International Journal of Recent Innovations in Academic Research

E-ISSN: 2635-3040; P-ISSN: 2659-1561
Homepage: https://www.ijriar.com/
Volume-10, Issue-3, July-September-2026: 61-65

Research Article

Assessment of Heavy Metal Concentrations in Cassava Flour from Jalingo and Yorro Local Government Areas, Taraba State, Nigeria

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Article History
Received: July 27, 2026
Accepted: August 18, 2026
Published: August 24, 2026

Abstract
This research examined the levels of heavy metal in cassava flour collected from Jalingo and Yorro Local Government Areas, Taraba State, Nigeria. A total of ten samples of cassava flour (five samples per each LGA) were analyzed for their levels of chromium (Cr), lead (Pb), cadmium (Cd), and magnesium (Mg) using Atomic Absorption Spectrophotometry (AAS) after acid digestion. The levels of Cr, Pb, Cd, and Mg were measured and compared to permissible limits set by the Federal Ministry of Health (FMH) and the World Health Organization (WHO). It was found that none of the samples contained Cr. Pb levels were 0.033 mg/L in Jalingo and 0.044 mg/L in Yorro, exceeding the WHO permissible limit of 0.01 – 0.015 mg/L. Cd concentrations were 0.027 mg/L (Jalingo) and 0.041 mg/L (Yorro), which are significantly lower than the 1.0 mg/L value set by WHO. Mg concentrations were 1.637 mg/L (Jalingo) and 1.793 mg/L (Yorro), and also lower than the recommended dietary level of 35 – 40 mg/L. Comparison revealed high amounts of Pb and Cd in Yorro samples, which indicates that there is a possibility of localized environmental pollution despite the safe levels of Cd and Mg concentrations. Elevated levels of Pb concentration can pose health hazards owing to chronic exposure. These results reveal the importance of monitoring of cassava flour for future use.
Keywords: Cassava Flour, Heavy Metals, Taraba State, Food Safety, Atomic Absorption Spectrophotometry.

1. Introduction

Cassava (*Manihot esculenta* Crantz) is an important food crop for over 800 million individuals in the world, especially sub-Saharan Africa, Asia, and Latin America where it is a major source of energy and food security (Nassar *et al.,* 2019; FAO, 2023). Nigeria continues to be the world's largest producer of the crop with substantial production used locally and in industry (Ofoegbu *et al.,* 2022). Its drought tolerance and ability to grow in poor soils and climatic conditions make cassava very useful in combating hunger and malnutrition in developing countries (Etim *et al.,* 2021; Dennis *et al.,* 2025).

Nutritionally, cassava has high caloric production in terms of hectare compared to cereals, thus making it an important crop for food security initiatives (Akinola *et al.,* 2018). Nevertheless, the growing of cassava in marginal or polluted soils enhances the danger of accumulation of heavy metals such as cadmium (Cd), lead (Pb), chromium (Cr), and nickel (Ni), which are persistent environmental contaminants with health consequences (Alloway, 2013; Bilyaminu and Ezeonu, 2026). The heavy metals can enter the food chain via the soil-plant interaction, industrial emissions, agrochemical use, and oil pollution, particularly in regions like the Niger Delta (Sherma *et al.,* 2008; Ofoegbu *et al.,* 2022).

Research studies have indicated that cassava from contaminated or chemical-treated soils frequently exceeds the limits set by FAO/WHO for the concentration of heavy metals which results in the risk of carcinogenicity and toxicity to vital organs (Etim *et al.,* 2021; Dennis *et al.,* 2025). Continuous exposure to Cd and Pb for example has been associated with kidney disorders, nervous diseases and developmental abnormalities in children (Khan *et al.,* 2017; WHO, 2021). Hexavalent chromium is considered carcinogenic and trivalent chromium is an important trace mineral required for health (USEPA, 2020). Magnesium being an important nutrient for metabolic processes, must also be monitored to avoid imbalances in dietary intake (FAO/WHO, 2019). Consequently, contamination of cassava flour by heavy metals poses a serious public health issue. Reviews carried out recently have pointed out the necessity of constant monitoring, soil remediation, and more stringent agricultural policies in order to ensure food safety (Dennis *et al.,* 2025; Bilyaminu and Ezeonu, 2026). Furthermore, unevenness in contamination between rural and urban sites indicates the impact of anthropogenic activities like traffic pollution, industrial pollution, and improper waste disposal (Etim *et al.,* 2021; Ofoegbu *et al.,* 2022).

The importance of cassava in the diets of Africans and its possible susceptibility to contamination by heavy metals make it essential to test for heavy metal content in cassava flour so as to guarantee food security. This paper makes an effort in that direction by testing samples of cassava flour collected from the Jalingo and Yorro Local Government Areas of Taraba State, Nigeria, against standards set by FMH and WHO.

2. Materials and Methods

2.1. Study Area and Sample Collection

The cassava flour samples were obtained from two Local Government Areas (LGAs) of Taraba State, Nigeria. Jalingo and Yorro were chosen because of the importance of cassava farming and eating in those areas. A total of five samples of finely prepared cassava flour samples were obtained from the local markets of each LGA, using replicated analysis procedures to ensure representativeness (Etim *et al.,* 2021). To avoid any form of contamination, the samples were placed in polyethylene bags that had been washed using distilled water and dried, consistent with best practices in food safety research (Stanley *et al.,* 2026).

2.2. Sample Preparation and Digestion

For heavy metal analysis, 5 grams of each cassava flour sample were measured in porcelain crucibles. The digestion mixture consisted of 5 mL concentrated nitric acid (HNO_3) and 5 mL concentrated sulfuric acid (H_2SO_4) which was added, and the samples were kept in the flame cupboard for an hour after that. Careful heating was carried out at 450 °C until samples became solid. After cooling in a desiccator, 5 mL hydrogen peroxide (H_2O_2) was added, and deionized water was added to reach the calibration mark (Ofoegbu *et al.,* 2022). The above procedure is consistent with digestion techniques applied in related food security researches such as mineral and heavy metals profiling of avocado oil from the Mambila Plateau (Stanley *et al.,* 2026).

2.3. Preparation of Standard Solutions

Stock solutions of chromium (Cr), cadmium (Cd), lead (Pb), and magnesium (Mg) were prepared at known concentrations in 100 mL volumetric flasks using distilled water. These solutions were stored under refrigeration to prevent hydrolysis and photodegradation, remaining stable for up to three weeks (FAO, 2019). Serial dilutions were prepared for calibration curves, ensuring linearity between absorbance and concentration values (Khan *et al.,* 2017).

2.4. Instrumental Analysis

Concentrations of heavy metals were measured by atomic absorption spectrophotometry (AAS) utilizing air-acetylene flame (GBC Avanta Model 2.02). Wavelengths for each metal included: Cr (357.9 nm), Pb (283.3 nm) Cd (228.8 nm) and Mg (285.2 nm). The sample solution was introduced to the flame in the mixing chamber, in which the acetylene gas was fed at predetermined pressure, ensuring constant flame condition (Dennis *et al.,* 2025). Calibration curves were made based on standard solutions with high correlation coefficients (R^2) ranging between 0.999 and 0.995, confirming the reliability of the analytical method (Stanley *et al.,* 2026).

2.5. Quality Control and Assurance

Glassware was rinsed with distilled water and dried before use. Analytical grade reagents were used and blank determinations were carried out to remove background contamination. Replicate analyses were done to ensure reproducibility, with results recorded as mean ± standard deviation (Bilyaminu and Ezeonu, 2026). The method was compared to WHO and FAO standards for heavy metals in food crops (WHO, 2021).

3. Results and Discussion

3.1. Heavy Metal Concentrations in Cassava Flour

The concentrations of chromium (Cr), lead (Pb), cadmium (Cd), and magnesium (Mg) in cassava flour samples from Jalingo and Yorro LGAs were determined using atomic absorption spectrophotometry.

Table 1. Concentrations of heavy metals in cassava flour from Jalingo and Yorro Local Government Areas.

Parameter	Jalingo	Yorro	WHO	FMH
Chromium ppm	0.00	0.00	12-13	11-12
Lead ppm	0.033	0.044	0.01-0.015	0.01-0.010
Cadmium ppm	0.027	0.041	1.0	1.0
Magnesium ppm	1.637	1.793	40	35-40

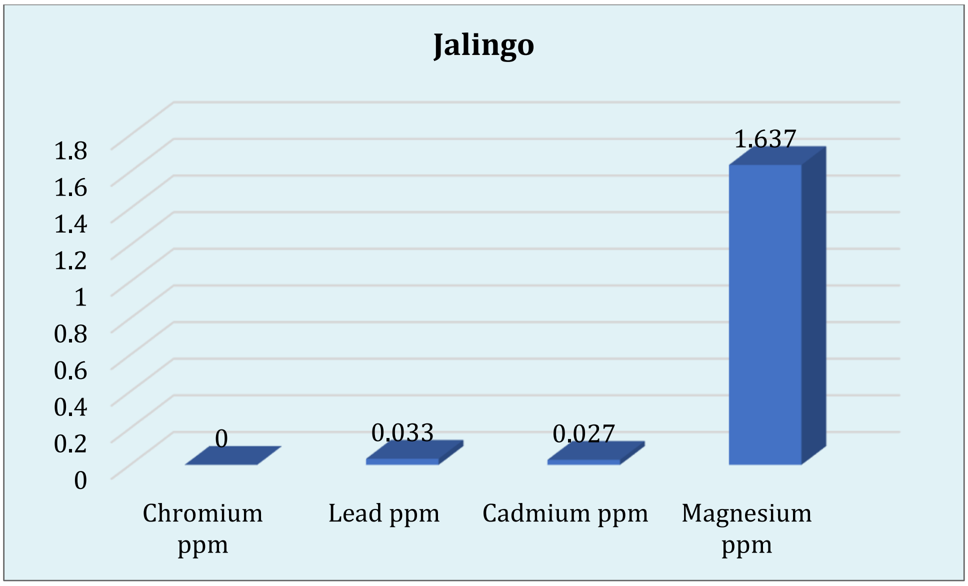

Figure 1. Concentrations of heavy metals in cassava flour from Jalingo.

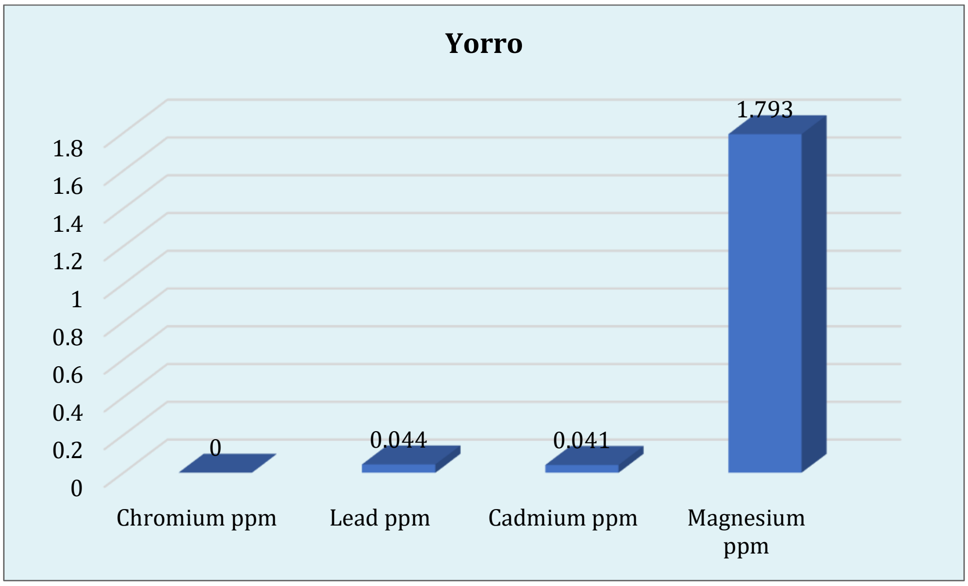

Figure 2. Concentrations of heavy metals in cassava flour from Yorro.

The Jalingo samples recorded Cr = 0.00 mg/L, Pb = 0.033 mg/L, Cd = 0.027 mg/L, and Mg = 1.637 mg/L, while Yorro samples recorded Cr = 0.00 mg/L, Pb = 0.044 mg/L, Cd = 0.041 mg/L, and Mg = 1.793 mg/L. These values were compared against the permissible limits set by the Federal Ministry of Health (FMH) and the World Health Organization (WHO). From the above results, it can be observed that there were no traces of Cr found in either of the samples, and this is in line with the previous studies conducted on cassava flour in Nigeria (Etim *et al.,* 2021). The levels of Pb in both Jalingo and Yorro surpassed the permissible levels stipulated by the WHO (0.01–0.015 mg/L), and this could be due to possible anthropogenic pollution from vehicles, industries, and agrochemicals (Khan *et al.,* 2017; Ofoegbu *et al.,* 2022). Although cadmium was detected, it was well below the permissible levels according to WHO (1.0 mg/L), and there are no dangers of cadmium toxicity from the consumption of cassava flours in the area (Dennis *et al.,* 2025). The concentrations of magnesium were below the recommended levels (35–40 mg/L), which may reflect soil nutrient depletion or limited uptake by cassava roots (FAO, 2019).

3.2. Comparative Analysis Between Jalingo and Yorro

A comparative analysis showed that samples of Yorro cassava flour contained significantly higher amounts of Pb and Cd compared with those from Jalingo. This could be due to the dissimilarities in soil conditions, farming practices, and environmental factors. The same trend was observed in previous studies on cassava cultivated along the Enugu-Port Harcourt expressway, where proximity to industrial and traffic activities influenced heavy metal accumulation (Ano *et al.,* 2007). The relatively high amounts of Pb and Cd found in Yorro may imply that there is localized pollution. This finding agrees with studies done on the profiling of avocado oil in the Mambila Plateau, Taraba State, which revealed considerable variation in the amounts of minerals and heavy metals among various cultivars owing to the ecological and soil differences (Stanley *et al.,* 2026).

3.3. Public Health Implications

Lead exposure, even in small amounts, is linked to neurotoxicity, children's development problems, and heart disease in adults (WHO, 2021). The Pb amounts found in Jalingo and Yorro cassava flour samples were above WHO's permissible limits, thereby posing a risk of chronic exposure through consumption. The amounts of Cd found in Jalingo and Yorro cassava flour were below permissible limits but can be dangerous with long-term kidney and liver accumulation (Bilyaminu and Ezeonu, 2026). Magnesium, though vital for enzymatic activity and metabolism, was not present optimally in either sample. This could lead to nutritional imbalance especially among people who consume cassava as a major source of food (FAO, 2023).

3.4. Comparison With Other Studies

The heavy metal contamination in cassava and other major crops is documented in Nigeria. Etim *et al.,* (2021) reported higher Pb concentration in cassava roots grown in polluted soil while Dennis *et al.,* (2025) drew attention to the variable concentration of heavy metals depending on the farming environment. The study on avocado oil from Mambila Plateau is another proof of the effect of ecology and soil on minerals and heavy metal content in crops (Stanley *et al.,* 2026).

3.5. Conclusion of Findings

Generally, cassava flour obtained from the Jalingo and Yorro LGAs is safe for consumption with regards to the Cd and Mg content but poses health hazards to consumers owing to its high Pb content. It is therefore necessary to monitor and practice soil remediation and better agricultural practices.

Declarations

Acknowledgments: The authors appreciate Mr. Emmanuel Chukwudi Onunze, a staff member of the Department of Chemical Science, Taraba State University, Jalingo, for his guidance throughout this research work.

Artificial Intelligence (AI) Use Statement: The authors declare that no artificial intelligence (AI)-assisted technologies were used in the conception, design, execution, analysis, interpretation, or writing of this manuscript.

Author Contributions: JS: Conceived and designed the study, coordinated sample collection, and led data interpretation and manuscript drafting; OTO: Carried out sample collection, laboratory analyses, and data acquisition; SSA: Contributed to heavy metal analysis and quality control; KAB: Performed statistical analysis, supported result interpretation, and critically reviewed the manuscript. All authors approved the final version of the manuscript.

Conflict of Interest: The authors declare no conflict of interest.

Consent to Publish: The authors agree to publish the paper in International Journal of Recent Innovations in Academic Research.

Data Availability Statement: The datasets generated and/or analyzed during this study are not publicly available but are available from the corresponding author upon reasonable request.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Research Content: The research content of the manuscript is original and has not been published elsewhere.

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Citation: John Stanley, Oyeyipo Titilayo Oluwakemi, Samuel Shinginba Alhamdu and Karima Abubakar Bassi. 2026. Assessment of Heavy Metal Concentrations in Cassava Flour from Jalingo and Yorro Local Government Areas, Taraba State, Nigeria. International Journal of Recent Innovations in Academic Research, 10(3): 61-65.