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RISK ASSESSMENT OF HEAVY METAL LEVELS IN MAIZE FROM WASTE DUMPSITES IN MINNA METROPOLIS

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Abstract **https://doi.org/10.65760/sjgs.v4.i2.9**

Maize (Zea mays L.) is one of Nigeria's most important cereal crops, contributing significantly to food security. As a staple food, it provides a substantial portion of the daily calorie and nutrient intake for millions of Nigerians, serving as an important source of carbohydrates, proteins, vitamins, and minerals. The study investigated maize cultivated near dumpsites in Minna, Nigeria, using interviews, questionnaires, and laboratory analyses of soil and maize samples from Maitumbi and Maikunkele areas. Heavy metals including lead (Pb), chromium (Cr), manganese (Mn), and copper (Cu) were analyzed using a Perkin-Elmer Model 403 Atomic Absorption Spectrophotometer at the Federal University of Technology, Minna. Results showed that soils from the Maikunkele dumpsite had the highest concentrations of most physicochemical properties. Maize samples from both dumpsites and control sites contained notable Mn levels that ranged between (2.91–3.75 mg/kg). While the control site had no detectable Pb, the Maikunkele dumpsite recorded 1.15 mg/kg. Overall, the findings indicate that maize cultivated on dumpsites in Minna is exposed to elevated levels of heavy metals, particularly Pb and Cr, posing potential health and environmental risks.

Keywords: *Dumpsites, Heavey metals, Maize, Physicochemical Properties*.

1.0 Introduction

Risk assessment of heavy metals in food crops has become an essential component of environmental health and food safety research due to the increasing contamination of agricultural soils by anthropogenic activities (World Health Organization [WHO], 2023; Food and Agriculture Organization of the United Nations [FAO], 2023). Consequently, assessing their concentrations in edible crops has become increasingly important for protecting consumers from chronic exposure and ensuring compliance with international food safety standards (Tóth *et al.,* 2022; WHO, 2023). There are serious concerns about food safety and public health as a result of agriculture's growing reliance on urban waste disposal sites (Ojiego, 2019; Aralu & Okoye, 2020; Ekere *et al.,* 2020). The close proximity of food crops to unmanaged waste disposal sites has resulted in higher levels of heavy metals in soil and farm produce in several developing nations, including Nigeria (Sanga & Pius, 2024). Because of its large root system and high biomass accumulation, maize (*Zea mays* L.), a staple crop that is consumed extensively throughout sub-Saharan Africa, Nigeria inclusive is one of the most important cereal crops, contributing significantly to food security and is chiefly susceptible to heavy metal uptake (FAO, 2023).

Maize (Zea mays L.) is a widely cultivated cereal crop and a dietary staple in sub-Saharan Africa. Due to its extensive root system and high biomass, maize is particularly effective at absorbing heavy metals from contaminated soils (Abd-Elhalim *et al.*, 2025). Research has demonstrated that maize grown on or near waste dumpsites often contains elevated levels of Pb and Cd, raising concerns about food safety and long-term health effects (Sanga & Pius, 2024). The consumption of heavy metal-contaminated maize can lead to serious health consequences. Chronic exposure to Pb and Cd has been associated with neurological disorders, renal dysfunction, and increased cancer risk (Osisanya *et al.*, 2025). Vulnerable populations such as children and pregnant women are particularly at risk. Health risk assessments using metrics like Estimated Daily Intake (EDI), Target Hazard Quotient (THQ), and Hazard Index (HI) have shown that maize from dumpsite-adjacent farms often poses non-carcinogenic risks to consumers (Abd-Elhalim *et al.*, 2025).

Lead (Pb), cadmium (Cd), arsenic (As), and nickel (Ni) are examples of heavy metals that are persistent environmental contaminants that can accumulate in food crops and cause major health problems. Through dietary consumption, these metals can enter the body and cause chronic ailments such as neurological disorders, kidney damage, and an elevated risk of cancer (Abd-Elhalim *et al.,* 2025). According to studies, Pb and Cd concentrations in roots, stems, leaves and cobs of maize with accumulation is usually highest in the roots, followed by the stems and leaves, while the grains (kernels/cobs) often contain lower concentrations, though contamination can still occur in edible parts (cobs/grains) under polluted conditions like dumpsites and mining areas (Awokunmi *et al.,* 2015; Akinola *et al.,* 2020; Chiwetalu *et al.,* 2022) which are frequently above global safety standards established by agencies like the FAO/WHO (Sanga & Pius, 2024).

Solid waste disposal still puts a lot of pressure on the environment, especially when it comes to the release of chemical and biological contaminants that change the composition of soil and the ecological balance. It has been demonstrated that unregulated disposal methods increase the levels of heavy metals like copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn), which are harmful to human health and the environment (Bisht *et al.,* 2024). The structure and function of soil microflora and microfauna, which are critical for nutrient cycling and ecosystem stability, are also disrupted by these pollutants, which also lower soil quality. According to Agbor *et al.* (2022), high concentrations of organic matter and heavy metals have a substantial impact on microbial populations in dumpsite soils, changing the species composition and lowering biodiversity. Microbial activity and the movement of pollutants through soil matrices are also influenced by variables like pH, electrical conductivity, and nitrogen concentration (Sam-Uroupa & Ogbeibu, 2020). These factors' combined impact emphasizes the necessity of sustainable waste management techniques to reduce hazards to the environment and public health.

Despite being high in nutrients, compost made from landfill debris frequently contains heavy metals in levels beyond permissible limits, which increases the danger of crop contamination (Abd-Elhalim *et al.*, 2025). In order to protect the health of consumers, this situation emphasizes how urgently ongoing environmental monitoring and the application of sustainable waste management techniques are needed.

While global studies have highlighted the dangers of heavy metal contamination in food crops, there remains a shortage of localized data specific to Maize in Minna, Niger State. Studies like Onakpa *et al.* (2018); Nkwunonwo *et al.* (2020); Oloruntoba *et al.* (2024) are review-based study designs that utilized secondary data which did not reflect current levels of heavy metal contamination. This study aims to bridge that gap by examining maize grown near dumpsites in Minna, Niger State, Nigeria, and assessing its implications for public health. The null hypothesis for this study is;

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H_0: There is no significant difference in heavy metal concentrations between maize grown on waste dumpsites and maize grown on uncontaminated soil.

2.0 Literature Review

Heavy metals such as lead (Pb), cadmium (Cd), arsenic (As), and nickel (Ni) are persistent environmental pollutants that pose serious ecological and health risks. Unlike organic pollutants, heavy metals do not degrade easily and can accumulate in soil and water systems over time (Sanga & Pius, 2024). Their presence in agricultural soils is often linked to anthropogenic activities including industrial discharge, vehicular emissions, and the indiscriminate disposal of municipal waste (Osisanya *et al.*, 2025).

Urban waste dumpsites are increasingly recognized as hotspots for heavy metal contamination. In many developing regions, these sites lack proper containment and leachate management systems, allowing toxic substances to infiltrate surrounding soils (Abd-Elhalim *et al.*, 2025). Studies conducted in Southern Nigeria and Tanzania have shown that soils near dumpsites contain elevated concentrations of heavy metals compared to control sites, often exceeding permissible limits set by international agencies (Sanga & Pius, 2024; Osisanya *et al.*, 2025).

Waste dumpsites, especially unmanaged or poorly regulated ones, pose significant threats to environmental health. Their impact spans soil degradation, water contamination, air pollution, and biodiversity loss. This review synthesizes findings from global and regional studies, with emphasis on developing countries like Nigeria.

In Obosi, Nigeria, Obiora & Obiekezie (2024) found dangerously high concentrations of lead and copper in soil samples within 500 meters of a landfill. Contaminated water sources near dumpsites have been linked to outbreaks of cholera, typhoid, and diarrhea. Rana *et al.* (2025) reviewed multiple cases where leachate from municipal dumpsites led to nitrate and heavy metal contamination in groundwater. Audi *et al.* (2024) documented increased respiratory issues among residents living near dumpsites in Abuja, Nigeria.

3.0 Research Methodology

Study Area Description

Geographically, the study area is located between latitudes 9°04′48″N and 9°38′24″N, and longitudes 6°00′36″E and 6°31′48″E. The study stations comprise of Maikunkele, and Maitunbi dumpsites of Bosso LGA, Niger State, Nigeria. The area experiences a different dry season (which persists from October – March) then a rainy period (which persists from April – October). Yearly precipitation ranged from a reasonable range of 1,200 mm within northern region to 1,600 mm within southern region of Nigeria. Raining period persists across a range of 150 days within North region, approximately 210 days within south region of the State (Ogundare *et al.*, 2012). Mean maximum temperature rises up to 32°C throughout the season, mostly between March and June, though the least temperatures are normally experienced between December and January (Lawal and Nagya, 2011).

The soil forms in the study area include; the ferruginous humid soils, hydromorphic soils and ferritics soil. The main soil forms are the Ferruginous humid, typically ferruginous humid are mostly gotten from the Basal Complex Rocks, likewise also from ancient deposited rocks. The ferruginous humid soils remain best to cultivate guinea corn, maize, millet and groundnut. The saturated soils are

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basically originated within wide wetland of the Niger River (Lawal and Nagya, 2011). Guinea Grassland foliage spreads through the whole land of the region. Similar to the rest regions with related plant covers, it is described as forests with high grasslands scattered with tall thick species (Lawal and Nagya, 2011).

The economic activities of the people of Bosso Local Government Area in Niger State, Nigeria, include primary, secondary and tertiary activities. Farming is a significant economic activity with crops such as maize, yam, cassava and vegetables being cultivated. Livestock farming is also practiced with the rearing of animals such as cattle, goats and sheep.

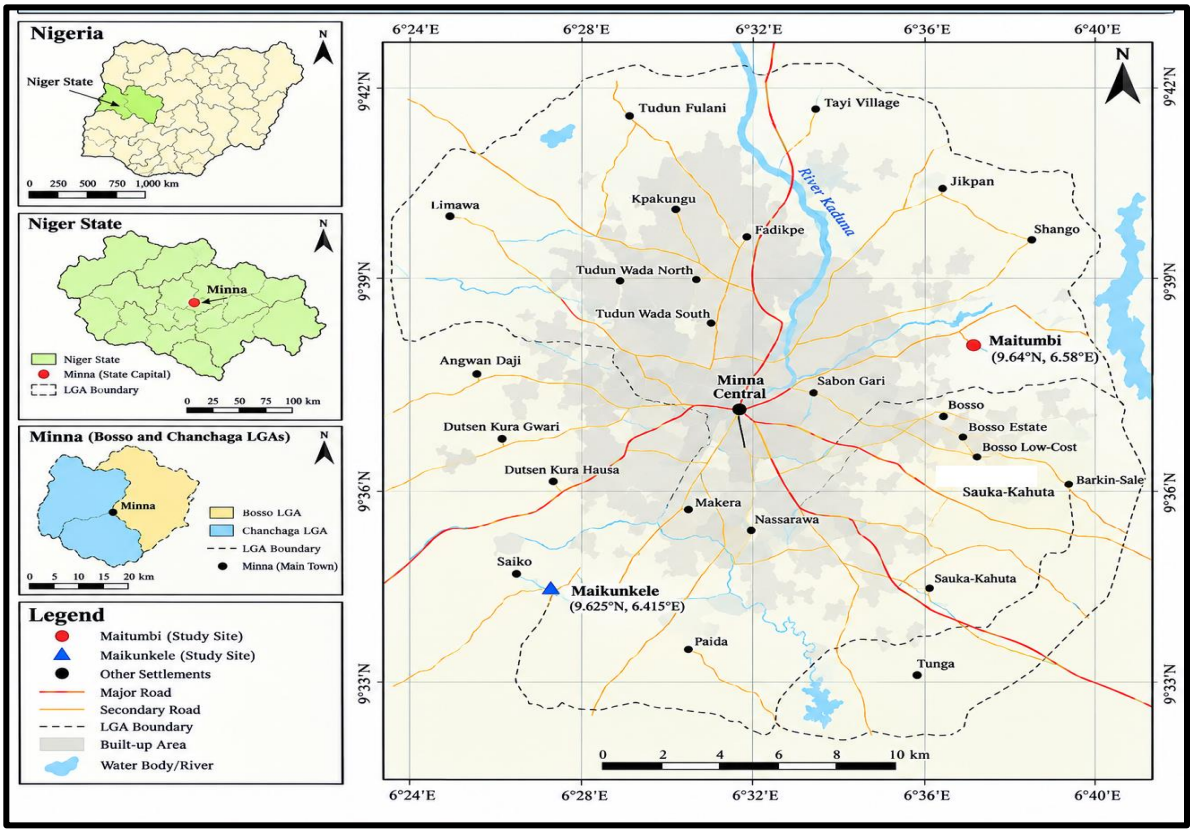

Figure 1: Locational Map of the Study Area
Source: Urban and Regional Planning Department, FUT Minna (2025)

3.0 Materials and Methods

Primary data was obtained through questionnaires as well as laboratory analysis of soil and maize, this is in line with the studies of Agwor *et al.* (2023); Awino *et al.* (2024); and Anwara (2024). Questionnaires were administered to residents of the neighborhood that are in close proximity to the dumpsites to elicit information on their level of awareness of the risk of consuming farm crops grown on waste dump sites. Two soil and crop (edible corn harvested from the plant) samples were taken at a depth of 0.15cm from each final dumpsite site located at both Maikunkele and Maitumbi which are the are the focus of this study. This included a control sample taken at a distance of about 2km from the final refuse dumpsite, therefore, a total of ten (10) samples were taken (i.e. 2 soil, 2 edible corn at Maikunkele and Maitumbi each and 2 control for both locations). Questionnaire were

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distributed to a total population of 237 in accordance with the work of Kothari, (1990). Data on the expected standard of consumption of the heavy metals from World Health Organization (WHO), and United State Environmental Protection Agency (USEPA) were used to determine the degree of contamination of the pollutant. This approach is agreement with the works of Awino *et al.* (2024) and Kyere *et al.* (2024). This was achieved through these objectives: analyze levels of heavy metals in farm produce cultivated on waste dumpsite; assess people's awareness of health risk associated with consumption of farm produce grown on waste dumpsite.

Instrument for Data Collection

Instruments used are stainless steel soil auger, hand trowel, clean polyethylene sample bags, GPS device (for recording sampling coordinates), permanent marker for labelling samples, disposable gloves. Preparation of samples required laboratory oven (60–105°C), mortar and pestle, stainless steel sieve (2 mm for soil), analytical balance (0.001 g precision), microwave digestion system, digestion flasks, and Whatman filter paper. The analytical instrument used was Atomic Absorption Spectrophotometer (AAS) to determine Pb, Cd, Cu, Zn, Cr, Ni, Fe, Mn. These approaches are in line with the works of Anwara (2024); and Okakpu *et al.* (2024).

Sampling Procedure

The sampling sites are two main final dumpsites, one located in Maintunbi and Maikunkele at the outskirt of Minna town. The control samples were taken 2 kilometers away from each of the sites, where there was no dumpsite or any form of human activities that could generate wastes by using clean stainless-steel shovel from 0-15 cm depth (Anwara *et al.* 2024).

Also, edible plant samples (Corn) were collected from each of the site with the aid of a stainless-steel trowel and knife. Immediately after collection, each sample was properly labeled with permanent marker indicating the sampling location and GPS coordinates). Disposable gloves were put on during collection and handling of samples. Clean polyethylene bags were used to collect the samples which were immediately sealed. Soil samples were air-dried and the corn stored in clean bags which were also dried to prevent decomposition. The collected samples were sealed to protect them from moisture, dust, and direct sunlight. The above procedure is in agreement with the work of Igiebor and Uwuigiaren (2024). Both plant and soil samples were packed in separate bags and taken to laboratory in FUT Minna for analysis.

Determination of Heavy Metals in Soil and Maize Plant

The Atomic Absorption Spectrophotometric (AAS) instrument and the British Pharmacopoeia calibration plot procedure were both adopted for the analysis. The concentrations of heavy metals such as (Pb, Cr, Mn and Cu) in all the samples were determined using the Perkin-Elmer model 403 Atomic Absorption Spectrophotometer (Anzene *et al.,* 2024; Omada *et al.,* 2024) at STEP B Federal University of Technology Minna.

Risk Associated with the Consumption of the Heavy Metals from the Maize Crops

By comparing the examined sample with dietary reference intakes for the metals provided by the National Academy of Sciences/Institute of Medicine, Food and Nutrition Board, Institute of Medicine, Washington, DC, 2003, the risk associated with consuming maize crops was examined. Recent food-safety studies have similarly compared estimated dietary exposure to metals in edible crops with dietary reference values as part of dietary health-risk assessment (Zhou & Liu, 2024).

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Data Analysis

The data collected were statistically analyzed using SPSS. Descriptive statistics was used to analyze data by way of percentages and mean and presented by use of charts. ANOVA was used for assessing the variation in concentration of heavy metals from different samples. The Bioaccumulation Factor (BAF) indicates the extent to which a crop accumulates a particular metal from the soil and is calculated as the ratio of the metal concentration in the crop tissue to that in the soil. This was calculated to understand the extent of risk and associated hazard due to ingestion consequent upon heavy metal accumulation in edible portion of the maize crops. The BAF for each heavy metal were computed based on the method described by Olawale *et al.* (2023). The heavy metal transfer from soil to the crops was calculated as follows:

$$BAF = \frac{Crops}{soil} \quad (1)$$

BAF = Bioaccumulation Factor Crops = Concentration of heavy metals in crops

Soil = Concentration of heavy metals in soils

4.0 Results and Discussion

Heavy Metal Concentration of Soil Samples

The heavy metal concentration in dumpsite from Maitumbi and Maikunkele is presented in Table 1. The result showed that lead (Pb) was not detected in the control soil sample while a significantly ($p<0.05$) higher lead concentration (4.42±0.08 mg/kg) was observed in soil sample from Maikunkele dumpsite. The results showed significant differences in manganese and chromium concentrations among the soil samples. Concentrations increased in the order of Maitumbi, Maikunkele, and the control site. The concentration of copper (Cu) was significantly ($p<0.05$) lower in soil from the control site (3.29±0.12 mg/kg) while a significantly higher concentration was observed in soil from Maitumbi dumpsite (9.40±0.13 mg/kg). Although, copper concentration in soil sample from Maikunkele dumpsite (6.89±0.10 mg/kg) was significantly higher than that in the control soil, it was significantly lower than that of Maitumbi dump site.

Table 1: Heavy Metal Concentration of Soil Samples

	Pb(mg/l)	Mn(mg/l)	Cr(mg/l)	Cu(mg/l)
CONTROL	ND	1.18±0.12a	2.08±0.19a	3.29±0.12a
Maitumbi	2.11±0.07a	7.46±0.51b	13.51±0.17b	9.40±0.13c
Maikunkele	4.42±0.08b	15.84±0.65c	22.60±2.67c	6.89±0.10b

Values are Mean±Standard Error of Mean of duplicate determinations. Values with different alphabets (a,b,c) along a column are significantly ($p<0.05$) different

ND = Not Detectable

The concentration of heavy metals in Maize grown on Maitumbi, Maikunkele soils and control dump sites is presented in Table 2. It was observed that lead (Pb) was not detected in maize grown on the control soil while a significantly ($p<0.05$) higher concentration of Pb (1.15±0.04 mg/kg) was present in maize grown in Maikunkele dumpsite. Maize grown on the control site had significantly (2.81±0.05 mg/kg) lower concentration of manganese compared to that obtained in Maitumbi and Maikunkele dumpsite which had significantly comparable ($p>0.05$) manganese concentration (3.75±0.23 and 3.54±0.06 mg/kg) respectively. Chromium concentration (0.54±0.02 mg/kg) was significantly lower ($p<0.05$) in maize sample grown on the control site while Maitumbi dump site

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grown maize had significantly ($p<0.05$) higher chromium concentration (2.79±0.04 mg/kg). The result also revealed that the concentration of copper was significantly ($p<0.05$) higher (1.75±0.04 mg/kg) in maize from Maikunkele site compared to that from Maitumbi, however, was statistically ($p<0.05$) comparable to that from the control dumpsite (1.56±0.04 mg/kg).

Table 2: Heavy Metal Concentration in Maize

	Pb(mg/l)	Mn(mg/l)	Cr(mg/l)	Cu(mg/l)
CONTROL	ND	2.81±0.05a	0.54±0.02a	1.56±0.04b
Maitumbi	0.60±0.02a	3.75±0.23b	2.79±0.04d	1.02±0.03a
Maikunkele	1.15±0.04b	3.54±0.06b	0.82±0.02ab	1.75±0.04b

Values are Mean±Standard Error of Mean of duplicate determinations. Values with different alphabets (a,b,c) along a column are significantly ($p<0.05$) different

ND = Not Detectable

Risk associated with the consumption of the heavy metals from the maize crops (Maitumbi)

The maximum concentrations of Mn and Cu were 3.75 and 1.75 mg/kg, respectively. These values were below the tolerable upper intake levels of 11 and 73.3 mg/kg, respectively as shown in Table 3. Although, manganese (Mn) and copper (Cu) are essential micronutrients required for normal physiological functions, excessive intake above established tolerable upper intake levels may result in adverse health effects. Excessive manganese exposure has been associated primarily with neurotoxicity, whereas excessive copper intake may cause gastrointestinal disturbances and liver damage (Binesh & Venkatachalam, 2024; EFSA NDA Panel, 2023). Additionally, it was determined that the levels of lead and chromium, particularly in samples from the dumpsite, were higher above the acceptable upper intake threshold of 0.3 mg/kg and 2.3 mg/kg. Lead and chromium have maximum concentrations of 0.62 mg/kg and 2.81 mg/kg, respectively, compared to the acceptable upper intake level of 0.3 and 2.3. Both chromium and lead are categorized as microelements that are not beneficial to humans. Excessive intake of certain metals can harm the kidneys and brain and eventually result in death. In contrast to the Maitumbi sample under analysis, where lead and chromium consumers were at danger. The Makunkele sample only showed the risk of Pb consumption at a maximum concentration of 1.16 mg/kg, which is significantly higher than the acceptable upper limit intake of 0.3 mg/kg. The concentrations of other metals, including Mn, Cr, and Cu, are below the acceptable upper limit intake of 11 mg/kg, 2.3 mg/kg, and 73.3 mg/kg, respectively.

Table 3: Heavy Metals in the Sampled Maize Crops with Dietary Reference Intakes

Metal concentration	Acceptable threshold level	Maitumbi dumpsite	Maikunkele dumpsite	control site
Pb(mg/l)	0.3	0.60	1.15	0
Mn(mg/l)	11	3.75	3.54	2.81
Cr(mg/l)	2.3	2.79	0.82	0.54
Cu(mg/l)	73.3	1.02	1.75	1.56

Bioaccumulation Factor of the dumpsite (BAF)

Figure 2 presents the bioaccumulation factors (BAFs) of heavy metals in maize grown at the Maitumbi and Maikunkele dumpsites. Among the metals analysed, manganese (Mn) showed the highest capacity to accumulate in maize at the Maitumbi dumpsite, with a BAF of 0.50 relative to its concentration in the soil. The results presented in Figure 2 indicate that the bioaccumulation factors

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(BAFs) of all the investigated heavy metals in maize from the Maitumbi and Maikunkele dumpsites were less than 1. Manganese (Mn) recorded a BAF of 0.22 in maize from Maikunkele, while lead (Pb) had a BAF of 0.26 at both Maitumbi and Maikunkele. Copper (Cu) recorded BAF values of 0.11 and 0.25 at Maitumbi and Maikunkele, respectively, whereas chromium (Cr) recorded the lowest BAF of 0.04 at Maikunkele and 0.21 at Maitumbi. The BAF values below 1 indicate that the concentrations of these metals in maize were lower than their corresponding concentrations in the soil, suggesting relatively limited soil-to-plant transfer. In general, a BAF below 1 is associated with low accumulation or metal-excluding behaviour, whereas a BAF greater than 1 indicates relatively greater accumulation of a metal in plant tissues compared with the soil (Aladesanmi *et al.,* 2019). The observed values therefore suggest that maize did not accumulate the investigated metals to levels exceeding their corresponding soil concentrations.

Previous research on maize has demonstrated that the transfer of metals from soil to maize varies considerably among elements and is strongly influenced by soil properties and the chemical forms of the metals (Aladesanmi *et al.,* 2019). The relatively low BAF observed for Cr, particularly the value of 0.04 at Maikunkele, may therefore indicate low availability or mobility of Cr in the soil-plant system, while the comparatively higher BAF of Cu at Maikunkele suggests greater relative transfer of Cu under the soil conditions prevailing at that location. It is important to note that a BAF below 1 should not be interpreted to mean that the soil is not a source of heavy metals in the maize. Rather, BAF is an index of the relative transfer of a metal from soil to plant and is not a source-apportionment measure. Thus, a BAF of 0.26 for Pb indicates that the concentration of Pb in maize was approximately 26% of its corresponding concentration in soil; it does not mean that only 26% of the Pb in maize originated from the soil. Furthermore, heavy metals may reach maize through several pathways, including root uptake from soil, atmospheric deposition of contaminated dust, irrigation water, surface runoff and other anthropogenic inputs. Recent studies have shown that atmospheric deposition can influence the mobility and bioavailability of heavy metals in surface soils, while source-apportionment studies have demonstrated that atmospheric inputs can contribute to metal accumulation in maize (Zhang *et al.,* 2024). Therefore, the relatively low BAF values observed in the present study indicate limited soil-to-maize transfer rather than the absence of soil-derived contamination.

Overall, the findings suggest that the investigated maize plants behaved as relatively low accumulators of Pb, Mn, Cu and Cr under the conditions prevailing at the Maitumbi and Maikunkele dumpsites. Nevertheless, the detection of these metals in maize demonstrates that transfer from the soil to the crop occurred. Consequently, assessment of the potential health implications of consuming the maize should not be based solely on BAF values; the actual concentrations in edible maize tissues, estimated dietary intake and appropriate human-health risk indices should also be considered.

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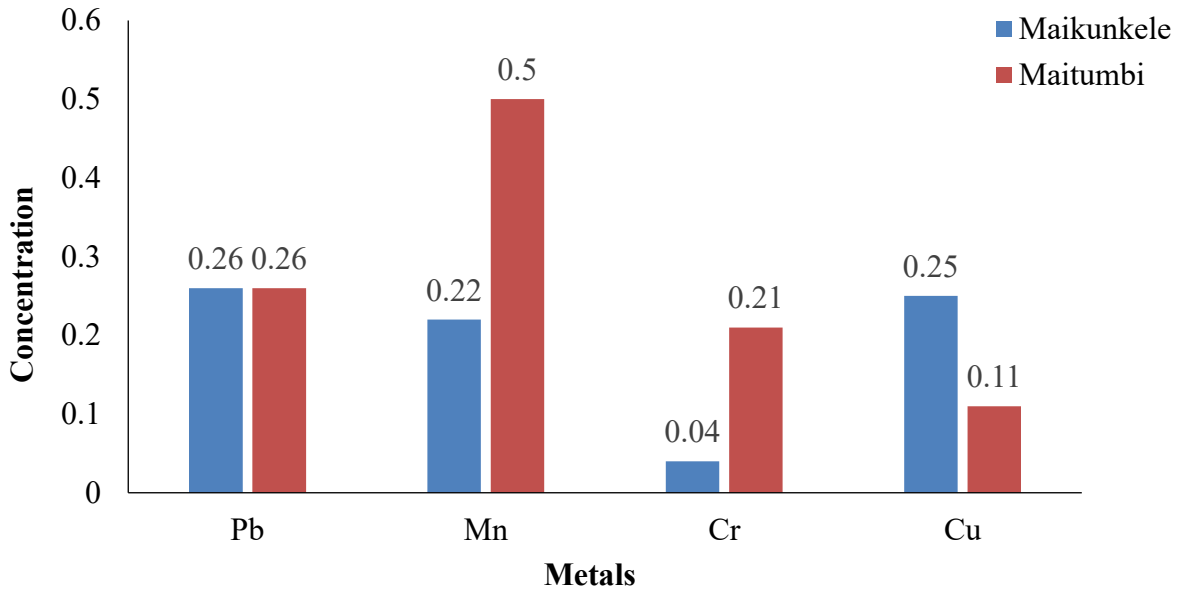

Figure 2: Bioaccumulation Factor of Dumpsite in Maitumbi and Maikunkele

Level of Awareness of the Health Hazards Associated with the Consumption of Maize Crop Cultivated around Waste Dumpsite

The socio-economic characteristics of the respondents provide important contextual information for understanding their level of awareness of the potential health hazards associated with consuming maize cultivated around waste dumpsites. The respondents comprised 41% males and 59% females. The higher proportion of female respondents was attributed to their greater availability at home during the period of questionnaire administration. This gender distribution is relevant to the assessment of awareness because women, particularly those who are primarily responsible for household food preparation and purchasing, may have considerable exposure to information and decisions concerning the selection, preparation and consumption of maize and other food crops. However, gender alone should not be interpreted as evidence of a higher or lower level of awareness. Marital status showed that 27% of the respondents were single, 62% were married, while 11% were divorced, widowed or separated. The predominance of married respondents may be relevant to the assessment of awareness because decisions concerning food production, purchasing and consumption mainly involve household considerations. Therefore, respondents with family responsibilities may also be more concerned about the possible health implications of consuming food crops cultivated around waste dumpsites, particularly where such crops constitute part of the household food supply.

The educational distribution indicates that 12% of the respondents had no formal education, 21% had primary education, 35% had secondary/technical education, 26% had a university degree, and 7% had postgraduate education. Thus, majority (68%) of the respondents had at least secondary education. This relatively high level of formal education may facilitate respondents' understanding of information concerning environmental contamination, heavy metals and potential food-safety risks. Education can also improve an individual's ability to obtain, interpret and apply health information. However, formal education should not automatically be equated with awareness of heavy-metal hazards because awareness depends specifically on whether respondents have previously encountered information about contamination of food crops, dumpsites and associated health risks.

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Therefore, the actual awareness responses provide stronger evidence of knowledge than educational attainment alone.

With respect to occupation, 40% of the respondents were civil servants, 26% were subsistence farmers, 14% were traders, 14% were artisans and approximately 11% had no independent source of income, including full-time housewives. The occupational structure is important because it reflects differences in respondents' potential exposure to the dumpsite environment and their dependence on locally produced food. Farmers may have more direct knowledge of the soil and crops cultivated around the dumpsites and may therefore be more familiar with the use of dumpsite-adjacent land for agricultural production. Conversely, civil servants, traders and artisans may obtain food from different sources and may have different levels of exposure to information about environmental health hazards. The relevance of these socio-economic characteristics becomes clearer when considered alongside the heavy-metal findings from the maize and soil analyses.

Table 4: Respondent's Demographic Information

Demographic information	Frequency	Percentage
Gender of Respondents		
Male	163	41.0
Female	235	59.0
Total	398	100
Level of education of Respondents		
Primary	84	21.0
Secondary/Technical School	139	35.0
Degree (BSc, HND)	103	26.0
Postgraduate	24	6.0
No formal education	48	12.0
Total	398	100
Marital Status		
Single	107	27.0
Married	247	62.0
Divorced/Separated/Widow	44	11.0
Total	398	100
Sources of income of the respondents		
Trading	56	14.0
Farming	103	26.0
Civil Servants	159	40.0
Artisans	44	11.0
None	36	9.0
Total	398	100

Figure 4 displays the degree of awareness regarding the risks associated with eating crops grown in the dumpsite. The survey found that the majority of respondents (64%) were unaware of the risks involved with eating the crops cultivated around dumpsites. However, 8% said they knew, and 26% of the respondents did not respond. This helps to determine whether people understand the possible health dangers of consuming crops contaminated by substances such as lead, cadmium, mercury, and

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harmful microorganisms and it shows how much the community recognizes environmental and food safety risks associated with dumpsite farming. However, it is beyond the scope of this study to ascertain the direct linkage or association of health complications (symptoms and illnesses) with the consumption of maize cultivated around Maitumbi and Maikunkele dumpsites.

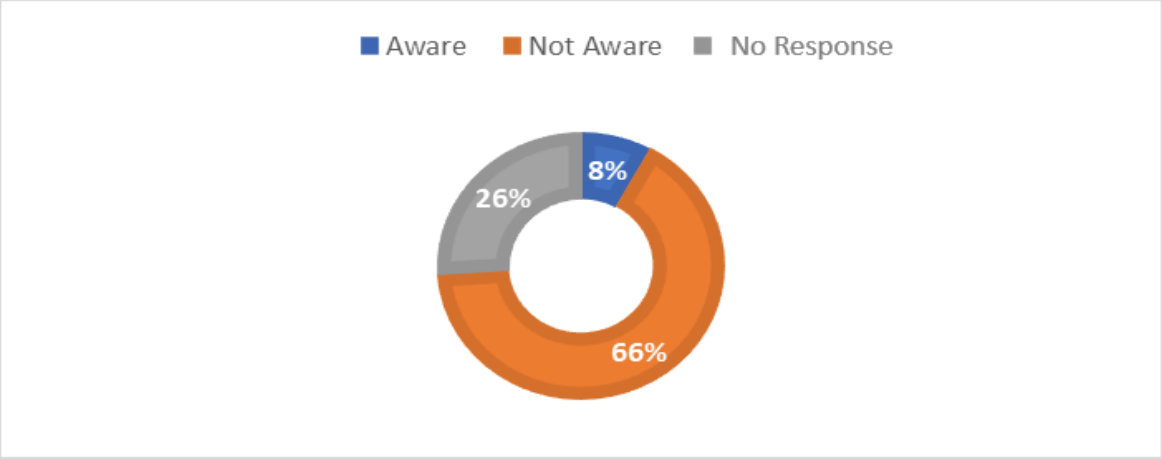

Figure 4: Level of Awareness

Summary of Findings

Globally, it is well known that open dumps are a significant source of numerous health and environmental risks. These landfills have been widely utilized as productive fields for growing crops and vegetables that can absorb large amounts of heavy metals from polluted and contaminated soils (Adefemi & Awokunmi, 2018; Awino *et al.,* 2024). As a result, this study showed the different levels of physiochemical parameters and heavy metals in samples taken from control soil and maize crop.

Due to the impact of dumping materials that could change the pH of the area, the statistical analysis of the results revealed that the pH (7.51±0.10 and 7.76±0.23) of the soil samples from the Maitumbi and Maikunkele dump sites, respectively, was significantly ($p<0.05$) higher than that of the control. The soil sample from the Maikunkele dumpsite had the highest mean concentrations for all the analyzed physicochemical properties, conductivity, with the exception of phosphorous, where its concentration was comparable to that from the Maitumbi dumpsite. However, the physicochemical parameters increased in the following order: Control < Maitumbi < Maikunkele. The control soil sample was significantly lower from the Maikunkele and Maitumbi dumpsites.

The analysis of the maize crop revealed that the Maitumbi and Maikunkele crop samples from the control site and dumpsite had significant concentrations of Mn, ranging from 2.91 mg/kg to 3.75 mg/kg. The control site had no Pb, while the Maikunkele dumpsite had a value of 1.15 mg/kg. Due to the local geology, it was also found that the concentration of Cr was high in the Maitumbi dumpsite (2.79 mg/kg), but the concentration of copper was high in the control site (1.56 mg/kg).

By comparing the tested sample with dietary reference intakes for the metals, the risk associated with consuming maize crops was examined. The results showed that crops produced on dumpsites had a significant risk of both Pb and Cr toxicity, as the values were higher than the acceptable upper intake threshold. Furthermore, according to the bioaccumulation factor derived from Maitumbi, Mn has the

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greatest capacity to accumulate in maize crops in relation to its concentration in the soil. The degree of knowledge of the risks connected to consumption of crops grown in the dumpsites showed that the majority of respondents (64%) were unaware of these risks. 26% said they were unconcerned, while 8% said they were aware. The null hypothesis was rejected as it shown that there is significant difference in heavy metal concentrations between maize grown on waste dumpsites and maize grown on uncontaminated soil.

5.0 Conclusion

In both Makunkele and Maitumbi waste dump sites, the concentration of heavy metals in the maize crop was found to be higher in the dumpsite-planted maize crops than in the control site. Pb, Cu, Cr, and Mn were the metals identified in ascending order for both Makunkele and Maitumbi dump sites. The ANOVA test indicates that the concentration of heavy metals, in the soils of Maitumbi and Maikunkele is significantly ($p<0.05$) higher than in the control sites, which may be due to human activity in the dumpsite. Because the concentration values of Pb and Cr were higher than the acceptable upper consumption threshold recommended by the National Academy of Sciences/Institute of Medicine in 2003, the metals analysis indicates that these concentrations offer a greater risk to those who consume maize crops.

Consequently, the following suggestions are offered in light of the findings:

i. Farmers should stop growing maize on dumpsites because of the elevated levels of lead and chromium found in maize.

ii. The government or other pertinent organizations should create and intensify awareness in order to deter the cultivation of these edible crops on the landfill.

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