staple food crop in tropical Africa. The processed flour form is commonly known as garri in Nigeria. Its unique high adaptivity in a variety of ecological conditions has earned it the status of being the most important famine reserved crop. Cassava can be consumed as either as raw (boiled) or in a variety of processed forms known by different names depending on local customs. Cassava produces include cassava meals, chips, flour and starch. Cassava flour (garri) is gaining fast recognition as a good substitute for wheat flour in bakeries and fast food industries. Cassava has the tendency to bioaccumulation heavy metals in their various parts from the environment. The metals enter the crops through human activities such as industrial agricultural mining and waste disposal activities. Emurotu (2012), in his research work on cassava flour (garri) sold in Anyigba market in Kogi state Nigeria, showed that the concentration of lead was above the acceptable limit of WHO (0.4mg/L for lead). In a similar research work by Iniebiya (2018), in his research on potato and cassava flour sold in different markets in Port Harcourt, River State obtained similar results. They suggested that people within the localities who continuously consume these tropical food crops are likely to be in potential health hazard.

Potato (*solumtuberosum*) is a food crop grown for its starchy edible tubers. Potatoes are frequently served whole or marshed as a cooked vegetable. It can also be made into potato flour used in baking and as a thickness for sauces. Oti and Nwabue (2013) had shown in their research work on sweet potato that the concentration of arsenic and lead exceeded the World Health Organization (WHO) limits and that the consumption of the food crop over a period of time may result to bioaccumulation of toxic metals which can lead to adverse health effects or even death. However, Shaid and Omar (2015) had stated in their work on the concentrations of heavy metals, iron and zinc, in potato consumed by households in Ingawa in Katsina State, Nigeria, that the continuous consumption of the food crop may lead to the build-up of biological molecules such as haemoglobin. From the contributions of the various researchers on heavy metals concentrations in food crops, it can suggested that heavy metals concentrations in crops depend on the type food crop, the nature of the soil the use of fertilizers during cultivation and a crops selective absorption for a particular metal.

MATERIALS AND METHODS

Materials

Yam tuber
Potato tuber
Cassava tuber
Weighing balance
Oven
Sieve
250ml beakers on conical flasks
Distilled water
Filter papers

Specimen containers
Funnel
Mortar and piston or blender
Aqua ragia solution

Samples collection and preparation

Three samples of tubers (yam, cassava and potato) were obtained from Aluu market, a residential and agrarian community in Ikwerre Local Government Area with close proximity to Port Harcourt, Rivers State, Nigeria. Each of the samples were peeled, marshed with tap water and rinsed for proper cleaning. The cleaned samples were air-dried before oven – drying at 65^{o}c. The dried samples were powdered and sieved before digesting with aqua-ragia (i.e. a mixture of concentrated HNO_3 and HCl in 3:1 ratio). After digestion, the digest were dissolved with distilled water and filtered using Whatman filter paper. Filtrates of the different samples were put into different specimen containers properly labeled before sending the samples for analysis of the concentration of zinc, iron and lead in each sample using atomic adsorption spectrophometer (AAS).

RESULTS AND DISCUSSION

Results

The results obtained from the analysis of the metals (Zn, Fe and Pb) concentrations in selected samples of yam, cassava and potato are recorded in (Table 1).

Table 1: Result of the concentrations of Zn, Fe and Pb

	Zn (mg/Kg)	Fe (Mg/Kg)	Pb (Mg/Kg)
Yam	92.39	24.78	2.57
Cassava	69.42	30.50	3.26
Potato	11.04	33.87	1.83
WHO/FAC	60.00	48.00	2 – 3
NAFDAC	50.00	40 – 55	2 – 3

DISCUSSION

The results showed that the concentration of Zn in Cassava was higher than that of Fe and value is also above WHO/FAO and NAFDAC recommended values. This may be probably due to the fact that the soil where the crop was grown is rich in but low in Fe. It may also be attributed to the crop is selective absorption for Zn. According to Lovet and Kaplan (2014), crops individual plants have different capacities to absorb and accumulate heavy metals which can lead to contamination of the food chain. The concentration of lead in cassava was above WHO/FAO and NAFDAC limits. The high value to Pb in the Cassava sample may be as a result of the closeness of the area where the crop was cultivated to industrial area or selective absorptivity for Zn by yam. The high value Zn in the Yam sample means that yam is a better source of Zn than Fe. The concentration of lead in the yam sample was higher than the recommended values for human accumulation. Potato gave low values for Zn and Fe. The low values can be attributed to the nature of the soil as the crops low absorption for these metals. Potato also gave the lowest concentration of Pb that below the recommended limits for human absorption. The values obtained from the analysis of the metals (Zn, Fe and Pb) in the crops samples, show that potato sample from Aluu market may not be a good source Zn and Fe but consumers may be free from lead accumulation and probably lead poisoning.

Conclusion

The food crops samples analyzed (i.e. yam, cassava and potato) for heavy metals (Zn, Fe, Pb) concentrations are popular staple foods with high consumption rates in Nigeria. The high values obtained for Zn and Fe in yam and cassava shows that the two crops can serve as good sources of these beneficial heavy metals. However, continuous completion of the crops may lead to lead accumulation and possibly lead poisoning in humans. But this may not be the case for potato which has the lowest concentration of lead even though it is a poor source of Zn and Fe.

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