NILEST JOURNAL OF SCIENCE TECHNOLOGY, AND MANAGEMENT
(NIJOSTAM) VOLUME 1, ISSUE 1, DECEMBER, 2023, pp. 65-73
eISSN: 3027-2580 www.nijostam.org

DETERMINATION OF SOME HEAVY METALS IN *AMARANTHUS SPINOSUS (AMARANTHEAE)* IN SOME SELECTED AREAS IN ZARIA METROPOLIS

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ABSTRACT

The levels of some heavy metals (Cd, Cr, Pb, Zn, and Fe) were determined. Portions of fresh spinach were randomly handpicked from three different farms. The leaves were cleaned with distilled water, sliced and dried in an oven at 80 ^{0} C. Three grams of each powdered leave sample were weighed out into a kjadhal digestion flask, and the samples were digested using aqua re, diluted with distilled water and filtered. The filtrate was analyzed for the presence of heavy metals (Cd et al. using an Atomic Absorption Spectrophotometer (AAS), and the levels of heavy metals in the vegetable samples obtained from samples A, B, and C were determined in ppm. The concentration of Cd was 0.0020, 0.0481 and 0.0127 respectively. Cr was 0.1555, 5.5416 and 13.7827ppm, Fe was 0.3171, 0.4283 and 0.6195, Pb was 0.1496, 0.1683 and 0.1699, Zn was 0.0035, 0.0106 and 0.0137ppm. The concentration levels of some metals were higher than the WHO permissible limit. The result generally showed no significant level of metals (P>0.05) in the vegetable leaves for samples obtained from A, B and C for Zn, Pb, Fe and Cd. However, there was a significant difference (P<0.05) for Cr in samples B and C. Consuming vegetables from these various farms as food may cause health hazards.

KEYWORDS

Atomic absorption spectrometry, digestion, heavy metals, *Amaranthus spinosus*, vegetable

ARTICLE HISTORY:

Received: September, 2023
Received: in revised: October, 2023
Accepted: November, 2023
Published online: December, 2023

INTRODUCTION

The term "heavy metal" is collectively applied to a group of metals (and metal-like elements) with a density greater than 5 g/cm3 and an atomic number above 20 (Raut *et al*., 2012). Heavy metals enter the environment by natural and anthropogenic means such as natural weathering of the earth's crust, mining, soil erosion, industrial discharge, urban runoff, sewage effluents, pest or disease control agents applied to plants, air pollution fallout and several others. Although some individuals are primarily exposed to these contaminants in the workplace, for most people, the primary source of exposure to these toxic elements is their diet (food and water) (Raut *et al*., 2012).

Heavy metals are natural components of the earth's crust and get into the water food cycles through various chemical and geochemical processes (Alengebawy *et al*., 2021). Even though it is almost impossible to visualize a soil without a trace of heavy metals, most heavy metals are essential for living organisms. However, their excess amount is generally harmful to plants, animals and human health (Alengebawy *et al*., 2021). Heavy metals are contaminants found on the surface and in the tissue of fresh vegetables (Teklay & Abraha, 2018). VegetablesVegetables are essential to the human diet since they contain carbohydrates, protein, vitamins, minerals and heavy metals. Several elements such as lead (Pb), cadmium (Cd), nickel (Ni), cobalt (Co), chromium (Cr), copper (Cu) and selenium (Se) can be harmful to plants and humans, even at relatively low concentration (Islam *et al.,* 2015). Food chain contamination is essential for entering these toxic pollutants into the human body (Jaishankar, 2014).

Amaranthus spinosus, also known as Spiny Amaranth or spiny pigweed, belongs to the family *Amaranthaceae* and is a troublesome weed of vegetables, row crops, and pasture in warm climates. Native to the lowland tropics in America, Spiny Amaranth has spread through tropical and subtropical latitudes worldwide (Lojka *et al*., 2011). It is classified as a weed in some parts of the world, but in West Africa, it is cultivated for its edible leaves (Thomas *et al*., 2021). In Nigeria, it is a common vegetable with some carbohydrate dishes. It is also an excellent source of vitamins, including vitamins A, B_6, and C, riboflavin, and folate.

It is also a significant source of dietary minerals, including calcium, iron, magnesium, phosphorus, potassium, zinc, copper, and manganese (Sisti *et al.*, 2019). However, its seeds have been shown to contain protein (Tahir & Mathew, 2021). Some studies have shown that amaranth seeds or oil may benefit people with hypertension and cardiovascular disease; hence, regular consumption reduces blood pressure and cholesterol levels while improving antioxidant status and some immune parameters via its content of plant stanols and squalene (Jannika *et al*., 2022).

Cadmium, in particular, is an Environmental Protection Agency (EPA) regulated heavy metal used as anti-corrosion and decorative coatings on metal alloys. Cadmium enters waterways through industrial discharges and galvanized pipe breakdown. It is a non-essential metal to living organisms and can become toxic by displacing zinc. Low exposures may result in kidney damage (ILO, 2023). In addition, epidemiological studies have revealed that cadmium may be a contributing factor in some forms of cancer in humans (Giuseppe, 2020).

The heavy metals hazardous to humans include Copper, Zinc, Nickel, Lead, Mercury, Cadmium, Arsenic, and Chromium. Such metals are found naturally in the soil in trace Amounts, which pose few problems. When concentrated in particular areas, however, they present a severe danger. Arsenic and cadmium, for instance, can cause cancer. Mercury can cause mutations and genetic damage, while copper, nickel, and zinc can cause brain and bone damage (Mukesh & Lokendra, 2013). Therefore, this research determined the concentration of heavy metals (Cu, Zn, Pb, Cr, Fe) in *Amaranthus spinosus* grown in different locations in Zaria metropolis and compared the result obtained with the standard limit set by WHO (World Health Organization).

MATERIALS AND METHODS

Sampling and Sample Treatment

Amaranthus spinosus **(***Amarantheae***)** samples were collected in August 2017 from different farms (A, B and C). Edible portions of the fresh samples of spinach were randomly collected (handpicked) from three different vegetable farms in Biya in Shika, Hunkuyi, and Hayin Mallam in Giwa, labelled as A, B and C, respectively, which supply most vegetables consumed in Samara–Zaria, Kaduna State, Nigeria. Only fresh vegetables in good condition were collected to produce good-quality dried products (Obike-Martins *et al.*, 2022). The samples were wrapped in big brown envelopes and labelled. In the laboratory, vegetable samples were washed with tap water and, after that, distilled water, which was allowed to drip out. They were then sliced into smaller portions and dried in an oven at 80^0C for 5 hours. At the end of the drying, the oven was turned off and left overnight to enable the sample to cool to room temperature. Each sample was ground into a fine powder, sieved, and finally stored in polyethylene and appropriately labelled.

Digestion Procedure

Three grams of each powdered leaf sample was weighed out into a Kjaldah digestion flask and mixed with $20cm^3$ of hydrochloric acid (with a specific gravity of 1.19, percentage purity of 37.7%) and nitric acid (with a specific gravity of 1.42, percentage purity of 68%) in the ratio of 1:3, was added. The heat was increased to 12℃, and the mixture turned black afterwards (Obike-Martin *et al*., 2023). The digestion process was complete when the solution turned clear and white fumes were emitted. Next, the digest was mixed with distilled water and boiled for 15 minutes. After cooling down, it was poured into $100cm^3$ volumetric flasks and filled to the mark using distilled water. Finally, the sample solution was filtered through filter paper and collected in a polyethylene bottle with a cap.

Determination of Heavy Metals

Levels of Cd, Zn, Pb, Cr, and Fe in the vegetable sample were determined using an Atomic Absorption Spectrophotometer (model BUCK 210 VGP) with an air acetylene burner and hallow cathode dilution of 1000ppm stock. The solution of each metal and a calibration curve were constructed by plotting absorbance versus concentration (Jabeen *et al.,* 2010).

Statistical Analysis

All analysis was performed in triplicates. Results were expressed as the mean of ± SD. Statistical significance was established using a one-way analysis of variance (ANOVA) and was separated according to Duncan's multiple range analysis using the software SPSS 16.0.

RESULTS

Data for the results of the concentration of metals from analysis of the vegetable samples (*Amaranthus spinosus*) obtained from three different locations are presented in Table 1. The heavy metal contents in the vegetable sample varied significantly from location to location.

In sample A obtained from the Shika town, the metal concentrations in part per million (ppm) were: Cd, 0.0020±0.0014; Cr, 0.1555±0.1110; Fe, 0.3171±0.3966; Pb, 0.1496±0.0671; Zn, 0.0035±0.0007. In those obtained from Hunkuyi (sample B), the metals Concentration levels were: Cd, 0.0481±0.5839; Cr, 5.5416±1.5054; Fe, 0.4283±0.788; Pb, 0.1683±0.0014; Zn, 0.0106±0.0692 while in sample C obtained from Giwa town the level of the metals were: Cd, 0.0127±0.2776; Cr, 13.7827±4.5325; Fe, 0.6195±0.1930; for Pb, 0.1699±0.0169; and Zn, 0.0137±0.0169. The concentration levels of the heavy metals were lower than the threshold value considered toxic for mature plant tissue except for samples B and C, in which Cr contents were relatively high (B = 5.5416±1.5054ppm and C =13.7827±4.5325ppm) as against 1.3ppm (WHO, 2011).

Table 1: The Concentration of Some Metals in Spinach (*Amaranthus spinosus*) Grown in Different Parts of Zaria

S/NO	Metals	A (ppm)	B (ppm)	C (ppm)	WHO (2011) (ppm)
1	Cd	0.0020±0.0014	0.0481±0.5839	0.0127±0.2776	0.2
2	Cr	0.1555±0.1110	5.5416±1.5054	13.7827±4.5325	1.3
3	Fe	0.3171±0.3966	0.4283±0.788	0.6195±0.1930	425.0
4	Pb	0.1496±0.0671	0.1683±0.0014	0.1699±0.0169	0.3
5	Zn	0.0035±0.0007	0.0106±0.0692	0.0137±0.0169	5.00

Mean ± standard deviation; WHO World Health Organization.

DISCUSSION

The findings show that the chromium concentration in the analysed samples is higher than WHO limits for samples B and C. In contrast, the concentration of the other metals analysed is within the safe range. The high concentration of chromium recorded in samples B and C is attributed to the presence of chromium-containing materials deposited on the farmland, leading to the elevated levels of the metal in the vegetables, probably due to excessive usage of fertilizer and other agro-chemicals as well as the use of wastewater in irrigating the soil and of course the environmental factor of the areas (Saïda *et al.*, 2019). Heavy metal contamination in agricultural environments can come from atmospheric fallout, pesticide formulations, and contamination by chemical fertilizers and irrigation with water of poor quality (Loubna *et al*., 2017). Heavy metals rank high amongst the chief contaminants of leafy vegetables and medicinal plants (Kulhari *et al*., 2013). The uptake of trace elements by plants varies and depends mainly on several factors, such as soil pH and organic matter content (Hamdan *et al*., 2022). Plant uptake is one of the major routes of food chain exposure to trace elements in the soil.

CONCLUSION

From the results of the samples analysed, samples B and C were contaminated with chromium, looking at the concentration levels relative to the WHO recommended limits. They are, therefore, not whole for human consumption. Further research is needed to obtain specific information about the effects of the age of the plant on the accumulation and distribution of heavy metals in the different parts of the plants.

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