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Research Article

Heavy Metal Pollution and Related Health Risks in Potato and Carrot Consumed in Selected Markets in Osun State, Nigeria

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About Article

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ABSTRACT

In this study, carrot (*Daucus carota*) and potato (*Solanum tuberosum*) were sampled from four major markets across Ilesa East and Obokun-Oriade Local Government Areas of Osun State, Nigeria, and Cd, Fe, Ni, Cu, and Pb concentrations were determined. Each sampling was done in triplicate, and then converted to powdered form through mechanical grinding, followed by sieving to obtain the fine powdered samples, through aqua regia, the samples were digested and metal analysis was carried out with atomic absorption spectroscopy (AAS). When the concentrations of the metals were reported, it was found that Cd (0.235 mg/kg) and Pb (0.718 mg/kg) in carrot while potato containing Cd = 0.0488 mg/kg; Pb = 0.4188 mg/kg. In all the vegetables, the amounts of Cd = 0.1419 mg/kg, Pb = 0.5681 mg/kg, Ni = 0.146 mg/kg, Fe = 2.067 mg/kg, and Cu = 0.3607 mg/kg representing the average concentration of the metal in the markets. The study addressed the health risk assessment via Estimated Daily Intake (EDI), Target Hazard Quotient (THQ), and Hazard Index (HI) using USEPA reference doses, with 0.9232 value of HI for adults which is below the acceptable limit, while children emphasizing critical non-carcinogenic issue with an HI value of 2.155. There exist higher health challenges in Carrot through consumption with Hazard index = 1.3387 in adults; HI = 3.175 in children than potato. This present studies show the need for consistent and continuous monitoring of the heavy metal concentrations, especially Pb and Cd as the children category being the vulnerable to dietary heavy metal exposure. Total pollution assessment of the vegetables is recommended through seasonal collection of the samples.

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1. INTRODUCTION

Contamination of the ecosystems by unclean water supply, effluents from industries, and release of pollutants from agricultural chemicals is a major health issue throughout the world (Munir *et al.*, 2021). Higher concentrations of heavy metals exceeding the World Health Organization (WHO) limit were recorded in fruits, fish, and vegetables in locations such as Ondo, Lagos, and Ogun States (Laoye *et al.*, 2024). Food crops accumulate higher amounts of heavy metals such as Cd, Pb, Ni, and other toxic metals through the application of fertilizers, irrigation with wastewater, and the use of sewage sludge (Rashid *et al.*, 2023).

Carrots (*Daucus carota*) and potatoes (*Solanum tuberosum*) are important parts of non-leafy vegetables with their root hairs that are sensitive to heavy metals by absorption from polluted soils and also through the emission from industries, release from vehicle exhausts, improper waste disposal, and other anthropogenic activities (Rashid *et al.*, 2023). Cadmium (Cd) and lead (Pb) have been reported in studies conducted in food chains worldwide through systematic review, while other studies in food crops have shown that adults and children are vulnerable to the pollution from lead (Pb), cadmium (Cd), manganese (Mn), and copper (Cu) which produced hazard quotients (HI) that exceeded the safe limit of greater than one (>1) and carcinogenic risk estimates greater than the limit of 0.00001 (Samuel & Chibuisi, 2025). Cadmium causes immune dysfunction, cardiovascular diseases, and neuro-developmental issues in children (Huang *et al.*, 2024).

Heavy metal non-carcinogenic health issues have been examined through Estimated Daily Intake (EDI), Target Hazard Quotient (THQ), and Hazard Index (HI) by considering diverse dietary intakes. In Bangladeshi vegetables, Target Hazard Quotient (THQ) has been used to examine the non-carcinogenic risk assessments of lead (Pb) and arsenic (As) with THQ value greater than unity (Nowar *et al.*, 2024). Consumption of contaminated vegetables causes detrimental health challenges to both man and animals. Pb analysis in drinking water in Ethiopia confirmed that known percentages of children (8%) and adults (2.3%) were prone to risk due to the fact that hazard quotient is more than the acceptable limit (Endale *et al.*, 2021). Also study showed that hazard index of these metals increased in children and within the normal acceptable limit in category of adults in hand-dug wells from Gombe State, Nigeria (Balogun *et al.*, 2023). As carrots and potatoes are parts of the diets, coupled with the contamination posed by heavy metals in these vegetables, it is important and pertinent to monitor the diffusion and distribution of these metals in the environments and the health risks accompany them, especially with the less data available on the bioaccumulation of the metals along their health hazards in food samples in these particular major market locations in Ilesa and its environs in Osun State. These markets include Sabo and Atakumosa markets (Ilesa town), Ijebu-jesa market (Ijebu-jesa town), and Esa-oke Market (Esa-oke town) all in Osun State, Nigeria, and they are the major locations where the vegetable are distributed to retailers and final consumers in neighboring regions. The presence of the movements of vehicles and heavy duties, occurrence of dumpsites that are open, closeness to fuel pump filling stations, which are likely

sources of heavy metals in the environment. The major goals of this present study are to: assess the amounts of Pb, Ni, Cu, Cd, and Fe in carrots and potatoes; make use of standard models from United States Environmental Protection Agency (US EPA) and Joints Expert Committee on Food Additives (JECFA) in the examination of non-carcinogenic risks; and emphasize the effects and results of the health issues about the pollution on the population, children category in particular.

2. LITERATURE REVIEW

Heavy metal pollution in vegetable crops have been studied and reported in many areas of research. It has been reported that maximum concentration of cadmium exhibited, which is more than 1.0 mg/kg set limit and in turn produced carcinogenic risks greater than 0.0001 for Cadmium and Cobalt, respectively in vegetables obtained from irrigated farmlands in Lagos and Ogun States (Taiwo *et al.*, 2025; Babafemi *et al.*, 2024). Other research works have identified higher concentration of Cadmium and cancer effects caused in vegetables in which the hazard index more than 0.0001 standard limit posing a carcinogenic risk of one in ten thousand for consumers (Adesida & Alimba, 2025). This contamination caused by heavy metals as a result of their accumulation in vegetables can easily results in serious health issues such as disruption of physiological system of humans (Manwani *et al.*, 2023).

Research conducted in vegetables from some market locations in Zaria, Nigeria reveals the absence of cadmium in some of the vegetable samples but the amount of other heavy metals such as arsenic (As) was on the high level than the standard limit set by WHO and resulted in higher health risk to consumers (Onaji *et al.*, 2024). In the same vein, Pb, Co, As, Ni, and Hg concentrations were reported in tuberous and vegetable samples such as potato, carrot, yam and cassava in Nigeria, with some of these metals below standard limits (Omeje *et al.*, 2024). Vegetables close to Riruwai mining site in Kano State, Nigeria exhibited greater amounts of heavy metals such as Cd, Pb, Zn, and As, which exceeds WHO/FAO standards with bioaccumulation factor shown by cadmium greater than unity (1.0) (Badamasi *et al.*, 2023). Contaminations are caused by cadmium and lead in carrots, spinach, and onion cultivated in lands irrigated with wastewater in Shadara industrial area in Kano State, Nigeria (Suleiman & Ibrahim, 2025). These systematic reviews show that there is need for proper attention on the environmental and public health awareness due to the widespread health challenge posed by the heavy metal contaminations.

3. METHODOLOGY

3.1. Study area and sampling

Atakumosa (Oja-oba) and Sabo markets in Ilesa East local government area, and Esa-Oke and Ijebu-jesa markets in Obokun-Oriade Local Government Areas of Osun State, Nigeria, are the major locations where potato and carrot were sampled in triplicates on three separate periods in the months of April and June, 2025 with total composite samples of 72 so as to have better representation and minimize potential sampling bias with single time. The proximity of the locations to the distribution of these vegetables directly from farms makes the locations worthwhile. The period of sampling is early time



of rain when vegetable consumption is high and to reduce short-term variability. After the sample collection, followed by thorough washing with normal water and then distilled water, cut into pieces, air-dried for 48 h and then dried in an oven at 60 °C to obtain the constant mass. The dried mass of the samples were grounded into powder using mechanical grinder, sieved with 2 mm mesh size to obtain a fine powder, and stored in an airtight containers prior to metal.

3.2. Reagents and standards

The analytical grade reagents were used. Concentrated nitric acid ($\geq 69\%$), Hydrochloric acid ($\geq 37\%$), and de-ionized water (18.2 mΩ cm, millipore) were used for digestion and dilution. All chemicals were supplied by Sigma-Aldrich (USA) through Finlab Nigeria Ltd., Lagos. Standard stock solutions (1000 mg/L) for Cd, Pb, Ni, Fe, and Cu were obtained from PerkinElmer (USA) and used to prepare calibration standards. No further purification was carried out on the chemicals used, they were commercially bought, no restricted materials were employed, ensuring full reproducibility of the analytical procedures.

3.3. Instrumentation and calibration

Atomic Absorption Spectrophotometer (AAS, PerkinElmer Analyst 400) was used in the heavy metal analyses. The instrument is equipped with a deuterium background corrector and air-acetylene flame. Calibration curves were constructed using at least five working standards within the expected concentration range. Correlation coefficients (R^2) for all elements exceeded 0.999. Instrument calibration was confirmed after every 10 samples using mid-range standards. Detection limits (mg/kg) were: Cd = 0.002, Pb = 0.01, Ni = 0.005, Fe = 0.02, and Cu = 0.01.

3.4. Sample digestion and metal analysis

Weight of 1.0 g of each sample in powdery form was put into a digestion flask and treated with 10 mL aqua regia ($\text{HNO}_3:\text{HCl}$) was added in ratio 3:1, followed by heating of the mixture with the aid of a hot plate at 90 °C for a period of 60 mins until a clear solution was occurred. The filtration of the solution was done after cooling using Whatman No. 42 filter paper, distilled water was added to the filtrate up to 50 mL.

Atomic Absorption Spectrophotometer (AAS, PerkinElmer Analyst model) was used in the metal analysis such as Cd, Pb, Ni, Fe, and Cu of the filtrate with appropriate wavelengths for each metal. Certified reference materials were used in the preparation of standard solutions. Each analyte was done in triplicate, with blanks simultaneously confirming the control and quality assurance.

3.5. Quality assurance and quality control (QA/QC)

Reliability of the data was carried out as the following measures:

- Procedural blanks and duplicate samples were analyzed with every batch of 10 samples.
- Certified Reference Material (CRM), NIST SRM 1573a (Tomato Leaves), was analyzed to verify accuracy.
- The percentage range of recoveries for the metals is between 93.5% to 104%.
- The triplicate experiments were used for the precision determination, with the percentage value of the relative standard deviation for the metals less than 5 %.
- Blank correction was applied to all results.
- Limit of detection (LOD) and limit of quantification (LOQ) were calculated as 3σ and 10σ of blank readings, respectively.

3.6. Health risk assessment

The standard models from United States Environmental Protection Agency (US EPA) and Joint FAO/WHO Expert Committee on Food Additives (JECFA) were used in determining the health risk assessment; with average adult body weight of 70 kg and daily vegetable ingestion rate of 0.2 kg/day, while for children, a body weight of 15 kg and ingestion rate of 0.1 kg/day as indicators of the analyses (Negassa *et al.*, 2025). The use of CRM data to replicate the analyses and validate the accuracy was utilized to reduce the uncertainties in measurement and risk estimates.

3.7. Estimated daily intake (EDI)

The EDI for each metal was calculated as:

$$\text{EDI} = \frac{C \times \text{FIR}}{\text{BW}} \quad \dots(1)$$

$$\text{THQ} = \frac{\text{EDI}}{\text{RfD}} \quad \dots(2)$$

$$\text{HI} = \sum \text{THQs} \quad \dots(3)$$

Where RfD = oral reference dose for each metal (mg/kg-day): Cd = 0.001, Pb = 0.0035, Ni = 0.02, Fe = 0.8, Cu = 0.04 mg/kg/day. If HI < 1 = no significant risk, if HI > 1 = major non-carcinogenic health issues.

3.8. Data analysis

The differences in concentrations of the metals in the market locations and types of the vegetables were carried out with two-way ANOVA analysis with $p < 0.05$. The data were analysed with the SPSS version 25 package.

4. RESULTS AND DISCUSSION

Table 1. Average concentrations of metal in Carrot

Market	Cd	Pb	Ni	Fe	Cu
Atakumosa	0.550±0.007	0.75±0.13	0.0850±0.007	3.060±0.028	0.790±0.04
Esaoke	0.200±0.014	0.74±0.099	0.650±0.021	2.825±0.02	0.465±0.007
Ijebujsa	0.100±0.014	0.850±0.099	0.110±0.014	2.560±0.014	0.415±0.007
Sabo	0.0900±0.042	0.530±0.099	0.070±0.00	2.585±0.007	0.350±0.01
Total	0.235±0.04	0.718±0.148	0.229±0.021	2.758±0.22	0.505±0.18



Table 2. Average concentrations of metal in Potato

Market	Cd	Pb	Ni	Fe	Cu
Atakumosa	0.085±0.05	0.565±0.92	0.065±0.035	1.240±0.00	0.210±0.03
Esaoke	0.035±0.03	0.505±0.035	0.070±0.014	0.845±0.02	0.165±0.05
Ijebujesa	0.015±0.007	0.565±0.30	0.105±0.05	1.26±0.03	0.20±0.04
Sabo	0.060±0.028	0.040±0.028	0.020±0.028	2.155±0.02	0.29±0.03
Total	0.0488±0.037	0.4188±0.26	0.065±0.041	1.375±0.5	0.2163±0.06

Table 3. Average concentrations of metals in the Markets

Market	Cd	Pb	Ni	Fe	Cu
Atakumosa	0.3175±0.03	0.6575±0.12	0.075±0.02	2.150±1.05	0.500±0.34
Esaoke	0.1175±0.02	0.6225±0.14	0.360±0.02	1.835±1.14	0.315±0.18
Ijebujesa	0.0575±0.05	0.7075±0.25	0.1075±0.03	1.91±0.75	0.3075±0.13
Sabo	0.075±0.03	0.2850±0.29	0.045±0.03	2.37±0.25	0.320±0.04
Total	0.1419±0.04	0.5681±0.25	0.146±0.03	2.067±0.81	0.3607±0.20

4.1. Discussion

In this present research, the concentrations of the metals were obtained in the carrots and potatoes. In the table 1, cadmium and lead showed increase average concentrations in Carrot than in potato concentrations in the table 2, while their average concentrations in the markets (Table 3) exhibiting 0.1419 mg/kg Cd, 0.5681 mg/kg Pb, 0.146 mg/kg Ni, 2.067 mg/kg Fe, and 0.3607 mg/kg Cu. The higher amounts of cadmium and lead posed a serious health challenges in humans and the environments at large. From the tables 1, the concentrations of 0.718 mg/kg Pb, 0.235 mg/kg Cd in the potato, and 0.4188 mg/kg Pb, 0.0488 mg/kg Cd in the Carrots table 2 are significantly increased may be due to the increased surface area of the root hairs of the vegetables and ability of the metals to diffuse from the soils into the vegetables. Accumulation of heavy metals is easier in roots of carrot than in its leaves, with small amounts moving to the upper parts of the vegetable (Sham *et al.*, 2025). The type of the heavy metal and the properties of the soil determine the accumulation of heavy metals in roots and shoots of vegetables, with maximum amount of Cr found in carrots, and Fe, Pb, Ni, and Zn in were deposited in lettuce (Eben *et al.*, 2024; Aksouh *et al.*, 2024). Research have shown the widespread environmental and agricultural pollution in the northern part of Nigeria and Ethiopia through the increase in the concentration of Pb in the root of vegetables which surpassed the limit set by WHO/FAO (Negassa *et al.*, 2025; Adesida & Alimba *et al.*, 2025). The amount of Cd in carrot higher than 0.2 mg/kg limits set by FAO/WHO, also potatoes, beetroots and carrot showed the concentration of Pb higher than 0.3 mg/kg by FAO/WHO

through the research conducted in Ethiopia (Mekonnen & Ketema, 2023). In another study, leafy vegetables showing higher levels of amounts of Ni, Pb, Cd, and Cr which exceeded the standard limits of WHO/FAO, emphasizing that vegetables on a farm contain less contaminants than those that have been transported to market locations (Rahim *et al.*, 2024). Therefore there is need for continuous assessment and remediation of ecosystems to safe the health of the public from the heavy metals pollution through vegetable consumption. There are significant differences ($p < 0.05$) between the vegetable types and heavy metal concentrations, as well as markets and heavy metal concentrations with 0.235 mg/kg of Cd and 0.718 mg/kg of Pb in carrots (Table 1) higher than the 0.0488 mg/kg of Cd and 0.4188 mg/kg of Pb found in potatoes through maximum amount of lead (Table 2) showing significant difference between the two vegetable samples. In the table 3, there is significance difference was observed among the market locations with Cd concentrations having 0.0575 mg/kg at Ijebujesa market and 0.3175 mg/kg at Atakumosa market, and Pb exhibiting concentrations 0.2850 mg/kg at Sabo market, 0.7075 mg/kg at Ijebujesa market, respectively. Higher concentration of the metals, especially Fe (3.06 mg/kg) and Cu (0.79 mg/kg) were found in carrot at Atakumosa market than potato samples from Sabo market, with minimum amounts across most metals (table 1). These results provide the evidence-based analysis that the bioaccumulation of the heavy metals is affected by the vegetables and environmental factor of the market location.

4.2. Health risk assessment

Table 4. Estimated daily intake and total hazard quotient for 70 kg adults and 15 kg children based on market-average total concentrations used

Metal	Conc (mg/kg)	EDI adult (mg/kg/d)	THQ adult	EDI child (mg/kg/d)	THQ child
Cd	0.1419	0.0004054	0.4054	0.000946	0.946
Pb	0.5681	0.0016231	0.4637	0.00379	1.083



Ni	0.1460	0.0004171	0.0209	0.00097	0.049
Fe	2.0670	0.0059057	0.0074	0.01378	0.017
Cu	0.3607	0.0010306	0.0258	0.00240	0.060

$$HI = THQ_{Cd} + THQ_{Pb} + THQ_{Ni} + THQ_{Fe} + THQ_{Cu}$$

$$HI (Adult) = 0.4054 + 0.4637 + 0.0209 + 0.0074 + 0.0258 = 0.9232$$

$$HI (Children) = 0.946 + 1.083 + 0.049 + 0.017 + 0.060 = 2.1550$$

Table 5. EDI and THQ for both adults (70 kg) and children (15 kg) based on carrot and potato consumption

Metal	EDI Adult Carrot	THQ Adult Carrot	EDI Adult Potato	THQ Adult Potato	EDI Children Carrot	THQ Children Carrot	EDI Children Potato	THQ Children Potato
Cd	0.00067	0.67	0.000139	0.139	0.001567	1.567	0.000325	0.325
Pb	0.00205	0.59	0.001197	0.342	0.004987	1.425	0.002792	0.798
Ni	0.00065	0.033	0.000186	0.0093	0.001527	0.076	0.000433	0.022
Fe	0.00788	0.0099	0.003929	0.0049	0.018387	0.023	0.009167	0.011
Cu	0.00144	0.036	0.000618	0.0155	0.003367	0.084	0.001442	0.036

$$HI (Adult) carrot = 0.67 + 0.59 + 0.033 + 0.0099 + 0.0360 = 1.3389$$

$$HI (Adult) potato = 0.139 + 0.342 + 0.00930 + 0.0049 + 0.0155 = 0.5107$$

$$HI (Children) Carrot = 1.567 + 1.425 + 0.076 + 0.0230 + 0.084 = 3.175$$

$$HI (Children) potato = 0.32500 + 0.798 + 0.022 + 0.011 + 0.036 = 1.1920$$

The risk assessment was based on Estimated Daily Intake (EDI), Target Hazard Quotient (THQ), and Hazard Index (HI), calculated with USEPA/JECFA standard formulas and RfD values (Cd = 0.001, Pb = 0.0035, Ni = 0.02, Fe = 0.8, Cu = 0.04 mg/kg/day). The adult of mass 70 kg category showing no significance of non-carcinogenic risk with average concentration of hazard index 0.9232 within market locations and 0.2 kg/day ingestion rate, while there is health risks challenges through constant consumption of the vegetables as the hazard index greater than unity in children with 15 kg mass with hazard index of 2.155, and ingestion rate of 0.1 kg/day. Through comparison of the samples, both the carrot and potato exhibited hazard indices greater than unity in children category with values 3.175 and 1.192, and in adult with 1.3387 in carrot but showing 0.5107 hazard index in potato. The results underscore the vulnerability of children category to heavy metal pollution due to their smaller mass of the body and increase consumption of the vegetables per body weight. It has been reported that some toxic heavy metals such as Pb, Cr, Cd were above the recommended limits by FAO/WHO (Chowdhury *et al.*, 2024; Abira *et al.*, 2024; Osae *et al.*, 2023; Sarvestani *et al.*, 2024). Hazard indices of 3.880-384.122 in children and 0.46-41.156 in adults with higher non-carcinogenic risks have been reported in various research works where the indices are greater than unity and also Ni, Cr, As, and Cd through the consumption of vegetables have shown the higher carcinogenic risks greater than 0.0001 (Osae *et al.*, 2023; Abira *et al.*, 2024; Sarvestani *et al.*, 2024). Carrots have shown higher contamination risks of cadmium than other types of root vegetables.

4.3. Implications of Elevated Cd and Pb

Cd and Pb are micro elements, potentially toxic metals possessing strong health risks. Some of the health challenges of

Cd exposure are impairment of kidney function and bone health. Lead (Pb) is neuro-toxic, particularly in children, and linked to cognitive impairment, behavioral disorders, and developmental delays (Shafie & Ashour, 2025; Huang *et al.*, 2024). There exist long term non-carcinogenic effects in children as the hazard index is greater than unity ($HI > 1$). Little contributions were made by iron and copper due to their higher reference doses (RfD), the concentrations are within the acceptable limits, and they are also essential elements needed in higher quantities in the foods chains. The amount of copper in vegetables was within the stated standards while Cd and Pb were more tolerable standards in potatoes and carrots as reported in Ethiopia, and hazard indices for Cu and Pb in carrots were greater unity but below one other vegetable (Mekonnen & Ketema, 2023). Also, Fe contributed to the increase in hazard index which in turn showed potential health issues of vegetable sampled in Algeria (Aksouh *et al.*, 2024), and in a research reported in Bangladesh, the concentration of Fe was higher than the standard reference dosages by FAO/WHO with the overall hazard index greater than unity (1.0) in potato showing health risks (Chowdhury *et al.*, 2024). In other words, study in Saudi Arabia has reported lower hazard index less than 1 despite the fact that the concentration of Fe was very high, showing the abundance of the metal in vegetables (Alarifia *et al.*, 2023).

4.4. Market and Spatial Variability

Differences in contamination across the four markets may reflect variations in soil quality, irrigation practices, atmospheric deposition, and post-harvest handling. For instance, Atakumosa and Ijebujsa markets showed relatively higher Pb and Cd levels, consistent with findings from urban-periurban studies where traffic emissions and industrial effluents influence crop contamination (Ahogle *et al.*, 2023, Ekpunobi *et al.*, 2023).



Sabo market, though showing higher Fe concentrations, had relatively lower toxic metal burdens, suggesting site-specific differences in contamination sources. This spatial variability underscores the need for targeted monitoring programs to identify high-risk zones.

4.5. Novelty statement

Results from the accumulation of heavy metals such as Cd, Pb, Ni, Fe and Cu were reported from carrots and potatoes in the market locations of the local government areas under study; this assessment has contributed to the little or no literatures existing on vegetables in the areas. The study has highlighted the dietary intakes of the two major vegetables through the use of the models from US EPA and JECFA for both categories of adults and children to the understanding of the public, as children being the recipient of the health challenges via constant consumption of the vegetables. This study has provided evidenced-based reports through the dry weight concentrations for proper handling of vegetables, both on the farm locations and in markets places

5. CONCLUSION

These results indicated that the concentrations of Cd and Pb in carrots are 0.235 mg/kg and 0.718 mg/kg, respectively. These values surpassed international food safety standards, but the concentrations were minimal in potatoes. The lower hazard index found in adults with hazard index less than unity ($HI < 1$) in both vegetables while it is greater than unity ($HI > 1$) in children; carrot ($HI = 3.175$) and potato ($HI = 1.192$) through models from USEPA/JECFA. This is showing major health issues in children in the consumption of carrots and potatoes. Therefore there is need for major and constant monitoring these dangerous metals in vegetables especially in these locations so as to ensure food safety, and consumer protection in the country. There should be sensitization of farmers through education on safe agricultural practices such as the application of organic and inorganic fertilizers, irrigation with clean water, and how to preserve the quality of the soil. Enactment of regulations by government agencies such as NAFDAC, NESREA in compliance with international standards such WHO and FAO, and ensures continuous research on heavy metals in vegetables directly from farm location and markets, respectively. Reduction of heavy metals, particularly the toxic ones, in food crops should be assisted through remediation programs. Public awareness should be carried out by health officials on the risks of pollution by heavy metals through the consumption of vegetables. Public health should be protected from heavy metal contamination of food chain via constant research on heavy metal pathways and the viable methods to mitigate it in Nigeria.

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