

Health Risk Assessment of Heavy Metal Concentrations in Sewage Compost Manure Used for Agriculture in Zaria, Nigeria

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ABSTRACT

The increasing use of sewage composts as fertilizer has raised concerns regarding the accumulation of heavy metals in agricultural soils. This study examined the health risks of the composts used by farmers in Zaria Metropolis, Nigeria. Ten compost samples and two reference soil samples were collected as representative samples and analyzed at the Center for Energy Research and Training, Ahmadu Bello University, Zaria, using Neutron Activation Analysis (NAA). A total of six (6) heavy metals, namely Fe, Mn, Zn, Cr, Co, and As were detected. The results showed that the mean concentrations of these heavy metals in the compost were significantly higher than those in the reference soils, with Fe (19677.2 ± 305.7 mg/kg) having the highest concentration, followed by $> \text{Mn}$ (328.1 ± 4.32 mg/kg) $> \text{Zn}$ (124.31 ± 20.87 mg/kg) $> \text{Cr}$ (27.777 ± 2.554 mg/kg) $> \text{Co}$ (9.231 ± 0.366 mg/kg) and As (0.452 ± 0.064) in that order. The elevated concentrations indicate potential environmental and health risks associated with prolonged applications of these sewage compost. The study highlights the need for continuous monitoring and regulation of compost use in agriculture to prevent soil contamination and food chain transfer of toxic elements.

Keywords:

Heavy metals,
Sewage compost,
Instrumental neutron
activation analysis,
Environmental monitoring,
Soil contamination,
Nigeria.

INTRODUCTION

Sewage compost, also known as biosolids, is widely used as an organic fertilizer due to its high nutrient and organic matter content, which enhances soil fertility and crop productivity (Pereira *et al.*, 2020). Its application represents an environmentally sustainable approach to waste management by recycling nutrients into agricultural systems (Bertanza *et al.*, 2016). However, sewage composts may contain elevated levels of heavy metals originating from industrial, domestic, and urban waste streams (Alloway, 2013).

Heavy metals such as chromium (Cr), arsenic (As), zinc (Zn), and cobalt (Co) are non-biodegradable and can accumulate in soils over time, posing risks to plant growth, environmental quality, and human health (Islam *et al.*, 2017; Smith, 2009). Continuous application of contaminated compost may result in the transfer of these metals into the food chain, leading to toxicological effects (McBride, 2003). Toxic elements such as cadmium, mercury, and lead are of particular concern due to their adverse effects on human health. Exposure to mercury and lead has been linked to neurological disorders, kidney diseases, and other chronic health conditions, while cadmium is recognized as a

carcinogenic element capable of causing severe organ damage and skeletal disorders (Barakat, 2011; Bolan *et al.*, 2013). Elevated concentration of heavy metal in water, fish and sediment samples are experienced due to anthropological activities (Bello, *et al.*, 2025). These activities contribute to the contamination of the environment with potential ecological and public health implications. Similarly, the accumulations of heavy metals in soil around metal scraps yards can lead to further contamination of the soil within that area which can lead to substantial increase of heavy metal contamination of various environmental matrices (Abdulsalam, *et al.*, 2024).

Neutron Activation Analysis (NAA) is a highly sensitive and non-destructive analytical technique used for multi-element determination in environmental samples (Glascock, 2003). Its ability to detect trace elements with high precision makes it suitable for analyzing complex matrices such as sewage composts (Maharaz *et al.*, 2015; Kucera 2007).

This study aims to determine the concentration of heavy metals in sewage composts used for agriculture in Zaria Metropolis, Nigeria, and to assess their potential environmental and health implications. The study

provides baseline data for regulatory assessment of using treated sewage compost in Nigeria.

MATERIALS AND METHODS

Study Area

Zaria is located in Kaduna State, Nigeria (Latitude 11.04°N; Longitude 7.71°E). The region is characterized

by intensive agricultural activity. In this work, compost samples were collected from the following locations: Shika, Bomo, Samaru, Saye, and Biye, all within Zaria metropolis.

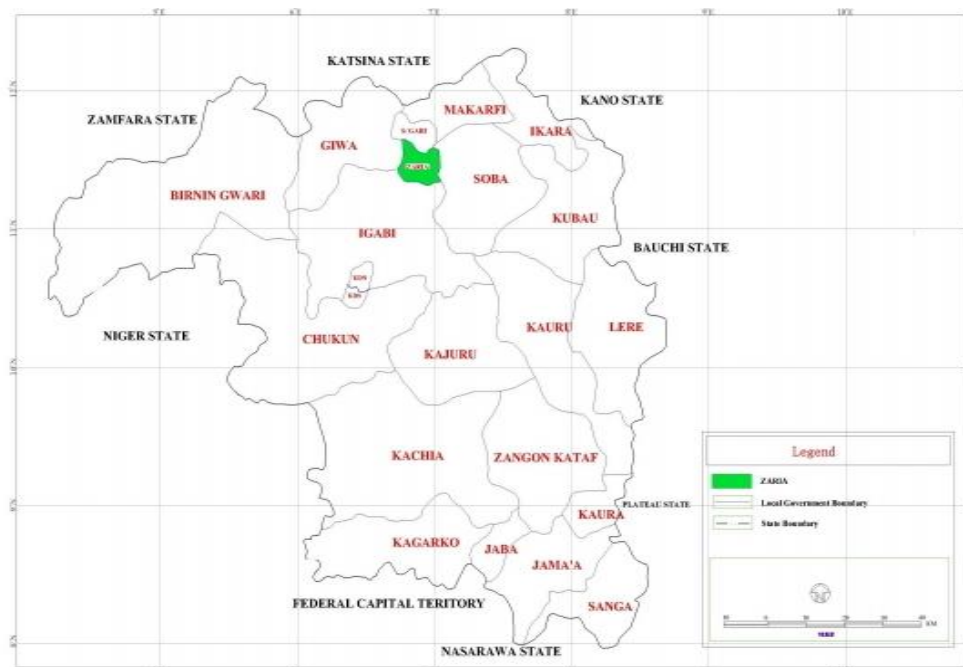


Figure 1: Map of Kaduna State highlighting The Study Area Zaria

Sample Collection and Preparation

Ten treated sewage compost samples (Z1–Z10), two from each location as representative, were collected from different agricultural locations. Two soil samples (C1 and C2) were also collected, far from the compost dump, as reference/controls. The samples were collected using hand gloves, plastic containers and collecting spoon to prevent contamination. These samples were properly labeled at the points of collections to avoid mix-up. The locations of collection of the samples were tagged respectively as site I, site II ...to site X. The Samples were labeled as sample (I) or Z(1), sample(II) or Z(2)... to sample(X) or Z(10) respectively. The samples were then transported to the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria, for analysis. In the laboratory, the samples were left open to ensure they are completely dried. They were then crushed into fine powder using mortar and pestle and then passed through a mesh sieve of size 2 mm to obtain a homogeneous matrix. Each sample was poured into a small transparent polythene leather and weighed using an electronic balance to achieve a sample weight of 0.15 g.

Each of the samples was then sealed using a hand dryer, and then finally placed inside a small vial and sealed ready for irradiation.

Irradiation and Gamma Spectrometry

Irradiation was conducted in the Nigeria Research Reactor-1 (NIRR-1) located at the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria. The samples were irradiated with thermal neutron flux of $5.0 \times 10^{11} \text{ n}\cdot\text{cm}^{-2}\cdot\text{s}^{-1}$ in two stages. For the short-lived radionuclides, the irradiation was carried out for 1 minute while for the long-lived radionuclides it was carried out for 6 minutes.

After irradiation, each of the samples was taken to the detection system consisting of a high purity germanium detector (HPGe) connected to a PC with Maestro software installed, for gamma spectroscopy (Jonah, *et al.*, 2006).

A total of six (6) heavy elements were detected. They are presented in Table 1 for the composts and Table 2 for the reference soil sample.

Table 1: Concentration of Heavy Metals in the Compost (ppm)

| Sample code | Mn | As | Cr | Fe | Co | Zn |
|-------------|--------------|---------------|----------------|-----------------|---------------|----------------|
| Z1 | 211 ± 2 | BDL | 11.0 ± 1.9 | 12790 ± 371 | 4.85 ± 0.48 | 47.3 ± 12.2 |
| Z2 | 271 ± 2 | 0.73 ± 0.16 | 18.8 ± 2.5 | 11250 ± 349 | 4.11 ± 0.50 | 104 ± 15 |
| Z3 | 246 ± 2 | BDL | 42.3 ± 6 | 92400 ± 738 | 57.4 ± 0.92 | 77.9 ± 14.8 |
| Z4 | 654 ± 3 | BDL | 8.47 ± 2.14 | 17350 ± 382 | 4.49 ± 0.46 | 42.6 ± 14.3 |
| Z5 | 316 ± 2.5 | BDL | 11.9 ± 2.2 | 3201 ± 22 | 0.71 | BDL |
| Z6 | 371 ± 2.6 | BDL | BDL | 5971 ± 29 | 1.47 | BDL |
| Z7 | 287 ± 2.3 | BDL | 29.4 ± 2.4 | 12330 ± 272 | 4.82 ± 0.30 | 73.3 ± 7.5 |
| Z8 | 283 ± 2 | 1.93 ± 0.22 | 42.7 ± 2.8 | 17730 ± 337 | 6.51 ± 0.36 | 288 ± 0.90 |
| Z9 | 342 ± 3 | 1.36 ± 0.17 | 28.0 ± 2.6 | 11280 ± 271 | 3.76 ± 0.32 | 379 ± 132 |
| Z10 | 300 ± 2 | 0.50 ± 0.09 | 55.2 ± 3.0 | 12420 ± 286 | 4.19 ± 0.32 | 231 ± 12 |
| MEAN | 328.1 ± 4.32 | 0.452 ± 0.064 | 27.777 ± 2.554 | 19677.2 ± 305.7 | 9.231 ± 0.366 | 124.31 ± 20.87 |

Table 2: Concentration of Heavy Metals in the Reference Samples (ppm)

| Sample code | Mn | As | Cr | Fe | Co | Zn |
|-------------|---------|-------------|-------------|-------------|--------------|------------|
| C1 | 224 ± 2 | 1.62 ± 0.11 | 35.4 ± 5.5 | 19760 ± 751 | 4.67 ± 1.01 | BDL |
| C2 | 218 ± 2 | 1.10 ± 0.10 | 48.2 ± 3.6 | 13020 ± 299 | 3.24 ± 0.33 | 37.3 ± 8.1 |
| MEAN(C1,C2) | 221 ± 2 | 1.36 ± 0.11 | 41.8 ± 4.55 | 16390 ± 525 | 3.955 ± 0.67 | 37.3 ± 8.1 |

The determination of the extent of pollution of heavy metals in the compost samples (Z1 –Z10) were evaluated using three parameters: Contamination Factor (CF), Enrichment Factor (EF), and Geo-accumulation index (Igeo).

Contamination Factor (CF)

The contamination factor (CF) is a widely used index for evaluating the degree of heavy metal pollution in environmental samples such as soil and compost. It compares the measured concentration of a metal in a samples with its background or reference value. In this work, the contamination factor was calculated using: (Hakanson 1980)

$$CF = \frac{C_{sample}}{C_{background}} \quad (1)$$

Where: C_{sample} and $C_{background}$ are concentration of pollutant (metal) in compost and concentration of pollutant (metal) in reference soil respectively. The contamination factor (CF) was calculated as the ratio of the concentration of a pollutant (metal) in the compost sample to the concentration of pollutant (metal) in the reference soil. The CF is widely used to assess the degree of metal contamination in environmental samples. According to the classification proposed by Hakanson (1980), a CF value less than 1 indicates low contamination, a value between 1 and 3 indicates moderate contamination, a value between 3 and 6 indicates considerable contamination, while a value greater than or equal to 6 indicates very high contamination.

The contamination factor provides a measure of the degree of metal contamination relative to background levels. The CF values obtained in this study are presented in Table 3 and the values ranged widely across the sampled locations. For manganese (Mn), the CF values varied between 0.95 and 2.96, indicating low to moderate contamination across most samples. The highest value was observed in sample Z4 with CF = 2.96, suggesting localized enrichment, possibly due to the nature of organic waste inputs. Arsenic (As) showed generally low CF values (<1) in the few samples where it was detected, indicating minimal contamination and suggesting that arsenic is not a major pollutant in the study area. Chromium (Cr) exhibited CF values mostly below 1, except for Z3 and Z10 where values slightly exceeded unity (CF = 1.01 and 1.32, respectively), indicating minor contamination. This suggests limited anthropogenic influence on chromium levels. Iron (Fe), which was used as a reference element, showed CF values mostly below 1, except in Z3 (CF = 5.63), which indicates considerable enrichment. This anomaly may be linked to specific waste materials rich in iron. Cobalt (Co) displayed significant variability, with CF values ranging from 0.18 to 14.50. The exceptionally high value in Z3 (CF = 14.50) indicates very high contamination, suggesting a strong localized input source. Zinc (Zn) showed the most pronounced contamination among the studied metals. CF values ranged from 1.14 to 10.16, with extremely high values recorded in Z8, Z9, and Z10. These results indicate moderate to very high contamination, highlighting zinc as a major pollutant in the composts.

Table 3: Contamination Factor (CF)

| Sample code | Mn | As | Cr | Fe | Co | Zn |
|-------------|------|------|------|------|-------|-------|
| Z1 | 0.95 | - | 0.26 | 0.78 | 1.22 | 1.27 |
| Z2 | 1.23 | 0.54 | 0.45 | 0.69 | 1.04 | 2.79 |
| Z3 | 1.11 | - | 1.01 | 5.63 | 14.50 | 2.09 |
| Z4 | 2.96 | - | 0.20 | 1.06 | 1.13 | 1.14 |
| Z5 | 1.43 | - | 0.28 | 0.20 | 0.18 | - |
| Z6 | 1.68 | - | - | 0.36 | 0.37 | - |
| Z7 | 1.30 | - | 0.70 | 0.75 | 1.22 | 1.97 |
| Z8 | 1.28 | 1.42 | 1.02 | 1.08 | 1.64 | 7.72 |
| Z9 | 1.55 | 1.00 | 0.67 | 0.69 | 0.95 | 10.16 |
| Z10 | 1.36 | 0.37 | 1.32 | 0.76 | 1.06 | 6.19 |

Enrichment Factor (EF)

Enrichment factor is a ratio used to assess the concentration of a specific element, mineral, or substance compared to a natural background or baseline (Sutherland, 2000). It was computed to assess anthropogenic contribution of heavy metals concentration in environmental samples by normalizing the measured values against a reference element. Fe was used as the reference element due to its crustal stability. According to (Sutherland, 2000), the enrichment factor is defined as

$$EF = \frac{[C_x/C_{ref}]_{compost}}{[C_x/C_{ref}]_{background}} \quad (2)$$

Where: C_x and C_{ref} are the concentration of metal and reference element (Fe) in the compost and the background source respectively. Fe is used as the reference element due to its natural stability and minimal anthropogenic influence. EF values are interpreted as suggested by Sutherland, (2000). The enrichment factor (EF) is used to assess the degree of elemental enrichment in a sample relative to a background reference. An EF value less than or equal to 1 indicates no enrichment. An EF value between 1 and 2 indicates minimal enrichment. Values ranging from 2 to less than 5 indicates moderate enrichment, while values from 5 to less than 20 indicates

significant enrichment. An EF value between 20 and less than 40 is considered very high enrichment, whereas an EF value of 40 or greater indicates extremely high enrichment.

The enrichment factor was used to distinguish between natural and anthropogenic sources of metals, using Fe as a normalizing element. The results obtained using equation (2) are presented in Table 4.

Most metals exhibited EF values close to unity, indicating that their presence is largely controlled by natural sources. For example, Mn showed EF values between 1.01 and 2.79, suggesting minimal to moderate enrichment. Arsenic and chromium also displayed EF values generally below 2, further confirming their predominantly natural origin. However, zinc showed significantly elevated EF values, particularly in Z8 (EF = 7.14), Z9 (EF = 14.70), and Z10 (EF = 8.14). These values indicate significant to very high enrichment, clearly pointing to anthropogenic contributions. Possible sources include municipal waste, batteries, metal scraps, and industrial residues commonly found in composts feedstock. Cobalt exhibited moderate enrichment in some samples, particularly Z3 (EF = 2.57), supporting the earlier observation of localized contamination. The EF values for Fe remained approximately unity across all samples, validating its use as a conservative reference element in this study.

Table 4: Enrichment Factor (CF)

| Sample code | Mn | As | Cr | Fe | Co | Zn |
|-------------|------|------|------|------|------|-------|
| Z1 | 1.01 | - | 0.33 | 1.00 | 1.57 | 1.63 |
| Z2 | 1.79 | 0.79 | 0.65 | 1.00 | 1.50 | 4.03 |
| Z3 | 0.20 | - | 0.19 | 1.00 | 2.57 | 0.37 |
| Z4 | 2.79 | - | 0.19 | 1.00 | 1.07 | 1.08 |
| Z5 | 7.15 | - | 1.40 | 1.00 | 0.89 | - |
| Z6 | 4.69 | - | - | 1.00 | 1.04 | - |
| Z7 | 1.73 | - | 0.94 | 1.00 | 1.63 | 2.63 |
| Z8 | 1.31 | 1.45 | 1.04 | 1.00 | 1.52 | 7.14 |
| Z9 | 2.25 | 1.45 | 0.97 | 1.00 | 1.38 | 14.70 |
| Z10 | 1.79 | 0.49 | 1.73 | 1.00 | 1.39 | 8.14 |

Geo-Accumulation Index (Igeo)

The Geo-accumulation index (Igeo) is widely used geochemical tool to quantify the degree of heavy metal concentration in sediments, soils, and aquatic environments compared to pre-industrial background levels (Muller, 1969). In this work, it was employed to evaluate the level of metal pollution by comparing present concentration with background values while incorporating a correction factor to account for natural geological variability (Muller, 1969). The formula employed to evaluate the metal pollution in terms of seven enrichment classes ranging from background concentration to very heavy pollution is given by: (Muller, 1969)

$$I_{geo} = \log_2 \left(\frac{C_n}{1.5 \cdot B_n} \right) \quad (3)$$

Where:

C_n = measured concentration of the element in the sample

B_n = background value of the element

1.5 = correction factor to account for natural fluctuations in background levels due to lithogenic effects.

The geo-accumulation index (Igeo) classification proposed by Müller (1969) is used to assess the degree of heavy metal contamination in environmental samples. According to this classification, Igeo values less than 0 indicates an uncontaminated condition, while values between 0 and less than 1 indicates an uncontaminated to

moderately contaminate. Igeo values ranging from 1 to less than 2 are considered moderately contaminated, and values from 2 to less than 3 indicate moderate to heavy contamination. Values between 3 and less than 4 indicates heavily contaminated conditions, while values from 4 to less than 5 indicates heavily to extremely contaminated. Finally, Igeo values greater than or equal to 5 are classified as extremely contaminated.

It provides insight into the pollution status of the composts by comparing current concentrations with pre-industrial levels. The values obtained from equation (3) are presented in Table 5. The Igeo values for most metals were negative, indicating an unpolluted condition. For instance, Mn, Cr, and Fe consistently recorded Igeo values less than zero across most samples. Zinc, however, exhibited positive Igeo values in several locations. Samples Z8 (Igeo = 2.36), Z9 (Igeo = 2.76), and Z10 (Igeo = 2.01) fall within the moderately to heavily polluted category. This confirms that zinc contamination is significant and widespread in the study area. Cobalt in sample Z3 showed an Igeo value of 3.27, indicating heavy pollution, which aligns with the high CF and EF values observed earlier. Other metals such as arsenic and chromium remained within the unpolluted to slightly polluted categories, indicating minimal environmental concern.

Table 5: Geo-Accumulation Index (Igeo)

| Sample code | Mn | As | Cr | Fe | Co | Zn |
|-------------|-------|-------|-------|-------|-------|-------|
| Z1 | -0.66 | - | -2.53 | -0.95 | -0.30 | -0.24 |
| Z2 | -0.28 | -1.47 | -1.74 | -1.12 | -0.53 | 0.90 |
| Z3 | -0.42 | - | -0.59 | 1.86 | 3.27 | 0.48 |
| Z4 | -0.64 | - | -2.91 | -0.49 | -0.43 | -0.41 |
| Z5 | -0.09 | - | -2.42 | -2.89 | -2.74 | - |
| Z6 | 0.15 | - | - | -1.98 | -1.43 | - |
| Z7 | -0.22 | - | -1.10 | -1.00 | -0.31 | 0.39 |
| Z8 | -0.23 | -0.08 | -0.56 | -0.48 | 0.12 | 2.36 |
| Z9 | 0.06 | -0.58 | -1.16 | -1.12 | -0.66 | 2.76 |
| Z10 | -0.14 | -2.03 | -0.19 | -0.99 | -0.51 | 2.01 |

RESULTS AND DISCUSSION

A total of six major heavy metals of concern: Fe, Mn, Zn, Cr, Co, and As were detected. In Tables 1 and 2, we presented the concentrations of the heavy metals determined in the composts as well as in the reference samples. From these tables, Fe has values ranging from 3201 ± 22 to 92400 ± 738 ppm and a mean value of 19677.2 ± 305.7 ppm for the composts, and 13020 ± 299 to 19760 ± 701 ppm and mean value of 16390 ± 525 ppm for the reference soil sample while As, though not detected in most of the compost, has a range of 0.73 ± 0.16 to 1.93 ± 0.22 ppm and mean value of 0.452 ± 0.064 ppm for the composts and a range of 1.10 ± 0.10 to 1.62 ± 0.11 ppm and a mean value of 1.36 ± 0.11 for the reference soil, Mn has a concentration of 211 ± 22 to 654

± 3 ppm in the composts and 218 ± 2 to 224 ± 2 ppm in the standard. Zn, has a range of concentration of 47.3 ± 12.2 to 379 ± 132 ppm in the composts and 37.3 ± 8.1 ppm in the standard. On the other hand, Cr, has a range of concentration of 8.47 ± 2.14 to 55.2 ± 3 ppm in the composts and 35.4 ± 5.5 to 48.2 ± 3.6 ppm in the reference while Co has a range of values of 0.71 to 57.4 ± 0.92 ppm in the composts and 3.24 ± 0.33 to 4.67 ± 1.01 ppm in the reference sample. The results reveal that the concentration of the various heavy metals in the composts are higher than those in the reference soil samples. This implies that these composts contain larger quantities of these heavy elements than the reference samples. This might lead to further introduction of contaminants (heavy metals) into the soil due to

continuous usage as fertilizer by farmers. This can further lead to making the environment toxic, affecting human health and plant performance in some cases. Reference soil samples showed comparatively lower concentrations for most elements compared to that of sewage composts. The concentrations of these metals were significantly higher in the composts compared to reference soils, indicating contamination from sewage-derived materials. For example, iron (Fe) recorded the highest concentration, suggesting its abundance in sewage waste streams. Heavy metals are persistent in soils and can accumulate over time, leading to long-term environmental degradation. Excess manganese may alter soil pH and nutrient balance, while chromium, particularly in its hexavalent form, is highly toxic and carcinogenic. Arsenic exposure is associated with severe health effects, including cancer and skin disorders. Similarly, excessive zinc and cobalt can disrupt plant metabolism and reduce crop productivity.

The higher concentrations observed in composts compared to reference soils suggest that continuous application may increase soil contamination levels and facilitate the transfer of toxic metals into crops. Heavy metals have a lot of toxic effect if not properly managed. We shall consider them briefly here.

Arsenic (As)

This is a harmful heavy metal which is one of the major risk factor for public health. Arsenic is highly toxic in its inorganic form and is often referred to as the king of poisoning. Exposure to arsenic mainly via food chain and drinking water can lead to serious arsenic poisoning, cancer and skin lesions. (Smith et al., 2002).

Manganese (Mn)

Manganese is a very important trace element for plant growth. However, when in excess, can alter the soil acidic level. Its accumulation in the soil over time can interfere in the uptake of other essential nutrients like Fe and Mg which is likely to cause some deficiencies in plant growth. Manganese is also an essential trace element in human body system necessary for enzymes activities, bone formation and brain function however, and its accumulation in the soil can lead to injurious damage to the human body. It can be toxic to some sensitive parts of the human body such as the nervous system. (Alloway, 2013).

Chromium (Cr)

Chromium exists mainly in two forms. These include trivalent chromium and hexavalent chromium. Trivalent chromium is a significant trace element for glucose and lipid metabolism, but hexavalent chromium is highly toxic and carcinogenic and is the major cause of chromium poisoning in human body system. Chromium can be introduced into the environment as well as the

food chain through the usage of sewage composts which can be detrimental to human health causing a series of illness such as nose and throat irritation, dizziness, headache, chronic bronchitis, lung tissue damage and even lung cancer as a result of prolonged exposure to hexavalent chromium. Hexavalent chromium can easily enter the human cell and further reduced to trivalent chromium which eventually leads to the generation of reactive oxygen species (ROS) imposing a potential damage to the DNA and cell membranes. Chromium can also accumulate in the liver, kidney and heart which is likely to cause liver damage, kidney failure and hypertension. Chromium can also cause skin ulcer and dermatitis. (De Flora, 2008). Chromium accumulation in the soil can lead to reduction in seed germination, reduction in microbial activity soil fertility and can also cause stunted growth due to impaired nutrient uptake and cell division inhibition. It can also interfere with chlorophyll synthesis. The presence of chromium in excess amount can disrupt the uptake of Fe, Mg, Ca and K which can eventually lead to nutrient deficiency symptoms and osmotic stress. (Costa and Klein, 2006).

Iron (Fe)

Iron is an essential trace element needed for oxygen transport and enzymes function. Intake of iron in excess can lead to alteration of the body system causing illness such as nausea, vomiting, abdominal pain and diarrhea. It can also cause gastrointestinal bleeding, liver damage and low blood pressure. Chronic iron toxicity which is sometimes referred to as iron overload can also accumulate in the body as a result of excessive intake passed into the food chain. This can lead to liver cirrhosis, joint pain and arthritis skin pigmentation and can also increase the risk of certain cancers. Iron accumulation in the soil can be toxic to plants especially in waterlogged or acidic soil. Iron in excess can cause chlorosis, stunted growth and reduced crop yield and quality (Smith 2009).

Cobalt (Co)

Cobalt is a vital trace element which happens to be a component of vitamin B12 (cobalamin). It is important for the production of red blood cell and healthy nervous system. However, excessive exposure and accumulation can result to some illnesses such as Asthma, breathing difficulty, abdominal pain, heart failure, and nerve damage as well as lung cancer. Cobalt is also a micronutrient for plants which is required in minute amount for nitrogen fixation in legumes and enzymes activity. Cobalt can accumulate in soil, thereby entering the food chain as a result of using sewage composts as fertilizer for plant growth and these can lead to some irregularities such as reduction in seed germination, stunted growth, chlorosis, and leaf necrosis. Excess

cobalt in the soil can also reduce the uptake of Fe, Mn and Zn. (McBride, 2003).

Zinc (Zn)

Zinc is a very important trace element required for a lot of biological processes which includes immune function enzyme activity wound healing and DNA synthesis. Zinc can be toxic to human body when it enters the food chain as a result of using fertilizer like sewage composts to boost plant growth. Zinc can be a threat to the wellbeing of humans when it is ingested over a short period of time and this can lead to illness such as nausea, vomiting stomach cramps, diarrhea, loss of appetite fatigue and muscle pain. Prolong intake of zinc can lead to copper deficiency which can lead to anemia and weakened immune function. Zinc is also an essential micronutrient for plants needful for enzyme activation, protein synthesis and chlorophyll production. Zinc can accumulate in the soil over time as a result of the use of zinc based fertilizer which in turn can impair the food chain leading to negative effects on plants such as chlorosis, stunted growth, root damage and nutrient imbalance. Zinc when in excess can interfere with uptake of vital elements like Fe, Mn, and P which can further result in decrease of crop productivity and quality.

CONCLUSION

This study has shown that sewage composts used in Zaria metropolis contain elevated levels of heavy metals, which exceed those found in natural soils. The accumulation of these metals poses potential environmental and health risks, particularly with prolonged use. The combined use of Contamination Factor, Enrichment Factor and Geo-accumulation Index provides a good understanding of contamination patterns and sources. Metals such as Mn, Cr, and Fe are primarily of geogenic origin, as indicated by low CF and EF values. The Zn contamination is clearly anthropogenic, supported by high CF (>6), high EF (>5), and positive Igeo values. Co contamination in Z3 suggests a localized pollution source, possibly from industrial or metallic waste materials. Although sewage compost improves soil fertility, its application must be carefully regulated to prevent contamination. Regular monitoring and adherence to safety guidelines are essential to ensure sustainable agricultural practices.

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