

Assessment of Lead Accumulation in Edible Fruits Growing on Selected Waste Dumpsites in Owerri and Its Environs

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ABSTRACT:

This study assessed Lead Accumulation in Edible Fruits Growing on Selected Waste Dumpsites in Owerri and Its Environs. Eight (8) dump sites were visited namely 1 dump at Avu, 3 dumps at Nekede, 2 dumps at Obinze one dump at Owerri Municipal and one dump at Port Harcourt Road. Of the 8 dump sites sampled, edible fruits were only growing in three sites: Avu and 2 dump site at Nekede. Three edible fruits growing in the waste dump site: namely pawpaw, African pear and banana were counted, collected and identified during the month of May and June 2023. The level of bioaccumulated lead in these fruits was analyzed using Atomic Absorption Spectrophotometer (AAS). The result from AAS showed that the all the edible fruits collected from the waste dump contained some level of lead. The average value of lead found in these edible fruits are, pawpaw (0.55mg/kg), African pear (0.175mg/kg), banana (0.05mg/kg). Advancements are required for the effectiveness of new environmentally friendly remediation strategies which can help mitigate lead toxicity.

Keywords: Bioaccumulation, Lead, Dumpsites, Edible Fruits

INTRODUCTION:

Bioaccumulation is the net accumulation of a contaminant in an organism from all sources including water, air, and diet. These substances can be naturally occurring or man-made, and they are often persistent in the environment. Bioaccumulation typically occurs through the food chain. Heavy metals (HM) refers to 'the metallic chemical elements' which have a specific weight greater than 5 g/cm³ and have poisonous nature at lower concentrations (Collin *et al.*, 2022). They include essential metals (Cu, Zn, Co, Cr, Mn, and Fe), non-essential metals (Ba, Al, Li, and Zr), less toxic metals (Sn and As), and highly toxic metals (Hg, Cd, and Pb) (Duffus, 2002). When the rate of intake of these HM by biological systems exceeds the rate of excretion, then we call that bioaccumulation of HM in biological systems (Wang *et al.*, 2020; Ali *et al.*, 2019). Heavy metals have harmful effects on plants, such as low biomass accumulation, chlorosis, growth, and photosynthetic inhibition, altered water balance and nutrient assimilation, and senescence (Balkhair and Ashraf, 2016), all of which leads to plant mortality.

Lead (Pb) is one of the most common heavy metal contaminants in soils. Plants are exceedingly harmful to it (Zeng *et al.*, 2007). Lead contamination had a stimulating effect on soil enzymatic activities and microbial biomass at low concentrations and an inhibitory effect at high concentrations (Zeng *et al.*, 2007). Increasing Pb contents linearly decreases enzyme activities, which was evident especially for aryl sulfatase (Brown and Bates, 1972). Lead has been identified as a toxic metal at elevated concentrations, and extensive use of Pb is reported to result in widespread environmental contamination and health problems globally (Li *et al.*, 2019). Being a cumulative toxicant, Pb can influence the neurologic system, kidneys, and blood circulation, especially in children, infants, and fetuses (Zwolak *et al.*, 2019). Pb is distributed in the brain, liver, kidney and bones (Zwolak *et al.*, 2019), and may accumulate over time in teeth and bones, reflecting a cumulative human exposure.

Lead may also affect brain and intellectual development in children, inducing apoptosis in organ tissues (Mani *et al.*, 2019); in some cases, irreversible neurological

damage occurs. Pb was considered to be responsible for 540,000 deaths worldwide in 2016 (Li *et al.*, 2019), and Pb exposure is estimated to account for 0.6% of the global burden of disease (expressed in disability-adjusted life years, or DALY) with the highest burden in developing regions (WHO, 2010). Studies on the bioaccumulation of lead on edible fruits growing in a waste dump site are important as they help to identify potential health risks, inform policy and interventions, and ultimately protect the health of the communities living near these sites (Collin *et al.*, 2022).

MATERIALS AND METHODS:

Study Area:

The study was conducted in Owerri. Owerri comprise of 3 Local Governments Areas namely; Owerri Municipal, Owerri West and Owerri North all located in Imo State

Sample Size:

The sample population consists of edible fruits growing in waste dumps in Owerri

Data Collection:

Waste dumps in Owerri, Municipal, Avu, Nekede. Obinze and Port Harcourt road were visited and samples of edible fruits growing on them were counted. Samples of those edible fruits were collected and identified. After collection of the samples from the waste dump sites, they

were taken to the lab. The fruits were mashed. After that, all the samples were put in a beaker. Then spatula was used to put the sample from the beaker into the conical flask and it was placed on the electronic weighing balance to measure 10grams. The process was repeat for all the samples.

Digestion of sample:

The acid use for digestion is aqua regia. The aqua regia is a combination of two or more strong acid but it cannot be one acid. For this particular experiment, two strong acid were combined which are; Nitric acid and hydrochloric acid, and the measurement used are 84ml and 56ml respectively. i.e Nitric acid = 84ml while hydrochloric acid = 56ml. Their ratio is 3:2. The acid combined are colorless but when combined, it produced a burnt orange color. 30ml of aqua regia was used to digest each samples. After that, the samples were boiled in a pot of water for further digestion, to pieces the samples. NB: When the brown foam stops coming out, then you have achieve your goal. Then it was filtered with filter paper and funnel into a volumetric flask, then distilled deionized water was used to make it up to 50ml for each samples.

Data Analysis:

The data was presented in tables bearing decimal readings, standard calibration curve, standard used and Cal Zero.

Figures 1-3: Edible fruits growing in the dump sites



Fig. 1: Pawpaw (*Carica papaya*)



Fig. 2: Bananas (*Musa balbisiana*)



Fig. 3: African pear (*Dacryodes edulis*)

RESULTS:

Table 1 shows Edible fruits growing on waste dumps. From the table, Eight (8) waste dump sites were visited and only three edible fruits Pawpaw species, Bananas species, African pear were collected. Also pawpaw (3) was the highest edible fruit collected followed by Bananna (2) while African pear (1) was the least. Table 2 shows the analysis on the amount of the bioaccumulation of lead found in edible fruits growing in waste dump sites. Atomic absorption spectrophotometer (AAS) was used to analyze the samples. Two runs were conducted in Table 2.0 for quality control. From the result, it was revealed

that in pawpaw sample, the first run has (0.40) amount of lead, while the second run has (0.70) amount of lead. On the account of the second sample which is African pear, the first run has (0.20) amount of lead, while the second run has (0.15) amount of lead. On the account of the third sample which is banana, the first run has (0.05) amount of lead, while the second run has (0.05) amount of lead. Therefore, it is deduced that among all the samples that were analyzed, Pawpaw was seen to have the highest amount of lead with an average of (0.55mg/kg), seconded by African pear with an average amount of (0.175mg/kg), followed by banana with an average amount of (0.05mg/kg).

Table 1: Edible fruits growing on waste dump sites in the study area

S/N	Waste dump site	Edible fruits and number observed		
		Pawpaw	Banana	African pear
1.	Avu site	3	0	0
2.	Nekede site 1	0	2	0
3.	Nekede site 2	0	0	1
4.	Nekede site 3	0	0	0
5.	Owerri Municipal dump site	0	0	0
6.	Obinze site 1	0	0	0
7.	Obinze site 2	0	0	0
8.	Port Harcourt Road site	0	0	0
Total edible fruits recorded		3	2	1

Table 2: Analysis on the amount of the bioaccumulation of lead found in edible fruits growing in waste dumpsite.

Test	Pawpaw		Pear		Banana		Methods
	Run 1	Run 2	Run 1	Run 2	Run 1	Run 2	
Lead,mg/kg Pb	0.40	0.70	0.20	0.15	0.05	0.05	AAS
Average	0.55mg/kg		0.175mg/kg		0.05mg/kg		AAS

DISCUSSION:

Of the three edible fruits that were collected and analyzed, result from Atomic Absorption Spectrophotometer (AAS) showed that pawpaw, African pear and banana has some level of bioaccumulated lead. The average value of lead found in the edible fruits are pawpaw (0.55mg/kg), African pear (0.175mg/kg), and banana (0.05mg/kg). This result shows that pawpaw has a significantly higher bioaccumulated level of lead, seconded by African pear. Banana has the least lead bioaccumulation result in this study.

The present result is not uncommon because heavy metals have been identified to bioaccumulate in various fish organs, such as the liver, spleen, and kidneys, as well as the digestive system and gills (Jezierska and Witeska, 2006). Heavy metals include essential metals (copper, zinc, chromium, manganese, iron, cobalt), non-essential metals (barium, aluminum, lithium, zirconium), less toxic metals (tin, arsenic), and highly toxic metals (mercury, cadmium, lead) (Duffus, 2002). The present result of lead that has been bioaccumulated in plant is similar to the result of study conducted in Nigeria by found that fruits grown in waste dump sites had significantly higher concentration of lead compared to those grown in non-dumpsite soils (Nwachukwu *et al.* 2022). Of great worry is that the present work has showed that lead can be bioaccumulated in edible fruits. Another worry is that lead is the most common heavy metal that can contaminate edible fruit due to anthropogenic activities. Therefore, it may not be uncommon that our farmland where edible fruits are planted may be contaminated by lead. This may pose public health problem to our people who feed on those fruit. During the study, it was evident that some people were harvesting the fruit that were grown in those waste dump site and these waste dump sites are, Avu waste dump sites, Nekede waste dump site 1, and Nekede waste dump sites 2. Some scavengers were seen to be harvesting those pawpaw and African pear without knowing that they have some levels of bioaccumulated lead in them. The scavenging people may contaminate their hands with lead while scavenging the waste dump and the possible consumption of fruits collected from those dumps may constitute health risk to them. People are seen to be collecting humus from this dump site to use as manure in their farmland, thereby, contaminating the fruit produce by lead and other heavy metals, which now pose public health risk during consumption.

Result from study conducted in India examined the lead accumulation in different parts of three common fruits – mango, guava, and papaya growing in a landfill site. The study found that fruits of these trees had accumulated significant levels of lead, making them unsafe for human consumption (Kumar *et al.* 2017). Similarly, studies

conducted in Mexico examined the bioaccumulation of lead in different edible plants growing in a waste dump site. The studies found that fruits such as papaya, guava, and sapodilla had accumulated high levels of lead, posing a potential risk to human health (Ávila Vázquez *et al.*, 2025; Norton *et al.*, 2015). Edible fruits have the capacity to accumulate lead at different level which now poses health risk. The presence of these fruits that was grown in the various dump sites were as a result of the decomposed manure and organic matter that was transferred from the temporal dumpsite to the permanent dumpsite. The permanency of dumps will determine whether a fruit can harbor lead or ever grow. Fruits growing in waste dump site should not be harvested because there is presence of lead in them. Lead accumulation in the environment is constantly increasing due to increased anthropogenic activities. Human activities play a role in the contamination of fruit and constitute a major problem to public health. Due to the increase in population and human activities, there is still a need for more focused research to evaluate the effectiveness bioremediation method. Moreover, advancements are required for the effectiveness of new environmentally friendly remediation strategies which can help mitigate lead toxicity.

CONCLUSION:

The present study revealed that edible fruits growing on waste dumpsites in Owerri and its environs accumulated measurable concentrations of lead. Among the fruits analyzed, pawpaw recorded the highest level of lead accumulation, followed by African pear, while banana showed the least concentration. The findings indicate that consumption of fruits harvested from waste dumpsites may expose humans to potential health risks associated with lead toxicity.

The study further emphasizes the role of anthropogenic activities and poor waste management practices in environmental contamination. Therefore, there is need for proper waste disposal systems, public awareness on the dangers of consuming fruits grown on dumpsites, and continuous environmental monitoring of heavy metal contamination in agricultural produce. Further studies involving more fruits, larger sample sizes, and additional heavy metals are recommended.

Ethical Approval:

No human or vertebrate animal subjects were involved in this study. Environmental samples were collected following standard laboratory and environmental safety procedures.

Conflict of Interest:

The authors declare that there is no conflict of interest regarding this study.

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Limitation of Study:

The study was limited by the small number of edible fruit samples available on the dumpsites during the sampling period. Future studies involving larger sample sizes and more sampling locations are recommended.

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