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Evaluation of Heavy Metals in Selected Vegetables Commonly Vended In Igbona Market, Osogbo, Osun State

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Abstract: *Consumption of contaminated vegetables constitutes an important route of heavy metal exposure to animals and humans. The present study is aimed at determine the heavy metal concentrations of selected vegetables in Igbona market, Osogbo, Osun state. Three different vegetables were purchased in Igbona markets. The edible portion of the collected vegetable samples were properly separated, washed and chopped into small pieces using a knife. The vegetables were air-dried and then dried in an oven at 80 °C. Dried samples of the vegetables were ground into a fine powder (80 mesh) using a commercial blender. Heavy metals in vegetable samples were extracted by acid digestion and analyzed for Cadmium, Lead, Cobalt, Chromium and Nickel using a flame atomic absorption spectrophotometer. The results obtained showed that Water leaf, African spinach and Lagos spinach had Cadmium (0.01±0.006, 0.02±0.006 and 0.005±0.006 mg/kg), Lead (0.48±0.06, 0.46±0.01 and 0.29±0.008 mg/kg), Cobalt (0.99±0.07, 0.23±0.008 and 0.87±0.006mg/kg), Chromium (0.11±0.008, 0.01±0.006 and 0.04±0.006 mg/kg) and Nickel (0.005±0.006, 0.01±0.006 and 0.01±0.006). Vegetables assessed for heavy metal are within the required regulatory standard for heavy metals permissible level.*

Keywords: Vegetables, heavy metals, Acid digestion and flame atomic absorption spectrophotometer

1. INTRODUCTION

In both developed and developing countries around the world, the desire for industrialization and concern about food safety is growing. Because of the potential health risk to the public, environmental pollution and food safety are becoming more of a worry (Manzoor et al., 2018; Sultana et al., 2017). Heavy metals resulting from anthropogenic and other activities have gained a lot of attention among environmental pollutants because of their substantial health implications for people when accumulated in high concentrations exceeding body requirements (Wang et al., 2018).
Vegetable demand and consumption is steadily increasing in all parts of the world, as indicated by literature, as it establishes a crucial component of human diet and nutrition (Shaheen et al., 2016). However, it has been established that the majority of commercially accessible vegetables are grown in urban and suburban areas of major cities, particularly in developing countries (Sulaiman and Hamzah, 2018). As a result, these plants are subjected to anthropogenic pollution caused by sources such as municipal and industrial waste, mining and smelting, and metallurgical enterprises, among others (Mekonnen et al., 2014). This clearly indicates that food safety concerns and the potential for public harm have been a major source of concern around the world (Gizaw, 2019).
The greatest sources of heavy metals are industrial and domestic effluents, which contribute to the constant growth of metallic contaminants in aquatic and terrestrial environments in most parts of the world (Bukar and Onoja, 2020). Heavy metals and other pollutants are also continually delivered into soils on a regular basis through land waste disposal, atmospheric input, metals from vehicular exhaust emissions, and irrigation by municipal waste water (Matthews-Amune, 2018).
Due to their accumulation in the food chain and persistence in nature, heavy metals have a high density and are usually hazardous to humans, plants, and animals regardless of their quantities (Ahmed et al., 2019). Cultivated crops, such as vegetables, grown on contaminated soils may absorb heavy metals through their root systems and transport them to various parts of the plant, eventually reaching toxic levels, as vegetables are known to accumulate heavy metals in their edible parts (Khan, 2015). As a result, heavy metals are viewed as an international problem due to their effects on the ecosystem in most countries (Egila, et al., 2019).
Human exposure to heavy metals and intake was primarily through food, inhalation, and dermal contact (Khan, et al., 2014; Martorell, et al., 2011). Surveys also revealed that continuous consumption of high concentrations of heavy metals through foodstuffs

resulted in large metal accumulations in the kidney and liver of humans, disrupting numerous body processes and leading to cardiovascular, nervous, kidney, and bone diseases (Khan, et al., 2014; Martor (Sabina Braun 2015). Heavy metals and their compounds are a global problem because they easily contaminate arable farmland (Laughlin and Agrawal, 2015). They are the most harmful to soil ecosystems and, as a result, the food chain. Lead, for example, is a recognized toxin that inhibits the action of aminolaevolinic acid dehydratase, which catalyzes the committed phase of heme production (heamatopoietic system). It quickly builds up in the kidneys, creating a health risk (Engwa et al., 2019).
The goal of this study was to compare the concentrations of selected heavy metals in various vegetables typically sold in the Igbona market to FAO/WHO maximum allowable limits in vegetables.

2. METHODOLGY

2.1 Collection of samples

Three samples of the vegetable were purchased from Igbona market in Osogbo, Osun State, Nigeria. The samples were taken to Laboratory for the analysis.

2.2 Pretreatment

After collection, the samples were brought to the laboratory and processed further for analysis. Edible portions of the samples were used for analysis while bruised or rotten samples were removed.

2.3 Washing of samples

The edible portion of the collected vegetable samples were properly separated and washed to remove dust particles. The samples were then chopped into small pieces using a knife. The vegetables were air-dried and then dried in an oven at 80 °C.

2.4 Grinding of samples

Dried samples of the vegetables were ground into a fine powder (80 mesh) using a commercial blender and stored in polyethylene bags, until used for acid digestion.

2.5 Acid Digestion

The following acid digestion process was used to remove heavy metals from vegetable samples: In a digestion tube, 1.0 g of the dry weight of each sample obtained at those marketplaces was weighed, and 10ml of 98 percent nitric acid was added. After that, it was placed in a water bath and left to boil for 72 hours. The resulting pale yellow solution was produced up to 25ml with de-ionized water and kept after digestion was completed. For each market, a composite of the samples was created.

2.6. Heavy Metals Analysis

The vegetal solution was analyzed for Cadmium (Cd), Lead (Pb), Cobalt (Co), Chromium (Cr) and Nickel (Ni) using a flame atomic absorption spectrophotometer (AAS, Perkin Elmer model 2130). A certified standard reference material was used to ensure accuracy and the analytical values were within the range of certified value. Blank and standards were run after five determinations to calibrate the instrument.

2.7 Statistical Analysis

Data were subjected to appropriate analysis

3. RESULT AND DISCUSSION

3.1 RESULT

3.1.1 Concentration of Cadmium in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete)

The three vegetables were considered in this study and they include Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete) while heavy metals examined in the stated vegetables are Cadmium (Cd), Lead (Pb), Cobalt (Co), Chromiun (Cr) and Nickel (Ni) Figure 1).
Highest concentration of Cadium (0.05±0.006 mg/kg) was recorded in Lagos spinach (Efo Sokoyokto), preceded by African spinach (Efo tete) (0.02±0.006 mg/kg) while Water leaf (Gbure) had the least concentration (0.01 ±0.006 mg/kg) of cadmium (Figure 1)

3.1.2 Concentration of Lead in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete)

Water leaf (Gbure) had highest concentration of lead (0.48±0.06 mg/kg) and this was follow by African spinach (Efo tete) with lead concentration of 0.46±0.01 mg/kg. The least concentration (0.29±0.08 mg/kg) of lead was recorded in Lagos spinach (Efo Sokoyokto) (Figure 2).

3.1.3 Concentration of Cobalt in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete)

The higher concentration of Cobalt was found in water leaf (0.99±0.07mg/kg), next is 0.87±0.006 mg/kg recorded in Lagos spinach (Efo Sokoyokto) while the least content (0.23±0.08 mg/kg) was observed in African spinach (Efo tete) (Figure 3).

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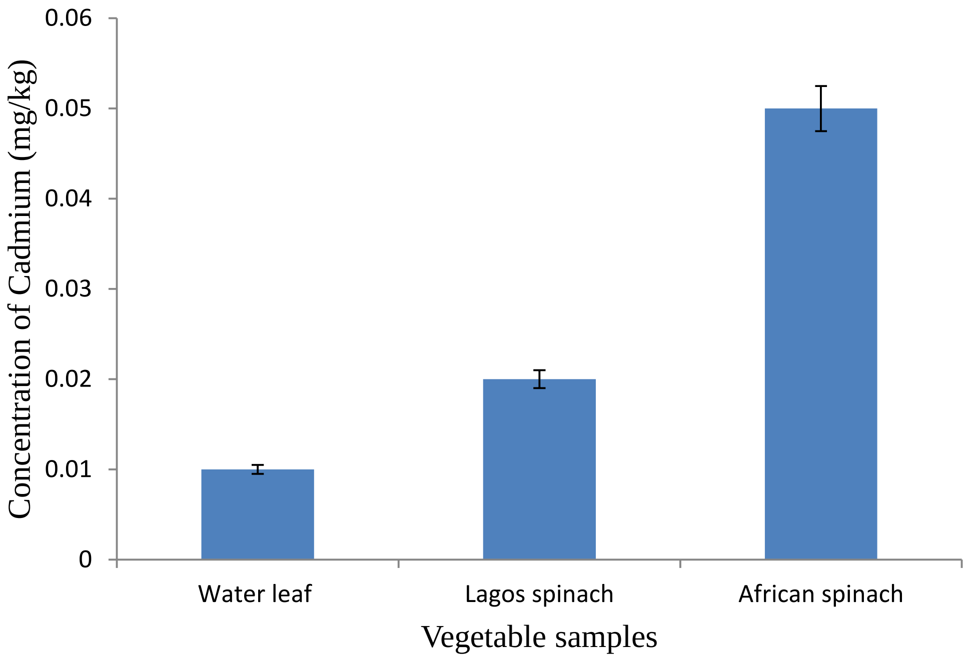

Figure 1: Concentration of Cadmium in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete) purchased in Igbona market Osogbo, Osun State

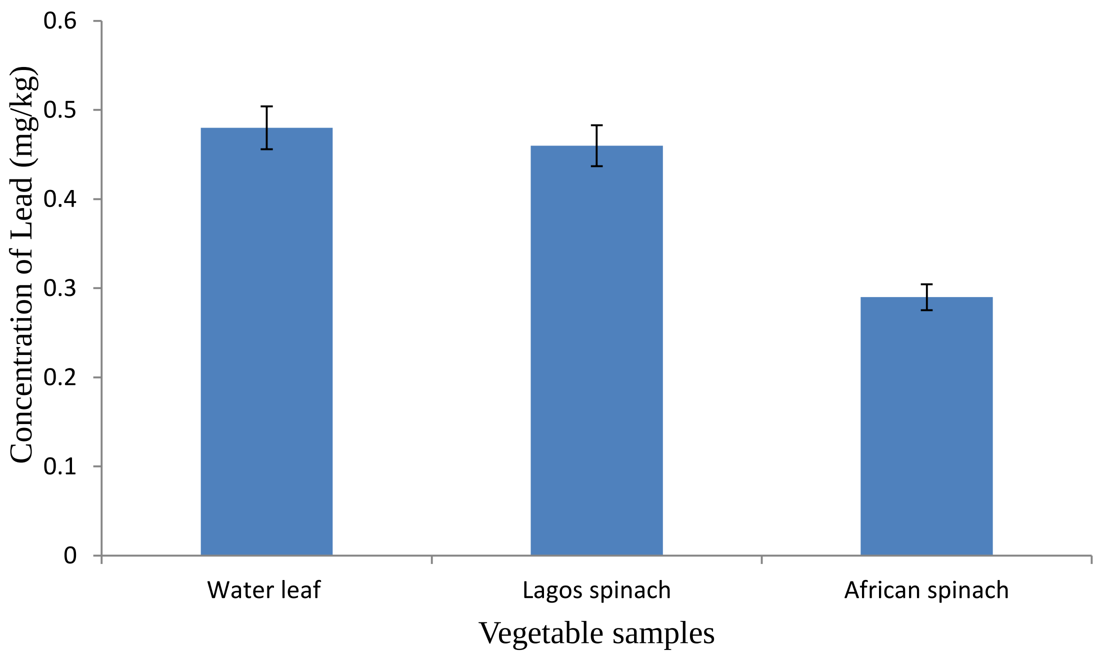

Figure 2: Concentration of Lead in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete) purchased in Igbona market Osogbo, Osun State

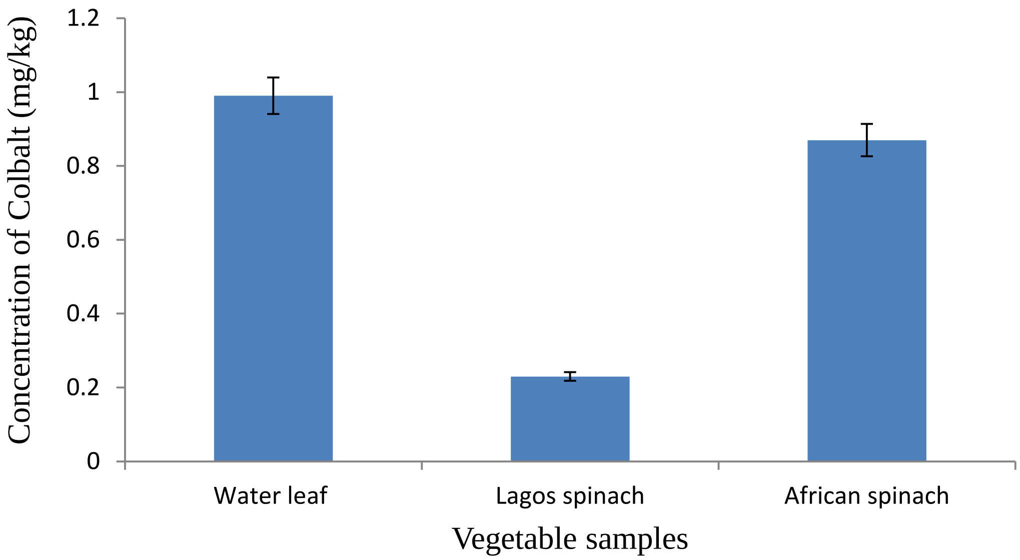

Figure 3: Concentration of Colbalt in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete) purchased in Igbona market Osogbo, Osun State

3.1.4 Concentration of Chromium in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete)
The higher concentration of Chromium was found in water leaf (0.11±0.008mg/kg), next is 0.04±0.006 mg/kg recorded in Lagos spinach (Efo Sokoyokto) while African spinach (Efo tete) had 0.01±0.006 mg/kg concentration of chromium (Figure 4).

3.1.5 Concentration of Nickel in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete)
The higher concentration of Nickel was found in water leaf (0.05±0.006mg/kg), next is 0.01±0.006 mg/kg recorded in both Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete) (Figure 5).

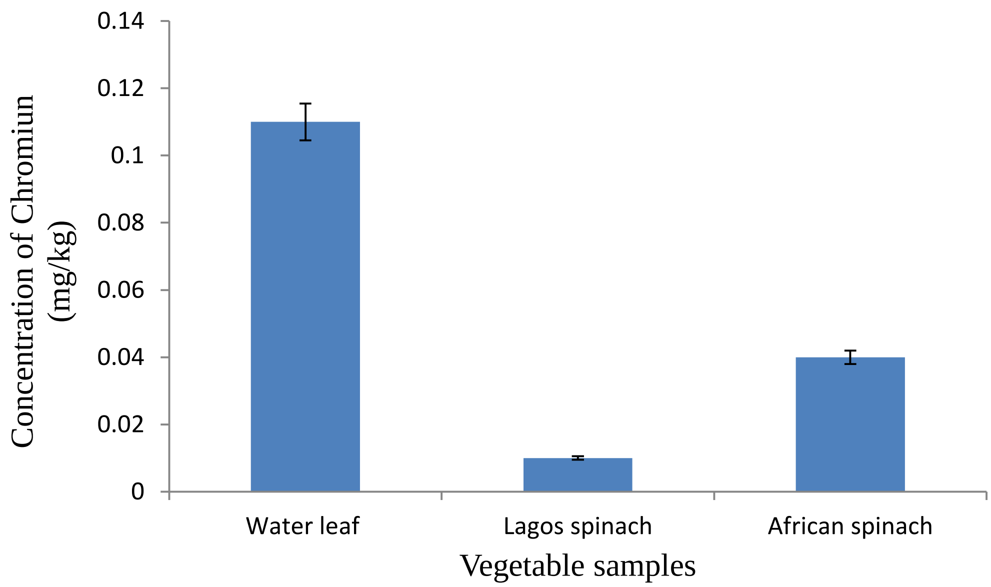

Figure 4: Concentration of Chromium in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete) purchased in Igbona market Osogbo, Osun State

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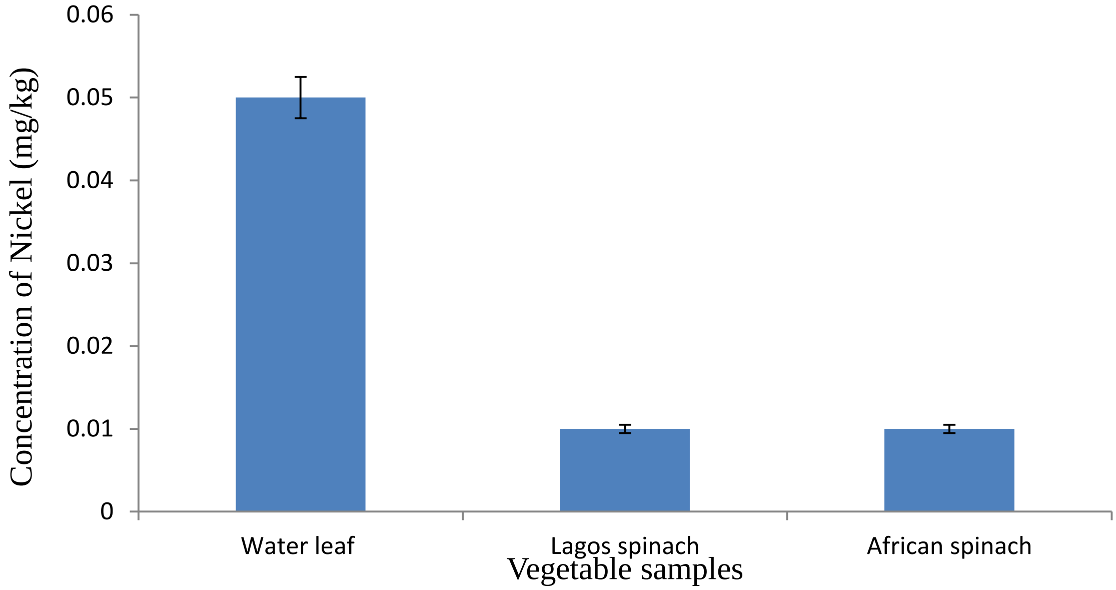

Figure 5: Concentration of Nickel in Water leaf (Gbure), Lagos spinach (Efo Sokoyokto) and African spinach (Efo tete) purchased in Igbona market Osogbo, Osun State

3.2 Discussion

The results for cadmium in the vegetables studied in this study vary from 0.010.006 to 0.050.006 mg/kg. Cadmium levels in all of the vegetables studied were less than the maximum standard limit of 0.1 mg/kg (within and not beyond permissible limit).
Radwan and Salama (2006), Parveen et al. (2003), and Karavoltsos et al. (2002), respectively, reported 0.05, 0.14, and 0.003 mg/kg for apple; watermelon (0.02 and 0.0004 mg/kg); orange (0.04 and 0.0009 mg/kg); and banana (0.02 and 0.001 mg/kg) by Radwan and Salama (2006) and Karavoltsos et al. (2002), Cadmium values of 0.02 and 0.0004 mg/kg for watermelon, 0.04 and 0.0009 mg/kg for orange, and 0.02 and 0.001 mg/kg for banana were similarly reported by Radwan and Salama (2006) and Karavoltos *et al*. (2002). Similarly, Divrikli *et al*. (2006) recently reported a cadmium level of 0.002 mg/kg in Indian basil, which is identical to the levels found in our study.
The presence of cadmium in foods has been linked to a variety of forms of environmental contamination (Adriano, 1984). Previous research has found varied values for leafy vegetables, such as 0.090 mg/kg for fluted pumpkin by Sobukola et al. (2010) and 0.049 mg/kg for lettuce by Muhammed and Umer (2008). Cadmium consumption in vegetables is limited to 0.2 mg/kg, according to the FAO/WHO. Except for fluted pumpkin leaf (Telfairia occidentalis) with 0.88330.02mg/kg, the results obtained for vegetables in this study are within regulatory agencies' requirements.
Cadmium is a toxic and hazardous element since it can be absorbed via the digestive tracts, pass through the placenta during pregnancy, and damage membranes and DNA. Once in the human body, it can stay in the metabolism for up to 33 years and has been related to a variety of health concerns, including kidney impairment and aberrant protein excretion in the urine. Cadmium exposure is connected to a decrease in bone calcium concentrations, an increase in urine calcium excretion, and death in these situations. It also has an impact on women's reproductive and endocrine systems (WHO, 2004). Vegetables may account for approximately 70% of human Cadmium intake, depending on the level of eating (Wagner, 1993). The cadmium levels found in all seven vegetables studied in this study were within the WHO and other health authorities' recommended limits for human bodies.
The concentration of lead in the vegetables studied in the above study ranged from 0.290.008 to 0.480.006 mg/kg. All of the veggies studied in the study had Lead levels below the maximum standard limit of 0.3 mg/kg (within and not beyond permissible limit). This demonstrates that all three vegetables studied in this study are below the World Health Organization's tolerable lead limit.
Cobalt concentrations in this study ranged from 0.230.008 to 0.990.07 mg/kg, with the lowest being found in African spinach (Amaranthus hybridus) and the highest in Dandelion greens (Taraxacum officinale). The daily recommended cobalt intake for humans is 0.005 mg/day (ATSDR, 2004b). The DIMetal levels reported in this study were higher than the suggested RDI; nevertheless, the DImetal levels were less than 30 mg/day, which can induce digestive and skin problems in humans (ATSDR, 2004 b).
All of the readings observed in this study's vegetable samples are below the regulatory-mandated Cobalt limit of 0.2 mg/kg. This is consistent with the findings of Sobukola et al. (2010), who found Cobalt levels of 0.015 and 0.046 mg/kg in Indian Basil and pumpkin, respectively, with range values of 0.024-0.031 mg/kg and 0.041-0.050 mg/kg.

Cobalt has been proved to be a carcinogen in animals and is considered a potential carcinogen in humans, according to studies. Cobalt toxicity can cause fatigue, nausea, vertigo, and balance problems, as well as poor memory and cognitive function, tinnitus and hearing problems, blindness, headaches, cardiomyopathy, hypothyroidism, peripheral neuropathy with tremors and loss of coordination, rashes, kidney failure, anxiety, and irritability. All of the values reported in this investigation for vegetables were below the permissible cobalt threshold in humans (0.2kg/mg).

Chromium concentrations in the vegetables studied in the above study varied from 0.010.006 to 0.11 mg/kg. All of the vegetables studied in this study had Chromium levels below the maximum standard limit of 02.3 mg/kg (within and not beyond permissible limit). This demonstrates that all three vegetables studied in this study are within the World Health Organization's tolerable Chromium level (WHO).

The concentration of Nickel in above study in vegetables examined ranges between 0.01±0.006 and 0.05±0.06mg/kg. The values recorded for Nickel for all vegetables examined in this study are below the maximum standard limit by World health organization (WHO).

4. CONCLUSION

In most cases, the quantities of heavy metals investigated in this study were modest and within regulatory authorities' acceptable standards. This could be due to the fact that there was no pollution in the locations where they were planted. In addition, all veggies tested for cadmium, lead, cobalt, chromium, and nickel were within permissible limits.

The heavy metal values found in vegetables acquired from Igbona market in Osun state, Nigeria, could be useful in food composition tables for Nigerians and the West African sub-region. Heavy metal levels in vegetables purchased at the Igbona market were found to be within acceptable limits, indicating that they are safe for human consumption.

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