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Impacts of Heavy Metals Pollution on Waterleaf (*Talinum triangulare*) Grown along Eleme-Port Harcourt Road in Rivers State, Nigeria

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Abstract
The problem of heavy metal pollution has drawn more attention in Nigeria, especially in the vicinity of major highways and industrial zones.
Hence, this study assessed the level of heavy metal pollution in vegetables (waterleaf) grown at the Eleme-Port Harcourt roadside in Rivers State, Nigeria, with a view to analyzing the potential health risks to local residents who consume vegetables contaminated with heavy metals. The fresh vegetable samples were collected at three different points at the Eleme-Port Harcourt roadside, located in Eleme, Eleme Local Government Area of Rivers State, Nigeria, carefully cleaned with tap water, and were sent to the laboratory for elemental analysis, in polythene bags. The samples were air-dried and then oven-dried for an hour at 105 ^{o}C. Before the elemental composition analysis, using Atomic Absorption Spectroscopy, the samples were ground into a powder using a mortar and pestle and sieved through a 2 mm sieve. Descriptive statistics (range, mean, and standard deviation) and one-way analysis of variance were adopted in analyzing the data collected. The results obtained showed elevated levels of heavy metals pollution, with average concentrations of 26.20 mg/kg for chromium; 10.40 mg/kg for lead; 36.80 mg/kg for nickel; 9.40 mg/kg for cadmium; 150.60 mg/kg for zinc; 238.10 mg/kg for manganese; 15.65 mg/kg for calcium; and 790.20 mg/kg for iron. This calls for risk management and remediation measures as the dangerous levels of heavy metals were higher than those recommended by the World Health Organization (WHO). This implies that consumers may be at serious risk of health problems due to the high levels of heavy metal pollution in the waterleaf cultivated at the Eleme-Port Harcourt roadside.

Key Words: *Heavy metals, Pollution, Waterleaf, Health risk, Leafy vegetable, Remediation*

INTRODUCTION

High atomic weight metallic elements are known as heavy metals, and when they are present in excess, they can be harmful to both people and the environment. Lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr) are a few prevalent heavy metals that are cause for concern. Numerous causes, such as inappropriate trash disposal, vehicle emissions, and industrial operations, can release these metals into the environment. They can build up in soil, water, and plant tissues after being discharged into the environment (Umoh *et al*., 2024).

Waterleaf (*Talinum triangulare*) is a leafy vegetable widely consumed in many parts of Nigeria and other African countries due to its nutritional value and culinary significance. It is rich in essential nutrients such as vitamins, minerals, and antioxidants, making it a popular ingredient in various traditional dishes and salads (Maheswari and Thilagavathi, 2015; Umoh *et al*., 2024). However, the safety of consuming waterleaf, particularly when it is grown in areas with potential environmental pollution is a significant concern.

Globally, agricultural practices, public health, and food security are all impacted by heavy metal pollution. Since these metals are not biodegradable, they build up in food crops like vegetables and remain in soils and ecosystems for extended periods of time. Agricultural soils frequently contain heavy metals such as cadmium (Cd), lead (Pb), mercury (Hg), and chromium (Cr) as a result of industrial processes, sewage sludge, and automobile emissions. These pollutants endanger the health of people who eat vegetables as well as the development and quality of the crops when they are absorbed by them. Long-term ingestion of food tainted with heavy metals can have harmful consequences, such as cancer, bone issues, and renal impairment (Alloway, 2013; Khan *et al*., 2008).

Contaminated agricultural soils frequently contain metals including lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg), especially in urban or industrial regions (Peralta-Videa *et al*., 2009). These metals build up in edible plant components after entering the food chain through the roots of the plants, where they might be harmful if ingested. Long-term ingestion of vegetables cultivated in polluted soils can cause heavy metals to bio-accumulate in the body, which can result in long-term health problems like cancer, heart disease, and respiratory disorders (Tchounwou *et al*., 2012).
Jaishankar *et al*. (2014) reported that heavy metals present significant public health issues in addition to endangering food safety. For instance, it is well recognized that lead (Pb) can impact the nervous system, especially in children, resulting in cognitive deficits and developmental problems. In a similar vein, exposure to cadmium (Cd) is associated with bone demineralization and renal failure, whilst mercury (Hg) and arsenic (As) are carcinogenic.

The problem of heavy metal pollution has drawn more attention in Nigeria, especially in the vicinity of major highways and industrial zones. An excellent illustration of a place where industrial activity, including as petrochemical plants and oil refineries, contribute to environmental contamination is the Eleme-Port Harcourt Express Road in Rivers State. Nduka *et al.* (2008) reported that farmlands' closeness to these industrial and traffic sources greatly

increases the soil's concentration of heavy metals, which are then absorbed by crops like cereals, leafy vegetables, and root tubers. The contamination levels in agricultural products are further increased when contaminated water sources or wastewater are used for irrigation (Ogunkunle and Fatoba, 2014).

According to Umoh *et al*. (2024), waterleaf grown near the automobile workshop at Akwa Ibom State University is contaminated with elevated levels of heavy metals (cadmium, chromium, lead, zinc, manganese, nickel, iron and calcium), posing significant health risks to consumers. The presence of heavy metals in the soil potentially impact surrounding vegetation, including waterleaf crops grown nearby. The hazardous levels of heavy metals exceeded the World Health Organization Standards (WHO) indicating an urgent need for remediation and risk management strategies.

Heavy metal pollution is mostly caused by industries along the Eleme-Port Harcourt Express Road, including petrochemical factories, metal processing facilities, and oil refineries. According to Nwankwoala and Ibe (2016), these businesses frequently discharge effluents that contain dangerous elements like lead, cadmium, mercury, and arsenic either directly into adjacent water bodies or by air deposition.

Waterleaf and other plants are frequently employed as bio-indicators to evaluate environmental contamination. As a reflection of the degree of pollution in their tissues, they can absorb heavy metals from the soil and water. Because of this characteristic, waterleaf is a good plant to investigate possible heavy metal contamination in regions close to auto shops (Umoh *et al*., 2024; Singh and Raju, 2018).

According to studies, eating vegetables tainted with heavy metals on a regular basis can cause long-term health problems such renal damage, neurological diseases, and several types of cancer (Umoh *et al*., 2024; Jarup, 2003; Duruibe *et al*., 2007). Notwithstanding these established dangers, little local study has been done to measure the concentrations of heavy metals in vegetables planted alongside the Eleme-Port Harcourt Express Road and evaluate any possible health effects.

Thus, the primary issue to be addressed in this study is the unknown level of heavy metal contamination of vegetables planted along the Eleme-Port Harcourt Express Road and the health concerns to consumers that result from this contamination. Knowing the degree of pollution will give local health officials, environmental regulators, and legislators the information they need to take the necessary steps to reduce health hazards and guarantee food safety in the area.

This study therefore is aimed at assessing the level of heavy metal pollution in vegetables (waterleaf) grown along the Eleme-Port Harcourt roadside in Rivers State, Nigeria, with a view to analyzing the potential health risks to local residents who consume vegetables contaminated with heavy metals.

RESEARCH METHODOLOGY

Study Area

This study was performed at the roadside in Ogale community, along Eleme-Port Harcourt Road in Rivers State, Nigeria. Eleme is located between Latitude 5º04'60.00"N and Longitude 6º38'59.99"E, South Southern Nigeria. It has a total land mass of approximately, 138 square kilometres, and a total population of approximately, 190,884, as at the 2006 population census.

Sample Collection and Analysis

The triangular research method, described by Umoh *et al*. (2024), was adopted for sample collection. The fresh vegetable samples were collected at three different points at the Eleme-Port Harcourt roadside, located in Eleme, Eleme Local Government Area of Rivers State, Nigeria. To get rid of the dirt and other undesirable components, the samples were carefully cleaned with tap water. The cleaned samples were sent to the laboratory for elemental analysis in polythene bags. To guarantee that all of the water content was gone, the samples were air-dried and then oven-dried for an hour at 105 ºC. Before being kept for the elemental composition analysis using Atomic Absorption Spectroscopy, the samples were ground into a powder using a mortar and pestle and sieved through a 2 mm sieve (Umoh *et al*., 2024).

Statistical Analysis

Descriptive statistics (range, mean, and standard deviation) and one-way analysis of variance were adopted in analyzing the data collected.

RESULTS AND DISCUSSIONS

The average concentration of some heavy metals in waterleaf grown at the Eleme-Port Harcourt roadside is presented in Table 1.

Table 1: Concentration of Heavy Metals in Waterleaf (*Talinium triangulare*)

S/N	Heavy metal/symbol	Concentration (mg/kg)
1	Chromium (Cr)	26.20 ± 0.21
2	Lead (Pb)	10.40 ± 0.22
3	Nickel (Ni)	36.80 ± 0.12
4	Cadmium (Cd)	9.40 ± 0.17
5	Zinc (Zn)	150.60 ± 0.10
6	Manganese (Mn)	238.10 ± 0.07
7	Calcium (Ca)	15.65 ± 0.21
8	Iron (Fe)	790.20 ± 2.14

Note: Values are mean ± standard deviation of triplicate determination

Chromium

The results showed that the average chromium concentration was 26.20 mg/kg (Table 1). This value is slightly lower than the 28.50 mg/kg of sample for waterleaf grown next to the car workshop at Akwa Ibom State University, Ikot Akpaden (Umoh *et al*., 2024), but it is higher than the World Health Organization's (WHO) (2015) limit of 2.30 mg/kg for leafy vegetables and higher than the range of 0.10 to 2.79 mg/kg previously reported by Babayemi *et al*. (2017). Compounds containing hexavalent chromium can cause skin irritation, respiratory problems, and cancer.

Lead

The average concentration of lead in the sample was 10.40 mg/kg (Table 1), which is higher than the WHO (2015) maximum limit of 0.3 mg/kg (300µg/kg) for lead in leafy vegetables and higher than the 22.15 to 24.45 mg/kg reported by Babayemi *et al*. (2017); 8.30 mg/kg for waterleaf grown next to the automotive workshop at Akwa Ibom State University, Ikot Akpaden (Umoh *et al*., 2024). Lead is a neurotoxin that can cause developmental issues in children and cardiovascular problems in adults.

Nickel

According to Table 1, the sample's average nickel concentration was 36.60 mg/kg. This value is consistent with 36.10 mg/kg for waterleaf planted next to the automotive workshop at Akwa Ibom State University, Ikot Akpaden (Umoh *et al*., 2024). It is higher than the range of 2.60 to 15.85 mg/kg previously reported by Babayemi et al. (2017), but lower than the WHO (2015) limit of 67.9 mg/kg for nickel in leafy vegetables. Exposure to nickel might result in respiratory issues and allergic reactions.

Cadmium

According to the findings, waterleaf grown along the Eleme-Port Harcourt roadside had an average cadmium value of 9.40 mg/kg of sample (Table 1). This figure exceeds both the 0.50 to 0.60 mg/kg range of values reported by Babayemi *et al*. (2017) and the WHO (2015) maximum limit of 0.1 mg/kg (100µg/kg) for cadmium in leafy greens. Heavy metals like lead, cadmium, and zinc can enter the soil from routinely spilling grease and motor oil into the ground. Chronic exposure to cadmium is known to have harmful effects on the kidneys, bones, and other organs.

Zinc

Table 1 shows that the average concentration of zinc was 150.60 mg/kg, which is much higher than the WHO (2015) limit of 99.4 mg/kg for zinc in leafy vegetables and higher than 140.30 mg/kg in waterleaf planted next to the car workshop on the main campus of Akwa Ibom State University (Umoh *et al*., 2024). Lubricating fluids and metal fragments from cars may have contributed to the zinc content of the soil. Although too much zinc might cause digestive problems, it is a necessary element.

Manganese

Manganese, as one of the heavy metals, had an average value of 238.10 mg/kg of sample (Table 1). This result is slightly higher than 228.30 mg/kg in waterleaf planted near the car workshop in Akwa Ibom State University main campus (Umoh *et al*., 2024). However, the WHO (2015) has not established a particular manganese limit for leafy vegetables. Toxic levels of manganese can cause respiratory problems and neurological abnormalities.

Calcium

Calcium had an average concentration of 15.65 mg/kg of sample, according to the results (Table 1), which is similar to the 15.70 mg/kg previously reported by Umoh *et al*. (2024). There isn't a specific WHO (2015) calcium limit for leafy vegetables. Healthy bones require calcium.

Iron

The average concentration of iron in the sample, as indicated in Table 1, is 790.20 mg/kg, which is slightly higher than the 784.20 mg/kg for the waterleaf sample grown next to the automotive workshop at Akwa Ibom State University, Ikot Akpaden, and much higher than the WHO (2015) limit of 425.5 mg/kg for iron in leafy vegetables (Umoh *et al*., 2024). The presence of iron and scrap metals scattered along the roadside can contribute to soil contamination with iron, which is necessary for good health but can cause toxicity and gastrointestinal distress in extreme situations.

CONCLUSIONS

According to the study, consumers may be at serious risk of health problems due to the high levels of heavy metal pollution in the waterleaf cultivated at the Eleme-Port Harcourt roadside. Based on the heavy metal results from the waterleaf samples, the presence of heavy metals in the soil may have an impact on locally grown waterleaf crops as well as other vegetation. There is an urgent need for risk management and remediation measures because the dangerous levels of heavy metals are higher than those recommended by the World Health Organization (WHO). This will ultimately help in reducing the health hazards and guarantee food safety in the area.

Conflicts of Interest

The Authors hereby declare that no conflicts of interest exist.

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