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# Determination of heavy metals in some selected varieties of cassava cultivated in Jalingo, Taraba state

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## Abstract

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. The analysis of heavy metals concentration in cassava sourced from one farm each from the two study locations were carried out. The representative samples of the three different varieties of cassava were washed and dried in an oven at 60 °C. The dried samples were ground into homogeneous powdered. the representative sample was further ashed then digested using aqua regia. The concentration of the heavy metals in various filtrate from the digested samples were determined using Atomic Absorption Spectrophotometry (AAS). The results showed that the concentrations of 0.940±0.004 µg/g 0.011±0.004 µg/g of lead in improved variety in college of agriculture was greater compared to 0.010±0.005 µg/g *Dankasa* and 0.060±0.19 µg/g *Shiga banza* varieties. Also, mean concentrations of 0.015 µg/g of lead and 0.297 µg/g of zinc were detected in the flours of all the three cassava varieties. It was concluded that the concentrations of the heavy metals (lead and Zinc) obtained from the analysis of the three cassava varieties falls within the daily recommended concentrations of the metal elements and high concentrations of the heavy metals were found in the peels.

**Keywords:** Heavy metals (Zinc, Lead, Cadmium, Chromium); Bioaccumulation; Cassava varieties

## 1. Introduction

Global sensitization on the safety of foods items is on the increase. The healthy life style of humans relies greatly on the variety of food they consume. Root crops like cassava and yam are mostly consumed as staple food for over 500 million people in the developing world (falade,2010). It also used as raw materials for small scale industries, notable in underdeveloped countries. To Nigeria communities this tropical root crop cassava is of great important. Cassava when planted utilize the nutrient available in the soil and eventually it can assimilate heavy metals in their roots. Heavy metals are high density element found in the earth's crust and are completely non-degradable which are present in different food items which can in turns contaminates such food items. The contamination of food stuff by these elements is mainly related with global industrialization and every day increase in air, soil and water pollution within our environment (Anamika Kalita Deka *et al.,* 2023) Lead (Pb), (Zinc), copper (Cu) Cadmium (Cd) and Chromium (Cr) are all considered a serious threat both to human health and environment (Alengebawy *et al.,* 2021) The carcinogenic, toxicity and other health challenges associated with heavy metals varies as a result of variation in their physiochemical properties and features ( Deka *et al.,* 2023).

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Cassava peel is the epidermal layer of cassava root tuber and as such after harvesting and processing, constitutes 25% of the whole plant. Cassava peels obtained from the products of cassava are usually either discarded as waste in the environment or used as animal feeds if properly processed. The large volume of processed cassava is proportional to the volume of cassava peels wasted without proper use (Okon *et al.,* 2021).

The increase in the concentration of heavy metals as a due high consumption them above the WHO/FAO permissible limits can result to certain disorder in both animals and humans, National Research Council (1999) Zinc is considered and one of the most abundant heavy metals present in the earth's crust, and appears to an essential trace metal necessary for the growth of living beings, Mediation Number of immunomodulatory functions are regulated by zinc and also serve as cofactor for major proteins. Zinc induce toxicity can be emanating from taking overdose of Zn which is mainly due to lack of sensitization. However, Zn toxicity can be treated in humans and considered as non-life-threatening condition, the number of symptoms cause discomfort in human dealing and health, comprises of difficulty in breathing, fever, nausea, cough and chest pain (Hussain *et al.,*2022). One heavy metal that is very concerning for both the environment and the workplace is cadmium. It is present in the crust of the earth in large quantities, with an average concentration of 0.1 mg/kg. Cadmium rich foodstuffs are considered to elevate the concentration of cadmium in the human system and main distribution route in the body is the circulatory system while blood vessels are thought to be the primary organs affected by cadmium poisoning. Many regulatory agencies have classified cadmium compounds to be carcinogenic. Enough evidence confirming cadmium to be human carcinogen was made available by the International Agency for Research on cancer and U.S. National Toxicity program (Tchounwou *et al.,* 2014).

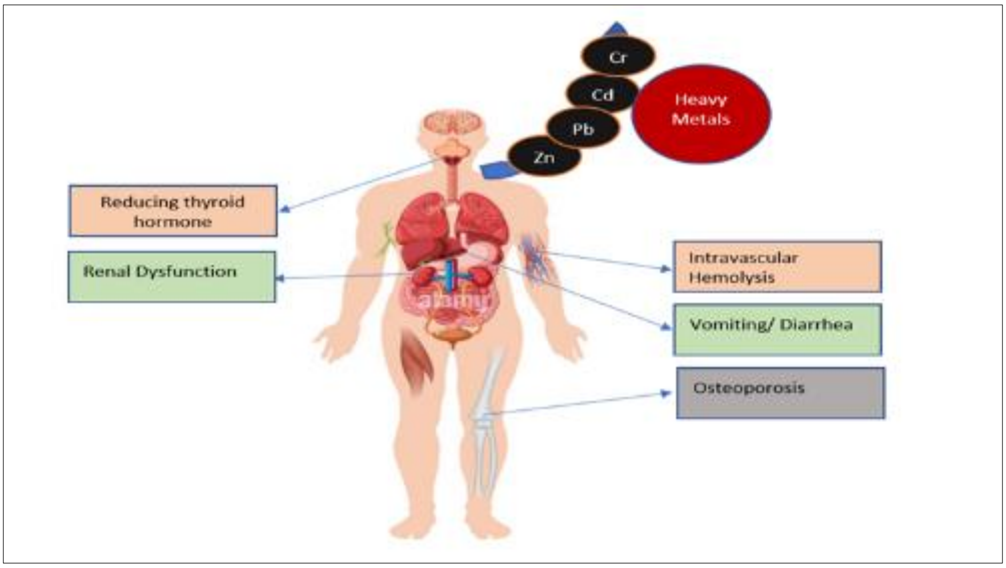


**Figure 1** Heavy metals Effect on Human Health

Cassava (*Manihot esculenta)* is a member of the Euphorbiaceae family. It widely grown in the tropical and subtropical regions due to its edible starchy tuberous root, which provides a significant source of carbohydrates (Taiye Ohunene and Kehinde, 2021) In Nigeria, cassava is primarily produced for its tubers. This is because cassava tubers are quite high in carbohydrates.

## 2. Methodology

### 2.1. Sample Location and collection

The sampling method described by Radojevic and Bashkin, (1999) was adopted and randomized complete block experimental design was followed. This technique involves

Sampling → Washing → Drying → Grinding → Digestion/Extraction → Analysis

Cassava roots of 12 months old were collected from one farm each from the two study locations Wuro-Sambe which lies between Latitude 8⁰ 51′ 8′′N and Longitude 11⁰ 24′ 4′′E, and College of Agriculture which lies between Latitude 8⁰ 51′ 12′′N and Longitude 11⁰ 18′ 14′′ E in Taraba state Nigeria

On these farms, the local and improved cassava varieties were intercropped on the farmlands. The local cassava varieties were identified and distinguished from the improved variety by their different morphological characteristic features associated with each particular variety. *Shiga banza* has six lobes of leaves spotted with white stripes on the leaves, palmate shape and a light-green petiole holding the leaves, the stem is also light-green. *Dankasa* variety has seven lobes of leaves with a palmate shape. The petiole holding the leaves is reddish in colour. The stems of *Dankasa* are reddish in colour. Improved variety has thin lobes of leaves with about seven to nine lobes of leaves. The stem of improved variety is greenish and shorter compared to the stems of *Shiga banza* and *Dankasa*. Each cassava variety was sampled randomly across two farms at five spots on each farmland. These five spots were the northern, eastern, western, southern and central parts of the farm. A total of fifteen samples of cassava roots were collected from each farm.

### 2.2. Sample Preparation

First of all, the outer brown covering (periderm) of the roots of representative samples of the three different varieties of cassava were washed properly using polythene sack sponge to remove the soil particle from the periderm. The cortex (peel) was separated from the parenchyma (flesh) by peeling using a stainless knife. The cortex and parenchyma tissues were washed and rinsed with distilled water and then dried in an oven at 60$^oC$ for 24 hours in the laboratory. The dried samples were ground into homogeneous powdered using mortar and pestle and was sieved through a sieve of less than 125cm. finally the representative sample of the three variety of cassava were poured in a plastic container and labelled properly based on sample locations and an electric weighing balance was used to weigh 5.0g of each sample for ashing and digestion.

Ashing method by Nelson (1994) was used to ashed the samples. The ash was then dissolved in the aqua regia (5ml of 1M Conc $HNO_3$ and 3ml of 1M Conc of HCL). The digest was then dissolved in distilled water and filtered using Whatman filter paper. The filtrate was poured in to plastic bottles and properly labeled and the concentration of the heavy metals were determine using Atomic Absorption Spectrophotometry (AAS).

## 3. Results

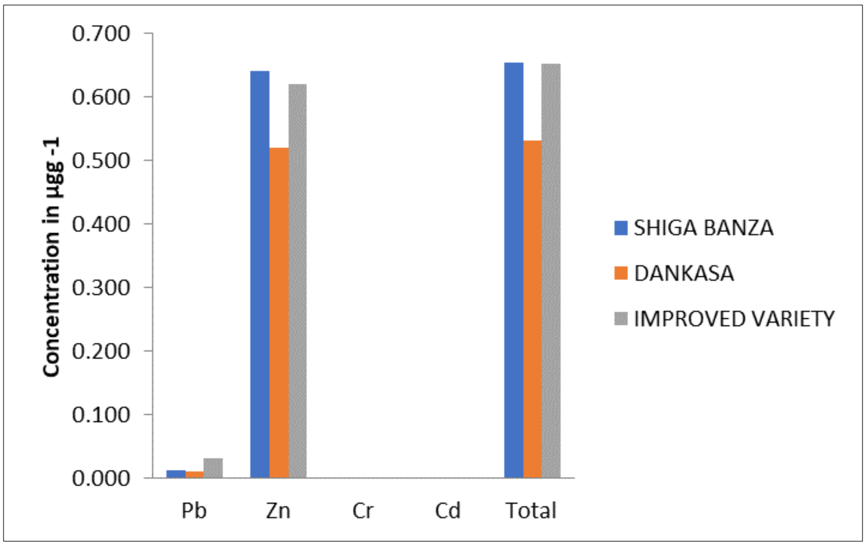


**Figure 1** Comparison of Heavy Metals in Peels of the Three Cassava Varieties in Wuro-sambe , Jalingo

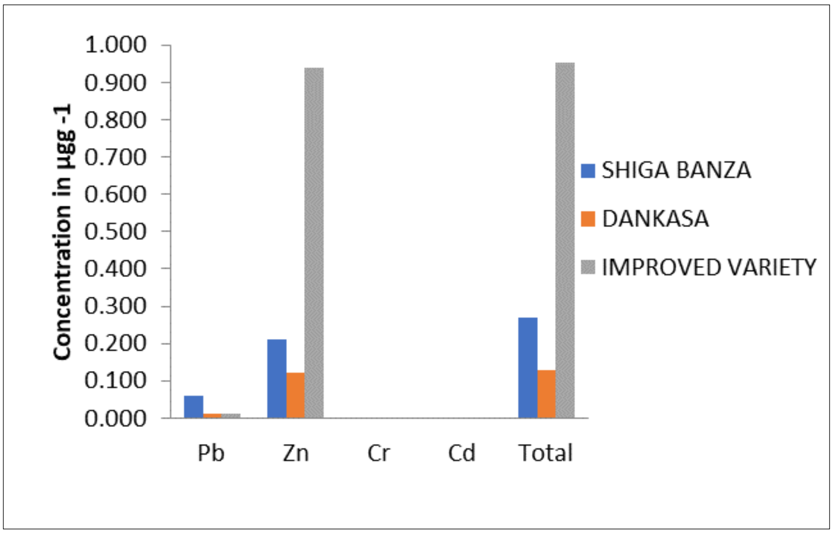


**Figure 2** Comparison of Heavy Metals in Peels of the Three Cassava Varieties in College of Agriculture, Jalingo

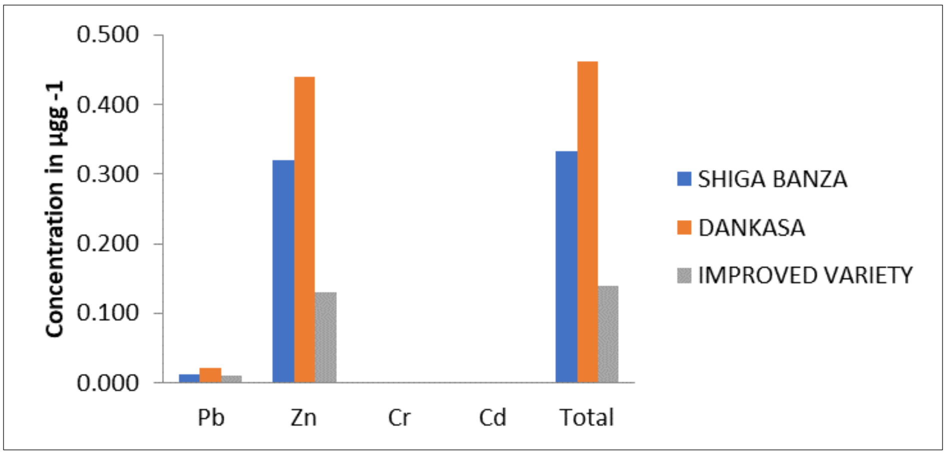


**Figure 3** Comparison of Heavy Metals in Flour of the Three Cassava Varieties in Wuro-sambe Jalingo

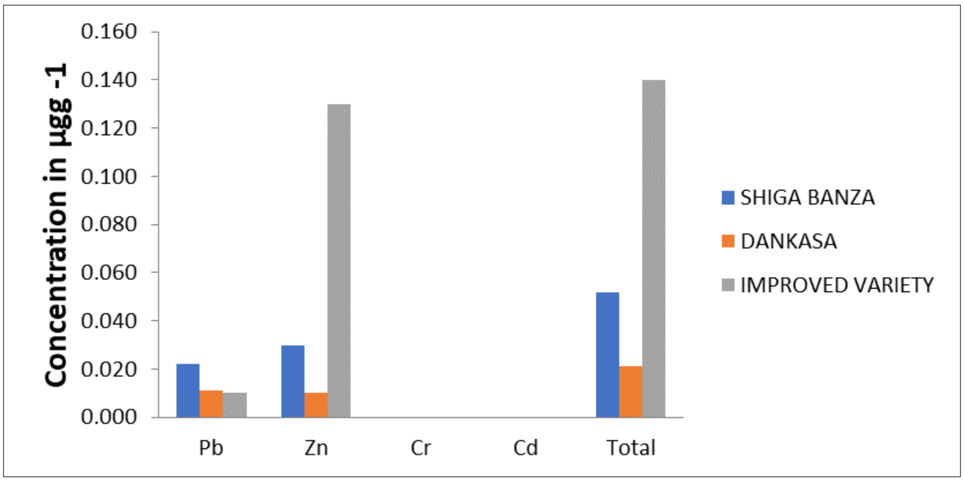


**Figure 4** Comparison of Heavy Metals in Flour of the Three Cassava Varieties in College of Agriculture, Jalingo

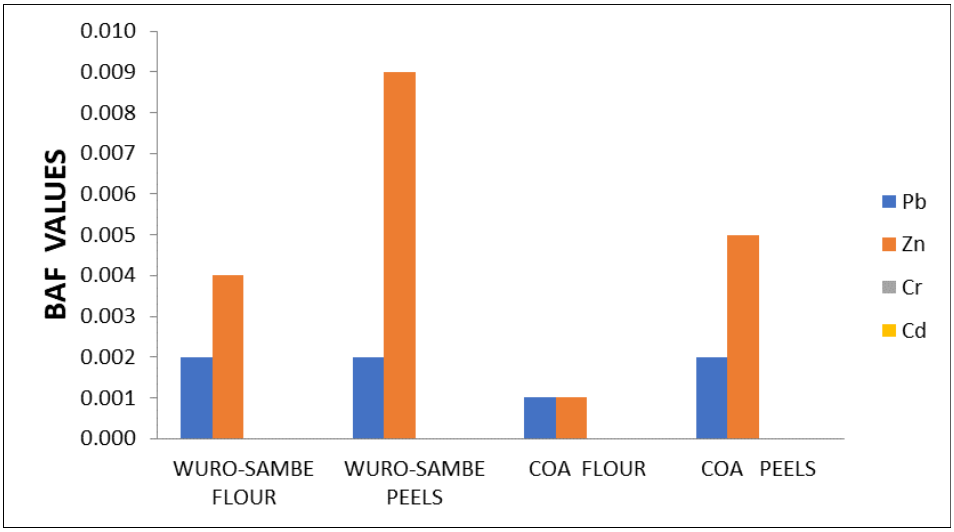


**Figure 5** Bio-accumulated Factors values of Heavy Metals in Cassava for the Study Locations.

## 4. Discussion of the Findings

### 4.1. Comparison of Heavy Metals in peels

The concentration of lead and zinc were found to be higher in the peels of *Shiga banza* and improved varieties, Figure 2. So, it is safer to use the peels of *Dankasa* and improved variety as animal feeds than that of *Shiga banza* variety as a result of lower amount of heavy metal in *Dankasa* and improved variety as shown in Figures 1 and 2. This position agrees with that of Ogah and Ekpete (2021). The mean concentration of zinc for this study is also lower than the average value of 0.630 µg/g in Katsina-Ala in a study on some trace metals in soils and tubers of cassava grown under usage of agrochemicals in some parts of Benue State, Nigeria (Abah, *et al.,* 2013). Average lead levels for this study were lower than the average value of 0.50 µg/g of lead which was obtained in a similar study along the highways of Benue state in Nigeria (Ochadu *et al.,* 2015) and less than 1.73 µg/g of lead in cassava tubers recorded by Nkwocha, Pat-Mbano and Tony-Njoku (2012) in an oil field in Bayelsa state, Nigeria.

### 4.2. Comparison of Heavy Metals in flours

The concentrations of 0.940$\pm$0.004 µg/g 0.011$\pm$0.004 µg/g of lead in improved variety in college of agriculture was greater compared to 0.010$\pm$0.005 µg/g *Dankasa* and 0.060$\pm$0.19 µg/g *Shiga banza* varieties. This implies that it is safer to eat *Dankasa* and *Shiga banza* varieties with less concentration of lead compared to improved varieties. This corroborates the position of Udiba *et al.* (2019). In Figure 3, the concentration of zinc and lead were higher in *Dankasa* flour than that of *Shiga banza* and improved variety. The concentration of lead was higher in *Dankasa* banza than shiga and improved variety. The concentration of zinc in *Dankasa* flour was lower than that of *Shiga banza* and improved variety, Figure 4. The concentration of lead was higher in *Shiga banza* than improved variety and *Dankasa*, Figure 4. This result aligns with the findings of Ogah & Ekpete (2021). The results of heavy metals revealed that mean concentrations of 0.015 µg/g of lead and 0.297 µg/g of zinc were detected in the flours of all the three cassava varieties. The lead levels for this study were eleven (11) times lower than the permissible levels stipulated by FAO (2020) and Indian standard (Harrison *et al.,* 2018).

The mean concentration of zinc (0.297 µg/g) in the flours of the cassava varieties for this study was lower than the average value 17.93 µg/g of zinc which was obtained in a similar study along the highways of Benue state in Nigeria (Ochadu *et al.,* 2015) and less than 18.24 µg/g of zinc which was obtained in a similar study of heavy metals in leaves of three improved varieties of cassava (Mbong, *et al.,* 2013). The low levels of lead and zinc detected in this study accounts for insufficient availability of fertilizers to the farmers to be applied on their farms. Some farms were located near river bank in Wuro Sambe which could be affected by leaching and exhaustion of soil nutrients as a result of prolong farming activities on the same piece of land for many years. Low application of agrochemicals on the farms also contribute to the low heavy metals in the cassava variety grown in the area.

The consumptions of foods exceeding the WHO/FAO permissible limits of the concentration of heavy metals results to some disorders in animals and humans. Lead exposure poses significant health risks across all life stages. Even low levels can have lasting, irreversible effects, particularly in children (Olufemi *et al.,* 2022). Lead can disrupt cellular metabolism by replacing essential ions like calcium and iron, leading to brain disorders, reduced IQ, and behavioral problems (Olufemi *et al.,* 2022; Aisha *et al., 2018*). It affects multiple body systems, including renal, hematopoietic, reproductive, and central nervous systems (*Aisha et al., 2018*; Assi *et al.,* 2016). Lead accumulates in bones and can be released into the bloodstream over time (*Aisha et al., 2018*). This is because of its bio-accumulation in the tissue and blood causing such ailments as dysfunction of the kidneys, reproductive system, liver, brain and the central nervous system (Collins *et al.,* 2022).

Zinc at trace level is important to the human body. Zinc acts as micronutrient for the growth of animals and human beings when present in trace quantities (Mbong *et al.,* 2013). The continuous generation of immune cells in bone marrow and the clonal expansion of lymphocytes in response to antigenic stimulation requires the availability of sufficient iron and zinc (Monteith and Skaar, 2021). However, zinc at a concentration above 60.00 µg/g is toxic (WHO/FAO, 2020).

### 4.3. Bio-accumulation Factor (BAF) of Heavy Metals

The bioaccumulation factor (BAF) is a measure of a plant's ability to accumulate heavy metals from soil, calculated as the ratio of metal content in plant roots to that in soil (Mganga, 2014: Pachura *et al.,* 2016). BAF values vary among plant species and metals. The BAF is calculated as follows:

$$BAF = \frac{C_{plant}}{C_{soil}} = \frac{C_{cassava}}{C_{soil}}$$

Where, $C_{plant}$ and $C_{soil}$ represent the heavy metal concentrations in edible part of the plant and soils respectively. Heavy metals concentrations of soils and crops were calculated on the basis of dry weight.

Typically, the soil to plant transfer factor is one of the key components of human exposure to metals through the food chain. Figure 5 shows the bio-accumulation factor calculated values for each heavy metal transfer from soil to corresponding cassava samples per sampling sites. The calculated results indicated the mean transfer values in the BAF values was in the order of Zn >Pb in both flours and peels of the three cassava varieties. The BAF values for Pb in the flours and peels of the three cassava varieties were lower than that BAF values for Zn in both flours and peels. The BAF values of Zn were higher than those for Pb. This implies that Zn were more mobile than Pb. The bio-accumulation of Pb and Zn may be transferred into the food chain through the consumption of cassava tubers by either animal or man.

## 5. Conclusion

The study revealed that improved variety contained lower concentrations of heavy metals. The concentrations of the heavy metals (lead and Zinc) obtained from the analysis of the three cassava varieties falls within the daily recommended concentrations of the metal elements. Generally, high concentrations of the heavy metals were found in the peels.

### *Recommendations*

- The cultivation of *Shiga banza* and *Dankasa* cassava varieties should be encourage in the study areas since they contain higher amounts of essential elements than the Improved variety that is encouraged by the government.
- Further work is recommended to investigate the cyanide content of the three cassava varieties. The work can be extended to the leaves and stems of the cassava varieties so as to give a better comparison.

## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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