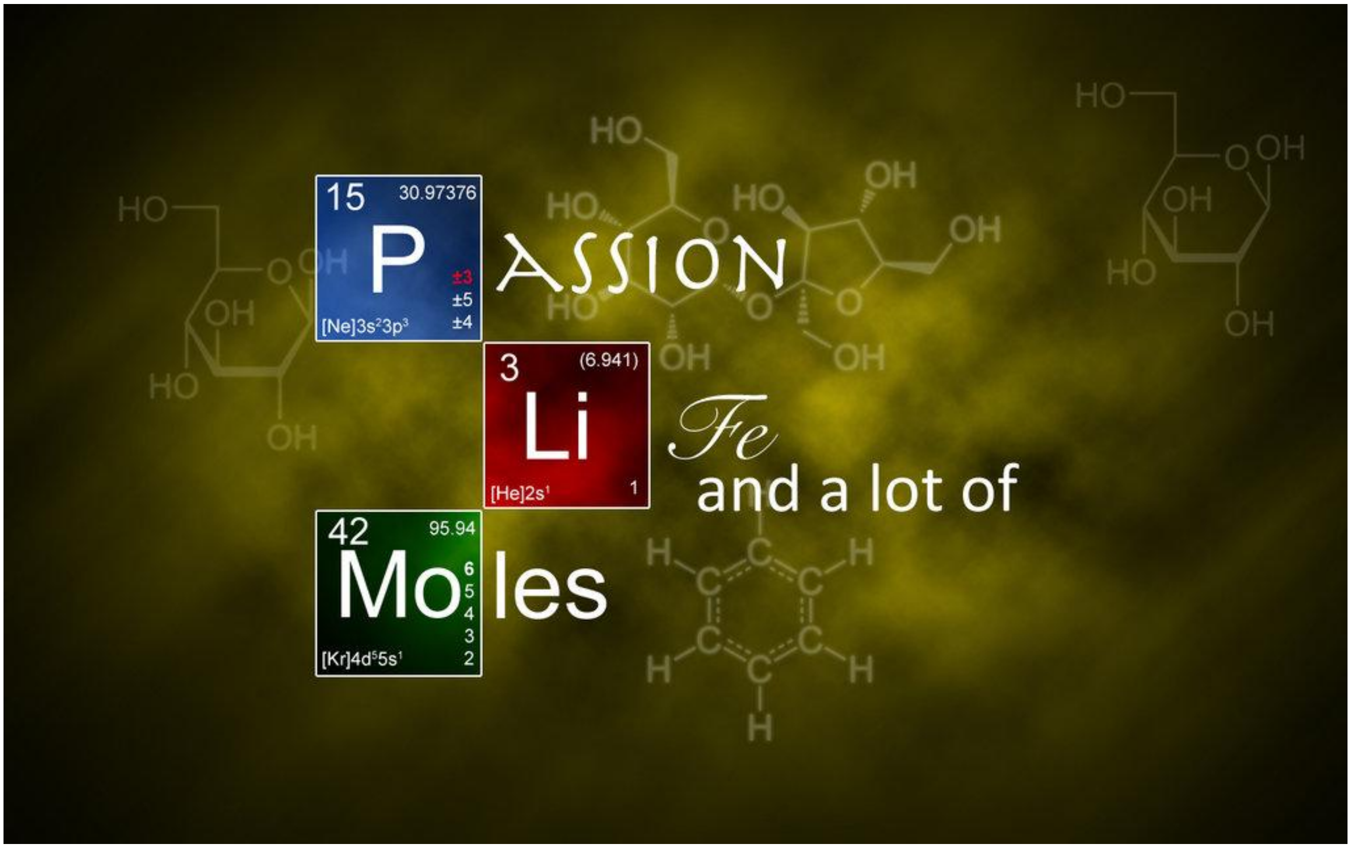

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HEAVY METAL PROFILE OF SOME FRUITS AND VEGETABLES GROWN IN ABUJA URBAN RESIDENTIAL GARDEN

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ABSTRACT

The trace heavy metals contents of some fruits and vegetables normally grown in the residential garden in urban areas of Abuja FCT (Nigeria) were analyzed. Atomic absorption spectrophotometer (AAS) was used to determine the level of heavy metals Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn). All the sample products analyzed contained the heavy metals studied in various concentrations. The overall results ranged from 0.110 – 0.082, 0.012 – 0.058, 0.011 – 0.092, 0.133 – 0.788, 0.215 – 3.892, 0.078 – 0.922, 0.035 – 0.092, 0.011 – 0.095 and 1.098 – 2.971 mg/g for Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn, respectively. There was no significant difference ($P<0.05$) between the level of trace heavy metals in the six different fruit and vegetable samples studied. Results of correlation analysis conducted revealed positive correlation between Cd in most the samples and negative correlation between Cd and some few elements like Co in okro fruit while there is perfect correlation exist between Ni and Pb in pumpkin sample. When the result was compared to food standard set by WHO/FAO, Cd level in some the samples were found to be higher than the maximum permissible limit.

Key words: Heavy metal, contamination, fruits and vegetables, urban residential garden.

INTRODUCTION

There has been increasing recognition amongst the scientists and developing countries of the rising importance of food production in city area, particularly in those parts of the world that have been characterized by economic collapse [1]. Urban and peri–urban agriculture offer wide–range benefits. It can contribute substantial amounts to the proportion of food consumed in the city; [1], for example, has estimated that 15–20% of the world's supply of vegetables and meat is produced in urban areas, and FAO estimates that 800 million urban dwellers are actively engaged in urban agricultural activities, while 200 million providing food for markets [2].

Traditional farming system before, the advent of chemical fertilizer employed shifting cultivation, rotational fallowing and ploughing back crop residues. This is because farmers associated soil fertility with organic matter [3]. However, with a growing population and the expansion of markets, fallow periods have become shorter and cultivation periods longer. This situation is worsened by incessant uncontrolled bush fires, poor cropping systems and unfavourable weather [4].

Trace elements are introduced into soils from various sources, including atmospheric deposition of metal/metalloid-bearing particles, application of sewage sludge, phosphate fertiliser, pig slurry and pesticides, where they exist in several chemical forms. Their fate in soil depends on the chemical state of the element in the contaminating material [5].

Risks associated with polluted soils are contamination of the food chain. They are closely related to the bioavailability of toxic elements (i.e. ability to enter the different compartments of the food chain) and primarily to the phytoavailability (i.e. availability to plants). Plants are essential components of natural ecosystems and agroecosystems, and are the first compartment of the terrestrial food chain. When grown on polluted soils they become a potential threat to human and animal health, as they may accumulate toxic elements (e.g. metals) in their tissues, as dramatically illustrated by the Itai-Itai disease that affected farmers on a long-term diet of cadmium-contaminated rice. Plants may also have their growth sharply reduced by high levels of toxic elements in their tissues, causing a decrease in crop yields and further economic damage to farmers, as can be observed near metal smelters or mine spoils. On the other hand, some elements, toxic when present at high concentration in tissues, are also essential to plants, and their deficiency induces loss in biomass production and physiological disorders in plants [6].

Plants take up trace elements from the soil solution, where ions are in equilibrium with those located in the solid phase through various reactions, including adsorption, exchange, complexation with organic and inorganic ligands, redox reactions, and precipitation-dissolution [7]. The extent of the reactions, and hence the solubility of trace elements, is a function of soil mineral content (e.g. silicate layers, carbonates, oxides and hydroxides), soil organic matter (e.g. humic and fulvic acids, polysaccharides and organic acids), soil pH, redox potential and soil temperature and humidity [8]. The risks of heavy metal transfer into the food chain are dependent on the mobility of the heavy metal species and their availability in the soil [9].

Absorption of trace elements by plant roots is controlled by the concentration of other elements and interactions have often been observed. They may be positive or negative, the uptake of a given element being improved or depressed by others present at high concentrations in the soil. Macronutrients interfere antagonistically with uptake of trace elements. Phosphate ions reduce the uptake of Cd and Zn in plants [10, 11], and diminish the toxic effects of As, as observed on soils treated with arsenic pesticides [12].

Calcium controls the absorption of metals, e.g. Cd, as a result of competition for available absorption sites at the root surface [13]. Antagonism between micronutrients is quite frequent. Leaf chlorosis, a symptom due to Fe deficiency, can be induced by an excess of other metals such as Zn, Ni, and Cu, which depresses Fe uptake by plant roots. Conversely, Fe affects Cd absorption, acting as a strong antagonist against the toxic metal. Cd and Zn, two metals chemically close in similarity in electronic configuration and reactivity with organic ligands, interact in the soil-plant system, causing the well-known Cd/Zn antagonism. Zn depresses Cd uptake [11]. On the other hand, at low concentrations the interaction is synergistic and the input of Zn increases Cd uptake [10].

Application of K fertilisers to the soil leads to increasing uptake of Cd, Zn, Cu and Ni by oats. This is assumed to be the result of competition between K and microelements for exchange sites on the solid phase of the soil. It is necessary to remember that fertilisers can contain considerable amounts of trace elements. Two major sources of soil contamination are sludge and phosphate fertilisers.

During the period of sludge decomposition, after application to soils trace elements may remain highly available to plants as a result of the release of soluble organic carbon and the decrease in pH following mineralisation/nitrification, which increases the solubility of heavy metals (Dudley *et al.,* 1986; Alekseev, 1987). Long-term use of phosphate fertilisers can elevate the content of many trace elements (e.g. Cd, Hg and As) in soils. It has been shown that the use of these fertilisers significantly increase Cd in soil and the subsequent uptake of the metal by plant roots [14, 15, and 16].

The availability to plants of trace elements from the soil is also controlled by plant micronutrient requirements and their ability to take up or exclude toxic elements. Some plants are well adapted for survival in stressful environmental conditions. They can hold in their tissues amounts higher than 1% of the metal and up to 25% on a dry matter basis. These plants are called 'hyper accumulators'.

Grasses take up fewer trace elements than fast-growing plants, e.g. lettuce, spinach and carrots. When grown in the same soil, accumulation of Cd by different plant species decreases in the order: leafy vegetables > root vegetables > grain crops [17]. Screening of cultivars that exclude toxic elements should be a priority to protect food quality.

Although there have been considerable number of studies on the concentrations of heavy metals in plants and vegetables, but very few were carried out in Abuja (FCT) and data on pollutant metal concentrations and distribution in the fruits and vegetables grown in urban residential garden, especially on edible food crops and vegetables are extremely scarce. The investigation of heavy metal pollutants level in the fruits and vegetables in relation to environmental pollution was prompted by the recent concerns about the pollution in residential areas, and soil for these agricultural practices on which fruits and vegetables are produced in most residential areas in Abuja and its surrounding satellite towns. Thus information about heavy metal concentrations in food products and their dietary intake is very important for assessing their risk to human health. Taking into consideration the dumping of refuse on the residential areas and application of compost manure from dumpsite on residential garden or farmland, this study was designed to investigate the heavy metal (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) concentrations in fruits and vegetables. Also to estimate the potential health risks of metals to humans through consumption of these fruits and vegetables grown in such place. Therefore, this study was initiated to assess the level of contamination of crops especially fruits and vegetables grown in urban residential garden by some heavy metals within Abuja and its satellites town of FCT, since there have been no studies about the extent of contamination of the vegetables and food crops grown in the area by trace metal pollutants.

Study Area

Abuja is located between latitude 7^1 20^0 north of the equator and longitude 6^1 45 and 7^1 39^0 east of Greenwich. The capital territory occupies a land area of 8,000 square kilometres. It is bounded on the north by Kaduna state, on the west by Niger state. On the east and south by Nassarawa state and on the south-west by Kogi state. Federal Capital Territory consist of six area councils namely Municipal, Bawari,Kuje, Gwagwalada,Kwali and Abuja. Abuja has a tropical sub-humid climate, with two distinct seasons, namely a wet and dry season. The wet season this lasts for seven months starts from April and ends in October. Its major elements have regimes that are transitional from those of the southern and northern parts of the country. Thus, relative humidity is not as high as in the northern parts and temperatures are not as high as in the far north either. The annual rainfall total ranges from 1,200mm to 1,500mm. Temperatures are generally very high during the day, particularly in the months of March and April.

MATERIALS AND METHODS

Sample Collection

The samples were collected for about seven months, covering the harvesting period of the studied samples from April to October. The samples were collected directly from a farm gardens in the residential areas in Abuja metropolis. Six different fruits and vegetables, namely Okro (Abelmoschus esculentus), Spinach (Spinasia oleracea), Tomatoes (Lycorpersicon esculentum), Fluted Pumpkin (Telfaira oceidentalis) maize (Zea mays) and pepper were collected from different residential farm garden in the study areas. These are major fruits and vegetables cultivated within urban residential garden in the experimental area for immediate consumption by the farmers and urban resident within the city. The whole samples were washed with clean tap water to remove the soil particles. The samples were oven dried at 80^{o}C to constant weight. The dried samples were grounded, passed through a 2 mm sieve and stored for analysis. For heavy metal extractions, 1 g of dried fruits and vegetables samples were weighed into conical flask using the US EPA 3050 method [18]. The 10 cm^3 of HNO_3 was added and mixture was heated for 15 min on a hot plate at 100 oC. The digest was allowed to cool and another 5 cm^3 of HNO_3 was added and heating continued for 30 min at 100 ^{o}C. The volume of the digest was reduced by boiling and allowed to cool. The 5 cm^3 of de-ionized water was added when effervescence sub–sided 10 cm^3 of H_2O_2 (60%) was added and heating continued for another 15 min. The final digest was allowed to cool and filtered. The final volume of digest was made up to 50 cm^3 with de-ionized distilled water and was analyzed for the required heavy metal by flame atomic absorption spectrophotometer. 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 cheek. 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.

Results and Discussion

The results of heavy metal concentrations in the fruits and vegetables sampled from the residential garden are presented in Tables (1-6), and the summary of results are presented in (Table 7).The mean concentration of heavy metals in the Spinach and pumpkin vegetables were higher than those obtained from the other fruits and vegetable samples studied. But generally the results were similar, and the qualitative similarity of the elements present in the all the fruits and vegetables samples studied is an indication that elements determined might come from the same sources. Out of the various fruits and vegetables samples considered, the Spinach and pumpkin vegetables shows the highest concentration of some the elements determined. The overall results ranged from 0.11–0.082, 0.012–0.058, 0.011–0.092, 0.133–0.788, 0.215–3.892, 0.078–0.922, 0.035–0.092, 0.011–0.095 and 1.098–2.971 mg/g for Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn, respectively. Generally, in the fruits and vegetables samples studied, the concentrations of the heavy metals were varies, all the samples analyzed contained the elements determined in various concentrations. Because of the complicated pattern in the concentration relationship of the samples, focusing on the comparison between the six types of the fruits and vegetables sample products will be futile; instead, the general profile of each product will be discussed focusing attention to any anomaly. Although the inorganic chemicals specifically the heavy metals can exist naturally in soil through parent material, they can also be artificially introduced into soil by processes such as metal production, fossil fuel combustion, waste incineration, emissions from car exhaust, pesticide and fertilizer usage, sewage sludge, mines and smelting factories among others. Addition of organic matter amendments, such as compost, fertilizers and wastes, is a common practice for immobilization of heavy metals and soil amelioration of contaminated soils [1]. A part from pH, other soil properties, such as cation exchange capacity, organic matter content, quantity and type of clay minerals, content of the oxides of Fe, Al, Mn, and their redox potential determine the soil's ability to retain and immobilize heavy metals. When this ability is exceeded, the quantities of heavy metals available to plants increase, resulting in the appearance of toxicity phenomena.

The discrepancies in the differing quantitative pattern among the samples were expected. The reason may hinge on several factors. For instance, toxic metal uptake by fruits and vegetables plants depends on the level of metal contaminants in the soil, soil amendment [17], and soil pH [19]. Also, Potential health risks to humans and animals from consumption of crops can be due to heavy metal uptake from contaminated soils via plant roots as well as direct deposition of contaminants from the atmosphere onto plant surfaces [17]. Some species of plants have ability to bio–accumulates and bio– concentrate heavy metals, making the level higher in the plants than in the soil where the plants grow. These toxic metals could be transferred from one organism to the other through food chain [20]. Therefore among factors which may account for these differences in elemental concentrations are: soil's heavy metal concentration rate, plant characteristics, the soil's physicochemical properties and manures, fertilizers and other chemical applications [6].

Cultivation of crops for human or livestock consumption on contaminated soil can potentially lead to the uptake and accumulation of trace metals in the edible plant parts with a resulting risk to human and animal health. They can also cause illnesses in humans and animals ingesting the produce through the food chain. The ubiquitous distribution and known toxicity of lead pollution in urban environment are posing great concern, in terms of human health and environment [10].

As follows from Table 1, 2, 3, 4, 5 and 6, the presence of trace heavy metals determined (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) indicated that some of these fruits and vegetables grown in residential garden of satellite town in federal capital territory (FCT) Abuja could be carcinogenic [21].The carcinogenicity nature from observation has no correlation from the nature of fruits and vegetables but from the soils where the fruits and vegetables were cultivated. Even though toxic trace elements present in studied samples do not entirely determine the risk likely to be caused by the fruits and vegetables consumptions, they can become more hazardous where they are present in higher concentrations, and could lead to higher health risk. Special attention has been given to the elements that play a significant toxicological role after entering the human body through contaminated fruits and vegetables consumptions. For instance, research has shown that significant flux of heavy metal, among other toxins, reach the lungs through consumption of contaminated food products [22].

All the samples contained detectable amounts of these heavy metals of interest. Pb, a ubiquitous and versatile metal was also detected in all the samples. It has become widely distributed and mobilized in the environment and human exposure to and uptake of this non-essential element has consequently increased [23]. At high levels of human exposure, there is damage to almost all organs and systems, most importantly the central nervous system, kidneys and blood, culminating in death at excessive levels. At low levels, haem synthesis and other biochemical processes have been reported to be affected by lead contamination [24, 25]. Lead continues to be a significant public health problem in developing countries where there are considerable variations in the sources and pathways of exposure, therefore care need to be taking in the consumption of Pb contaminated fruit and vegetable products since Pb exposure is through direct contact. It was investigated and it has been shown that exposure to Pb can lead to a wide range of biological defects in human depending on duration and level of exposure. The developing foetus and infants are far more sensitive than adults. High exposure can cause problems in the synthesis of haemoglobins, damage to the kidneys, gastrointestinal tract, joints, reproductive system and the nervous system. Cadmium when ingested by humans, it accumulates in the intestine, liver and kidney [24]. The health effects of chronic exposure of Cd include proximal tubular disease and osteomalacia. Long term exposure to cadmium is associated with renal dysfunction. Cadmium is bio persistent and once absorbed remains resident for many years. High exposure can lead to obstructive lung diseases and has been linked to lung cancer. Cadmium may also cause bone defects in humans and animals. The average daily intake for humans is estimated as 0.15 µg from air and 1µg from water [26]. Maximum limit of 0.2 µg/g Cd in plant and 5.0 µg/g Pb in plant was prescribed by WHO/FAO [27]. The values for the standard compared to our work indicate Cd pollution of some fruits and vegetables grown in residential garden in the study areas. Chromium is considered non-essential for plants, but an essential element for animals. The average abundance of Cr in the earth's crust is 122 ppm; in soils Cr ranges from 11-22 ppm [13]. Cr toxicity in man has been limited to haemorrhage, respiratory impairment and liver lesions [13]. Low exposure to chromium can irritate the skin and cause ulceration. Long term exposure can cause kidney and liver damage. It can also cause damage to circulatory and nerve tissues. In this work, Cr was found to ranged between 0.011 – 0.092 µg/g with an average of 0.040±0.023 µg/g. This value is less than 150 µg/g safe limits giving by EU commission regulation [39] Cr concentration in this study is lower than 0.10 µg/g maximum limit set by WHO/FAO [27].

Levels of Ni in the six type of fruit and vegetable sample products analyzed were almost similar, the slight differences in their concentration were statistically not significant ($p<0.5$). The mean Ni concentration in the sample products (0.067, 0.057, 0.064, 0.063, 0.047 and 0.067 µg/g). It is important to note that Ni concentrations in all the samples investigated were lower than what was obtained by other researchers in the similar studies [13, 15]. Nickel apparently has a limited acute toxicity in humans, including airway irritation, but the important adverse effects relate to allergic eczema and respiratory cancers [10, 13]. Excessive amounts of nickel can be mildly toxic. Long term exposure can cause decreased body weight, heart and liver damage and skin irritation; the symptoms of exposure to some poisonous nickel compounds include nausea, vomiting, headaches and sleeplessness. The symptoms get worse later on from 12 to 24 hours after exposure and include a speeding heart, difficult breathing, chest pains and extreme fatigue.

The mean levels of Co and Cu in the samples studied were 0.039±0.011 and 0.476±0.162 µg/g. The average Fe concentration (1.037±0.975 µg/g) was obtained in the samples studied .Copper, cobalt and iron are classified as essential to life due to their involvement in certain physiological processes, but elevated levels of these elements, however, have been found to be toxic. Copper, Fe and Co form the essential group of metals required for some metabolic activities in organisms. Toxicological effects of large amounts of Co include vasodilatation, flushing and cardiomyopathy in humans and animals and high doses of copper can cause anaemia, liver and kidney damage, and stomach and intestinal irritation. People with Wilson's disease are at greater risk for health effects from over exposure to copper. Mn concentration in all the samples studied ranged from 0.078 – 0.922 µg/g and higher concentration of Mn was detected in the Spinach plants. Manganese is known to block calcium channels and with chronic exposure results in CNS dopamine depletion. This duplicates almost all of the symptomology of Parkinson's disease.

According to the mean and range values (Table 7) of the Co, Cu, Fe and Mn in the all samples of fruits and vegetables studied revealed that the levels of these metals were lower than the limit level for standard for World Health Organization [27].

The mean concentration of Zn in the six fruit and vegetable samples analyzed ranges from 1.098 to 2.97 µg/g. Thus in the present study, the highest amount of Zn found in the samples is much lower than the permissible level of 250: µg/g [7, 27]. However, these values are similarly related to those reported in several studies [28, 29, and 30]. Although humans can handle proportionally large concentrations of zinc, too much zinc can still cause eminent health problems, such as stomach cramps, skin irritations, vomiting, nausea and anaemia. Very high levels of zinc can damage the pancreas and disturb the protein metabolism, and cause arteriosclerosis [10, 13].

From the range and mean values, there is a clear indication that the fruits and vegetables grown in urban residential garden contained trace heavy metals in various concentrations. There was however no appreciable difference in the concentration of heavy metals in all the samples studied. Analysis of Variances (ANOVA) showed a no significant variation (P<0.05) between the concentration of heavy metals in the all the fruit and vegetable samples analyzed. All the samples contained these heavy metals. The sources of these heavy metals on the fruit and vegetable samples from urban residential garden may be attributed to application of sludges, phosphate fertilisers, composite manures, irrigation with contaminated water and geological distribution of minerals that vary from one location to the other[6,7].

Pearson correlation among heavy metals in the studied sample products was calculated to see if some metals were interrelated and the results are presented in Table 8. Correlation study of the data indicated a strong correlation between some metals determined like in pumpkin Ni/Pb shown perfect correlation, while Cd is also positively correlated with most of the metal in most of the samples studied. The negative correlation was observed in some of the metals shows that the metals are probably not from the same source and the presence of one does not necessarily indicate the presence of the other.

Although the trace heavy metal determined were present in all the fruit and vegetables studied but the present concentrations may not pose any serious health hazard except Cd all parameters examined in the fruit and vegetable samples have values that are below or within the maximum permissible limit of WHO, FAO and EC Standards, hence the present result may not pose any serious health hazard, but attention should be given to Cd which present some samples at level more than permissible limit of WHO standard and Pb could be harmful to human after prolong exposure to these pollutants even at lower concentration.

Table 1: Trace heavy Metal contents (µg/g) of okro harvested from residential farm garden within study area

Metals	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
A	0.023	0.035	0.056	0.432	0.367	0.122	0.045	0.012	1.231
B	0.012	0.045	0.042	0.231	0.445	0.131	0.065	0.017	1.971
C	0.042	0.033	0.022	0.653	0.534	0.765	0.055	0.012	1.554
D	0.035	0.034	0.011	0.788	0.723	0.144	0.067	0.011	1.767
E	0.025	0.041	0.012	0.678	0.338	0.175	0.061	0.013	1.876
F	0.011	0.045	0.028	0.133	0.512	0.166	0.087	0.018	1.997
G	0.013	0.042	0.017	0.699	0.334	0.098	0.092	0.021	1.543
H	0.015	0.037	0.021	0.589	0.321	0.144	0.077	0.016	1.234
I	0.017	0.038	0.025	0.321	0.332	0.089	0.054	0.011	1.543
J	0.021	0.033	0.029	0.431	0.412	0.201	0.071	0.019	1.675

Table 2: Trace Heavy Metal contents (µg/g) of Spinach harvested from residential farm garden within study area

Metals	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
A	0.067	0.048	0.026	0.444	0.512	0.078	0.055	0.014	1.654
B	0.078	0.044	0.019	0.333	0.435	0.132	0.045	0.012	1.098
C	0.082	0.042	0.018	0.237	0.412	0.141	0.065	0.013	1.123
D	0.079	0.041	0.029	0.387	0.234	0.211	0.081	0.011	1.543
E	0.063	0.048	0.023	0.298	0.433	0.171	0.055	0.028	1.987
F	0.072	0.032	0.055	0.422	0.332	0.122	0.045	0.012	1.231
G	0.082	0.044	0.041	0.232	0.441	0.131	0.065	0.017	1.971
H	0.062	0.036	0.022	0.453	0.431	0.465	0.054	0.012	1.534
I	0.054	0.045	0.014	0.488	0.332	0.134	0.057	0.011	1.567
J	0.064	0.032	0.012	0.428	0.234	0.165	0.051	0.014	1.476

Table 3: Trace Heavy Metal contents (µg/g) of fluted Pumpkin leaves harvested from residential farm garden within study area

Metals	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
A	0.076	0.045	0.057	0.544	0.311	0.922	0.085	0.095	2.123
B	0.063	0.055	0.059	0.512	0.411	0.831	0.055	0.065	2.971
C	0.052	0.043	0.049	0.445	0.349	0.701	0.065	0.075	2.554
D	0.055	0.044	0.035	0.432	0.218	0.744	0.057	0.067	2.065
E	0.045	0.051	0.056	0.612	0.378	0.875	0.051	0.061	2.876
F	0.065	0.055	0.088	0.551	0.412	0.666	0.077	0.087	1.997
G	0.075	0.052	0.045	0.456	0.321	0.698	0.082	0.092	2.543
H	0.054	0.047	0.075	0.475	0.422	0.844	0.067	0.077	2.234
I	0.068	0.048	0.067	0.621	0.321	0.689	0.044	0.054	2.543
J	0.053	0.043	0.073	0.552	0.322	0.801	0.061	0.071	2.675

Table 4: Trace Heavy Metal contents (µg/g) of pepper fruits harvested from residential farm garden within study area

Metals	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
A	0.063	0.058	0.092	0.544	0.332	0.788	0.045	0.055	2.654
B	0.028	0.054	0.088	0.657	0.245	0.732	0.075	0.085	2.098
C	0.067	0.052	0.075	0.567	0.451	0.841	0.055	0.065	2.012
D	0.057	0.051	0.077	0.554	0.422	0.887	0.071	0.081	2.122
E	0.033	0.058	0.054	0.674	0.321	0.771	0.065	0.075	1.987
F	0.052	0.044	0.072	0.701	0.411	0.811	0.062	0.071	2.675
G	0.062	0.054	0.058	0.543	0.323	0.832	0.054	0.064	2.971
H	0.053	0.042	0.074	0.612	0.451	0.843	0.066	0.076	2.233
I	0.027	0.033	0.087	0.557	0.511	0.733	0.074	0.087	2.097
J	0.043	0.044	0.048	0.556	0.388	0.702	0.066	0.077	2.553

Table 5: Trace Heavy Metal contents (µg/g) of Maize seed harvested from residential farm garden within study area

Metals	**Cd**	**Co**	**Cr**	**Cu**	**Fe**	**Mn**	**Ni**	**Pb**	**Zn**
A	0.033	0.028	0.032	0.345	3.199	0.688	0.035	0.045	2.154
B	0.028	0.014	0.028	0.234	2.015	0.632	0.055	0.055	2.018
C	0.027	0.012	0.025	0.431	2.101	0.541	0.045	0.055	2.012
D	0.027	0.021	0.027	0.221	3.892	0.587	0.051	0.061	2.022
E	0.033	0.018	0.024	0.332	3.101	0.571	0.045	0.055	1.487
F	0.032	0.024	0.022	0.311	2.055	0.501	0.051	0.051	2.175
G	0.032	0.024	0.028	0.401	2.122	0.532	0.044	0.044	2.271
H	0.033	0.012	0.024	0.302	2.288	0.643	0.046	0.046	2.133
I	0.027	0.023	0.027	0.543	2.014	0.533	0.054	0.067	2.017
J	0.033	0.014	0.028	0.643	2.374	0.602	0.046	0.057	2.053

Table 6: Trace Heavy Metal contents (µg/g) of Tomatoes harvested from residential farm garden within study area

Metals	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
A	0.023	0.035	0.056	0.432	2.511	0.122	0.045	0.012	1.231
B	0.012	0.045	0.042	0.231	2.321	0.131	0.065	0.017	1.971
C	0.042	0.033	0.022	0.653	1.975	0.765	0.055	0.012	1.554
D	0.035	0.034	0.011	0.788	2.245	0.144	0.067	0.011	1.767
E	0.025	0.041	0.012	0.678	2.331	0.175	0.061	0.013	1.876
F	0.011	0.045	0.028	0.133	1.859	0.166	0.087	0.018	1.997
G	0.013	0.042	0.017	0.699	2.222	0.098	0.092	0.021	1.543
H	0.015	0.037	0.021	0.589	1.789	0.144	0.077	0.016	1.234
I	0.017	0.038	0.025	0.321	2.208	0.089	0.054	0.011	1.543
J	0.021	0.033	0.029	0.431	2.156	0.201	0.071	0.019	1.675

Table 7: Summary of the results of total heavy metal content of crops and vegetables from the study area

Metals	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
Okro									
Mean.	0.021	0.038	0.026	0.496	0.432	0.204	0.067	0.015	1.639
STD	0.010	0.005	0.014	0.220	0.128	0.200	0.015	0.004	0.273
MIN	0.011	0.033	0.011	0.133	0.321	0.089	0.045	0.011	1.231
MAX.	0.042	0.045	0.056	0.788	0.723	0.765	0.092	0.021	1.997
Spinach									
Mean.	0.070	0.041	0.026	0.372	0.380	0.175	0.057	0.014	1.518
STD	0.010	0.006	0.013	0.092	0.093	0.108	0.011	0.005	0.310
MIN	0.054	0.032	0.012	0.232	0.234	0.078	0.045	0.011	1.098
MAX.	0.082	0.048	0.055	0.488	0.512	0.465	0.081	0.028	1.987
Pumpkin									
Mean.	0.061	0.048	0.060	0.520	0.347	0.777	0.064	0.074	2.458
STD	0.010	0.005	0.016	0.067	0.062	0.089	0.014	0.014	0.340
MIN	0.045	0.043	0.035	0.432	0.218	0.666	0.044	0.054	1.997
MAX.	0.076	0.055	0.088	0.621	0.422	0.922	0.085	0.095	2.971
Pepper									
Mean.	0.049	0.049	0.073	0.597	0.386	0.794	0.063	0.074	2.340
STD	0.015	0.008	0.015	0.060	0.080	0.059	0.010	0.010	0.344
MIN	0.027	0.033	0.048	0.543	0.245	0.702	0.045	0.055	1.987
MAX.	0.067	0.058	0.092	0.701	0.511	0.887	0.075	0.087	2.971
Maize									
Mean.	0.031	0.019	0.027	0.376	2.516	0.583	0.047	0.054	2.034
STD	0.003	0.006	0.003	0.133	0.651	0.059	0.006	0.007	0.211
MIN	0.027	0.012	0.022	0.221	2.014	0.501	0.035	0.044	1.487
MAX.	0.033	0.028	0.032	0.643	3.892	0.688	0.055	0.067	2.271
Tomatoes									
Mean	0.021	0.038	0.026	0.496	2.162	0.204	0.067	0.015	1.639
STD	0.010	0.005	0.014	0.220	0.225	0.200	0.015	0.004	0.273
MIN	0.011	0.033	0.011	0.133	1.789	0.089	0.045	0.011	1.231
MAX.	0.042	0.045	0.056	0.788	2.511	0.765	0.092	0.021	1.997
All the samples									
Mean.	0.041	0.039	0.040	0.476	1.037	0.456	0.061	0.041	1.938
STD	0.021	0.011	0.023	0.162	0.975	0.301	0.014	0.028	0.463
MIN	0.011	0.012	0.011	0.133	0.218	0.078	0.035	0.011	1.098

MAX	0.082	0.058	0.092	0.788	3.892	0.922	0.092	0.095	2.971

Table 8: Inter–elemental correlation among the study Heavy metals

Metals→	Cd	Co	Cr	Cu	Fe	Mn	Ni	Pb	Zn
		-0.726	-0.273	0.616	0.561	0.721	-0.519	-0.648	-0.113
			0.047	-0.492	-0.239	-0.418	0.484	0.467	0.567
Okro				-0.615	-0.224	-0.132	-0.419	0.011	-0.237
					0.175	0.245	-0.009	-0.233	-0.311
						0.315	0.000	-0.286	0.412
							-0.267	-0.250	-0.043
								0.817	0.275
									0.199
		0.026	0.385	-0.737	0.076	-0.249	0.390	-0.130	-0.272
			-0.238	-0.321	0.596	-0.355	0.250	0.421	0.422
				-0.141	0.064	-0.160	-0.026	0.004	0.087
Spinach					-0.307	0.245	-0.286	-0.450	-0.109
						-0.040	-0.276	0.319	0.191
							0.075	-0.107	0.052
								-0.063	0.284
									0.666
		0.278	0.007	0.011	-0.131	-0.147	0.557	0.557	-0.296
			0.301	0.254	0.593	-0.141	0.056	0.056	0.223
Pumpkin				0.511	0.677	-0.035	0.063	0.063	-0.136
					0.254	0.206	-0.375	-0.375	0.290
						0.139	0.049	0.049	0.274
							0.043	0.043	0.194
								1.000	-0.525
									-0.525
		0.327	-0.016	-0.414	0.136	0.732	-0.769	-0.788	0.442
			-0.081	0.067	-0.768	0.223	-0.499	-0.542	0.083
Pepper fruit				-0.077	0.098	0.096	0.028	0.041	-0.240
					-0.284	-0.123	0.309	0.246	-0.210
						0.244	0.152	0.194	-0.233
							-0.289	-0.331	0.028
								0.995	-0.567
									-0.568
		0.142	-0.021	0.105	0.037	0.277	-0.603	-0.684	0.002
			0.359	-0.082	0.288	-0.120	-0.260	-0.137	0.262
Maize corn				0.166	0.267	0.594	-0.415	-0.102	0.283
					-0.380	-0.231	-0.109	0.293	0.059
						0.376	-0.317	0.078	-0.333
							-0.436	-0.320	0.025
								0.661	-0.078
									-0.395
		-0.726	-0.273	0.616	0.086	0.721	-0.519	-0.648	-0.113

	0.047	-0.492	-0.032	-0.418	0.484	0.467	0.567
Tomatoes		-0.615	0.388	-0.132	-0.419	0.011	-0.237
			0.092	0.245	-0.009	-0.233	-0.311
				-0.328	-0.523	-0.267	0.017
					-0.267	-0.250	-0.043
						0.817	0.275
							0.199

CONCLUSION

Analysis of some of the trace heavy metals distribution in six different fruit and vegetable products grown in residential garden in some satellite town in Abuja metropolis has been conducted in some. Nine trace heavy metals have been determined for all the samples. The mean levels of trace heavy metals like Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn were found distributed in all the fruit and vegetable samples which were investigated. The level of these metals especially Cd was higher in the Spinach and pumpkin vegetables. The concentration levels of this metal (Cd) in some of the fruits and vegetable samples are in excess compared to safe limits specified by the WHO's in food samples indicating potential health risk for consumer of such fruits and vegetables. The study is of the view that the common practice of application of fossil fuel combustion, waste incineration, emissions from car exhaust, pesticide and fertilizer usage, sewage sludge, organic matter amendments, such as compost, fertilizers and refuse wastes from home normally increase the heavy metal contents of residential garden thereby increase metal uptake by fruit and vegetable crops grown in such garden. For the safety of population that depends on such fruits and vegetables as mineral and fibre source, routine assessment of heavy metals contaminants in vegetables grown on residential garden in urban areas is necessary. In order to reduce the health risk caused by taking the contaminated fruits and vegetables, the use of compost, fertilizer to boost yield or excess dumping of refuse in such garden should be discourage by authority.

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