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ASSESSMENT OF HEAVY METALS CONCENTRATION AND HEALTH RISK ON CONSUMPTION OF WATERLEAF GROWN BESIDE AUTOMOBILE WORKSHOP

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ABSTRACT: *This study assessed the level of concentration of heavy metals and health risks in the consumption of waterleaf (Talinum triangulare) grown beside an automobile workshop in Akwa Ibom State University, Ikot Akpaden, Mkpat Enin Local Government Area (LGA). The triangular research method was adopted for sample collection. The fresh samples of waterleaf were collected at three designated points at an automobile workshop in Akwa Ibom State University located in Ikot Akpaden, Mkpat Enin L.G.A. The samples were washed thoroughly using tap water to remove the dirt and other unwanted materials. The washed samples were put in polythene bags and taken to the laboratory for elemental analysis. Data collected were analyzed using descriptive statistics (range, mean, and standard deviation) and one-way analysis of variance. The results obtained showed elevated levels of heavy metals and their average concentrations were as follows: Cadmium (7.30 mg/kg), Chromium (28.50 mg/kg), Lead (8.30 mg/kg), Zinc (140.30 mg/kg), Manganese (228.30 mg/kg), Nickel (36.10 mg/kg), Iron (784.20 mg/kg), and Calcium (15.70 mg/kg). The hazard identification index was 0.83 indicating potential health risks associated with the consumption of waterleaf contaminated with heavy m--etals. The results also showed that the proportion of heavy metals present in the waterleaf planted beside the automobile workshop exceeded World Health Organization Standards (WHO), thereby posing severe health risks when consumed. The sources of contamination and pathways through which heavy metals entered the soil include; diesel and fuel engine operation, abandoned cars, iron and scrap metals, grease and engine oil disposal, disposal of artificial wood, and the presence of a step-up transformer. Based on the results, an urgent need for remediation and health risk management strategies should be taken.*

KEYWORDS: Risk assessment, Heavy metal, Waterleaf, Hazard index, Spectrophotometry.

INTRODUCTION

Heavy metals are metallic elements with high atomic weights that can be toxic to humans and the environment when present in excessive quantities. Some common heavy metals of concern include Lead (Pb), Cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr). These metals can enter the environment through various sources, including industrial activities, vehicular emissions, and improper waste disposal. When released into the environment, they can accumulate in soil, water, and plant tissues (Alloway, 2013). According to Usoh *et al.* (2023), soil contaminated by heavy metals is a serious problem because soils are regarded as the ultimate sink for heavy metals discharged into the environment, as many heavy metals are bound to soils. The lack of appropriate soil and water conservation measures has led to land degradation (Ahuchaogu *et al*., 2022). Lead may cause birth defects, abnormality in behaviour and learning problems in children, decreased kidney function, a reproductive disorder, cardiovascular problems, etc (Mudipalli, 2007; Wang *et al*., 2009; Skerfving *et al*., 2015). Human health effects of cadmium include genetic disorders, cancer, impairment of renal function, bronchiolitis, a decrease in haemoglobin level, etc (Cabral *et al.*, 2015; Cartularo *et al*., 2015; Zang, 2016). Cadmium causes nasal irritations, cancer, bronchitis, ulcerations of the septum and decreased pulmonary function (Shanker and Venkateswarlu, 2011; Babayemi *et al.*, 2016). These toxic elements find their way into the environment usually as a result of pollution arising from human activities, and consequently, contaminate the different environmental media on which human life depends.

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 andThilagavathi, 2015). However, the safety of consuming waterleaf, particularly when it is grown in areas with potential environmental contamination is a significant concern. One such area of concern is the proximity of waterleaf farms to automobile workshops, which often deal with hazardous materials and heavy metals (Singh and Raju, 2018). Plants like waterleaf are often used as bio-indicators to assess environmental contamination. They can accumulate heavy metals from the soil and water, reflecting the level of contamination in their tissues. This property makes waterleaf a suitable plant for studying potential heavy metal contamination in areas near automobile workshops (Singh and Raju, 2018).

Automobile workshops are known to use a variety of materials and chemicals that may contain heavy metals. For example, paints, batteries, lubricants, and fuel or diesel systems in vehicles often contain lead, cadmium, and other heavy metals. When these materials degrade or are disposed of improperly, heavy metals can leach into the surrounding soil and water, potentially contaminating nearby crops (Nriagu, 1988). There is a lack of adequate comprehensive studies addressing the risk associated with the consumption of waterleaf grown near an automobile workshop, specifically at Akwa Ibom State University, Ikot Akpaden main campus. Despite the potential dangers of heavy metal contamination in this agricultural setting, there is a dearth of research investigating the extent of heavy metal accumulation in waterleaf and the subsequent health risks to the local population. To address these issues, it is imperative to determine the concentration of heavy metals in waterleaf samples cultivated near the automobile workshop and evaluate the potential health risks to consumers. Such information is critical for making informed decisions about food safety and implementing mitigation measures to protect public health in this region. Therefore, this

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study aimed mainly at evaluating the levels of heavy metals concentration in waterleaf (*Talinum triangulare*) grown near an automobile workshop in Akwa Ibom State University, Ikot Akpaden main campus.

MATERIALS AND METHODS

Study Area

The experiment was conducted at an automobile workshop in Akwa Ibom State University, located in Ikot Akpaden, Mkpat Enin L.G.A. Mkpat Enin is in South Southern Nigeria and is located between $4^{O}35^{II}$ and $4^{O}40^{II}$north latitude and $4^{O}35^{II}$ and $4^{O}40^{II}$ east longitude. Mkpat Enin is in the equatorial zone and the most notable attribute of the equatorial environment is its year-round temperature consistency. It sits at an altitude of approximately 185 metres above sea level and has an area of 322.352 square kilometres.

Collection and Analysis of Sample

The triangular research method was adopted for sample collection. The fresh samples of waterleaf were collected at three designated points at an automobile workshop in Akwa Ibom State University, located in Ikot Akpaden, Mkpat Enin L.G.A. The samples were washed thoroughly using tap water to remove the dirt and other unwanted materials. The washed samples were put in polythene bags and taken to the laboratory for elemental analysis. The samples were air-dried and oven-dried at a temperature of $105^{o}C$ for one hour to ensure complete removal of water content from it. The samples were crushed to powder form with mortar and pestle and sieved to pass through a 2mm sieve and stored for the following physicochemical analysis: cadmium, chromium, lead, zinc, manganese, nickel, iron and calcium.

Statistical Analysis

Data collected were analysed using descriptive statistics (range, mean, and standard deviation) and one-way analysis of variance.

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RESULTS AND DISCUSSION

3Heavy Metal Concentration and Health Risk Assessment:

The results of the heavy metals concentration in the waterleaf planted beside the automobile workshop at Akwa Ibom State University, Ikot Akpaden are presented in Table 1.

Table 1: Heavy metals concentration in waterleaf (*Talinum triangulare*)

S/N	Heavy metal/ symbol	Concentration (mg/kg)
1	Cadmium (Cd)	7.30 ± 0.17
2	Chromium (Cr)	28.50 ± 0.22
3	Lead (Pb)	8.30 ± 0.22
4	Zinc (Zn)	140.30 ± 0.10
5	Manganese (Mn)	228.30 ± 0.07
6	Nickle (Ni)	36.10 ± 0.12
7	Iron (Fe)	784.20 ± 2.44
8	Calcium (Ca)	15.70 ± 0.21

Values are means ± standard deviations of triple determination.

Cadmium (Cd)

The results showed that the average concentration of Cadmium in waterleaf planted beside the automobile workshop at Akwa Ibom State University is 7.30 mg/kg (Table 1). This value is higher than 0.1 mg/kg (100µg/kg) which is the WHO (2015) maximum limit for cadmium in leafy vegetables, and also higher than the 0.50 to 0.60 mg/kg range of values reported by Babayemi *et al*. (2017). Regular pouring of grease and engine oil onto the ground can introduce heavy metals such as lead, cadmium, and zinc into the soil. These metals may be present as contaminants in the lubricants or may leach from metal components of the engines. Cadmium is known to have toxic effects on various organs, including the kidneys and bones as well as chronic exposure.

Chromium (Cr)

The results indicated an average concentration of 28.50 mg/kg for chromium (Table 1). This value is higher than the WHO (2015) limit of 2.30 mg/kg for leafy vegetables, and also higher than the range of 0.10 to 2.79 mg/kg, earlier reported by Babayemi *et al*. (2017). Hexavalent chromium compounds are carcinogenic and can cause respiratory issues and skin irritation.

Lead (Pb)

The average concentration of Lead was 8.30 mg/kg (Table 1). This value is higher than the WHO (2015) maximum limit of 0.3mg/kg (300µg/kg) for lead in leafy vegetables, and also higher than 22.15 to 24.45 mg/kg, as reported by Babayemi *et al*. (2017). Old cars that have been abandoned in the vicinity of the automobile workshop for 10 to 12 years may contain heavy metals in their components, such as lead in lead-acid batteries and cadmium in brake pads. Over time, these metals can corrode and leach into the soil, especially during rainfall or

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as a result of the physical degradation of the car parts. Lead is a neurotoxin that can cause developmental issues in children and cardiovascular problems in adults.

Zinc (Zn)

Zinc had an average concentration of 140.30 mg/kg in waterleaf planted near the automobile workshop in Akwa Ibom State University's main campus (Table 1), which is quite higher than the WHO (2015) limit of 99.4mg/kg for zinc in leafy vegetables. The presence of zinc in the soil could be due to the contribution of the lubricating oils and metal scraps from vehicles. Zinc is an essential mineral, but excessive intake can lead to gastrointestinal issues.

Manganese (Mn)

Manganese, as one of the heavy metals, had an average concentration of 228.30 mg/kg in waterleaf planted near the automobile workshop in Akwa Ibom State University, main campus (Table 1). However, there is no specific WHO (2015) limit for manganese in leafy vegetables. Manganese toxicity can result in neurological symptoms and respiratory issues.

Nickel (Ni)

The average concentration of Nickel in the sample was 36.10 mg/kg (Table 1). This value is lower than the WHO (2015) limit of 67.9 mg/kg for nickel in leafy vegetables but higher than the range of 2.60 to 15.85 mg/kg, earlier reported by Babayemi*et al*. (2017). Nickel exposure can cause allergic reactions and respiratory problems. The presence of nickel contamination could be a result of the disposal of spent automobile batteries and different paint wastes directly into the soil.

Iron (Fe)

As shown in Table 1, the result of the average concentration of Iron in the sample is reported as 784.20 mg/kg. This value is quite higher than the WHO (2015) limit of 425.5 mg/kg for iron in leafy vegetables. The presence of iron and scrap metals littered around the automobile workshop can contribute to soil contamination with iron. Iron is essential for health, but excessive intake can lead to gastrointestinal discomfort and toxicity in extreme cases.

Calcium (Ca)

The results showed that calcium recorded an average concentration of 15.70 mg/kg in the sample (Table 1), and there is no specific WHO (2015) limit for calcium in leafy vegetables. Calcium is essential for bone health, and the levels found in the samples are within acceptable limits.

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CONCLUSION

The study revealed that waterleaf grown near the automobile workshop at Akwa Ibom State University is contaminated with elevated levels of heavy metals, posing significant health risks to consumers. The presence of heavy metals in the soil can then potentially impact surrounding vegetation, including waterleaf crops grown nearby, as shown in the heavy metal results obtained from the waterleaf samples. The hazardous levels of heavy metals exceeded the World Health Organization Standards (WHO) indicating an urgent need for remediation and risk management strategies.

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