HEALTH RISK ASSESSMENT OF HEAVY METALS IN OKRA (Abelmosclus esculentus) AND RED PEPPER (Capsicum anuum) GROWN WITHIN SOME DUMPSITES IN SAPELE TOWN, DELTA STATE

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Abstract – This study was carried out to assess the uptake of heavy metals (Cd, Ni, Pb, Fe and Zn) by okra (Abelmosclus esculentus) and red pepper (Capsicum anuum) grown within and around three dumpsites located in Sapele, Delta State and to also determine the possible health hazards associated with the consumption of such vegetable crops. Soil and plant samples were collected and subjected to laboratory analysis to determine the concentration of heavy metals using Atomic Absorption Spectrophotometer (AAS). The heavy metal concentrations recorded in the soil samples were above the maximum permissible limits, except Ni and Pb which were below the limits reported by WHO and EU). The mean Cd, Ni, Pb, Fe and Zn concentrations in the okra and red pepper samples across all the sampling sites were determined and the data was subjected to statistical test of significance using one way ANOVA at ($p < 0.05$) to determine whether there was any significant difference in the heavy metals present in the vegetable samples between the study sites. The concentration of heavy metal in the vegetables was in the order; Fe > Zn > Pb > Cd > Ni and were above the maximum permissible limits, except Ni and Fe that were below this limits set by WHO. The transfer factors (TF) recorded were (< I) with Zn having the highest TF value of 0.556. Risk assessment in terms of daily intake of metals gave DIM value for Cd and Pb greater than the maximum oral reference dose (RFD) as established by EPA-IRIS and the health risk index (HRI) recorded for Cd and Pb were (>1) with the highest HRI value of 4.8350 and 2.3145 respectively, indicating a potential health risk to consumers for the continuous consumption of vegetables grown within and around the studied dumpsites over time.

Keywords: Assessment, waste dumpsite, vegetables, heavy metals, health risk

1.0 Introduction

During the last three decades, increasing demand for food safety has stimulated research regarding risks associated with consumption of food stuffs contaminated by pesticides, heavy metals and toxins. The increasing trends in food contamination in urban areas are largely attributed to polluted environment in urban agriculture, contaminated food handling, poor market sanitary and use of contaminated waste water for irrigation [1]. Heavy metal contamination of vegetable crops cannot be underestimated, because these foodstuffs are important components of human diet.

The bioaccumulation of heavy metals is a major route through which increased levels of pollutants are transferred across the food chain [2]. The presence of heavy metals in the ecosystem has far reaching implications directly to the soil and indirectly to man. It has been reported that vegetable crops have high ability to accumulate toxic metals at a very high concentration from the environment, which may pose serious health challenge to human health when they are grown on or near contaminated areas and consumed. These metals are very harmful because of their non-biodegradable nature, long biological half-life and their potential to accumulate in different body parts [3]. Their toxicity can result to cancer, diarrhea, incurable vomiting, and damage to other neurological organs [4]. Even at low concentrations, heavy metals can also be toxic because there is no good mechanism for their elimination from the body when ingested particularly in elevated concentrations above the very low body requirements. The health risk associated with heavy metal contamination depends upon the chemical composition of the waste materials, its physical characteristics, and types of vegetables cultivated and the rate of consumption [5].

Most waste dumpsites and abandoned waste dumpsites in many towns and villages are still used as fertile grounds for the cultivation of varieties of vegetable crops with little regard to the probable health hazard the heavy metal content of such soils may pose [6].

Due to the potential toxicity and persistent nature of heavy metals and the frequent consumption of vegetable crops, it is necessary to analyze vegetable crops cultivated on contaminated soils in order to ascertain if the level of

this contaminant is within limits acceptable by international organization for food quality and safety [7].
The aim of this study is to evaluate the uptake of the heavy metals (Cd, Ni, Pb, Fe and Zn) by okra (*Abelmosclus esculentus)* and red pepper (*Capsicum anuum*) vegetable crops cultivated within and around some selected waste dumpsite soils in Sapele town, and to estimate the daily intake of the heavy metals from the vegetables crops in human diets and to determine the potential health risk of these heavy metals ingested by the local residents.

1.1 Study Area

This study was carried out at three different waste dumpsites namely; Ogodo road waste dumpsite, borrow pit waste dumpsite Ugberikoko road and Ogorode road dumpsite , all within Sapele in Sapele Local Government Area, Delta State, Nigeria.
Sapele is located in latitude 5.89° north of the equator, and longitude 5.68° east of the Greenwich meridian and 33 meters elevation above the sea level, and covers an approximate area of 450 km². Sapele is a big town in Delta state with a population of 174,273 and a projected population of about 240,000 by the year 2016 [8].

Figure 1: Location Map showing the Sampled Points

The choice of the study area was chosen because the local residents are attracted to the waste dumpsites for the cultivation of vegetable crops for consumption.

2.0 Materials and Methods

2.1 Sample Collection and Treatment

Sample collection was done in July 2017, at the Ogodo road waste dump site; borrow pit waste dumpsite Ugberikoko road and Ogorode road waste dumpsite, all within Sapele, Delta State Nigeria.
Three plots measuring approximately 4m² were established on each of the dumpsites, 20 meters away from the dumpsites and that of the control site. Okra (*Abelmosclus esculentus*) and Red pepper (*Capsicum anuum)* seedlings were bought from the local market and were planted on each plot. The crops were properly nurtured, the okra and red pepper vegetables were harvested at maturity after 127days (4 months and one week) and 95 days (3 months and 5 days) respectively.

A total of 127 okra and 145 red pepper fruits were collected and soil samples were also collected from the same spots at a depth of 15 cm, where the crop samples were earlier collected. The 0 -15 cm depth was considered to

represent the plough layer and average root zone for nutrients and heavy metals uptake by plant roots [9]. The samples were put in a well labeled polyethylene bags and transported to the laboratory for analysis.
The vegetable samples were cut with stainless knife and air dried for 24 hours and then oven dried at 70℃ until stable weight was obtained. The dried vegetable samples were ground with ceramic mortar and pestle and passed through a 0.5 mm sieve. The ground samples were then stored in well labeled plastic containers for analysis.
The soil samples were air dried for 2 days and oven dried at 105°C for 24 hours in order to remove any possible moisture, the dried soil samples were crushed, passed through a 0.5 mm sieve, put in well labeled polyethylene bags and stored for laboratory analysis.

2.2 Analysis of Heavy Metal Content in Soil Samples

All glass and non-glass apparatus used in this analysis were washed with deionized water and immersed in 2% nitric acid (HNO_3) for 24 hours to prevent heavy metal contamination. Glass wares used throughout the analysis had no metal liners that could contaminate the samples and reagents were of analytical grade. Deionized water was used throughout the sample preparation and analysis [10].
Triplicate samples of 1.0 g of the dried and sieved soil samples were digested with 25 ml of a 3:1 mixture of aqua regia (HNO_3–HCl) at 120 °C using corning Pc-351 model hot plate in a fume cupboard until the brown fumes were totally removed and a clear solution was obtained. The digested samples were filtered through 0.45 micron Whatmann ashless qualitative filter paper into a 100 ml volumetric flask and made up to the mark with distilled water. The filtrate was transferred into well labeled clean dry plastic containers for heavy metal concentration analysis.
The concentrations of the heavy metals in the digested soil samples were determined using Buck scientific VGP 210 Atomic Absorption Spectrophotometer [11]. The metals analyzed in the soil samples were; Cd, Ni, Pb, Fe and Zn.

2.3 Analysis of Heavy Metal Content in the Vegetable Samples

Triplicate (1.0 g) of the sieved vegetable samples were weighed into different conical flasks and treated with 25 ml of a 3:1 mixture of aqua regia (HNO_3–HCl) and then digested at 110 °C using corning Pc – 351 model hot plate in a fume cupboard until a clear solution was obtained. The digested samples were left to cool and then filtered using 0.45 micron Whatmann ashless qualitative filter paper into a 100 ml volumetric flask and made up to the mark with distilled water. The filtrate was transferred into well labeled clean dry plastic containers for heavy metal content analysis. The concentration of the metals in the digested vegetable crop samples was determined using the buck scientific VGP 210 Atomic Absorption Spectrophotometer [11]. The metals analyzed for in the vegetable samples were; Cd, Ni, Pb, Fe and Zn.

2.4 Transfer Factor

Transfer factor (T_F) is the ratio of the concentration of heavy metals in a plant to the concentration of heavy metals in the soil. The Transfer factor (T_F) of the metals (Cd, Pb, Ni, Fe and Zn) from the dump site soil to the plant was calculated using the formula;

$$T_F = \frac{C_{PLANT}}{C_{SOIL}}$$

Where:
C_{PLANT} = Concentration of heavy metal in plant
C_{SOIL} = Concentration of heavy metal in soil [12].

Higher transfer factor reflects relatively poor retention in soils or greater efficiency of vegetables to absorb metals, while low transfer factor reflects the strong sorption of metals to the soil colloids.

2.5 Daily Intake of Metals (D.I.M)

The daily intake of heavy metals from vegetables consumed by the local residents was estimated and compared with those given by international organization for food quality and safety. The daily intake of metals (D.I.M) was calculated using the equation provided [13].

$$D.I.M = \frac{(C_{metal} \times C_{factor} \times D_{food\ intake})}{B_{average\ weight}}$$

Where:
D.I.M = Daily intake of metals (mg/kg)

C_{metal} = Heavy metal concentration in vegetable (mg/kg)
C_{factor} = conversion factor = 0.085. The ratio is used to convert fresh vegetable wet weight to dry vegetable
$D_{food\ intake}$ = daily intake of vegetable
$B_{average}$ weight = average weight of a person in kg.
For the purpose of this study, the average daily intake of vegetable was 0.527 kg per person/day and the average body weight for an adult population was 55.5 kg: these values were also used for the calculation of HRI as well. The D.I.M values estimated according to the average vegetable consumption for adult was compared with the recommended daily intake [7].

2.6 Health Risk Index (HRI)

By using the daily intake of metals (D.I.M) and reference oral dose, we obtain the health risk index. The following formula was used for the calculation of health risk index (HRI).

$$HRI = \frac{DIM}{R_f D}$$

If the value of HRI is less than 1, then the exposed population is said to be safe [7].

2.7 Statistical Data Analysis

Analysis using one way analysis of variance (ANOVA) was carried out to examine the statistical significant differences in mean concentration of heavy metals in vegetables (okra and red pepper) cultivated on different waste dumpsites using SPSS version 16. A probability level of $P<0.05$ was considered significant.

3.0 Results

3.1 Concentration of Heavy Metals in Soil Samples

The mean concentrations of cadmium, Nickel, lead, Iron, and zinc in the soil samples from the study and control sites were presented in Tables 1-3.

Table 1: Heavy metal concentration (mg/kg) in waste dumpsite and control soils.

Element	Ogodo road		Borrow pit		Ogorode road		control
	Soil(A)	Soil(B)	Soil(C)	Soil(D)	Soil(E)	Soil(F)	Soil(CT)
Cd	12.15 ± 0.04	13.88±0.04	15.46 ± 0.05	17.16± 0.03	6.34± 0.05	4.67 ± 0.10	0.63 ± 0.02
Ni	7.14± 0.03	5.33± 0.05	10.02 ± 0.03	7.31± 0.04	8.63± 0.09	7.11 ± 0.16	1.30 ± 0.04
Pb	30.70 ± 0.04	34.27±0.02	27.51 ± 0.07	44.05± 0.04	45.23 ± 0.03	56.06 ± 0.03	7.96 ± 0.01
Fe	1118.33 ± 0.05	981.14 ± 0.04	1200.00 ± 1.96	866.11 ± 0.06	1346.70 ± 0.16	975.90 ± 0.04	714.29 ± 0.15
Zn	163.05± 0.02	133.31 ± 0.08	105.85 ± 0.07	87.86± 0.09	121.28 ± 0.10	103.87 ± 0.10	45.71 ± 0.17

The alphabet in the parenthesis (A, B, C, D, E and F) indicates the location where the soils were collected.
A and B – Soil collected from Ogodo road dumpsite and 20 meters away from the dumpsite respectively.
C and D - Soil collected from Borrow pit road dumpsite Ugberikoko road and 20 meters away from the site respectively.
E and F - Soil collected from Ogorode road dumpsite Ugberikoko road and 20 meters away from the dumpsite respectively.
CT – Soil collected from control site.

3.2 Concentration of Heavy Metals in Vegetable Samples

3.2.1 Concentration of Heavy Metals in okra Samples

The concentration of heavy metals in the okra samples grown in the dumpsites and 20 meters away from the dumpsites and the control site were presented in Table 3.

Table 3: Heavy metal concentration in okra grown on the dumpsite and control site.

Element	Ogodo road		Borrow pit		Ogorode road		Control
	Okra(1)	Okra(2)	Okra(3)	Okra(4)	Okra(5)	Okra(6)	Okra(CT)
Cd	2.73 ±0.02	4.35 ± 0.05	4.16 ± 0.03	5.99 ± 0.08	2.37 ± 0.06	3.16 ±0.03	0.02 ±0.01
Ni	1.17 ±0.02	0.80 ± 0.02	2.99 ± 0.09	1.18 ± 0.02	2.04 ± 0.03	0.93 ±0.05	0.30 ±0.02
Pb	5.58 ±0.03	5.94 ± 0.04	4.60 ± 0.07	6.94 ± 0.03	9.28 ± 0.04	11.47 ±0.04	1.52 ±0.04
Fe	157.74 ±0.04	128.75 ±0.03	148.72 ±0.06	131.32 ± 0.09	187.51 ± 0.06	107.13 ±0.05	73.50 ±0.08
Zn	75.03 ± 0.02	44.78 ±0.12	38.85 ± 0.08	23.53 ± 0.03	49.97 ± 0.04	57.79 ± 0.03	13.25 ±0.13

3.2.2 Concentration of Heavy Metals in red pepper Samples

Table 4: Heavy metal concentration in red pepper grown on the dumpsite and control site.

Element	Ogodo road		Borrow pit		Ogorode road		Control
	R. pepper (1)	R. pepper (2)	R. pepper (3)	R. pepper (4)	R. pepper (5)	R. pepper (6)	R. pepper (CT)
Cd	0.60 ±0.01	0.78 ± 0.03	1.33 ±0.02	2.07 ±0.02	1.01 ±0.02	0.58 ±0.02	0.01 ± 0.00
Ni	0.94 ±0.02	0.41 ± 0.01	1.32 ±0.02	0.92 ±0.05	1.04 ± 0.02	0.61 ±0.03	0.03 ± 0.01
Pb	2.36 ±0.03	2.67 ± 0.06	1.75 ±0.07	2.98 ±0.02	3.30 ± 0.03	5.03 ±0.04	0.08 ± 0.02
Fe	138.76 ±0.19	113.88 ±0.03	109.58 ±0.04	88.01 ±0.03	120.31 ±0.10	99.19 ±0.04	44.30 ±0.23
Zn	62.27 ±0.09	27.88 ± 0.07	22.24 ± 0.06	19.82 ±0.14	39.18 ± 0.59	42.74 ± 0.06	10.60 ±0.33

The value (1, 2, 3, 4, 5 and 6) in parenthesis indicates the location where the vegetables were collected
1 and 2 – vegetable collected from Ogodo road dumpsite and 20 meters away from the site respectively
3 and 4 – vegetable collected from Borrow pit road dumpsite Ugberikoko road and 20 meters away from the site respectively.
5 and 6 – vegetable collected from Ogorode road dumpsite Ugberikoko road and 20 meters away from the site

respectively.
CT – vegetable collected from control site.

3.2.3 Soil - Plant Transfer Factor

The soil to plant transfer factors for the vegetable samples were determined and presented in Table 5.

Table 5: Transfer Factor (TF) of heavy metal from dumpsite soil to okra and red pepper

Sites	Sample	Cd	Ni	Pb	Fe	Zn
Ogodo road	Okra (1)	0.225	0.164	0.182	0.141	0.460
	Okra (2)	0.313	0.150	0.173	0.131	0.336
	Red pepper(1)	0.049	0.132	0.077	0.124	0.382
	Red pepper (2)	0.056	0.077	0.078	0.116	0.209
Borrow pit	Okra (3)	0.269	0.298	0.167	0.124	0.367
	Okra (4)	0.349	0.161	0.158	0.152	0.268
	Red pepper (3)	0.086	0.132	0.167	0.091	0.210
	Red pepper (4)	0.121	0.126	0.068	0.102	0.226
Ogorode road	Okra (5)	0.374	0.236	0.205	0.139	0.412
	Okra (6)	0.477	0.131	0.205	0.110	0.556
	Red pepper (5)	0.159	0.120	0.073	0.089	0.323
	Red pepper (6)	0.124	0.086	0.089	0.102	0.412
Control	Okra (CT)	0.032	0.231	0.191	0.103	0.290
	Red pepper (CT)	0.016	0.023	0.010	0.062	0.232

3.2.4 Daily Intake of Metals (DIM)

The daily intake of metals from the vegetables were determined and presented in Table 6.

Table 6: Daily intake of metals (mg/person/day) from the Vegetables

Sites	Sample	Cd	Ni	Pb	Fe	Zn
Ogodo road	Okra (1)	0.002203	0.000944	0.004504	0.127315	0.060558
	Okra (2)	0.003511	0.000646	0.004794	0.103916	0.036143
	R. pepper (1)	0.000484	0.000759	0.001905	0.111996	0.050259
	R. pepper (2)	0.000630	0.000331	0.002155	0.091915	0.022502
Borrow pit	Okra (3)	0.003358	0.002413	0.003713	0.120035	0.031357
	Okra (4)	0.004835	0.000952	0.005601	0.105991	0.018992
	R. pepper (3)	0.001073	0.001065	00.001412	0.088444	0.017950
	R. pepper (4)	0.001671	0.000743	0.002405	0.071034	0.015997
Ogorode road	Okra (5)	0.001913	0.001647	0.007490	0.151343	0.040332
	Okra (6)	0.002550	0.000751	0.009258	0.086466	0.046643
	R. pepper (5)	0.000815	0.000839	0.002663	0.097104	0.031623
	R. pepper (6)	0.000468	0.000492	0.004060	0.080058	0.034496
Control	Okra (CT)	0.000016	0.000242	0.001227	0.059323	0.010694
	R. pepper(CT)	0.000008	0.000024	0.000065	0.035755	0.008553

3.2.5 Health Risk Index

The health risk indices for the metals through the consumption of the vegetables were determined and presented in Table 8.

Table 8: Health Risk Index (HRI) of heavy metal in Vegetable

Site	Sample	Cd	Ni	Pb	Fe	Zn
Ogodo road	Okra (1)	2.2030	0.0472	1.1260	0.1819	0.2019
	Okra (2)	3.5110	0.0323	1.1985	0.1485	0.1205
	R. pepper (1)	0.4840	0.0380	0.4763	0.1599	0.1675
	R. pepper (2)	0.6300	0.0166	0.5388	0.1313	0.0750
Borrow pit	Okra (3)	3.3580	0.1207	0.9283	0.1715	0.1045
	Okra (4)	4.8350	0.0476	1.4003	0.1514	0.0633
	R. pepper (3)	1.0730	0.0533	0.3530	0.1263	0.0598
	R. pepper (4)	1.6710	0.0372	0.6013	0.1015	0.0533
Ogorode road	Okra (5)	1.9130	0.0824	1.8725	0.2162	0.1344
	Okra (6)	2.5500	0.0376	2.3145	0.1235	0.1555
	R. pepper (5)	0.8150	0.0420	0.6658	0.1310	0.1054
	R. pepper (6)	0.4680	0.0246	1.0150	0.1144	0.1150
Control	Okra (CT)	0.0160	0.0121	0.3068	0.0848	0.0356
	R. pepper(CT)	0.0080	0.0012	0.0163	0.0511	0.0285

Discussion

From Table 1, the concentration of heavy metal in the soil samples from the study area ranged from 4.67± 0.10 to 17.16 ± 0.03 mg/kg for Cd, 5.33 ± 0.05 to 10.02 ± 0.03 mg/kg for Ni, 27.51 ± 0.07 to 56.06 ± 0.03 mg/kg for Pb, 866.11 ± 0.06 to 1346.79 ± 0.16 mg/kg for Fe and 87.86 ± 0.09 to 163.05 ± 0.02 mg/kg for Zn. Table 2 indicates that, the concentration of cadmium, Iron and Zinc recorded in the soil samples were above the maximum permissible limit as reported [15], while that recorded for lead and nickel were below these limits. The high concentration of cadmium, Iron and Zinc may be attributed to the indiscriminate disposal of sewages, municipal and industrial wastes into the study area which contains large amounts of these heavy metals.

Table 2: WHO Permissible Limits for heavy metals in soil and plants

Element	Limit for soil (mg/kg)	Limit for plant (mg/kg)
Cd	0.80	0.02
Ni	35.00	10.00
Pb	85.00	2.00
Fe	150.00	425.00
Zn	50.00	0.60

Source: [14]

The concentration of heavy metals in the vegetables varied between the study area and the vegetable species. The results from the one way ANOVA revealed that Cd, Ni, Pb and Zn had significant difference in the okra grown among the sampling sites, while Fe had no significant difference in the okra. For the red pepper grown among the sampling sites, Ni, Pb and Zn had significant differences, while Cd and Fe had no significant difference. The mean concentration of heavy metals recorded in okra ranges from 2.37 ±0.06 to 5.99 ± 0.08 mg/kg for Cd, 0.80 ± 0.02 to 2.99 ± 0.09 mg/kg for Ni, 4.60 ± 0.07 to 11.47 ± 0.04 mg/kg for Pb, 107.13 ± 0.05 to 187.51 ± 0.06 mg/kg for Fe and 23.53 ± 0.03 to 75.03 ± 0.02 mg/kg for Zn, while that recorded for red pepper ranges from 0.58 ± 0.02 to 2.07 ± 0.02, 0.41 ±0.01 to 1.32 ± 0.02, 1.75 ± 0.07 to 5.03 ± 0.04, 88.01 ± 0.03 to 138.76 ± 0.19 and 19.82 ± 0.14 to 62.27 ± 0.09 mg/kg for Cd, Ni, Pb, Fe and Zn respectively.

The concentration of Cd, Pb and Zn recorded in the vegetable samples exceeded the maximum permissible limit [14], while that recorded for Ni and Fe in the vegetables were below these safe limits (Table 2). Cadmium and

Lead were the main pollutants which made the vegetables unfit for human consumption. Cadmium and Lead both in the okra and red pepper from all the study sites exceeded the maximum safe limits. The high concentration of these metals in the vegetables could be attributed to the indiscriminate disposal of sewage, industrial waste, agricultural waste and municipal waste into the study area which contains large amount of these metals in cadmium – lead batteries, tyres, electronic devices, ceramics, plastics, etc. The concentration of heavy metals as detected in the vegetable samples follows the sequence; Fe > Zn > Pb > Cd > Ni. The concentration of Cd, Ni, Pb, Fe, and Zn recorded in the vegetable samples from the control site was below the maximum permissible limit. The result reported in this study was similar to the report made elsewhere [15]. The findings in this study were also similar to other research [16].
The Transfer Factor (TF) of heavy metal from dumpsite soil to okra and red pepper recorded (Table 5) were less than 1(<1) for all the heavy metals studied. The highest T_F value was 0.556 and 0.477 for Zn and Cd respectively in the okra. This might be due to higher mobility of these heavy metals in the soil [17], and low retention of Cd and Zn by the soil [12].

The daily intake of metals from the vegetables as determined (Table 6) shows that Cd and Pb recorded for okra and red pepper from the consumption of the vegetables were above the maximum oral reference dose (R_fD) limit. While the daily intake of the metals Ni, Fe and Zn were within the safe limit set [7].
The reference oral dose (RFD) of selected metals was presented in Table 7.

Table 7: Reference Oral Dose (RFD) of some selected metals

S/No	Metal	RFD (mg/kg/day)
1	Cadmium	0.001
2	Nickel	0.020
3	Lead	0.004
4	Iron	0.700
5	Zinc	0.300

Source: [7].

The results in Table 8 reveals that the health risk indices (HRI) values recorded for Cd and Pb through the consumption of the vegetables was greater than 1 (> 1), with the highest HRI value of 4.8350 and 2.3145 for Cd and Pb respectively in okra. Thus, indicating possible future health hazard to the consumer on continuous consumption of the okra. The HRI value estimated for Ni, Fe, and Zn in the vegetables was less than 1(<1), indicating that the consumer may not be in any health danger of Ni, Fe and Zn via the consumption of okra in the study area. A similar result was obtained [18], where the potential human health impact associated with the consumption of okra contaminated with toxic heavy metals was investigated.

Conclusion

The result of this study reveals high level of heavy metal (Cd, Ni, Pb, Fe and Zn) in the soil samples from within and around the dumpsites which exceeded the maximum recommended safe limit. Ni and Pb were found to be below the safe limit. The concentration of heavy metal determined in the soil samples were in the order; Fe > Zn > Pb > Cd > Ni. The results also revealed high level of the metals in the vegetable samples across the sampling sites which were above the maximum permissible limit. However, the concentration of Fe and Ni were found below the permissible limit. It was found that Fe had the highest concentration, while Ni had the lowest concentration in the vegetables grown within and around the dumpsites. It was further established that the level of heavy metals was higher in the soil samples than in the vegetable samples.

The soil – plant transfer ratio (TF) was less than unity (<1) for all the heavy metals studied in the vegetable samples. The results also indicate that plants grown within and around the dumpsites accumulated more of the toxic metals than plants grown on sthe control site. The results also revealed daily intake of Cd and Pb to be greater than the maximum oral reference dose (R_FD). The HRI value was greater than 1 for Cd and Pb in most of the vegetables which gives a potential health risk on continuous consumption of the vegetables grown within and around the study area.

References

[1]. Fernando, G., Anderson, T., Takashi, M., Nericlarus, M. and Solange, C. (2012). Heavy metal in vegetable and potential risks for human health. Journal of Agricultural science, 69: 54-60.

[2] Singh, P., Moham, D., Sinha, S. and Dalwani, R. (2004). Impact assessment of treated/untreated wastewater toxicants discharged by sewage treatments plants on health, agricultural and environmental quality in the waste water disposal area. Journal of chemosphere, 55: 227 – 255.

[3]. Oti, W. J. O. and Nwabue, F. I. (2003). Heavy metals Effects due to contamination of vegetables from Enyigba lead mine in Ebonyi State, Nigeria. Environment and pollution, 2(1): 19-26.

[4]. Abbas, M., Parveen, Z., Iqbal, M., Riazuddin, S., Ahmed, M. and Bhutto, R. (2010). Monitoring of toxic metals (cadmium, lead, arsenic and mercury) in vegetables of Sindh, *Pakistan. Kathmandu University Journal of Science, Engineering and technology; 6, 60-65.*

[5]. Adewuyi, G. O. and Opasina, M. A. (2010). Physicochemical and heavy metals assessment of leachates from Aperin abandoned dumpsite in Ibadan city. Nigeria. *European Journal of Chemistry. 7(4): 1278 – 1283.*

[6]. Amusan, A. A., Ige, O. V and Olawale, R. (2005). Characteristic of soils and crops "uptake of metals in municipal solid waste landfill sites in Ibadan", Nigeria. *Journal of Environmental Health Research, 2, 32-37.*

[7]. EPA-IRIS. Environmental Protection Agency, Integrated Risk Information System–Database, US Environ. Protect. Agency. 2006

[8]. National Population Commission, Official Gazette of the Federal Republic of Nigeria, Abuja: National Bureau of statistics, 2007

[9]. Nyangababo, J. T. and Hamya, J. W. (1986). The Deposition of Lead, Cadmium, Zinc and Copper from motor traffic on Brachiaria enimi and soil along a major Bombo road to Kampala city. *International Journal of Environment Studies. 27(1 – 2), 115 – 119.*

[10]. Cui , Y. J., Zhu, Y. G., Zhai, R. H., Chen, D. Y., Huang, Y. Z., Qiu, Y. and Liang, J. Z., (2010). Transfer of metals from soil to vegetables in the area near a smelter in nanning, China, *International journal of environment.* 30:785-791.

[11]. Tukura, B. W., Kagbu, J. A. and Gimba, C. E. (2007). Effect of pH and Total organic carbon (TOC) on the distribution of trace metals in kubanni dam sediments, Zaria, Nigeria. *Science world Journal. 2(3): 1 – 6.*

[12]. Lokeshwari, H. and Chandrappa, G. T. (2006). Impact of heavy metal contamination of Bellandur Lake on soil and cultivated vegetables. Current Science, 91(5).

[13]. Sajjad, K., Robina, F., Shagufta, S., Mohamad, A. and Mana, S. (2009). Health Risks assessment of heavy metals for population via consumption of vegetables. *World Applied Science Journals 12(6): 1602 – 1606.*

[14]. World Health Organization. Permissible limits of heavy metals in soil and plants (Geneva: World Health Organization), Switzerland, 1996

[15]. Abdallah, S. A., Uzairu A., Kagbu. J. A. and Okunola, O. J. (2012). Assessment of heavy metals bioaccumulation by Eleusine Indica from refuse dumpsites in Kaduna Metropolis, Nigeria. *Journal of Environment Chemistry and Ecotoxicology 4(9): 153-160.*

[16]. Akpofure, R. (2012). Uptake of Heavy Metals by Okra (Hibiscus Esculentus) Grown on Abandoned Dumpsites in Effurun, Nigeria. *Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS), 3(4): 640-644.*

[17]. Alam, M. G., Snow, E. T. and Tanaka, A. (2003). Arsenic and heavy metals contamination of vegetables grown in Samta village Bangladesh. Science total environment, 308 (1 - 3), 83 – 96.

[18]. Khaled, S. B and Muhammad, A. A. (2016). Field accumulation risks of heavy metals in soil and vegetable crop Irrigated with sewage water in Western region of Saudi Arabia. *Saudi Journal of Biological Sciences.23: 32-44.*