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Evaluation of Heavy Metal Levels in African Walnut (*Tetracarpidium conophorum)* Seed Consume in Urban Areas of Kaduna, Nigeria

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Abstract

Heavy metals normally occur in nature and are essential to life but can become toxic through accumulation in organisms. The present study focuses on the toxicity level of heavy metals; Cadmium (Cd), Lead (Pb), Manganese (Mn), and Nickel (Ni) in African walnut *Tetracarpidium conophorum* consumed in some of the urban areas of Kaduna, Nigeria. Flame Atomic absorption spectrometry was used to estimate and evaluate the levels of these metals Detected levels of Mn ranged from 1.07 to 2.40, Pb; 0.41-1.52, Ni; 8.44-13.72 while Cd; 0.30-2.42 mg/g respectively. The estimated daily intakes of Mn through fruits and vegetables were found to be below the maximum tolerable levels recommended by FAO/WHO in all the locations while Pb was a bit higher than the recommended level. Ni and Cd was found to be higher than the recommended level in all the study area**.** Most of the element concentrations of analyzed in this study were found above safety baseline levels for human consumption. These heavy metals have high tendency of posing major various health issues when overly consumed.

Keywords: Cadmium, Fruit, Heavy Metals, WHO limit.

Introduction

Fruits are vital to the human diet, and in particular provide the well-known trace elements and heavy metals. Minor or trace elements are essential for good health if they come from an organic or plant source. In contrast, if they come from an inorganic or metallic source, they become toxic [1]. The processes of plant growth depend on the cycle of nutrients including trace elements, from soil to plant [2]. Fruits, especially leafy ones, accumulate higher amounts of heavy metals because they absorb these metals in their leaves [1].

However, the use of industrial wastewater for the growth of fruit plants, and increased application of pesticides and fertilizers may elevate the heavy metal content of fruits [3];[4]. As industrial wastewater and pesticides are the main sources of toxic heavy metals. Heavy metals may cause many diseases such as corrosion of mucosal layer, cancer, coagulopathy, hematemesis, hepatic injury, hematochezia, cardiotoxicity,

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nephrotoxicity, hepatotoxicity, immunotoxicity, shortness of breath, melena, cardiovascular collapse, kidney and bone diseases [5]; [6]. Alzheimer's and Parkinson's diseases are also linked with heavy metals [7]. In addition, heavy metals may initiate the production of high ROS which are the main cause of damaging biomolecules and DNA [8].

Fruit are good source of antioxidants and inhibits the production of high ROS, while heavy metals initiate the production of such species. It could be concluded that high content of heavy metals may reduce the antioxidant property of fruits [9].

The study focuses on biomonitoring contamination of heavy metals; Manganese, lead, Nickel and Cadmium in African walnut from selected urban areas of Kaduna in order to assure a significant improvement in food safety.

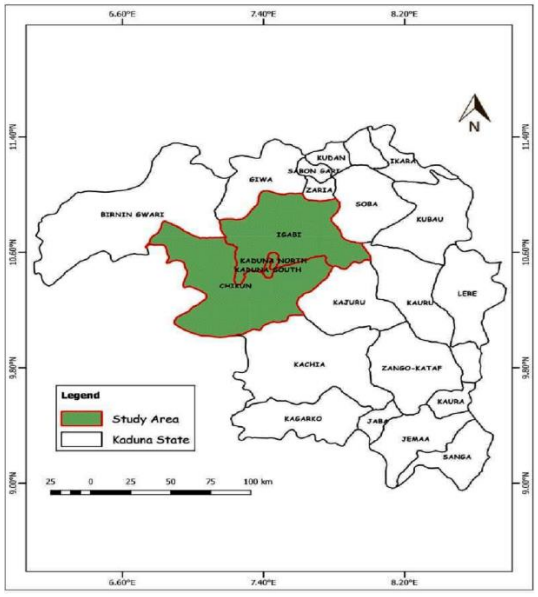


Fig 1: Map of the Study Area in Kaduna State

Source: Google. (2025). Kaduna, Nigeria Map.

Samples were randomly collected from the three (3) different fruit selling points in each of the local government areas of Kaduna State; Kaduna south local government (10.28° N, 7.25° E), Kaduna north local government (10.57° N and 10.45° E) and Igabi local government area (10.81° N and 7.71° E). The random sampling technique was adopted to minimize selection bias and ensured the samples were representative of those consumed by the urban population of Kaduna metropolis. The three local governments form the urban core of Kaduna metropolises which host the largest and diverse markets. Kaduna South Local Government Area: Kawo (10.57° N and 7.45° E), Unguwan Sarki (10.54° and 7.45°) and Rimi (10.52° N and 7.46°), Kaduna North Local Government Area; Tudun Wada (10.51° N and 7.41° E), Kakuri (10.45° E and 7.41° N) and Unguwa Muazu (10.42° E and 7.38° N). Igabi Local Government; Mando (10.71° E and 6.56° N), Rigasa (10.54° E and 7.33°N) and Danmani (10.54° E and 7.33° N) as triplicate. The samples were dried at room temperature for two weeks and grounded to homogenize the lumps. The powdered samples were sieved using 2 mm sieve to bring the sample to same size.

Sample Digestion

The acid digestion method of Don-Lawson, 2020 was adopted with slight modification. Exactly 5g of dry sample was taken in an Erlenmeyer flask, and a mixture of 50 ml HNO_3 and $HClO_4$ (4:1) was added. The mixture was kept on electric hot plate at 250°C. The acid mixture was evaporated

and the remaining pasty mass was dissolved in distilled water, filtered into volumetric flask (50 ml) and diluted with distilled water up to final volume of 50 ml which was analyzed for heavy metals.

Atomic Absorption Spectroscopy

A serial dilution method was used to prepare the working standards and the concentration of the metals in each sample digested was determined using Atomic Absorption Spectrophotometer (Perkin Elmer AAS-700). A calibration curve was plotted between measured absorbance and concentration (mg/kg). The entire sample was analyzed using flame atomic absorption spectrophotometer. Measurements were done using hallow cathode lamp for manganese (Mn), Nickel (Ni), Lead (Pb) and Cadmium (Cd). Calibration was done with the standard for each metal under investigation at individual wavelengths.

Results

Table 1 shows the mean concentration (mg/kg) of Mg, Pb, Ni and Cd in *Tetracarpidium Conophorum* in sample code Kaduna South (KDS), Kaduna North (KDN) and Igabi (IG) Local Government Area. KDS has mean concentration of Mg and Pb as 2.40±0.59 and 6.41±1.16 mg/kg respectively, while Igabi has the highest mean concentration of Ni and Cd as 13.72±0.95 and 2.42±0.17 mg/kg.

Table 1: Mean concentrations (mg/kg) of heavy metals in *Tetracarpidium Conophorum* on dry weight bases

Location	Mn		Pb		Ni		Cd	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
KDS	2.40	0.59	6.41	1.16	10.36	1.73	0.30	0.22
KDN	1.07	0.92	1.52	2.22	8.44	3.19	0.80	0.25
IG	2.02	0.51	0.87	1.38	13.72	0.95	2.42	0.17
WHO (mg/kg)	5.0		0.5		5.0		0.2	

Keys;

KDS = Kaduna South

KDN = Kaduna North

IG = Igabi

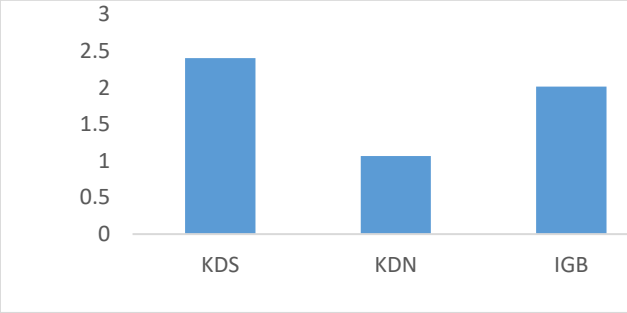


Fig 2: Mean concentrations of Mn in *Tetracarpidium Conophorum*

The highest concentration of Ni was observed in KDS while the lowest concentration was observed in KDN.

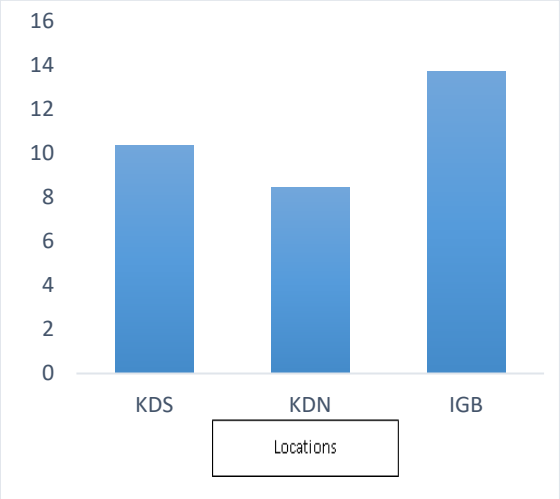


Fig 3: Mean concentrations of Ni in *Tetracarpidium Conophorum*. The highest concentration of Pb was observed in IGB while the lowest concentration was observed in KDN

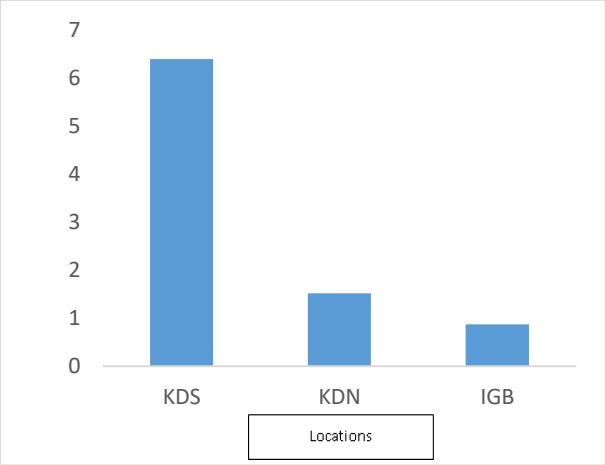


Fig 4: Mean concentrations of Pb in *Tetracarpidium Conophorum*.

The highest concentration was observed in KDS while the lowest concentration was observed in IGB.

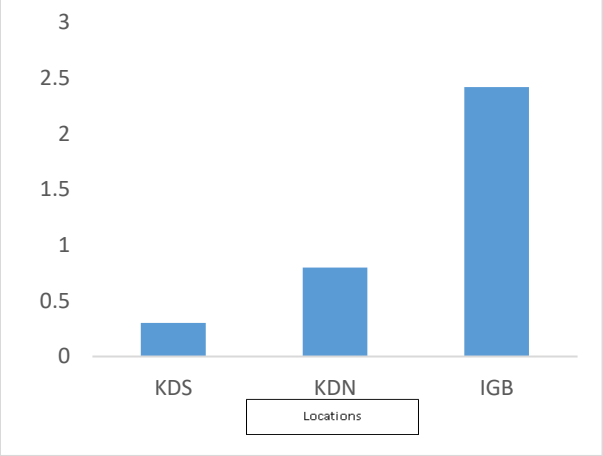


Fig 5: Mean concentrations of Cd in *Tetracarpidium Conophorum*. The highest concentration of Cd was observed in IGB while the lowest concentration was observed in KDS

Discussion

Fruits and vegetable are the important sources of nutrients and offer advantages over dietary supplements, because of low cost and wide availability. In daily diet of fruits and vegetable have been strongly associated with reduced risk for some forms of cancer, heart disease, stroke and other chronic ailments [10].

The study focused on the level of heavy metal in African Walnut which are selected from the urban markets of Kaduna, Nigeria. The heavy metal concentration is determined based on plants' dry weight. Heavy metals affect the nutritive contents of agricultural products and also have a harmful effect on humans. National and international regulations on food quality set the maximum permissible limit of toxic metals in human food; hence an essential aspect of food quality should be to regulate the concentrations of heavy metals in foods [11],[12].

Manganese is essential for the normal bone structure, reproduction and Mn play a very essential role in the functioning of the central nervous system. Mn deficiency will lead to reproductivity failure in both males and females [13]. Table 1 and Figure 2 respectively shows the concentration of Manganese (Mn) in the analyzed sample from the region were below the WHO permissible limits of 5.0 mg/kg. This result is not in agreement with that obtained by [14] who reported high concentration (25.83–70.76 mg/kg) of Mn in cereals and fruits respectively in Greece. Also, [15] recorded a value of 151.68-227 mg/kg for fruits and vegetables grown on refuse dumpsite. Since the level of Manganese in all fruit samples analyzed in this study was lower than the stipulated permissible limit, the continuous consumption of these fruit is predicted not pose any health effects [16], [17].

Cadmium is a non-essential element in foods and natural waters and primarily it accumulates in the kidneys and liver [18]. In all the samples analyzed from the markets, the concentration was observed to be a little above the permissible limit of 0.2 mg/kg as reported by [19], which might be a treat for human consumption. It was highest in samples in Igbi with a value of 2.42 mg/kg while samples from Kaduna South and North had 0.30 and 0.80 mg/kg respectively table 1 and Figure 5 respectively. [20] reported that levels of Cd were higher in the garden rocket vegetable species for both washed and unwashed samples. This slight increase in the concentration of the metal can be tagged to anthropogenic factors like battering manufacturing and most especially metal plating in the areas.

The concentrations of Pb that exceeded WHO established permissible limit of 0.5 mg/kg, were observed in all the samples in this study. The highest levels of Pb were observed in Kaduna South (6.41 mg/kg) and Kaduna North (1.52 mg/kg) while Igabi had the lowest (0.87 mg/kg) table 1 and figure 4 respectively. Pb being a harmful body poison can enter into the human system through air, water and food and cannot be

eliminated through fruits and vegetable washing [18]. Lead found in the samples might be linked to the concentration in the polluted area and also the consequence of road traffic and lead emission from petrol in the area where these fruits were cultivated and sold [22]. The level of Pb reported in this study is comparable to those reported for apple (0.76 mg/kg); by [11], [23].

The mean concentrations of Ni were shown in table 1 and fig 3, respectively. It is of Ni was beyond the 5.0 (mg/g) of WHO. This is linked to the high number of industries in the area. In addition, excessive pesticides on food crops could result in higher accumulation of heavy metal in plants and animal tissues. Furthermore, the concentration of toxic heavy metals should be monitored in food crops in order to ensure safety of the public health.

Conclusion

The result of this study showed that the analyzed edible fruit *Tetracarpidium Conophorum* commonly consumed in the urban areas of Kaduna State, from the 9 different markets, were contaminated with different levels of heavy metals. Interestingly, the results showed that the observed concentrations of all the five metals are mostly higher than that of the WHO's maximum permissible limits. This might be due to numbers of industries and frequent application of pesticides which cause a problem to urban environment and ultimately to human food chain safety. It is concluded that, fruits and fruit juices consumed by urban consumers contains heavy metals more than their permissible levels.

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