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Influence of Municipal Wastes on the Mineral Contents of Food Crops Found at Selected Dump Sites in Owerri, Imo State, Nigeria

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Abstract: The influence of municipal wastes from selected dump sites in Imo State Nigeria, on the mineral and proximate contents of some crops found at the dumps was studied. The dump sites were located at Egbu-Timber road (5°31'57"N, 7°3'55"E) and World Bank layout (5°28'25"N, 7°1'10"E) in Owerri (both in Imo State, Nigeria). The Egbu Timber road dump is a tertiary dump site while the World Bank layout dump is a primary dump site. At the Egbu sample sites, the dump soil chromium content was 91.33% higher than that of the soil of the nearby normal farm. The farm crops also picked significant quantities of chromium. The nickel contents of crops should be watched as a substantial quantity was observed among the samples in relation to the soil nickel contents. There was also no substantial uptake of lead by the plants at this dump site. At the Owerri World Bank Housing Estate sample sites, some of the plants picked up some quantity of lead. There was a significant ($p<0.05$) pickup of vanadium by the dump pawpaw. The potassium contents of the crops at all the sample sites had the mineral values of the normal farm crops being much higher than those at the dump.

Key words: Municipal wastes, mineral content, proximate composition, dump site crops, Imo State, Nigeria

INTRODUCTION

Wastes are unused or left over portions of raw materials or products that are no longer wanted and thus often discarded (Hornby, 2000). Solid wastes can be grouped as biodegradable and non-biodegradable (Smith, 1996). They can also be grouped as hazardous and non-hazardous. The mismanagement of waste has been implicated in the pollution of ground water, streams, lakes and rivers as well as damages to the wildlife and vegetation. Plants (edible crops inclusive) have been reported to pick up some elements or components of degenerating solid waste and these often end up in the edible portion constituting some health hazard due to the intake of harmful elements/compounds or undesirable high level of needed elements which may cause body imbalance of nutrients (Nwafor, 2006). Unfortunately, wastes are still being dumped untreated along the road sides and in old borrow pits in Nigeria. Apart from the offensive odour emanating from such dumps and their serving as breeding sites for rodents and disease vectors, food crops such as pawpaw (*Carica papaya*), water leaf (*Talinum triangulare*), sweet potato (*Ipomoea batata*), cocoyam (*Xanthosoma* sp.) and even cassava (*Manihot* sp.) have been known to thrive on such sites. These crops are often harvested for consumption or sale by the scavengers of the dumps. The objectives of this study were: to identify the type of solid wastes at designated dump sites in Owerri (the capital city of Imo State) to harvest and determine the mineral contents of selected common edible crops growing on such sites and nearby normal farms outside the dumps; to compare the level of different mineral contents in each crop from normal and waste dump soils so as to detect the effect of the dumped wastes on the particular crops.

MATERIALS AND METHODS

The samples for this study were collected from two dumpsites. The dump sites were located at Egbu-Timber road (5°31'57"N, 7°3'55"E) and World Bank layout (5°28'25"N, 7°1'10"E) in Owerri (both in Imo State, Nigeria). The Egbu Timber road dump is a tertiary dump site while the World Bank layout dump is a primary dump site.

The crop samples growing in the dumps and collected for the study included pawpaw (*Carica*

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papaya) fruits, cocoyam (*Colocosia esculenta*) corms melon (*Colocynthis citrullus*) pods, cassava (*Manihot esculenta*) tubers, pumpkin (*Cucurbita pepo*) leaves, fluted pumpkin (*Telferia occidentalis*) leaves, sweet potato (*Ipomeoa batatas*) leaves, ahihara (*Corchorius olitorius*) leaves and waterleaves (*Talinum triangulare*). Cassava tubers were only seen and collected at the Egbu timber road dump in Owerri. Soil samples were collected with a new shovel and a hand trowel from every dump site studied and then put in plastic bags. Matching soil and similar plant materials samples were collected from the normal (non-dump) farms adjacent to the dump site, to form the reference (control) sample. The soil samples were air dried by exposure to ambient dry air then later ground and sieved to homogenous samples which were used for analysis. The plant sample were dried in the oven and pulverized with a corona type milling machine and stored in plastic containers for analyses.

The pH determinations were done in the Food Science and Technology Laboratory of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The bulk of the analytical research was done at the Laboratory of the Aluminum Smelting Company of Nigeria, Ikot-Abasi and Akwa-Ibom State.

The method described by Radojevic and Bashkin (1999) was employed for the pH determination. Here a 20 g sample of fresh soil which was free from stones, twigs and larger materials was placed in a beaker. About 40 mm of distilled water was added and it was vigorously stirred on a magnetic stirrer then allowed to stand for 30 min after which the pH was determined with the aid of a digital pH meter.

Determination of soil redox potential: The method described by Radojevic and Bashkin (1999) was adopted. Some 20 g sample of fresh soil sample free from stones, twigs and larger materials were placed in separate beakers. About 40 mL of distilled water was added to each with vigorous stirring on a magnetic stirrer. The samples were allowed to stand for 30 min. The redox potential was determined by measuring the potential difference between a platinum electrode and a reference electrode. The electrodes were immersed into the samples in the beaker. The potential was recorded in volts when the reading stabilized after a few minutes. The electrodes were rinsed with distilled water between each reading.

Determination of hydrogen cyanide content: The Acid Titration Method described by Onwuka (2005) was employed. A 5 g sample was dispersed in 50 mL distilled water in a corked conical flask. The sample was allowed to stay overnight for the extraction of HCl. The extract was filtered and the filtrate used for the cyanide determination. An alkaline picrate solution was prepared by dissolving 1 g of picrate and 50 g of sodium carbonate in 20 mL warm water. The volume was made up to 200 mL with distilled water. To 1 mL of the sample filtrate, 4 mL of the alkaline picrate solution was added in a corked test-tube and incubated in a water bath for 5 min. After a reddish brown colour developed, the absorbance of the mixed solution was read in a spectrophotometer at 490 nm. The absorbance of the blank containing only 1 mL distilled water and 4 mL alkaline picrate solution was read. The cyanide content was then extrapolated from a standard cyanide curve.

Mineral content determinations

Extraction of plant material for mineral determination: The wet ashing method described by Radojevic and Bashkin (1999) was employed. Here a 0.5 g of the oven dried ground and sieved samples (≤1 mm) were weighed into a 50 mL Kjedahl flask. About 1 mL of perchloric acid, 5 mL of nitric acid and 0.5 mL of the tetraoxosulphate (vi) acid were added. The mixture was gently swirled and digested at moderate heat first and then the heat was increased slowly. It was digested for 15 min after the appearance of white fumes. The flask was slowly cooled and then 10 mL of water added (for iron and manganese determination, it was boiled for 5 min before filtering). The mixture was filtered into a 50 mL volumetric flask and made up to the mark with distilled water. Blanks were prepared by repeating the same procedure but omitting the plant material. Calibration curves were prepared for standard solutions. Lead, iron, magnesium, nickel, vanadium, manganese, calcium, arsenic, copper, potassium, sodium, sulphur, cadmium and zinc were the minerals determined using the method described by Vogel (1978).

Soil digestion for mineral analysis: The method described by Radojevic and Bashkin (1999) was employed for the digestion. The soil samples were crushed manually using mortar and pestle. Individual samples from the same location were bulked into one sample in order to give an average value. Further reduction was achieved by passing through a coarse 2 mm sieve.

Dissolution and extraction: The method of MAFF (1981) was employed. About 1 g of dried and homogenized soil was weighed into a beaker and 10 mL nitric acid was added. The resultant mixture was heated until dryness. Thereafter, 10 mL HNO_3 and 3 mL $HClO_4$ were added and the solution was heated till fuming. The sample solution was obtained by processing residue with hot Emol/Hec (4 mL) and then filtered and diluted with water to 50 mL.

Mineral contents of the soil: After the procedure enumerated above was followed the individual elements were determined using the same procedure for the plant elemental determinations (Vogel, 1978).

Statistical analysis: The two-way ANOVA in randomized block was employed in analyzing the data using the SAS 1999 Version. The mean was separated using LSD at 95% confidence interval.

RESULTS AND DICUSSION

Dump site visual components: The dump site visual components are shown in Table 1. Visually, the components of the dump sites included paper materials of all forms, plastic containers and films, rubber materials (tyres and old foot wears), wood and textile materials, bottles and broken glasses, asbestos, electronic parts, animal carcasses and faeces among many other materials and also some unidentified materials. Observed with these unsightly objects were some edible crops growing among the heavily flourishing weeds and other plants.

Apart from the visual polluting components there was strong foul/objectionable odour perception around all the dump sites. Hosetti reported that many parameters govern the potential of infectious diseases through solid waste handling. The report further stated that some endemic pathogens such as entereovirus were so common and infectious in the developing countries that most young people acquired long life immunity at an early age with the result that additional environmental exposure do not cause any significant effects on health even under most unsanitary conditions. Hence, the consumers of foods from these dumps might or might not suffer from infections from microorganisms depending on their level of immunity though, other risks may exist from corroded metals and burnt substances that mix with the soil.

Soil pH, redox potential (mV) and salinity (g L^{-1}): From the Table 2, it was observed that the pH of the dump site soils were higher in values than the soil pH of normal farms near the dumps. That is the soils of the nearby farms tended to be more acidic than the soils of the dump. The pH which has been defined as the negative logarithm of the hydrogen ion activity is a measure of the free acidity that is the concentration of strong acids in dissociated form and not the total acidity present (Radojevic and Bashkin, 1999). The soil samples pH at the normal farms near the Egbu dump (4.57) is <pH 5.5. Soils with pH <5.5 were feared to contain exchangeable aluminum ions leached from clay minerals at high levels and could be toxic to plants (Radojevic and Bashkin,

Table 1: Components of the various dump sites

Dump components	Egbu dump	Owerri World Bank dump
Paper (pieces and cartons)	++	++
Plastics (scraps, cans and containers)	++	++
Rubber (tyres and foot wears)	++	+
Cellophane	+++	+++
Wood (chippings and pieces)	++	+
Textiles	++	++
Broken glasses	+++	++
Bottles		++
Metal (scraps and containers)	+++	++
Faeces		+++
Yard (tree, bush and grass trimmings)	+	+++
Dead animals	+	+
Asbestos		
Charcoal and burnt materials	+++	+++
Constructed and demolition debris	+	+
Bone	++	
Food scraps/wastes	+++	+++
Electronics parts	+++	+++
Farm yard wastes	+	+++
Leather	+	+
Unidentified material	+++	+++

+: Small amount observed; ++: Moderate amount observed; +++: Larger quantity observed

Table 2: The pH, redox potential (mV) and salinity of the soil samples

Sample site	pH	Redox potential	Salinity (g L^{-1})
Egbu normal farm	4.57	147	0
Egbu dump	7.49	8	0
Owerri World Bank normal farm	6.25	33	0
Owerri World Bank dump	6.57	11	0

1999). The redox potential values at the Egbu dump site (8 mV), Owerri World Bank dump soil (11 mV) potential values at the Egbu dump site (8 mV), Owerri World Bank dump soil (11 mV) are positive. Positive values indicated that the environments have enough oxygen for biodegradation. Redox potential determines the geochemical mobility of pollutants and nutrients (especially sulphur, nitrogen, phosphorus and heavy metals) in various compartments of the environment and consequently their influence on ecosystems (Radojevic and Bashkin, 1999). The salinity (g L^{-1}) of all the soil samples studied was 0.0 g L^{-1}. This might probably be attributed to the fact that the chosen sites were not in coastal areas.

The mineral compositions (mg kg^{-1}) of samples at Egbu: The mineral compositions (mg kg^{-1}) of samples at Egbu sample sites are shown in Table 3. At the Egbu sample sites, the aluminum content of the dump soil was significantly ($p<0.05$) higher than the aluminum content of the normal site soil. The levels of aluminum in the crops at both the dump and nearby normal farm were very low. At the dump, Ahihara that had the lowest aluminum content (1.89 mg kg^{-1}) gave a 0.91% level of aluminum in relation to the mineral in the dump soil. At the nearby normal farm at Egbu, pawpaw which had the lowest quantity of aluminum (0.681 mg kg^{-1}) had 0.92% level of aluminumin relation to the soil aluminum. While cassava with the highest aluminum content at the normal farm (2.10 mg kg^{-1}) had a 2. 82% of aluminum level in relation to the soil aluminum. The percentage of aluminum increase between the dump pawpaw and the farm pawpaw was as high as 270.59% (Table 3). The arsenic contents of the soil samples and the vegetation all tended to zero. The Calcium contents of the dump soil ($p \le 0.05$) exceeded that of the farm soil. The calcium contents of the crops also significantly ($p \le 0.05$) exceeded those of the nearby normal farm. Cassava tubers had a 20.59% increase between the normal farm samples and dump site samples (Table 3). The highest calcium value was from water leaf at the dump. It had a 71.34% level of calcium in relation to the dump soil calcium. While cassava with the least value at the dump had 68.61% level of calcium in relation to the soil calcium. At the normal farm, water leaf also had the highest percentage (70.68%) of calcium level in relation to the soil calcium. Cassava also had the least calcium quantity at the Egbu normal farm and this gave a 57.65% level of calcium in relation to the soil calcium. Water leaf may have an affinity for calcium. The plants sampled appeared to have high calcium contents and that may lead one to wonder why these vegetables are not included as major sources of calcium. The high up take of calcium by crops is an advantage as it has been reported that calcium is the most abundant mineral in the body and it is essentially required by all body processes. The high calcium content of the vegetation at the sample sites may not pose a threat to the consumers. This is because vegetables provide no calcium or little calcium to the body because they contain certain binders that prevent calcium absorption (Sizer and Whitney, 1994).

Table 3: Mineral composition (mg kg^{-1}) of samples and percentage (%) increase/decrease between them at Egbu (Imo State)

Egbu location	Al	As	Ca	Cd	CN	Co	Cr	Cu	Fe	K
Normal farm soil	74.230^{b}	0.00^{a}	1840.950^{b}	0.71^{b}	-	8.470^{a}	34.16^{b}	18.420^{d}	1327.100^{b}	112.000^{i}
Dump site soil	207.450^{a}	0.00^{a}	1865.250^{a}	1.45^{a}	-	5.240^{b}	65.36^{a}	34.610^{a}	1366.100^{a}	285.000^{h}
Percentage between farm soil and dump soil	179.470	0.00	1.320	104.23	0.000	38.130*	91.33	87.890	2.940	154.460
Ahihara leaves										
Farm crops	1.120^{f}	0.00^{a}	1269.150^{g}	0^{c}	-	3.950^{d}	2.53^{g}	17.050^{e}	88.150^{j}	8930.000^{f}
Dump crops	1.890^{e}	0.00^{a}	1289.250^{f}	0^{c}	-	4.470^{d}	3.08^{f}	18.850^{c}	98.220^{c}	8050.000^{g}
Percentage between Ahihara leaves at farm and dump	68.750	0.00	1.580	0	-	13.160	21.74	10.560	11.420	9.850*
Cassava tubers										
Farm crops	2.100^{e}	0.00^{a}	1061.250^{j}	0^{c}	3.740^{b}	3.730^{h}	1.96^{g}	7.410^{i}	382.520^{g}	8050.000^{g}
Dump crops	2.280^{d}	0.00^{a}	1279.750^{h}	0^{c}	4.480^{a}	3.980^{g}	11.33^{c}	8.650^{h}	387.610^{g}	11700.000^{b}
Percentage between cassava and the farm and dump	8.570	0.00	20.590	0	19.790	6.700	478.06	16.730	1.330	45.340
Unripe pawpaw										
Farm crops	0.680^{g}	0.00^{a}	1251.750^{i}	0^{c}	-	4.080^{f}	4.04^{e}	14.340^{g}	589.100^{d}	10200.000^{d}
Dump crops	2.520^{d}	0.00^{a}	1318.250^{d}	0^{c}	-	5.190^{c}	5.78^{d}	19.050^{b}	591.810^{c}	10700.000^{c}
Percentage between pawpaw at the farm and dump	270.590	0.00	5.310	0	-	27.210	43.07	32.850	0.460	4.900
Water leaves										
Farm crops	2.010^{e}	0.00^{a}	1301.250^{e}	0^{c}	-	4.330^{e}	3.06^{f}	14.410^{f}	191.410^{h}	11900.000^{a}
Dump crops	2.820^{c}	0.00^{a}	1330.750^{c}	0^{c}	-	4.480^{d}	3.14^{f}	18.230^{e}	465.910^{e}	10100.000^{e}
Percentage between waterleaves at the farm and dump	40.300	0.00	2.270	0	-	3.460	2.61	26.510	143.140	17.820*
LSD	0.248	0.00	0.735	0.003	0.031	0.026	0.48	0.032	0.139	0.774

Egbu location	Mg	Mn	Na	Ni	Pb	S	Se	Va	Zn
Normal farm soil	374.880^{d}	544.48^{b}	355.130^{b}	2.22^{c}	3.99^{b}	2.610^{e}	0	2.010^{c}	160.220^{d}
Dump site soil	582.350^{a}	1138.78^{a}	378.730^{a}	6.36^{a}	10.23^{a}	21.680^{a}	0	4.860^{a}	347.510^{a}
Percentage between farm soil and dump soil	55.340	109.15	6.650	186.49	156.39	730.650	0	141.790	116.900
Ahihara leaves									
Farm crops	309.750^{f}	18.62^{i}	55.830^{j}	0.09^{g}	0^{c}	0.780^{i}	0	0.060^{g}	61.350^{g}
ump crops	550.250^{b}	24.75^{h}	154.980^{h}	0.26^{f}	0^{c}	16.490^{b}	0	0.230^{f}	64.010^{g}
Percentage between ahihara leaves at farm and dump	77.640	32.92	117.590	188.89	0	2014.100	-	283.330	4.340
Cassava tubers									
Farm crops	306.250^{g}	13.22^{j}	78.780^{i}	0.19^{g}	0^{c}	0.120^{j}	0	0.040^{g}	22.550^{h}
Dump crops	383.250^{c}	47.75^{g}	286.350^{g}	3.83^{b}	0^{c}	6.590^{c}	0	2.130^{b}	172.430^{c}
Percentage between cassava and the farm and dump	25.140	261.2	263.480	1915.19	0	5391.670	-	5225.000	664.660
Unripe pawpaw									
Farm crops	288.950^{i}	276.51^{f}	295.900^{f}	0.73^{e}	0^{c}	1.070^{g}	0	0.180^{f}	78.520^{f}
Dump crops	305.800^{h}	310.61^{e}	347.350^{c}	0.09^{c}	0^{c}	5.360^{d}	0	0.180^{f}	79.750^{f}
Percentage between pawpaw at the farm and dump	5.830	12.33	17.390	711.11*	0	400.930	-	0.000	1.570
Water leaves									
Farm crops	323.950^{e}	481.22^{d}	316.750^{e}	1.46^{d}	0	0.250^{h}	0	0.920^{e}	150.430^{e}
Dump crops	383.750^{c}	495.93^{c}	323.950^{d}	3.83^{b}	0	2.520^{f}	0	1.050^{d}	267.730^{b}
Percentage between waterleaves at the farm and dump	18.460	3.06	2.270	162.33	0	908.000	-	14.130	77.980
LSD	0.675	0.50	0.405	0.03	0.026	0.023	0	0.051	5.071

[a-c]Means with different superscripts along the same column are significantly different ($p<0.05$), *Percentage decrease

The cadmium content of the dump soil significantly ($p \leq 0.05$) exceeded that of the normal farm soil. There was a 104.23% increase (Table 3) between the normal farm soil and the dump soil. The cadmium contents of the crop samples were approximately zero. The plants picked little or none of the cadmium found in the soils. The soil cadmium values fell within the range of cadmium values (<0.01-8 mg kg^{-1}) reported as the concentration of cadmium in typical soils (Radojevic and Bashkin, 1999). It is probable that paint residues, plastics, batteries and metal plaited materials at the dump have not degenerated to the level whereby toxic quantities of cadmium in them will be picked by the soil and crops, respectively. It may also be that the sample sites are not located near industries where industrial emissions can cause atmospheric deposition which will enhance uptake by plants. The ingestion of cadmium is liable to cause acute gastritis with vomiting and diarrhea.

The cyanide content of the cassava at the dump was significantly ($p \leq 0.05$) lower than that at the normal farm. It is possible that the low cyanide variety of cassava stems were planted at the farm.

The chromium content of the dump soil was significantly ($p \leq 0.05$) greater than that of the farm soil. There existed a 91.33% increase between the farm soil chromium and that of the dump soil (Table 4). The chromium uptake by plants was also low both at the dump and at the nearby normal farms. At the dump, Ahihara with the lowest value of chromium had a level of 4.71% chromium value in relation to the soil chromium while cassava with the highest chromium content at the dump (11.34 mg kg^{-1}) had its level of chromium to be 17.33% in relation to the soil chromium. At the nearby normal farm cassava had the lowest percentage level of chromium (5.75%) in relation to the soil chromium while pawpaw with the highest chromium content (4.04 mg kg^{-1})

Table 4: Mineral composition (mg kg^{-1}) of samples and percentage (%) increase/decrease between them at World Bank Housing Estate Owerri (Imo State)

World Bank Owerri samples	Al	As	Ca	Cd	Co	Cr	Cu	Fe	K
Normal farm soil	35.910^{b}	0	1657.50^{b}	0.060^{e}	7.530^{e}	9.260^{b}	19.980^{d}	1207.250^{b}	118.400^{j}
Dump site soil	173.510^{a}	0	1835.50^{a}	2.200^{a}	12.870^{a}	17.560^{a}	25.730^{a}	1248.500^{a}	326.250^{i}
Percentage between farm soil and dump soil	383.181	0	10.74	3566.7	70.920	89.630	28.780	3.420	175.550
Ahihara leaves									
Farm crops	4.010^{f}	0	1269.50^{f}	0	5.060^{g}	3.920^{f}	17.400^{f}	100.450^{f}	13621.500^{a}
Dump crops	12.010^{c}	0	1282.50^{e}	0	10.040^{b}	4.170^{e}	19.250^{e}	207.100^{c}	12780.500^{c}
Percentage between ahihara leaves in farm and dump	199.500	0	1.02	0	98.420	6.380	10.630	106.170	6.580*
Pumpkin leaves									
Farm crops	1.070^{j}	0	1446.50^{d}	0	4.710^{h}	5.120^{d}	15.700^{b}	1.420^{j}	9462.500^{f}
Dump crops	2.630^{h}	0	1532.50^{c}	0.560^{c}	9.090^{c}	8.140^{c}	25.300^{a}	164.400^{d}	11432.500^{d}
Percentage between pumpkin leaves in farm and dump	145.790	0	5.95	0	92.990	58.980	61.150	11477.460	20.820
Melon seeds									
Farm crops	2.120^{i}	0	843.80^{i}	0	4.740^{h}	3.080^{h}	19.950^{e}	56.400^{i}	6810.500^{g}
Dump crops	10.010^{d}	0	917.10^{h}	0.810^{b}	9.080^{c}	3.750^{g}	23.050^{c}	88.120^{g}	4117.500^{h}
Percentage between Melon seeds at the farm and at the dump	419.340	0	8.69	0	91.560	21.750	15.540	56.240	39.540*
Unripe pawpaw fruit									
Farm crops	3.920^{g}	0	1215.50^{g}	0	5.120^{f}	1.790^{i}	15.450^{g}	68.720^{h}	10812.000^{e}
Dump crops	8.860^{e}	0	1282.50^{e}	0.150^{d}	8.080^{d}	3.970^{c}	24.600^{b}	125.200^{e}	13512.500^{b}
Percentage between pawpaw at the farm and dump	126.020	0	5.51	0	57.810	121.790	59.220	82.190	24.980
LSD	0.150	0	10.25	0.011	0.034	0.028	0.434	1.034	1.524

World Bank Owerri samples	Mg	Mn	Na	Ni	Pb	S	Se	Va	Zn
Normal farm soil	298.6000^{d}	38.5000^{c}	150.5800^{c}	4.14^{b}	1.85^{b}	2.590^{e}	0	2.330^{b}	80.7300
Dump site soil	345.5000^{a}	53.3800^{a}	243.2000^{a}	6.09^{a}	5.91^{a}	8.280^{a}	0	4.060^{a}	193.1800^{a}
Percentage between farm soil and dump soil	15.7100	38.6500	61.5100	47.1	219.46	219.690	0	74.250	139.2900
Ahihara leaves									
Farm crops	277.7000^{g}	11.2500^{j}	87.7500^{f}	0.06^{f}	0	0.060^{j}	0	0.090	66.2800^{f}
Dump crops	299.9000^{c}	29.2000^{h}	109.2500^{e}	0.08^{e}	0	4.020^{d}	0	1.030^{e}	77.0500^{e}
Percentage between ahihara leaves in farm and dump	7.9900	159.5600	24.5000	33.33	0	6600.000	0	1044.400	16.2500
Pumpkin leaves									
Farm crops	273.7000^{h}	19.1000^{i}	49.6500^{h}	0.01^{g}	0	0.190^{i}	0	0.130^{g}	54.4000^{h}
Dump crops	295.8500^{e}	44.0500^{b}	130.8500^{d}	0.06^{d}	1.04^{c}	4.180^{c}	0	0.210^{f}	108.9500^{b}
Percentage between pumpkin leaves in farm and dump	8.0900	130.6300	163.5400	500	0	2100.000	0	61.540	100.2800
Melon seeds									
Farm crops	263.6500^{i}	31.1000^{g}	46.2500^{j}	0.05^{f}	0	0.620^{h}	0	0.050^{i}	58.8500^{g}
Dump crops	317.3500^{b}	34.2800^{d}	48.1200^{i}	0.22^{d}	0.07^{e}	0.840^{g}	0	0.070^{hi}	87.9000^{c}
Percentage between melon seeds at the farm and at the dump	20.3700	10.2300	4.0400	340	29.03	35.480	0	40.000	49.3600
Unripe pawpaw fruit									
Farm crops	294.2500^{f}	32.4500^{f}	81.2500^{g}	0.01^{g}	0	2.030^{f}	0	2.000^{d}	35.8800^{j}
Dump crops	252.3000^{j}	33.3000^{e}	192.3500^{b}	0.38^{c}	0.10^{d}	6.020^{b}	0	2.080^{c}	40.2000^{i}
Percentage between pawpaw at the farm and dump	14.2600*	2.6200	136.7400	3700	0	196.550	0	4.000	12.0400
LSD	0.5582	0.6742	0.2859	0.0167	0.0125	0.054	0	0.025	0.5683

$^{a-c}$Means with different superscripts along the same column are significantly different ($p<0.05$), *Percentage decrease chromium value had 11.81% chromium level in relation to the soil chromium. Generally, the chromium contents of the soils and vegetations were low across board. The low chromium values obtained do not pose any harm to the individuals consuming the plants. Chromium toxicity is reported in animals and humans to a lesser degree (Radojevic and Bashkin, 1999). The toxicological affects of chromium poisoning include lung and kidney damage, in activation of various enzymes and skin disorders.

The copper content of the dump soil significantly ($p \leq 0.05$) exceeded that of at the nearby normal soil. There was a 87.89% increase between the soil copper and the dump soil copper (Table 3) their values fall within the reported range of 1-40 ppm copper concentrations in the soil (Havlin *et al*., 2003). In as much as the copper content of the crops at the dump were significantly ($p \leq 0.05$) higher than those at the dumps (their percentage increases in Table 3) however, the percentage of copper absorbed by the plants at the nearby normal farms were higher than those by the crops at the dump site. For instance, pawpaw with the highest copper value at the Egbu dump had 54.92% of copper level in relation to the dump soil copper while Ahihara at the nearby farm had 92.56% of copper level in relation to the soil copper content. The normal crop copper concentration in plant tissues ranges from 5-20 ppm (Havlin *et al*., 2003). The copper contents of crops at the Egbu sample sites all fell within this range.

The iron contents of the dump soil and crops significantly ($p \leq 0.05$) exceeded those of the nearby normal farms. The iron contents of the crops were on the high side. Intake of 50 mg of iron per day or 25-75 mg day^{-1} by man has been cited as safe (Onigbinde, 2001). Hence, it is possible to obtain this quantity of iron from the samples at various locations if there are no chelating substances interfering with their absorption. Though, the quantity of iron that will cause iron overload is not recorded, caution should be taken when consuming crops from these sites. The magnesium contents at the dumps exceeded those at the normal farms. Though the pH at the normal site was lower than that at the dump (Table 3) which may have affected its low absorption.

The magnesium uptake by the crops both at the dump and at the nearby normal farms were both high in relation with their soil magnesium contents. Ahihara leaves with the highest magnesium content (550.25 mg kg^{-1}) at the dump had 94.19% of magnesium absorbed in relation to the dump soil magnesium. Pawpaw with the least magnesium content (305.80 mg kg^{-1}) at the dump had 52.5% of magnesium uptake in relation to the soil magnesium content. At the nearby normal farm, water leaf with the highest content of magnesium (323.95 mg kg^{-1}) has 86.42% level of magnesium while pawpaw had the least level of 77.08% magnesium in relation to the soil magnesium. The plants may be said to have an affinity for magnesium. Magnesium toxicity from the crops may not be likely. This is because Fleet and Cashman (2001) reported that healthy normal people eating diets that are naturally high in magnesium do not experience toxicity. Also that magnesium toxicity is seen only when normal healthy individuals consume supplements.

The manganese content of the dump soil was more than twice that of the soil of the nearby farm. The manganese uptake by plants at the dump was low. Water leaf with the highest manganese content 1495.93 mg kg^{-1} at the dump had 43.55% uptake of manganese in relation to the soil manganese. At the nearby normal farm, Cassava had the least manganese uptake of 2.43%.

In addition to the manganese uptake by plant being low, an adult human absorption of manganese from the diets has long been assumed to be no >5% (Bowman and Russel, 2001). Hence, the possibility of manganese toxicity from the sampled crops may not exist. The nickel content of the dump soil greatly exceeded that of the nearby normal farm. The nickel contents of the soils crops were rather low (<7.00 mg kg^{-1}). Nickel is introduced into terrestrial environment as solid waste from metallurgical industries or a deposition of atmospheric emissions (Radojevic and Bashkin, 1999). That may account for the low values of Nickel at this site as the area is not an industrial one. Uptake of nickel by the plants is not sufficient enough to be of concern in the food chain.

Lead content of the dump soil (10.23 mg kg^{-1}) significantly ($p<0.05$) exceeded that of the nearby normal farm soil (3.99 mg kg^{-1}). This amounted to an increase of 156.39% between the normal farm soil and the dump soil. The crops did not pick any substantial amount of lead as their lead contents were approximately zero. It is probable that components of the dump (Table 1) containing lead may not have decomposed to the stage where they could be picked up by the plants. The selenium contents of the samples both the dump and normal ones also tended to zero. The vanadium content of the dump soil significantly ($p \leq 0.05$) exceeded that of the nearby normal farm soil. The increase was that of 141.79% between the two samples (Table 3).

The vanadium content of the soils and crops were <10 mg kg^{-1}. These low concentrations of vanadium may be advantageous to the crops as low concentrations of vanadium are beneficial for the growth of micro organisms, animals and higher plants (Havlin *et al*., 2003). Zinc contents of the dump soils were significantly

($p \leq 0.05$) greater than those of the soil of nearby normal farms. The crops from the dump sites also had higher zinc contents than the crops from nearby farms. The percentages of absorption of zinc from the soils were also high. Zinc is a micronutrient whose normal concentration range is 25-150 ppm in plants (Havlin *et al*., 2003). Most of the plants had their zinc contents within this range. Though zinc works with the enzymes that make part of cells genetic materials, make heme in hemoglobin, help the pancreas with its digestive functions, help metabolize carbohydrate, protein and fat, liberates Vitamin A from storage in liver and dispose of damaging free radicals. It may cause toxicity when consumed in large quantities. Hence, the water leaf at the Egbu dump may cause zinc toxicity if consumed in large quantities. About 100 mg day^{-1} of zinc lowers high density lipo protein, 150 mg day^{-1} impairs immune function, lowers high density lipo protein and raises low density lipo protein (Whitney *et al*., 1987).

The mineral compositions (mg kg^{-1}) of samples at World Bank Owerri: The mineral compositions of samples at World Bank Owerri and the percentage increase/decrease in the mineral compositions between the dump and the nearby farm samples are shown in Table 4. Aluminum content of the dump soil significantly ($p \leq 0.05$) exceeded that of the nearby farm. The dump crops aluminum contents were also greater than those of the nearby normal farms. The crop, pumpkin leaves with the lowest aluminum value (2.63 mg kg^{-1}) at the dump also had the lowest value of aluminum (1.07 mg kg^{-1}) at the normal farm. Ahihara also had the highest value both at the dump and nearby normal farms.

The percentage aluminum increase between the dump and normal crops were also high. Ahihara (199.50%), pumpkin leaves (145.79%) melon seeds (372.17%) and pawpaw (126.02%), respectively. The values of crop aluminum were rather low (1.07-12.01 mg kg^{-1}). The fear of aluminum toxicity from the consumption of these crops is unlikely. Aluminum toxicity is known to cause Alheizemer's disease. The arsenic contents of the soils and plant samples all tended to zero. Hence, there is no fear of contamination from the consumption of these. The cadmium content of the dump soil was significantly ($p \leq 0.05$) greater than that of the normal soil. All the crops at the normal farm had their cadmium contents tending to zero. The dump crops had low cadmium contents ranging from 0.15-0.81 mg kg^{-1}. The value of soil cadmium fall within the range (<0.01-8 mg kg^{-1}) of cadmium concentration reported in typical soils (Radojevic and Bashkin, 1999). It might be possible that cadmium containing substances like paints, plastics, batteries and metal plaited materials at the dump (Table 1) have not degenerated to the level whereby toxic quantities will be picked up by the soil and crops consequently. Hence, consumption of crops from these locations is not likely to cause any toxicity. The chromium content of the dump soil significantly ($p \leq 0.05$) exceeded that of the normal farm soil. There was 89.63% increase between the farm soil and the dump soil (Table 4). The dump crops also had higher chromium values than the normal farm crops.

The chromium values obtained fell within the range of <1-1000 mg kg^{-1} reported at sites (Radojevic and Bashkin, 1999). The chromium values of all the crops range between 1.79-8.14 mg kg^{-1}. Hence, the contents of the plant chromium may not pose any harm to individuals consuming them. The toxicological effects of chromium poisoning include lung and kidney damage, inactivation of various enzymes and skin disorder. Chromium chloride is poorly absorbed by the body thus high oral intakes would be necessary to attain toxic levels (Stoecker, 2001). The copper content of the dump soil was significantly ($p \leq 0.05$) higher than the copper content of the nearby normal farm. The percentages of copper uptake at both sites were quite high. Dump pumpkin leaves with the highest copper content (25.3 mg kg^{-1}) showed 98.35% level of copper in relation to the soil copper while melon at the normal site with the highest copper content (19.45 mg kg^{-1}) showed 97.37% of copper uptake in relation to the soil copper. It is reported that copper concentration in soils range from 1-40 ppm and averages about 9 ppm while the total soil copper may be 1 or 2 ppm in deficient soils (Havlin *et al*., 2003). The soil samples at Owerri fell within this range. Copper is absorbed as a component of either natural or synthetic organic complexes. Its normal concentration in plant tissues ranges from 5-20 ppm (Havlin *et al*., 2003). Most of the crops had their copper values within this range. The iron content of the dump soil significantly ($p \leq 0.05$) exceeded the iron content of the normal farm soil. Though the percentage increase (3.42%, Table 4) between the farm soil and dump soil was not much. The dump crops also had higher iron contents than the normal farm crops. The percentage of iron increase between the pumpkin leaves at the dump and the farm was as high as 11477.46% (Table 4). The iron uptake by the plants in relation to the soil iron contents was rather low, both at the dump and at the normal sites. At the dump, Ahihara with highest iron content (207.10 mg kg^{-1}) had 16.59% of iron uptake in relation to the soil iron content while melon seeds with the least iron content of 88.12 mg kg^{-1} at the dump had 7.06% level of iron in relation to the dump soil iron content. At the nearby normal farm, Ahihara with the highest iron content had 8.32% level of iron in relation to the soil iron content. While pumpkin leaves with the least iron content (1.42 mg kg^{-1}) had 0.12% level of iron in relation to the soil iron. An intake of 50 mg of iron per day or 25-75 mg day^{-1} by man has been cited as safe. Thus, the pumpkin leaves at the dump and Ahihara leaves at the dump may cause iron overdose to the body if consumed in excess.

The magnesium content of the dump soil significantly ($p \le 0.05$) exceeded that of the normal soil. The uptake of magnesium by the crops was high. Melon at the dump site with the highest magnesium content (317.35 mg kg^{-1}) among all the crops had 91.85% of magnesium uptake. While pawpaw with the least magnesium content (252.30 mg kg^{-1}) had 73.02% of magnesium uptake in relation to the dump soil magnesium content. The plants seem to have an affinity for magnesium. Magnesium is absorbed as Mg^{2+} and its concentration varies between 0.1 and 0.4% (Havlin *et al*., 2003). The absorption of magnesium by plants depends on the amount of solution Mg^{2+}, soil pH, the percentage magnesium saturation, the cation exchange capacity and the quantity of other exchangeable ion and the type of clay.

The cation exchange capacities of the sampled soils may have been high for the magnesium uptake of the plants to be quite high. The toxicity of magnesium from the crops is not likely as magnesium toxicity is reported only in normal healthy humans that consume supplements (Fleet and Cashman, 2001). The manganese content of the dump soil (53.88 mg kg^{-1}) significantly ($p \le 0.05$) exceeded the manganese content (38.55%) of the normal soil. The same trend was also observed among the crops with the manganese uptake by plants in relation to soil manganese being also high. Manganese exists as solution Mn^{2+}, exchangeable $Mn^{2+,}$ organically bound Mn and as various manganese minerals. The equilibrium among the forms determines manganese availability to plants. Manganese is considered an essential nutrient for humans because it is known to function as an enzyme activator and to be a constituent of several metalloenzymes (Leach and Harris, 1997). The numerous enzymes that can be activated by manganese include oxidoreductases, lyases, ligases, hydrolaxes, kinases, decarboxylases and transferases (Bowman and Russel, 2001). For the adult human, absorption of manganese from the diet has long been assumed to be no >5% (Bowman and Russel, 2001). Hence, the possibility of manganese toxicity from the sampled crops may not exist.

The nickel content of the dump soil was significantly ($p \le 0.05$) greater than that of the normal soil. There was 47.10% increase between the normal site soil and the dump soil (Table 4). The nickel contents of the crops fall within the range of about 0.1-1.0 ppm reported in literature (Havlin *et al*., 2003). The low nickel content of the crops is an advantage as nickel is extremely toxic. The lead content of the dump soil was significantly ($p \le 0.05$) higher than that the normal farm. There was a 219.46% increase in the lead content between the normal and the dump soil. The crops picked little or no lead from the soil. Lead is a poisonous metal so, the lower its content in food the better. Lead on entering the body is not excreted or metabolized rather it competes with calcium, iron and zinc and interferes with many of the body's system (Whitney *et al*., 1987).

CONCLUSION

The selenium contents of the soil and crops tended to zero. Thus, there would be no selenium toxicity resulting from the consumption of crops at the sample sites. Selenium in high doses is toxic as high soil levels results in accumulation of selenium in plants that causes acute toxicity in livestock (NRC, 1983). In humans, high selenium dosages can cause loss of hair and nails, lesions of the skin and nervous systems and possible damage to the teeth (Whitney *et al*., 1987). The vanadium content of the dump soil significantly ($p \le 0.05$) exceeded that of the nearby normal soil. There was a 74.25% increase between the vanadium content of the normal soil and that of the dump soil. The vanadium contents of the crops were rather low, pawpaw with the highest vanadium content at the dump and the normal farm, had the highest vanadium uptake in relation to the soil vanadium contents.

REFERENCES

Bowman, B.A. and R.M. Russel, 2001. Present Knowledge in Nutrition. 8th Edn., International Life Sciences Press, Washington, DC, USA .

Fleet, J.C. and K.D. Cashman, 2001. Magnesium. In: Present Knowledge in Nutrition. 8th Edn., Bowman, B.A. and R.M. Russel (Eds.). ILSI Press, Washington, DC, USA., pp: 292-301.

Havlin, J.L., J.D. Beaton, S.L. Tisdale and W.L. Nelson, 2003. Soil Fertility and Fertilizers. 6th Edn., Pearson Education, Pearson Education, Pages: 499.

Hornby, A.S., 2000. Oxford Advanced Learner's Dictionary. 6th Edn., Oxford University Press, UK., ISBN: 9780194367950.

Leach, R.M.J. and E.D. Harris, 1997. Manganese. In: Handbook of Nutritionally Essential Minerals. O'Dell, B.L. and R.A. Sunde (Eds.). Marcel Dekker, New York, USA., pp: 335-355.

MAFF, 1981. Ministry of Agriculture, Fisheries and Food: Review of Financial Planning and Control Systems. Academics S.L. Leon, UK., Pages: 221.

NRC, 1983. Selenium in Nutrition. Rev. Edn., National Academy Press, Washington, DC, USA.

Nwafor, J.C., 2006. Environmental Impact Assessment for Sustainable Development: The Nigerian Perspective. Environment and Development Policy Centre for Africa, Enugu.

Onigbinde, A.O., 2001. Food and Human Nutrition (Biochemical Integration). Ilepeju Publishers Ltd., Benin City, Pages: 300.

Onwuka, G.I., 2005. Food Analysis and Instrumentation, Theory and Practice. Naphthali Print, Lagos, Nigeria.

Radojevic, M. and V.N. Bashkin, 1999. Practical Environment Analysis. Royal Society of Chemistry, Cambridge, UK.

Sizer, F. and E. Whitney, 1994. Nutrition: Concepts and Controversy. 6th Edn., West Publishers Coy, USA.

Smith, J.E., 1996. Biotechnology. 3rd Edn., Cambridge University Press, Cambridge, UK., pp: 140-159.

Stoecker, B.J., 2001. Chromium. In: Present Knowledge in Nutrition, 8th Edn., Bowman, B.A. and R.M. Russel (Eds.). International Life Sciences Press, Washington, DC USA., pp: 366-372.

Vogel, A.I., 1978. Vogel's Textbook of Quantitative Inorganic Analysis: Including Elementary Instrumental Analysis. 4th Edn., Longman Group Limited, London, Pages: 925.

Whitney, E.N., C.B. Cataldo and S.R. Rolfes, 1987. Understanding Normal and Clinical Nutrition. 2nd Edn., West Publishing Company, New York, USA., Pages: 413.