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Assessment of trace heavy metal contaminations of some selected vegetables irrigated with water from River Benue within Makurdi Metropolis, Benue State Nigeria

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ABSTRACT

Levels of cadmium, copper, manganese, nickel, lead and zinc were determined in irrigation water, vegetable and fruit and soils of Makurdi irrigated farmland along river Benue, Nigeria. The water used for irrigation had the following concentration 0.00013±0.0004, 0.0022±0.0010, 0.0024±0.009 µg/g For Cu, Mn and Zn respectively while Cd, Ni and Pb was not detected in irrigation water. The concentrations of all the heavy metals studied were detected in all the soil and plant samples. Heavy metal concentrations varied among different vegetable and fruit studied. Among the vegetable and fruit examined, Zn and Mn have the highest concentrations, but their concentrations in all the vegetable and fruit samples studied were below the recommended safe limits of heavy metals by WHO, FAO, EU Standards.

Keywords: Heavy metals, Vegetables, Soil, Water.

INTRODUCTION

Long term irrigation may lead to the accumulation of heavy metals in agricultural soils and plants. Substantial amount of irrigated vegetables is produced in Makurdi local government area of Benue state. Vegetables accumulate heavy metals in their edible and non-edible parts. Food safety issues and potential health risks make this as one of the most serious environmental concerns [1].Toxic effects of trace heavy metals such as Cd, Pb, and Hg etc to man, other animals and organisms are well known. This category of metals is not required by man even in small amounts[2,3].Although some of the heavy metals such as Zn, Mn, Ni, and Cu act as micro-nutrient at lower concentrations, they become toxic at higher concentrations. Potential toxicity of trace metals result from the fact that they are transitional elements able to form stable coordinated compounds with a range of both organic and inorganic ligands[4,5]. Many metals act as biological poisons even at parts of per billion (ppb) levels. The toxic elements accumulated in organic matter in soils are taken up by growing plants [6]. The metals are not toxic as the condensed free elements but are dangerous in the form of cations and when bonded to short chains of carbon atoms [7]. But trace metals such as copper and zinc are classified as essential to life due to their involvement in certain physiological process. Elevated level of these has however been found to be toxic [8]. Cadmium adversely affects several important enzymes. It can cause painful osteomalacia (bone disease), destruction of red blood cell and kidney damage. Lead has been found to be bio-accumulated by benthic bacteria, plants and other aquatic biota [9,10]. The ubiquity of this metal in the environment could be traced to a wide increase in industrial activities and the continual use of leaded petrol in many developing nations. Leaded petrol is still in use in Nigeria.

Intake of vegetables is an important path of heavy metal toxicity to human being. Crops and vegetables grown in soils contaminated with heavy metals have greater accumulation of heavy metals depends upon the nature of vegetables and some of them have a greater potential to accumulate higher concentrations of heavy metals than others. Dietary intake of heavy metals through contaminated vegetables may lead to various chronic diseases.It was suggested that bio-toxic effects of heavy metals depend upon the concentrations and oxidation states of heavy metals, kind of sources and mode of deposition [11]. Consumption of vegetable have increased in recent years due to the awareness that vegetables contain certain nutritionally important compounds necessary for human survival and are often called protective food due to their functions of preventing disease of human body [12,13]. Vegetable uptake of metals is one of the major pathways which soil-metals enter into food chain and is subsequently bio-accumulated to high concentrations causing serious risk to human health when plant based food stuffs are consumed [2]. The health risks will depend on the chemical composition of the waste material, its physical characteristics, the vegetables cultivated and the consumption rate [14]. The sources of water used for irrigation are enormous, but in Makurdi, water from river Benue is dominant source. As an urban and commercial centre the soil inherited heavy metals from parent material, run off augmented by the use of organic and inorganic fertilizers and atmospheric deposition [15,16].

The present work, deals with the determination of heavy metal concentrations in irrigated water, soils and some of the vegetables grown along river Benue within Makurdi metropolis.

MATERIALS AND METHODS

Water samples from river Benue used for irrigation were collected along with the blank (distilled water) in a $100cm^3$ pre acid- washed polypropylene bottle and $1cm^3$ of concentrated HNO_3 was added to the sample to avoid microbial activity.

Soil samples were collected at each place and time the vegetables were plucked and uprooted and soil mixed thoroughly to give a represent able fraction. The soil samples were air dried ground and sieved through 200µm mesh size.

Sampling spots of about 20-30 m apart from each other were mapped out for soil sample collection within each sampling sites. Samples were collected using clean stainless steel trowel from about 0-15cm depth. A soil sample from control sites were also collected from where farming, mining and industrial activities were absent. The collected soil sub-samples were thoroughly mixed, pooled together to make a composite of each soil sample.

The collected soil samples were air-dried for 2 weeks to remove excess moisture. Large soil clods were also crushed to facilitate the drying. The dried soil samples were crushed in a porcelain mortar with a pestle. The crushed soil samples were sieved through a 2 mm sieve made of stainless steel, for analyzing soil pH and particle size. Some portion of the individual sieved soil samples were further pulverized to a fine powder and passed through a 0.5mm sieve for analyzing organic carbon and total metal content. The pH of the soil samples was determined with pH meter Hanna (Model H1991000) according to standard analytical methods. Organic matter was determined using the chromic acid oxidation method [17]. Particle size distribution was determined by the hydrometer method as described by [18]. The exchangeable cation was determined by the method described by [19].

The method developed by the United States Environmental Protection Agency for (total sobbed) heavy metals in soil, sediments and sludge (USEPA SW-846, method 3050) (USEPA 1986), was used in the preparation of the soil samples for the determination of total metal content in this study. One gram (1g) of the soil sample was weighed into a beaker for acid digestion. Analar grade nitric acid, hydrogen peroxide (about 30%) and concentrated Hydrochloric acid were used for the digestion. The digest was filtered through whatman filter paper. Each filtrate was collected in 100ml volumetric flask and deionized water was used to rinse the filter paper into volumetric flask. Each filterate was later made up to 100ml with deionized water. Standards were prepared with serial dilution techniques within the range of each metal determined. The standards used were Analar grade; the instrument was first calibrated with stock solutions of the prepared standards before analyzed using flame atomic absorption spectrophotometer. After every five samples analyzed using AAS, the first sample was repeated for quality check. Only when the result was within 10% of earlier readings did the analysis proceed further. The data obtained in the study were analyzed using Pearson correlation analysis.

The enrichment factors for the soils were calculated according to the following equation

$$EFc = (Cx/C_{Fe})_{soil}/(Cx/C_{Fe})_{Earth's\ crust}$$

Where (Cx/C_{Fe}) soil is the ratio of concentration of the element being determined (Cx) to that of Fe (C_{Fe}) in the soil sample and (Cx/C_{Fe}) earth's crust is the ratio in the reference Earth's crust [20,21,22].

Five irrigated vegetable and fruit comprising of leave and fruit have been studied from Makurdi area of Benue state. The vegetable and fruit studied were tomatoes, pumpkin, okoro, spinach and pepper. Samplings were done during their harvesting periods randomly, in all the farmlands along the river of the Benue used for irrigation within the study area. The same kinds of vegetable and fruit were mixed to give a representative fraction of the vegetable and fruit. The vegetable and fruit harvested were washed with the river water to remove soil particles. The vegetable and fruit was oven dried at 70^{o}C until stable weights were obtained. Samples were then grounded in a mortar, passed through a 2mm sieve and stored at room temperature before analysis.

One gram of prepared vegetable samples was weighed into 125 cm^3 conical flasks using the USEPA 3050 method by Miller and Mc Fee, (1983). Ten centimeter cube of HNO_3 was added and the mixture was heated for 30 minutes on a water bath at 100^{0}C. The digest was allowed to cool and another 5 cm^3 of HNO_3 was added and heating continued for 1 hour at 100^{0}c. The volume of the digest was reduced by boiling on the water bath and this was allowed to cool. Five centimeter cube of deionized water was added when effervescence subsided, 10 cm^3 of H_2O_2 (60%) was added and heating continued for another 30 mins. The final digest was allowed to cool and filtered. The final volume of digest was made up to 50 cm^3 with deionized-distilled water and was analyzed for the required heavy metal by flame atomic assumption spectrophotometer.

RESULTS AND DISCUSSION

Soil characteristics of the study area

The pH values ranged from 6.50-7.20, in the irrigated farmland soil samples. All the soils studied from the farmland were either weakly acid or neutral.

The soil organic carbon concentrations ranged from 0.90-1.52. The soils from the study area were generally low in organic carbon contents. Most of the soil samples studied from sample sites have organic carbon values of less than 2.00%. The clay contents ranged from 7.20-14.20%. The cation exchange capacity ranged from 10.20-20.50meq/100g, (Tables 1and 2).

Table 1 : Soil charateristics of the study site

Sample sites	pH	O.C	Sand (%)	Silt (%)	Clay (%)	C.E.C meq/100g
A	6.80	0.77	71.70	14.90	13.40	15.80
B	7.00	0.7	70.90	15.50	13.60	16.40
C	7.20	0.85	70.70	13.70	15.60	17.20
D	7.20	0.65	77.70	8.70	13.60	18.20
E	6.80	0.94	73.70	11.70	14.60	9.20
F	6.50	0.97	74.70	11.70	13.60	14.80
G	6.80	1.40	72.70	13.90	13.40	15.60
H	6.80	0.56	71.70	10.70	17.60	10.20
I	7.00	0.70	70.70	15.90	13.40	11.50
J	6.90	0.97	72.70	10.70	16.60	18.20
Cont1	7.20	0.85	70.70	13.70	15.60	17.20
Cont2	7.00	0.70	70.90	13.50	15.60	16.20
Cont3	6.90	0.94	73.70	9.60	16.70	15.60

Table 2: The ranges and mean of soil properties of irrigated farmland in the study site

		pH	O.C	Sand	Silt	Clay	C.E.C
study site	Range	6.50-7.20	0.56-1.40	70.70-77.70	8.70-15.90	13.40-16.60	9.20-18.20
n=10	Mean	7.03	0.83	71.77	12.27	15.97	16.33
	S.D	0.18	1.03	1.01	0.81	1.11	0.90

n=number of site

S.D= standard deviation

RESULTS AND DISCUSSION

Levels of heavy metals in water

The concentration of heavy metals in water used for irrigation was highest for Zn, followed by Mn, Cu, and Pb. Cd and Ni concentrations in irrigation water were below the detectable limit (Table 3). The study site "Makurdi" is an urban area (state capital of Benue).Many industries such as Benue brewery limited (BBL), Fertilizer blending company, Agro miller industry, NNPC deport and other small scale industries like dyeing, metal work, printing, paints and fuel filling stations discharge their effluents into the river which may be the cause of detectable Zn, Mn, Cu, and Pb in irrigation water. The concentrations (μg/ml) of Zn (0.0024), Mn (0.0022), Cu (0.0013) and Pb (0.0010) in irrigation water recorded during this study were lower than permissible limits of heavy metals allowed in the irrigation water limits [23].

Table 3: Trace heavy metal concentration (mg/g) in irrigated water from river Benue

Sites	Cd	Cu	Mn	Ni	Pb	Zn
A	N.D	0.001	0.004	N.D	N.D	0.004
B	N.D	0.002	0.003	N.D	0.001	0.003
C	N.D	0.001	0.002	N.D	N.D	0.003
D	N.D	0.001	0.001	N.D	N.D	0.002
E	N.D	0.002	0.002	N.D	0.001	0.002
F	N.D	0.001	0.003	N.D	N.D	0.003
G	N.D	0.001	0.002	N.D	N.D	0.001
H	N.D	0.002	0.001	N.D	N.D	0.002
I	N.D	0.001	0.003	N.D	N.D	0.001
J	N.D	0.001	0.001	N.D	0.001	0.003
MEAN	-	0.0013	0.0022	N.D	0.001	0.0024
S.D	-	0.000483	0.001033	N.D	-	0.000966

Heavy Metal Concentrations in Soil

The results of heavy metal concentrations in the irrigated farmland soil samples are presented in (Table 4). The soil samples from the sites "Makurdi" of Benue state revealed a little elevated level of these heavy metals (Cd, Cu, Mn, Ni, Pb and Zn) in irrigated farmland soil samples. The mean concentrations of heavy metals obtained from the control sites were lower than those obtained from the soils of the irrigated farmland under consideration. This reflects a contamination of soils of this irrigated farmland by heavy metals. Out of the heavy metals considered, Zn, Cd, Pb and Mn show the highest contamination in the area studied. The overall results ranged from 0.620-0.920µg/g, 12.100-18.600 µg/g, 100.470-109.300 µg/g, 11.280-14.830 µg/g, 5.800-8.100 µg/g and 20.670-29.730 µg/g for Cd, Cu, Mn, Ni, Pb and Zn respectively (Table 5).

Generally, in the area studied, the concentrations of the heavy metals in the soils were high especially Pb, Cd, Cu and Zn. This is an indication that these heavy metals are the contaminant in the irrigated soils which was also reflected in the low level of these metals obtained from the control sites in comparison with those obtained from the study sites. The degree of heavy metals contamination in irrigated soil samples which were determined by its accumulation factor was higher than unity (Table 6). It was suggested that the soil contamination may be considered when concentrations of an element in soils were two-three times greater than the average background levels [24]. Therefore the soil of irrigated farmland in the study area may be considered contaminated based on the fact that heavy metal contents in all the background soils in this study were low. From the mean results and accumulation factors, there is an indication that Pb, Cu, Cd and Zn are the contaminant in the irrigated soils where fertilizer application and other organic manure applied to soils cause soil contamination. City dwellers have long contended that any form of waste, with proper compositing and processing, can make into fertilizers that farmers will gladly pay for. Municipal refuse may contain paper, food wastes, metals, glass, ceramic and ashes. Studies have shown that these wastes can accumulate heavy metal which can persist in soils at environmentally hazardous levels [25]. The accumulation factors of trace heavy metals in the irrigated soils were 2.540, 2.830, 2.340, 2.420, 2.150 and 2.550 for Cd, Cu, Mn, Ni, Pb and Zn respectively, which some how higher than unity. Although the mean concentration of trace heavy metals obtained from all the sites (Table 5) falls within the acceptable limits proposed by E.U, ICRCL and UNEP limits. Thus, anthropogenic input of these heavy metals seemed to be less pronounced in the area under investigation.

Table 4: Total Metal Contents µg/g in irrigated Farm land in the study site

Sample sites	Cd	Cu	Mn	Ni	Pb	Zn
A	0.83	13.40	100.47	14.83	7.80	22.20
B	0.85	14.03	106.00	12.57	6.68	22.33
C	0.71	18.60	105.60	12.37	6.85	24.93
D	0.73	12.10	104.50	14.82	6.05	21.60
E	0.62	18.40	106.07	12.15	7.55	29.73
F	0.63	15.63	108.07	11.62	6.85	24.00
G	0.72	16.80	105.73	14.2	6.82	27.10
H	0.70	14.50	109.30	11.28	7.02	28.47
I	0.92	16.73	105.67	13.75	5.80	24.00
J	0.65	12.20	107.73	13.20	8.10	20.67
cont1	0.35	7.90	46.20	9.00	3.50	9.70
cont2	0.30	8.50	45.50	10.00	3.20	8.60
cont3	0.20	8.60	44.10	8.60	3.00	10.50

Table 5: Summary of total metal contents(μg/g) of the irrigated farmland in the study site

Sites	Metal	Range	mean/S.D
n=10	Cd	0.62-0.92	0.71±0.10
	Cu	12.10-18.60	15.24±2.37
	Mn	100.47- 109.30	105.91±2.39
	Ni	11.28-14.83	13.08±1.28
	Pb	5.80-8.10	6.95±0.72
	Zn	20.67-29.73	24.50±3.05

Table 6: Factors of accumulation of heavy metals in irrigated farmland in the study site

Site	Metal	F.A
n=10	Cd	2.54
	Cu	1.83
	Mn	2.34
	Ni	1.42
	Pb	2.15
	Zn	2.55

Levels of Heavy Metals in Vegetables

Trace heavy metal concentrations in vegetable and fruit samples from the study sites are shown in (Tables 7 - 11).The data presented were restricted to the edible parts of the vegetable and fruit. Generally, crops harvested in soils presented higher levels of metals when compared to those levels from irrigation water (Tables 12 and 4 respectively). This is interpreted to mean that if the level of these metals in soils is significantly increased, the test vegetables have the potential of showing increased uptake of the metals. Plant grown on soils possessing enhanced metal concentrations have increased heavy metal ion content. The uptake of metal ions has been shown to be influenced by the metal species and plant parts [26]. Among the vegetable and fruit studied Zn and Mn have the highest concentrations (Tables 12). Cd concentrations (µg/g) ranged from 0.070-0.110, 0.080-0.140, 0.110-0.160, 0.100-0.130 and 0.060-0.120 for tomatoes, okro, pumpkin, spinach and pepper respectively. Cu concentrations (µg/g) ranges from 1.220-2.550,2.150-3.120,3.980-5.220,3.990-5.120 and 2.120-2.660 for tomatoes, okro, pumpkin, spinach and pepper respectively (Table 12).Ni concentration ranged from0.430-0.950 µg/g with pumpkin and spinach have the highest concentrations. There was low concentration of Ni even in the soil analyzed. Ni is associated with growth dynamics, that is, its concentration is reduced due to dilution and vice versa [27]. Cd concentration ranged from 0.060-0.160 µg/g, pumpkin had the highest concentration of Cd (0.160 µg/g). Cd is relatively mobile in soil under range of pH, O.C and CEC conditions. The combination of Cd mobility and its association with organic matter made it to be enriched in soils relative to irrigation water because the former has higher organic contents [28].The concentration of Cd in the tested vegetable and fruit especially pumpkin could originate from atmospheric deposition as well as transfer from the soil. The soil Cd could be due to the application of phosphate fertilizers for its absence in the irrigation water analyzed indicated non-contribution of water to the accumulated metal. Heavy metal concentrations varied among different vegetable and fruit studied (Table 12), which may be attributed to differential absorption capacity of the test vegetable and fruit for different heavy metals [29]. This shows that some other soil factors in addition to the total soil contents of the metals also influenced metal uptake.

Vegetable and fruit Pb content is generally very low due to its low bioavailability. Pb concentrations in various vegetable and fruit samples studied ranged from 0.110-0.280 µg/g with highest concentration of 0.280 µg/g, were found in pumpkin and spinach. Although Cu is essential for plant growth, a very small amount of Cu is required by plant, between 5 to 20 µg/gin plant tissues [30]. However over 20 µg/g can be found in plants from contaminated area, especially plant roots grown in mining and smelting site [31]. In this study, Cu concentrations in vegetables ranged from 1.220-5.220 µg/g, pumpkin and spinach were found to contained highest concentration of 5.220 and 5.12 µg/g respectively (Tables 12) Zn and Mn is also one of micro-nutrients essential for normal plant growth, but only a small amount of these elements is required especially Zn (25-150 µg/g) . In this study the Zn concentrations ranged from 4.450-9.350 µg/g and the highest concentration of Zn was found in okro with, 9.350 µg/g. Mn concentrations ranged from 2.010-7.800 µg/g. The maximum Mn content was found in spinach with 7.800 µg/g. Metal uptake by plants can be affected by general factors including metal concentrations in soils, soil pH, cation exchange capacity, organic matter content, types and varieties of plants, and plant age. It is generally accepted that the metal concentration in soil is the dominant factor [25]. Relationships between total metal contents in vegetable and fruit and soils are shown in Table 13. Levels of metals in vegetable and fruit were compared with those of soils counterparts, although the relationships differ between vegetable and fruit species. Metals in vegetable and fruit did not show any significant correlations with those of soils. As mentioned above, there is a combination of factors affecting metal uptake by plants. Total metal concentrations in soil are main factor, being correlated positively with metals in plants on each occasion. In addition, soil pH, and organic carbon contents played an important role in governing metal uptake by plants. Other factors such as cations exchange capacity, loss on ignition and soil texture also contributed to the prediction of metal concentrations in plants in some cases [4].

Table 7: Trace heavy metal concentration (mg/g) in vegetable from the study site (Tomatoes)

site	Cd	Cu	Mn	Ni	Pb	Zn
A	0.08	1.65	5.51	0.82	0.23	5.23
B	0.10	1.70	5.42	0.92	0.22	4.85
C	0.09	1.22	4.91	0.67	0.19	5.23
D	0.08	1.75	4.51	0.78	0.24	4.59
E	0.07	1.80	4.34	0.85	0.27	5.15
F	0.10	1.95	5.01	0.69	0.21	5.03
G	0.07	2.05	4.22	0.72	0.25	5.23
H	0.10	2.31	4.56	0.68	0.19	5.95
I	0.11	2.55	5.12	0.77	0.21	4.99
J	0.09	2.15	4.25	0.72	0.18	5.82
MEAN	0.09	1.91	4.79	0.76	0.22	5.21
SD	0.01	0.37	0.47	0.08	0.02	0.41

Table 8: Trace heavy metal concentration (mg/g) in vegetable from the study site (Pumpkin)

Site	Cd	Cu	Mn	Ni	Pb	Zn
A	0.16	4.41	6.98	0.67	0.23	6.91
B	0.15	4.52	7.11	0.55	0.19	7.21
C	0.13	4.11	7.32	0.68	0.21	7.11
D	0.16	3.98	7.55	0.79	0.25	6.89
E	0.15	4.12	6.89	0.85	0.24	7.21
F	0.11	3.99	7.14	0.81	0.21	6.89
G	0.12	4.55	7.25	0.91	0.19	7.55
H	0.13	5.11	6.99	0.95	0.18	7.35
I	0.12	4.65	7.12	0.88	0.23	6.98
J	0.11	5.22	7.20	0.69	0.22	7.65
MEAN	0.13	4.47	7.16	0.78	0.22	7.18
SD	0.02	0.44	0.19	0.13	0.02	0.27

Table 9: Trace heavy metal concentration (mg/g) in vegetable from the study site (Spinach)

Sites	**Cd**	**Cu**	**Mn**	**Ni**	**Pb**	**Zn**
A	0.11	4.52	7.80	0.95	0.21	7.56
B	0.12	4.55	7.22	0.68	0.23	8.21
C	0.10	4.35	6.55	0.78	0.25	7.66
D	0.13	4.59	5.26	0.75	0.19	6.98
E	0.12	3.99	6.25	0.69	0.18	7.02
F	0.13	4.36	7.23	0.72	0.25	6.95
G	0.11	5.11	6.89	0.91	0.26	7.11
H	0.13	5.02	6.88	0.56	0.21	7.21
I	0.13	4.66	7.01	0.76	0.18	6.92
J	0.11	5.12	7.32	0.88	0.21	7.85
MEAN	0.12	4.63	6.84	0.77	0.22	7.35
SD	0.01	0.36	0.70	0.12	0.03	0.44

Table 10: Trace heavy metal concentration (mg/g) in vegetable from the study site (Okro)

Sites	**Cd**	**Cu**	**Mn**	**Ni**	**Pb**	**Zn**
A	0.11	2.22	7.12	0.69	0.12	8.52
B	0.12	2.15	6.85	0.87	0.21	9.21
C	0.14	3.12	6.66	0.92	0.21	8.72
D	0.09	3.11	7.25	0.66	0.19	9.12
E	0.08	2.59	7.23	0.84	0.23	9.23
F	0.11	3.11	6.98	0.73	0.28	9.35
G	0.13	2.58	6.88	0.85	0.19	7.21

H	0.08	3.11	7.01	0.87	0.22	6.94
I	0.12	2.25	6.95	0.88	0.25	6.89
J	0.11	2.81	7.23	0.95	0.17	7.11
MEAN	0.11	2.71	7.02	0.83	0.21	8.23
SD	0.02	0.40	0.19	0.09	0.044	1.06

Table 11: Trace heavy metal concentration (mg/g) in vegetable from the study site (Pepper)

Sites	Cd	Cu	Mn	Ni	Pb	Zn
A	0.09	2.20	3.41	0.55	0.14	6.11
B	0.08	2.12	3.55	0.54	0.21	5.90
C	0.06	2.45	3.45	0.43	0.13	5.12
D	0.08	2.55	3.59	0.55	0.11	5.44
E	0.07	2.45	3.55	0.49	0.13	5.11
F	0.09	2.23	3.45	0.46	0.15	5.21
G	0.08	2.35	4.11	0.62	0.11	4.95
H	0.09	2.65	2.22	0.44	0.12	4.99
I	0.11	2.46	2.05	0.51	0.11	5.22
J	0.12	2.66	2.01	0.55	0.15	4.45
MEAN	0.09	2.41	3.14	0.51	0.14	5.25
SD	0.02	0.18	0.75	0.06	0.03	0.47

Table 12: Summaries trace metal concentrations (mg/g) in some vegetables Makurdi irrigated farmland.

mg/g)	Tomatoes	Pumpkin	Okro	Spinach	Pepper
Cd					
Range	0.070-0.110	0.110-0.160	0.080-0.140	0.100-0.130	0.060-0.120
Mean±Sd	0.09±0.014	0.13±0.020	0.11±0.020	0.12±0.011	0.09±0.018
Cu					
Range	1.220-2.550	3.980-5.220	2.150-3.120	3.990-5.120	2.120-2.660
Mean±Sd	1.91±0.376	4.47±0.440	2.71±0.402	4.63±0.366	2.41±0.185
Mn					
Range	4.220-5.510	6.890-7.550	6.660-7.250	5.250-7.800	2.010-4.110
Mean±Sd	4.79±0.476	7.16±0.190	7.02±0.193	6.84±0.700	3.14±0.750
Ni					
Range	0.670-0.920	0.550-0.950	0.660-0.920	0.560-0.950	0.430-0.620
Mean±Sd	0.76±0.082	0.78±0.127	0.83±0.098	0.77±0.118	0.51±0.060
Pb					
Range	0.180-0.270	0.180-0.250	0.120-0.280	0.180-0.250	0.110-0.210
Mean±Sd	0.22±0.029	0.22±0.023	0.21±0.044	0.22±0.029	0.14±0.030
Zn					
Range	4.590-5.820	6.890-7.650	6.890-9.350	6.920-8.210	4.450-6.110
Mean±Sd	5.210±0.411	7.18±0.274	8.20±1.059	7.35±0.447	5.25±0.475

Table 13: Correlation Co-efficient between Trace Heavy metal contents in irrigated soils and vegetable

Metals	Tomatoes	Pumkpin	Spinach	Okro	Pepper
Cd	0.418	0.270	0.097	0.360	0.206
Cu	-0.158	-0.349	-0.465	-0.001	-0.118
Mn	-0.473	-0.054	-0.077	-0.105	-0.405
Ni	-0.256	-0.137	0.738*	-0.432	0.767*
Pb	-0.085	-0.045	0.076	-0.489	0.259
Zn	0.273	0.214	-0.452	-0.114	-0.264

CONCLUSION

Water irrigation led to the accumulation of heavy metals in soil and consequently into the vegetable and fruit. Heavy metal concentrations varied among the tested vegetable and fruit, which reflect the differences in their uptake capabilities and their further translocation to edible portion of the plants. The metals (Cd, Cu, Mn, Ni, Pb and Zn) investigated in this study were detected in all the vegetable and fruit samples, but their concentrations in all the vegetable and fruit samples studied were below the recommended safe limits of heavy metals by WHO, FAO,EU Standards. This study did not show any abnormal accumulation of metal due to irrigation and other industrial activities in the area. There no possible health risk to consumers of the vegetable and fruit planted in the area.

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