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Assessment Heavy-Metal Presence in agricultural soil and plant (Lettuce; *Latuca Sativa*) in Jimeta, Yola State, Nigeria.

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Abstract

Heavy metals are naturally occurring elements, but elevated levels of these metals can lead to a range of health problems, including neurological damage, developmental problems, and reproductive issues. The aim of this study is to assess the presence of heavy metals in garden soil and plant lettuce (Lactuca sativa) in Jimeta, Yola State, Nigeria. The study was carried out using Atomic Absorption Spectrophotometer (AAS). The levels of As, Al, B, Cd, Cu, Cr, Fe, Mn, Pb, and Zn in soil and vegetable samples were recorded using AAS. The results of the study revealed that heavy metal concentrations recorded in the soil recorded an average of below detection thresholds, as such were within allowable range set by FAO and WHO. The findings of the analysis indicated that the lettuce can be consumed by humans in the respective region without risk. In addition, the study concluded by recommending the need for further studies on the impact of e-waste site location on heavy metal content of soil.

Keywords: agricultural soil; Lettuce Latuca Sativa; heavy metal; transfer factor; Chronic Daily Intake

1.0 Introduction

The presence of heavy metals in soil and food sources has become an increasingly relevant issue due to the growing concern for environmental contamination and its impact on human health. Heavy metals are naturally occurring elements, but elevated levels of these metals can lead to a range of health problems, including neurological damage, developmental problems, and reproductive issues [1]. In particular, lead, cadmium, and arsenic are some of the heavy metals that pose a significant health risk when present in elevated levels in soil and food sources.

Soil contamination with heavy metals can occur due to various sources, such as industrial activities, agricultural practices, and mining operations [2]. Once in the soil, heavy metals can be absorbed by plants and enter the food chain, leading to potential health risks for humans and animals. For example, a study by [3] found elevated levels of lead, cadmium, and nickel in soil samples collected from contaminated sites in the Netherlands. Similarly, a study by [4] investigated soil contamination with heavy metals in China and found elevated levels of lead, cadmium, and zinc in some areas.

Lettuce (Lactuca sativa) is a widely cultivated plant that is widely consumed as a leaf vegetable in many regions of the world, including Nigeria. The plant is known to be sensitive to soil contamination with heavy metals and can absorb and accumulate these metals from contaminated soil [5]. This raises concerns about the potential health risks associated with consuming lettuce grown in contaminated soil.

In recent years, there has been a growing body of research focused on the presence of heavy metals in soil and food sources. For example, a study by [6] found elevated levels of lead, cadmium, and zinc in some soil samples in Lagos, Nigeria. Another study by [7] investigated the presence of heavy metals in vegetable crops in Iraq and found elevated levels of lead, cadmium, and zinc in some crops.

The aim of this study is to assess the presence of heavy metals in soil and lettuce (Lactuca sativa) in Jimeta, Yola State, Nigeria. The results of this study will provide valuable information on the levels of heavy metals in these sources and help to determine the potential health risks associated with consuming these sources in this region. This information will be important for policymakers, public health officials, and local communities as they work to ensure the safety of the food and water supply in Jimeta and other similar areas.

The results of this study will also contribute to the existing body of research on heavy metal contamination in soil and food sources. By providing a comprehensive assessment of heavy metal presence in soil and lettuce in Jimeta, this study will help to inform future research and efforts to address this issue. With increasing concerns about environmental contamination and its impact on human health, it is essential to continue to build our understanding of the presence of heavy metals in soil and food sources and to develop effective strategies for reducing exposure to these metals.

Materials and Methods

Study Station

The study was conducted in Jimeta-Yola, North Eastern Nigeria. The map of the sampling locations appears in Figure 1 whose locations were determined using geographic positioning system (GPS).

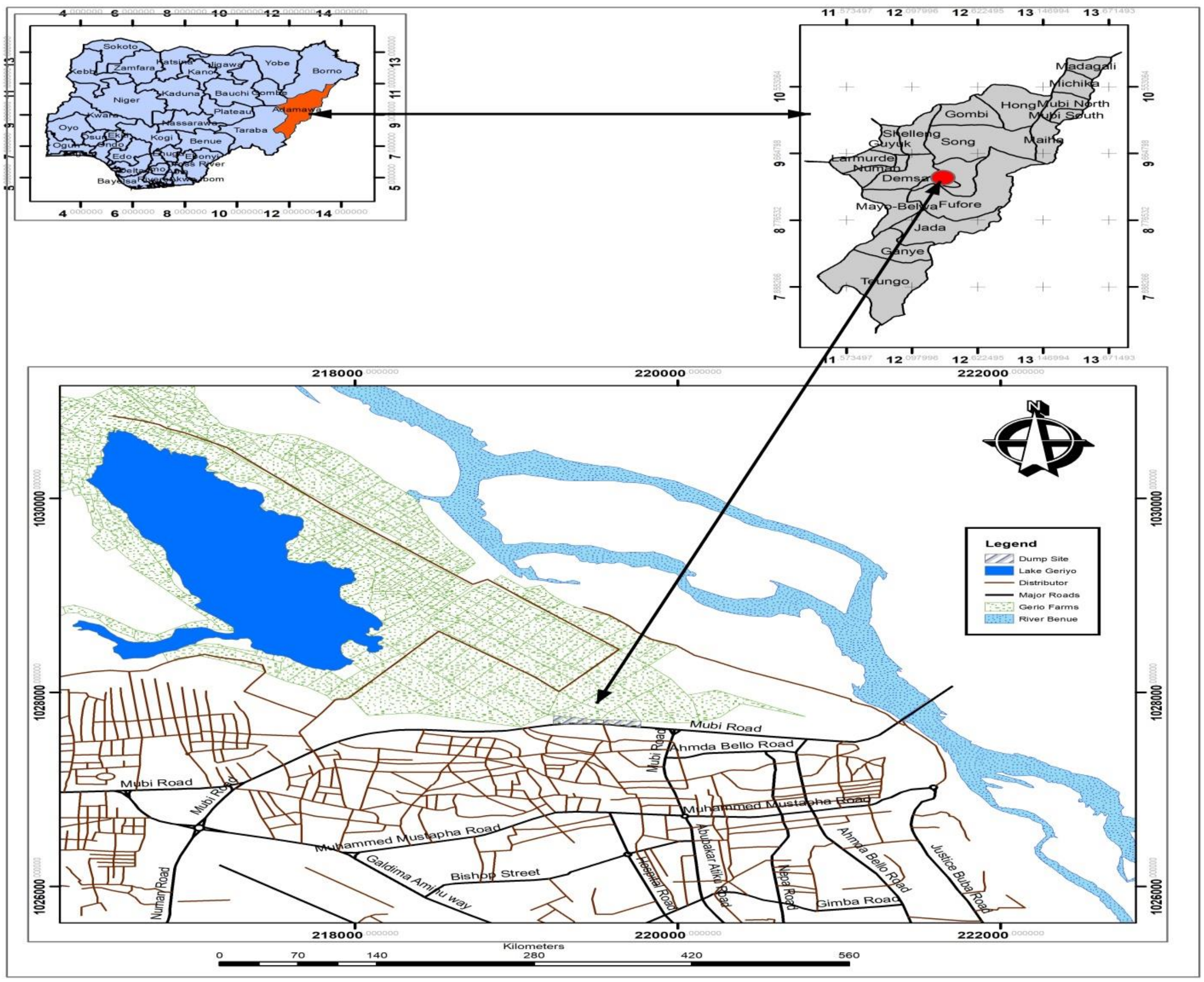

Figure1. Map of the study locations

2.2 Soil and Vegetable samples

A seasonal data on soil and plant were collected from the study area in November 2019 to March, 2020 and November 2020 to March 2021 at the irrigated farm site, in Jimata, Yola North, Nigeria.

Soils and vegetable samples were collected from the cropping sites adjacent to boreholes on the study area. Fifteen soil samples were randomly collected from the surface to a depth of approximately 15 cm. The fifteen samples were thereafter added together and thoroughly mixed, to create one composite. As with the soil, fifteen vegetable samples of lettuce *lettuca sativa* were from collected random locations on the cropping site after which the fifteen samples for vegetables were added together to create a single composite. After collecting the soil and vegetables, they were put in clean polythene bags and labeled. Thereafter, all samples were taken to the laboratory for preparation and analysis.

2.3 Laboratory Analysis

The Laboratory analysis were carried out at the Adamawa State University Soil Science and Chemistry Lab. The following parameters were analyzed; TDS, TH, Cl^-, CO_3^-, HCO_3, (titration method) [22] Ca, Mg, K, Na and heavy metals (As, Al, B, Cd, Cu, Cr, Fe, Mn, Zn,). Calcium and magnesium will be measured by EDTA titrimetric method. Chloride by standard AgNO3 titration and bicarbonate by titration with HCl. Sodium, potassium by flame photometer. Analyses for As, Al, B, Cd, Cu, Cr, Fe, Mn, Pb, Zn in soil and vegetable samples were carried out using Atomic Absorption Spectrophotometer (AAS) [8-9].

Risk Assessment Models

1. Transfer Factor (TF)

The results for soil and the bitter leaf were employed to determine the transfer factor (TF) as given in the following equation [10].

$$TF = \frac{[Heavy\ metals]vegetables\ \text{mg/kg}}{[Heavy\ metals]\times soil\ mg/l} \qquad (1)$$

Where $[Heavy\ metals]vegetables \frac{\text{mg}}{\text{kg}}$ = Concentration of heavy metal in bitter leaf

$[Heavy\ metals] \times soil \frac{mg}{l}$ = Concentration of heavy metal in soil.

2. Chronic Daily Intake (CDIing) via ingestion:

The result could be obtained using Equation (7) below.

$$Cdling = C_{soil} \times Ring \times EF \times \frac{ED}{BW} \times AT \times 10^{-6}$$

R = Rate of ingestion (100 mg/day in adult and 200 mg/day in children), EF = exposure frequency, ED = exposure duration (24 years in adults and 6 years in children), BW = body weight of the individual exposed (70 kg in adults, 15 kg in children), AT = averaging time in days (365 × ED adult/children).

Results and Discussions

Quality of soils in the study area as regards heavy metal presence

The safety of agricultural soil has a direct impact on the safety of food supplies; therefore, the safety of farmland soil is particularly vital to the maintenance of sustainable production. Soil heavy metal poisoning is a major source of concern in every industrialized country on the planet [25]. Heavy metal pollution not only has negative impacts on a variety of plant and yield-related metrics, but it also causes shifts in the size, composition, and activity of the community of microbes in an area. Heavy metal pollution is a major environmental problem [26]. As a consequence of these factors, heavy metals have become one of the primary contributors to soil pollution. Heavy metal pollution of the soil is caused by a number of metals, the most notable of which are copper, nickel, cadmium, zinc, lead, and lead compounds [25]. The detrimental impact that heavy metals have on the biological and biochemical features of soil has been the subject of a significant amount of research and documentation. The amount to which metals have an effect on the biological and biochemical qualities of organisms is significantly impacted by the properties of the soil, particularly its organic matter, clay content, and pH [27].

Heavy metals have a secondary effect on the enzymatic processes of soil by altering the composition of the microbial community, which is responsible for enzyme production [28]. Heavy metals have a harmful effect on the soil biota because they interfere with significant or critical microbial functions and reduce the number of soil microorganisms as well as their level of activity. The most typical form of heavy metal contamination in soils is found in composition of the microbial community, which is responsible for enzyme production [29]. Heavy metals have a harmful effect on the soil biota because they interfere with significant or critical microbial functions and reduce the number of soil microorganisms as well as their level of activity. The most typical form of heavy metal contamination in soils is found in [29]. Results in November 2019,

Table 1, and March 2020, Table 2, indicate that Al, As, and Pb are below detection levels. On the other hand, in November 2019, CD indicated the highest value of 0.310 mg/kg and the lowest value of 0.122 mg/kg, with a mean value of 0.01 mg/kg. In March 2020, Pb will indicate the highest value of 0.310 mg/kg. According to the threshold value established by the EU, which was not defined by FEPA, the levels of Cd found in soils are below the maximum concentrations that are necessary to be found in soils, which is 3 mg/kg. This evidence demonstrates that. According to the findings for CD in the month of March, the highest value was 0.277 mg/kg, the lowest value was 0.176 mg/kg, and the mean value was 0.08 mg/kg. The results show concentrations that are lower than the maximum levels permitted by FEPA and EU regulations.

In the month of November 2019, the mean value for Table 1 Zn was 0.464 mg/kg, with the highest value being 0.624 mg/kg and the lowest value being 0.274 mg/kg. This shows that the readings are lower than the maximum values advised by FEPA, which are between 300 and 400 mg/kg. The findings for the month of March 2020 are presented in Table 2, with the greatest value being 0.400 mg/kg and the lowest value being 0.176 mg/kg, and the mean being 0.309 mg/kg. Fe values In table 3, the maximum value is shown to be 1.325 mg/kg, while the lowest value is shown to be 1.075 mg/kg, and the mean value is shown to be 1.304 mg/kg. In the month of March, it ranged from a high of 1.281 mg/kg to a low of 1.085 mg/kg, with a value of 0.100 mg/kg serving as the average. The results for Fe indicate that they are lower than the maximum recommended limit of 400 mg/kg that is set by FEPA. In the month of November, the results for Cu indicate that the maximum value was 2.640 mg/kg, the lowest value was 0.154 mg/kg, and the mean value was 0.593 mg/kg. While in the month of March 2020, the value of Cu can range from as low as 0.098 mg/kg to as high as 0.500 mg/kg, with a mean of 0.186 mg/kg. The levels of copper were discovered to be significantly lower than the FEPA limit of 70–80 mg/kg and the EU maximum of 140 mg/kg. The lowest value for manganese in March was 0.087 mg/kg, while the greatest value for manganese in November was 0.315 mg/kg. The mean value for manganese in March was 0.037. The highest value for manganese in November was 0.315 mg/kg, while the lowest value was 0.045 mg/kg. It was discovered that all of the values for Fe, Cu, and Mn were lower than the concentrations observed in the FEPA and EU soils.

Table 1: Heavy metals in soil samples mg/kg in November 2019

	Al	As	Cr	Cd	Zn	Fe	Cu	Mn	Pb

1	BDL	BDL	BDL	0.221	0.624	1.325	0.220	0.300	BDL
2	BDL	BDL	BDL	0.301	0.575	1.175	2.640	0.090	BDL
3	BDL	BDL	BDL	0.188	0.473	1.075	0.154	0.045	BDL
4	BDL	BDL	BDL	0.310	0.575	1.325	0.242	0.315	BDL
5	BDL	BDL	BDL	0.122	0.375	1.500	0.308	0.030	BDL
6	BDL	BDL	BDL	0.156	0.274	1.435	0.374	BDL	BDL
7	BDL	BDL	BDL	0.200	0.410	2.100	0.396	0.406	BDL
8	BDL	BDL	BDL	BDL	0.525	1.125	0.418	BDL	BDL
9	BDL	BDL	BDL	BDL	0.402	1.225	0.462	BDL	BDL
10	BDL	BDL	BDL	BDL	0.425	1.225	0.488	BLD	BDL
11	BDL	BDL	BDL	BDL	0.410	1.210	0.524	BLD	BDL
12	BDL	BDL	BDL	BDL	0.540	1.184	0.411	BDL	BDL
13	BDL	BDL	BDL	BDL	0.474	1.227	0.473	BDL	BDL
14	BDL	BDL	BDL	BDL	0.410	1.210	0.395	BDL	BDL
15	BDL	BDL	BDL	BDL	0.473	1.223	0.419	BDL	BDL
Mean				0.010	0.464	1.304	0.528	0.079	
SD				0.119	0.091	0.246	0.593	0.139	

SD=Standard Deviation. BDL= Below Detection Level

Table 2: Heavy metals in soil samples mg/kg in March 2020

	Al	As	Cr	Cd	Zn	Fe	Cu	Mn	Pb
1	BDL	BDL	BDL	0.198	0.415	1.052	0.110	0.100	BDL
2	BDL	BDL	BDL	0.277	0.394	0.715	0.500	0.087	BDL
3	BDL	BDL	BDL	0.100	0.400	0.531	0.288	0.090	BDL
4	BDL	BDL	BDL	0.202	0.378	1.000	0.169	0.124	BDL
5	BDL	BDL	BDL	0.128	0.284	1.281	0.106	0.000	BDL
6	BDL	BDL	BDL	0.175	0.176	1.150	0.098	BDL	BDL
7	BDL	BDL	BDL	0.166	0.259	1.503	0.114	0.150	BDL
8	BDL	BDL	BDL	BDL	0.301	0.700	0.200	BDL	BDL
9	BDL	BDL	BDL	BDL	0.320	1.085	0.198	BDL	BDL
10	BDL	BDL	BDL	BDL	0.300	1.000	0.135	BLD	BDL
11	BDL	BDL	BDL	BDL	0.289	0.635	0.211	BLD	BDL
12	BDL	BDL	BDL	BDL	0.348	1.021	0.147	BDL	BDL
13	BDL	BDL	BDL	BDL	0.245	1.020	0.221	BDL	BDL
14	BDL	BDL	BDL	BDL	0.251	1.021	0.102	BDL	BDL

15	BDL	BDL	BDL	BDL	0.280	1.000	0.198	BDL	BDL
Mean				0.08	0.309	0.100	0.186	0.037	
SD				0.10	0.067	0.251	0.103	0.056	

SD=Standard Deviation. BDL= Below Detection Level

Table 3: Heavy metals in soil samples mg/kg in November 2020

	Al	As	Cr	Cd	Zn	Fe	Cu	Mn	Pb
1	BDL	BDL	BDL	0.239	0.630	1.400	0.242	0.345	BDL
2	BDL	BDL	BDL	0.314	0.590	1.190	1.321	0.130	BDL
3	BDL	BDL	BDL	0.195	0.570	1.184	0.354	0.100	BDL
4	BDL	BDL	BDL	0.349	0.585	1.398	0.342	0.335	BDL
5	BDL	BDL	BDL	0.146	0.566	1.540	0.319	0.100	BDL
6	BDL	BDL	BDL	0.177	0.542	1.476	0.384	BDL	BDL
7	BDL	BDL	BDL	0.234	0.535	2.154	0.352	0.455	BDL
8	BDL	BDL	BDL	BDL	0.547	1.150	0.479	BDL	BDL
9	BDL	BDL	BDL	BDL	0.541	1.260	0.489	BDL	BDL
10	BDL	BDL	BDL	BDL	0.544	1.300	0.499	BLD	BDL
11	BDL	BDL	BDL	BDL	0.540	1.245	0.540	BLD	BDL
12	BDL	BDL	BDL	BDL	0.550	1.200	0.502	BDL	BDL
13	BDL	BDL	BDL	BDL	0.540	1.260	0.485	BDL	BDL
14	BDL	BDL	BDL	BDL	0.541	1.259	0.412	BDL	BDL
15	BDL	BDL	BDL	BDL	0.540	1.278	0.431	BDL	BDL
Mean				0.112	0.557	1.353	0.477	0.098	
SD				0.131	0.026	0.248	0.248	0.154	

SD=Standard Deviation. BDL= Below Detection Level

In both November 2020 Table 3 and March 2021 Table 4, results reveal below-detection levels for Al, As, Cr, and Pb. In November, the highest CD values were 0.349 mg/kg and the lowest were 0.177 mg/kg, with a mean value of 0.112 mg/kg.In March 2021, results show CD's highest value at 0.349 and its lowest value at 0.146 mg/kg, with a mean value of 0.110 mg/kg. Zn values in November ranged from 0.473 to 0.248 mg/kg, with a mean of 0.333 mg/kg.In March, Zn results indicated a highest value of 0.389, a lowest value of 0.248 mg/kg, and a mean value of 0.276 mg/kg. Results for Fe in November show a highest value of 2.154 and a lowest value of 1.200

mg/kg, with a mean value of 1.353 mg/kg. The highest value was 1.511 mg/kg, and the lowest was 0.635 mg/kg, with a mean value of 1.041 mg/kg.

The values for Cu in November indicated a highest value of 0.540 and a lowest value of 0.242 mg/kg, with a mean value of 0.477 mg/kg. Mn values in November show a highest value of 0.345 and a lowest value of 0.100 mg/kg, with a mean value of 0.098 mg/kg. March results show the highest value of Mn to be 0.176 and the lowest value to be 0.102 mg/kg, with a mean value of 0.05 mg/kg. All values for Cd, Zn, Fe, Cu, and Mn exceeded the maximum recommended concentrations as described by FEPA and the EU.

Table 4 Heavy metals in soil samples mg/kg in March 2021

	Al	As	Cr	Cd	Zn	Fe	Cu	Mn	Pb
1	BDL	BDL	BDL	0.239	0.473	1.085	0.330	0.142	BDL
2	BDL	BDL	BDL	0.314	0.446	1.054	0.452	0.102	BDL
3	BDL	BDL	BDL	0.195	0.453	1.020	0.270	0.107	BDL
4	BDL	BDL	BDL	0.349	0.400	1.016	0.253	0.146	BDL
5	BDL	BDL	BDL	0.146	0.315	1.072	0.275	0.112	BDL
6	BDL	BDL	BDL	0.177	0.248	1.202	0.132	BDL	BDL
7	BDL	BDL	BDL	0.234	0.269	1.511	0.146	0.176	BDL
8	BDL	BDL	BDL	BDL	0.274	0.753	0.253	BDL	BDL
9	BDL	BDL	BDL	BDL	0.300	1.086	0.200	BDL	BDL
10	BDL	BDL	BDL	BDL	0.318	1.020	0.178	BLD	BDL
11	BDL	BDL	BDL	BDL	0.303	0.635	0.241	BLD	BDL
12	BDL	BDL	BDL	BDL	0.348	1.021	0.147	BDL	BDL
13	BDL	BDL	BDL	BDL	0.245	1.020	0.221	BDL	BDL
14	BDL	BDL	BDL	BDL	0.295	1.041	0.232	BDL	BDL
15	BDL	BDL	BDL	BDL	0.302	1.080	0.231	BDL	BDL
Mean				0.110	0.333	1.041	0.237	0.05	
SD				0.131	0.075	0.189	0.081	0.07	

SD=Standard Deviation. BDL= Below Detection Level

The levels of the heavy metals Al, As, Cd, Mn, and Pb found in lettuce (L. sativa) in March 2020 and March 2021 were below the detection threshold (Table 5 and table

6). The data show that the greatest value of zinc in March 2020 was 0.192 mg/kg, while the lowe st value was 0.047 mg/kg, and the mean value was 0.045 mg/kg (Table 5).

Table 5: Heavy metal in Lettuce (*latuca sativa*) mg/kg in March 2020.

	Al	As	Cr	Cd	Zn	Fe	Cu	Mn	Pb
1	BDL	BDL	BDL	BDL	0.100	0.387	0.323	BDL	BDL
2	BDL	BDL	BDL	BDL	0.129	0.365	0.301	BDL	BDL
3	BDL	BDL	BDL	BDL	0.121	0.354	0.311	BDL	BDL
4	BDL	BDL	BDL	BDL	0.111	0.314	0.323	BDL	BDL
5	BDL	BDL	BDL	BDL	0.187	0.300	0.315	BDL	BDL
6	BDL	BDL	BDL	BDL	0.192	0.321	0.344	BDL	BDL
7	BDL	BDL	BDL	BDL	0.134	0.195	0.343	BDL	BDL
8	BDL	BDL	BDL	BDL	0.100	0.187	0.358	BDL	BDL
9	BDL	BDL	BDL	BDL	0.060	0.124	0.198	BDL	BDL
10	BDL	BDL	BDL	BDL	0.057	0.112	0.100	BLD	BDL
11	BDL	BDL	BDL	BDL	0.056	0.100	0.111	BLD	BDL
12	BDL	BDL	BDL	BDL	0.055	0.098	0.121	BDL	BDL
13	BDL	BDL	BDL	BDL	0.098	0.098	0.115	BDL	BDL
14	BDL	BDL	BDL	BDL	0.047	0.097	0.132	BDL	BDL
15	BDL	BDL	BDL	BDL	0.098	0.100	0.104	BDL	BDL
Mean					0.103	0.327	0.233		
SD					0.045	0.283	0.107		

SD=Standard Deviation. BDL= Below Detection Level

In the month of March 2021, the value of zinc ranged from its highest point of 0.206 mg/kg to its lowest point of 0.088 mg/kg, with a mean value of 0.103 mg/kg (Table 6). All of the Zn readings that were measured in March 2020 and March 2021 were lower than the maximum allowable limits established by the FAO and WHO for heavy metals in vegetables, which are set at 99.40 mg/kg. The results for Fe in March 2020 are presented in Table 5, and they suggest a mean value of 0.283 mg/kg, with a maximum value of 0.387 mg/kg and a minimum value of 0.097 mg/kg. Results for the month of March 2021 show that the maximum value for Fe was 0.425 mg/kg, the lowest value was 0.075 mg/kg, and the mean value was 0.121 mg/kg (Table 6). The FAO and WHO stated that the Fe values were not set in stone. For the month of March 2020, the Cu values range from a high of 0.358 mg/kg to a low of 0.100 mg/kg, with a value of 0.107 mg/kg serving as the average (Table 5). In the month of March 2021, the value of Cu ranged from its maximum of 0.425 mg/kg to its lowest of 0.145 mg/kg, with a mean value of 0.111 mg/kg (Table 6). The findings indicate that the readings are lower than the maximum allowable limits established by the FAO and WHO in 2013. The findings indicate that the lettuce can be consumed by humans in the respective region without risk.

Table 6: Heavy metal in Lettuce (*latuca sativa*) mg/kg in March 2021

	Al	As	Cr	Cd	Zn	Fe	Cu	Mn	Pb
1	BDL	BDL	BDL	BDL	0.130	0.425	0.376	BDL	BDL
2	BDL	BDL	BDL	BDL	0.206	0.375	0.355	BDL	BDL
3	BDL	BDL	BDL	BDL	0.145	0.379	0.352	BDL	BDL
4	BDL	BDL	BDL	BDL	0.133	0.355	0.367	BDL	BDL
5	BDL	BDL	BDL	BDL	0.215	0.317	0.345	BDL	BDL
6	BDL	BDL	BDL	BDL	0.200	0.364	0.418	BDL	BDL
7	BDL	BDL	BDL	BDL	0.166	0.225	0.407	BDL	BDL
8	BDL	BDL	BDL	BDL	0.134	0.201	0.425	BDL	BDL
9	BDL	BDL	BDL	BDL	0.097	0.188	0.220	BDL	BDL
10	BDL	BDL	BDL	BDL	0.088	0.075	0.179	BLD	BDL
11	BDL	BDL	BDL	BDL	0.094	0.131	0.155	BLD	BDL
12	BDL	BDL	BDL	BDL	0.093	0.129	0.227	BDL	BDL
13	BDL	BDL	BDL	BDL	0.102	0.115	0.175	BDL	BDL
14	BDL	BDL	BDL	BDL	0.087	0.120	0.171	BDL	BDL
15	BDL	BDL	BDL	BDL	0.105	0.128	0.145	BDL	BDL
Mean					0.185	0.235	0.285		

SD	0.194	0.121	0.111

SD=Standard Deviation. BDL= Below Detection Level

3.2 Assessment of Transfer Factor (TF) for Heavy Metals in vegetables (Lettuce (*latuca sativa*).

3.2.1: Transfer Factor (TF)

The Transfer factor (TF) for only Cr, Fe, and Mn were estimated, because, the remaining heavy metal are measured below detection level. The transfer factors for *latuca sativa* were estimated for March 2020 and March 2021. Has shown in table 7 *latuca sativa* (mg/kg) recorded the highest TF value of Fe (14.43425; 14.51064) estimated in *latuca sativa* for both March 2020 and March 2021 respectively. TF for Cr in Lettuce sativa (mg/kg) in March 2020 and 2021 recorded 0.09708 and 0.054 respectively. According to Kumar et al. [26], high values *TF* indicate low retention capacity. Similarly, *TF* above 1 indicates hyper-accumulation, especially in soils, according to Eze and Ekanem [27], but values of 0.1 indicated that plant was excluding metals from its tissues, while the *TF* values of 0.2 indicated the probability of metal contamination by anthropogenic activities [28]. The *TF* values obtained from studied *latuca sativa* showed indications of poor accumulation of heavy metals (specifically Fe and Zn) in vegetable, suggesting affinity of metal to the soil colloids, hence preventing vegetable from entry into the metals [29]. The relatively low *TF* result obtained for vegetables in this study is consistent with earlier finding by [30], for most plants species. Similarly, Fe are plant essential elements, and most plants have the potential to keep them [31]. The occurrence of heavy metals in the ecosystem is catastrophic to plant and organisms, including humans, as a result of their bio-accumulating tendency and toxicity [32].

Table 7: Transfer Factor for Latuca Sativa(mg/kg)

Heavy Metals	**Transfer Factor** **March. 2020**	**March. 2021**
As	BDL	BDL
Al	BDL	BDL
B	BDL	BDL
Cd	BDL	BDL
Cr	0.0970874	0.0054054
Fe	14.434251	14.510638
Mn	1.2017167	1.2035088

Zn	BDL	BDL
Pb	BDL	BDL

BDL= Below Detection Level

3.2.2 Chronic Daily Intake (CDIing) for Lettuce *Latuca Sativa* in Adults and Children

Table 8 shows that adults have the least CDIing values in all the stations compared to those of the children in the agricultural soil. These values were also lower than those recorded for Zn, Fe, and Cu [33]. The acceptable range for CDIing is 10^{-6}–10^{-4} which showed that most values obtained for both children and adults fell above range. The chronic daily intake dose was also the heavy metal intake of noxious substances during the exposure period [33]. The chronic and acute health effect on ingestion of Cd and Ni as they accumulate in living bodies cannot be over-emphasized [34, 35]. This may be attributed to anthropogenic inputs as corroborated in similar research studies [36, 37].

Table 8: CDIing for Lettuce Latuca Sativa in both adults and children.

Heavy Metals	*CDIing*			
	Adults		Children	
	March 2020	March 2021	March 2020	March 2021
Zn	3.09×10^{-7}	5.556×10^{-7}	1.804×10^{-9}	3.24×10^{-9}
Fe	9.82×10^{-7}	7.12×10^{-7}	5.73×10^{-9}	4.12×10^{-9}
Cu	7.00×10^{-7}	8.56×10^{-7}	4.08×10^{-9}	4.99×10^{-9}

4. Conclusions

The study reveals that heavy metals (AS, AL, B, Cd and Zn), recorded in the soil recorded an average of below detection thresholds, as such were within allowable range set by European Union. Heavy metal concentration in Lettuce Latuca Sativa, recorded across seasons were within allowable maximum range sets by FAO and WHO, as such there are safe for human consumption. However, Fe records shows an average above detection threshold level of 1.353mg/l. There is an urgent need for systemic monitoring in order to determine the actual concentration which might have related negative effects on humans and plant. Also, anthropogenic activities around and which the study area, such as e-waste disposal needs to be studied. Heavy metal absorption through other routes other than ingestion should be evaluated.

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