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Heavy Metal Contents of Municipal and Rural Dumpsite Soils and Rate of Accumulation by *Carica papaya* and *Talinum triangulare* in Uyo, Nigeria

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Abstract: Dumpsites in Uyo and most cities in Nigeria are used nutrients rich soils for cultivating fruits and vegetables without regards to the risk of toxic metal pollution by the wastes. This development necessitated the research on the assessment of the impact of municipal and rural dumpsites on the metal levels of the underlying soils, the relationship between the dumpsite- soil metal content and the rate of bio-accumulation by plants, the effect of plant specie and plant part on the rate of metal uptake. Atomic absorption spectrophotometer was employed for the analysis of the samples and results obtained from municipal dumpsite soil indicated the following mean concentrations: Fe, 1711.20 µg/g; Pb, 43.28 µg/g; Zn, 88.34 µg/g; Ni, 12.18 µg/g; Cd, 14.10 µg/g and Cu, 56.33 µg/g. These concentrations were relatively higher than the following concentrations: Fe, 1016.98 µg/g; Pb, 18.57 µg/g; Zn, 57.90 µg/g; Ni, 7.98 µg/g; Cd, 9.25 µg/g and Cu, 33.70 µg/g recorded for the rural dumpsite soil. Consequently, plants grown on municipal dumpsites soil accumulated higher concentrations of the metals than those on rural dumpsites. Results obtained from this study also revealed that plants grown on dumpsite soils bio-accumulated higher metal concentrations than their counterparts obtained from normal agricultural soils. The ability of plants to bio-accumulate these metals were also observed as being different from one plant to the other and from one plant parts to the other. And apart from Fe and Zn which recorded higher concentrations in the leaves of the plants studied, other metals recorded higher concentrations in the roots. The general results obtained revealed that the levels of Cd in dumpsite-soil were above the standard while the levels of Cd and Pb in plants were also above the recommended levels in plants. The implications of these high concentrations of these metals in soil and plants have been discussed. Some useful recommendations on the proper handling of wastes to reduce toxic metal loads at dumpsites have also been highlighted.

Keywords: Dumpsite- soil, Pollution, Transfer ratio, *Carica papaya*, *Talinum triangulare*, Nigeria.

Introduction

The proper wastes disposal method has been a serious problem in Uyo and most cities in Nigeria. In Nigeria, leachates from refuse dumpsites constitute a source of heavy metal pollution to both soil and aquatic environments[1,2]. In some cases, wastes are dumped recklessly with no regards to the environmental implications, while in some dumpsites wastes are burnt in the open and ashes abandoned at the sites. The burning of wastes gets rid of the organic materials and oxidized the metals, leaving the ash richer in metal contents. After the processes of oxidation and corrosion, these metals will dissolved in rain water and leached into soil from where they are picked up by growing plants thereby entering the food chain[3]. Improper wastes management methods also pilot the contamination of underground water[4,5] while most of the metals are being washed away by runoff into streams and rivers thereby contaminating the marine environment[6]. Consequently, these metals accumulate in fish and other aquatic organisms, thus posing a health threat to the consumers[7].

According to Bishop[8], amongst all the classes of solid waste pose the greatest threat to life since, it has the potential of polluting the terrestrial, aquatic and aerial environments. Land pollution by components of refuse such as heavy metals has been of great concern in the last decades because of their health hazards to man and other organisms when accumulated within a biological system[9].

Recent studies have also revealed that wastes dumpsites can transfer significant levels of these toxic and persistent metals into the soil environment[10-13]. And eventually these metals are taken up by plants parts and transfer same into the food chain[14]. Consequently, higher soil heavy metal concentration can result in higher levels of uptake by plants[15]. Although the rate of metal uptake by crop plants could be influenced by factors such as metal species, plants species, plant age and plant part [16-19]. In Uyo metropolis, most of the dumpsites are used as fertile soils for the cultivation of some fruits and vegetables. Some farmers collect the decomposed parts of the dumpsites and apply to their farms as manure. These cultivated plants take up these metals either as mobile ions in the soil solution through their roots[20,13] or through their leaves thereby making them unfit for human consumption[21-24]. It was this apprehension that led to this research on the evaluation of metal concentrations in soil and plant samples obtained from both the rural and municipal dumpsites. Results obtained were also compared with the levels of these metals in soil and plat samples obtained from normal agricultural soils within the vicinity of the study areas. These soil and plant samples from both the dumpsites and normal agricultural soils were analyzed using atomic absorption spectrophotometer.

Experimental

This study was conducted at two locations: old stadium road dumpsite representing a typical urban center, and a rural community (Use Offot) refuse dumpsite, both sides locate within Uyo local government area, Akwa Ibom state, Nigeria. Roots, stems and leaves of *Carica papaya* (paw paw) and *Talinum triangulare* (water leaf) were collected from dumpsites and normal farmlands located within the vicinity of the study areas which served as Control samples. Top soil (0-15cm) samples were also collected from the dumpsites and the farmlands according to the methods of Udosen *et al*.[13]. This research work was carried out during the dry season of the study area in the month of November, 2006.

A total of seventy two plants and twenty four soil samples were collected from four different locations (three samples per location) at the dumpsites and normal farmlands into pre-cleaned polyethylene bags. The plants samples were properly washed with de-ionized water, dried in an oven at 80º C, and pulverized to fine powder using a stainless grinder. Ground plants samples collected in labeled polyethylene bags were placed in a desiccator. From each plant sample, 2g was accurately weighed into clean platinum crucibles, ashed at 450º C and then cooled to room temperature in a desiccator. The ash was dissolved in 5mL of 20% HCl (BDH) and the solution made up to volume in a 100 mL volumetric flask with de-ionized water[16].

The soil samples were air dried for twelve (12) days, crushed and passed through a 2mm sieve. 1g each of the sieved soil sample was digested in a 1:1 mixture of concentrated HNO_3 (BDH) and $HClO_4$ (BDH) acids by heating a mixture of the acids and sample in a water bath in a fume cupboard. The solution was heated to dryness[10] while the residue was re-dissolved in 5mL of 2.0M HCl (BDH).

The concentrations of iron (Fe); lead (Pb); zinc (Zn); nickel (Ni); cadmium (Cd) and copper (Cu) in both the ashed plants and digested soil samples were determined using atomic absorption spectrophotometer unicam 939/959 model.

Results and Discussion

Table 1 gives the concentrations (µg/g) of heavy metals in soil samples from Use Offot dumpsite and its control site. Heavy metal contents (µg/g) of soil samples from old stadium road dumpsite and the Control site are shown in Table 2. Table 3 shows the concentrations (µg/g) of heavy metals in *Carica papaya* and *Talinum triangulare* parts from Use Offot dumpsite and Control site. Heavy metal contents (µg/g) of *Carica papaya* and *Talinum triangulare* parts from old stadium road dumpsite and the Control site are shown in Table 4. The transfer ratios of heavy metals in *Carica papaya* and *Talinum triangulare* from Use Offot dumpsite and Control site are given in Table 5. While the transfer ratios of heavy metals in *Carica papaya* and *Talinum triangulare* from Use Offot dumpsite and Control site are given in Table 6.

Table 1. Heavy metal contents (µg/g) of soils in Use Offot dumpsite, (Rural community) and Control site.

Soil Parameter	Dump site	Control site
Fe	1016.98	510.75
Pb	18.57	9.15
Zn	57.90	23.72
Ni	7.98	1.15
Cd	9.25	1.86
Cu	33.70	15.73

Table 2. Heavy metal contents (µg/g) of soils in old stadium road, dumpsite (Municipal) and Control site

Soil Parameter	Dump site	Control site
Fe	1711.20	506.50
Pb	43.28	8.25
Zn	88.34	24.44
Ni	12.18	5.10
Cd	14.10	1.28
Cu	56.33	15.65

Table 3. Heavy metal contents (µg/g) of crop plants parts from Use Offot dumpsite and Control.

Metal Type	Dump site						Control site					
	Carica papaya			*Talinum triangulare*			*Carica papaya*			*Talinum triangulare*		
	Roots	Stem	Leaves	Roots	Stem	Leaves	Roots	Stem	Leaves	Roots	Stem	Leaves
Fe	132.15	141.28	170.00	113.42	120.00	153.20	98.17	80.00	98.81	93.20	95.24	99.13
Pb	4.86	3.03	3.74	3.97	2.55	3.83	1.82	1.10	1.96	1.27	1.00	1.06
Zn	7.92	7.15	9.72	5.28	3.10	6.24	5.00	5.55	6.18	5.76	5.19	7.04
Ni	0.83	0.51	0.66	0.61	0.58	0.52	0.17	0.08	0.06	0.13	0.10	0.07
Cd	0.67	0.49	0.45	0.43	0.32	0.30	0.21	0.05	0.07	0.08	0.03	0.05
Cu	7.36	5.00	6.11	8.73	6.41	6.83	5.22	4.77	5.02	5.01	3.80	4.03

Table 4. Heavy metal contents (µg/g) of crop plants parts from old stadium road dumpsite and Control site.

Metal Type	Dump site						Control site					
	Carica papaya			*Talinum triangulare*			*Carica papaya*			*Talinum triangulare*		
	Roots	Stem	Leaves	Roots	Stem	Leaves	Roots	Stem	Leaves	Roots	Stem	Leaves
Fe	172.32	150.00	183.16	143.01	137.00	163.17	97.27	96.03	99.01	94.40	96.00	98.86
Pb	19.04	7.19	7.07	14.30	10.31	10.44	3.17	2.04	2.77	1.19	0.94	0.97
Zn	16.53	13.11	17.70	14.37	12.93	15.18	6.36	4.41	7.03	8.13	7.10	9.04
Ni	4.13	3.10	3.77	3.19	3.10	2.99	0.09	0.06	0.04	0.06	0.02	0.01
Cd	3.10	3.02	2.96	2.20	1.74	1.16	0.05	0.01	0.02	0.08	0.04	0.01
Cu	14.72	11.15	13.08	14.11	10.05	11.36	5.34	4.47	4.56	5.37	5.30	4.81

Table 5. Statistical data on heavy metal contents (µg/g) of crop plants parts from Use Offot dumpsite

	Carica papaya						*Talinum triangulare*					
	Fe	Pb	Zn	Ni	Cd	Cu	Fe	Pb	Zn	Ni	Cd	Cu
No. of Samples	2	2	2	2	2	2	2	2	2	2	2	2
Arithmetic Mean	147.81	3.88	7.54	0.67	0.54	6.16	128.87	3.45	4.87	0.57	0.35	7.3
SD	19.75	0.92	0.55	0.16	0.12	1.18	21.32	0.78	1.16	0.05	0.07	1.2
SE	13.97	0.65	0.39	0.11	0.09	0.84	15.08	0.55	1.14	0.03	0.05	0.8
Minimum	132.15	3.03	7.15	0.51	0.45	5.00	113.42	2.55	3.10	0.52	0.30	6.4
Maximum	170	4.86	9.72	0.83	0.67	7.36	153.20	3.97	6.24	0.61	0.43	8.7
Range	37.85	1.83	2.57	0.32	0.22	2.36	39.78	1.42	3.14	0.09	0.13	2.3
CV (%)	13	24	7	24	22	19	17	23	33	9	20	17

Table 6. Statistical data on heavy metal contents (µg/g) of crop plants parts from Use Offot Control site.

	Carica papaya						*Talinum triangulare*					
	Fe	Pb	Zn	Ni	Cd	Cu	Fe	Pb	Zn	Ni	Cd	Cu
No.of Samples	2	2	2	2	2	2	2	2	2	2	2	2
Arithmetic Mean	92.33	1.63	5.58	0.10	0.11	5.00	95.86	1.11	6.00	0.16	0.05	4.28
SD	10.68	0.46	0.59	0.06	0.09	0.23	3.01	0.14	0.95	0.03	0.03	4.28
SE	7.55	0.33	0.42	0.04	0.06	0.16	2.13	0.10	0.67	0.02	0.02	0.45
Minimum	80.00	1.10	5.00	0.06	0.05	4.77	93.20	1.00	5.19	0.07	0.03	3.80
Maximum	98.81	1.96	6.18	0.17	0.21	5.22	99.13	1.27	7.04	0.13	0.08	5.01
Range	18.81	0.86	1.18	0.11	0.16	0.45	5.93	0.27	1.85	0.06	0.05	5.01
CV (%)	12	28	11	60	82	5	3	13	16	30	60	15

Table 7. Statistical data on heavy metal contents (µg/g) of crop plants parts from old stadium road dumpsite.

	Carica papaya						*Talinum triangulare*					
	Fe	Pb	Zn	Ni	Cd	Cu	Fe	Pb	Zn	Ni	Cd	Cu
No. of Samples	2	2	2	2	2	2	2	2	2	2	2	2
Arithmetic Mean	168.49	11.10	15.78	3.67	3.03	12.98	147.73	11.68	14.16	3.09	3.03	12.98
SD	16.91	6.88	2.39	0.52	0.07	1.79	13.71	2.27	1.14	1.10	0.07	1.79
SE	11.96	4.86	1.69	0.37	0.05	1.26	9.69	1.60	0.81	0.07	0.05	1.26
Minimum	150.00	7.07	13.11	3.10	2.96	11.15	137.00	10.31	12.93	2.99	2.96	11.15
Maximum	183.16	19.04	17.70	4.13	3.10	14.72	163.17	14.30	15.18	3.19	3.10	14.72
Range	33.16	11.97	4.59	1.03	0.14	3.57	26.17	3.99	2.25	0.20	0.14	3.57
CV (%)	10	62	15	14	2	14	9	19	8	3	2	14

Table 8. Statistical data on heavy metal contents (µg/g) of crop plants parts from old stadium road Control site.

	Carica papaya						*Talinum triangulare*					
	Fe	Pb	Zn	Ni	Cd	Cu	Fe	Pb	Zn	Ni	Cd	Cu
No. of Samples	2	2	2	2	2	2	2	2	2	2	2	2
Arithmetic Mean	97.44	2.66	5.93	0.06	0.03	4.97	96.42	1.03	8.09	0.03	0.04	5.16
SD	1.50	0.57	1.36	0.03	0.02	0.48	1.60	0.14	0.97	0.027	0.035	0.312
SE	1.06	0.41	0.96	0.02	0.015	0.34	1.60	0.10	0.69	0.02	0.025	0.22
Minimum	96.03	2.04	4.41	0.04	0.01	4.47	94.40	0.94	7.10	0.01	0.01	4.81
Maximum	99.01	3.17	7.03	0.09	0.05	5.34	98.86	1.19	9.04.	0.06	0.08	5.37
Range	2.98	1.13	2.62	0.05	0.04	0.87	4.46	0.24	1.94	0.05	0.07	0.56
CV (%)	2	21	23	50	67	10	2	14	12	90	88	6

Heavy Metal Content in Soils

Concentrations of metals analyzed for in both the dumpsites and Control sites are indicated in Tables 1 and 2 respectively. Results obtained show that soils from dumpsites recorded higher metal concentrations than their corresponding levels at the normal farmland (Control site). This is in agreement with the results obtained from similar studies[16] by Amusan *et al.,* and it could be attributed to the availability of metal containing wastes at dumpsites which are eventually leached into the underlying soils. Results in Table 1 indicate that the metal levels at Use Offot dumpsite ranged between 7.98 and 1016.98µg/g for Ni and Fe respectively. A similar trend was observed for Use Offot Control site with Fe recording the highest concentration of 510.75µg/g while Ni too recorded the lowest concentration of 1.15µg/g. At the municipal dumpsite (old stadium road) a range of 12.18 – 1711.20µg/g was recorded for the metals with Fe and Ni having the highest and lowest concentrations respectively. While the range of 1.28 – 506.50µg/g was recorded for the municipal Control site with Fe and Cd recording the highest and lowest concentrations. The results in Tables 1 and 2 have also revealed that Fe recorded the highest metal concentration among all the metals investigated. This could be attributed to the high availability of the metal in the earth's crust and the abundance of Fe – containing wastes in the environment[25]. These results also showed that metal levels in the soil samples from the municipal (old stadium road) dumpsite were higher than their corresponding levels in the rural (Use Offot) dumpsite. This maybe attributed to the differences in the living standards, consumption patterns and level of industrial development between city and rural communities. According to Ademoroti[26], municipal wastes dumpsite such as old stadium road contains less biodegradable wastes but more non-biodegradable wastes while the reverse is the case for a rural wastes dumpsite. Results recorded in this study have shown that soils from the Control sites in both locations do not differ significantly in their metal contents except for the concentrations of Ni. The top layer (0-15cm) of the soil was employed in this research since earlier studies by Nyangababo and Hamya[27], indicated the top soil layers as better indicators of metallic burdens. The general results recorded from this study have shown that levels obtained[28] for these metals at dumpsite soils from both locations were within normal ranges except for Cd. (Fe 100-7000mg/kg; Pb 2-200 mg/kg; Zn 10-300 mg/kg; Ni 10-1000 mg/kg; Cd 2-200mg/kg and Cu 2-100mg/kg). This enhanced Cd levels maybe attributed to large use of PVC plastics, nickel-cadmium batteries, insecticides, motor oil and the disposal of sludge in dumpsites[29]. Nevertheless, results obtained have shown that waste dumpsites contribute significant levels of toxic metals to the environment and therefore sorting and recycling of wastes should be intensified to reduce the quantity of these toxic metals at dumpsites. There is also a need for the establishment of a statutory body that can legislate and enforce the environmental rules and regulations on the general public.

Heavy metal content in plants parts

Heavy metal concentrations in plants parts from Use Offot dumpsite and Control are given in Table 3, while Table 4 shows the results of heavy metal concentrations in plants parts from old stadium road dumpsite and Control. . This study was limited to the roots, stems and leaves of *Carica papaya* and *Talinum triangulare,* so that the transfer ratio of the metals from soil to the plants could easily be assessed. Generally, plants parts harvested from dumpsites recorded higher metal concentrations than their counterparts from Control sites, this is in agreement with the findings of Udosen[30] and Amusan *et al.*[16], when similar studies were undertaken. This could be attributed to the high metal contents of dumpsite soils which are eventually accumulated by the plants grown on them. This also indicates that the concentrations of metals in plants are dependent upon their concentrations in the habitual soil environment and this is in agreement with the findings by Udosen *et al*[13]. The results in Tables 3 and 4 have shown that most of the metals analyzed for recorded higher concentrations in *Carica papaya* parts from most of the sites than their levels in the corresponding *T. triangulare* parts. This is in agreement with the findings reported by Juste and Mench[18], Micieta and Murin[31], and Amusan *et al*[16]., that plant species can significantly influenced the rate of metal uptake by plants. These results also revealed that Fe and Zn recorded higher concentrations in the leaves than in other parts of the plants at all the sites. Whereas other metals recorded higher concentrations in roots than other parts investigated, this is in conformity with the results reported from similar studied by Shuaibu and Ayodele[32], and Schaller[33]. These findings obtained have agreed with the aim and objective of this research work, because this was seen as the influence of plant parts and metal species on the rate of metal uptake as reported by Moreno *et al*[17]. Kabata-Pendias[19] . And since the rate of metal uptake is greatly influenced by plant species, the transfer ratio of the metals by each plant species was calculated using the method[34]. Transfer ratio represents the level of the metal in the plant parts as a ratio of the total metal concentration in the soil environment. Transfer ratios recorded in this study as shown in Tables 5 and 6 indicate some variations from one location to the other and from one plant specie to the other. For instance, at Use Offot dumpsite transfer ratio for Fe in *Carica papaya* was 0.44 while the ratio in *Talinum triangulare* was 0.38. Moreover, the transfer ratio for Cu in *Carica papaya* from Use Offot dumpsite was 0.55 whereas the ratio in the same plant from old stadium road dumpsite was 0.73. The transfer ratios of Pb, Zn, Ni and Cd in *Carica papaya* from Use Offot dumpsite were relatively higher than those from Use Offot Control site; while the reverse was the case for Fe and Cu. This indicates that some soil factors apart from total soil content of the metals also affect the rate of metal uptake by plants. The transfer ratios for Cu in *Carica papaya* and *Talinum triangulare* from Use Offot and old stadium road Control sites were particularly high. The ratios for Cu in *Carica papaya* from Use Offot and old stadium road Control sites were 0.95 and 0.92 respectively, while in *Talinum triangulare* the ratios were 0.82 and 0.99 respectively. The rate of Pb uptake by *Carica papaya* at Use Offot dumpsite was the highest (0.63) whereas; Cd recorded the lowest rate of metal uptake with transfer ratio of 0.17. *Talinum triangulare* indicated the highest potential for accumulating Cu with a transfer ratio of 0.65 while; the lowest potential for metal accumulation was recorded for Cd with transfer ratio of 0.11. At old stadium road dumpsite *Carica papaya* indicated the highest uptake rate for Ni with transfer ratio of 0.90 while the lowest rate (0.30) was recorded for Fe. Also, *Talinum triangulare* at the same dumpsite recorded highest uptake rate for Pb (0.81) while the lowest rate was recorded by Cd (0.36). The general results in Tables 3 and 4 indicate that, ranges recorded for Fe at both dumpsites in plants studied were above the recommended range of 20-100 mg/kg in plants[28]. While the ranges obtained for Pb and Cd in both plants from old stadium road (Municipal) dumpsite were above the normal ranges for agricultural soils (0.1-5 and 0.1-1mg/kg) respectively[28]. Therefore, the consumption of these plants may cause some health implications as reported by Roberts[35], Tucker *et al*[36]., and Dupler[37]. This shows that there were higher levels of these metals in the municipal dumpsite than in the rural dumpsite. These results have also revealed that; the consumption of these plants grown on the municipal dumpsite could be very dangerous since high levels of these metals can lead to their toxicity and attendants effects.

The statistical treatment of the data obtained has revealed that at Use Offot dumpsite the highest metal concentration in *Carica papaya* (147.81μg/g) was recorded by Fe while the lowest metal concentration (0.54μg/g) was indicated by Cd. Similarly, *Talinum triangulare* obtained at the same site indicated the same trend for metal concentrations with Fe recording the highest (128.87µg/g) and Cd having the lowest (0.35µg/g) (Table 5). At Use Offot Control site, Fe recorded the highest mean metal concentration (92.33µg/g) while Ni recorded the lowest mean concentration (0.10µg/g) in *Carica papaya*. The highest mean metal concentrations in *Talinum triangulare* obtained at the same location varied between 0.05µg/g recorded by Cd and 95.86µg/g recorded by Fe (Table 6). In Table 7 the statistical results for the data obtained in plants at old stadium road dumpsite are given and it shows that Fe recorded the highest mean metal concentrations in both Cari*ca papaya* and *Talinum triangulare* with concentrations of 168.49µg/g and 147.73µg/g respectively. The lowest and same mean metal concentrations (3.03 µg/g) were recorded by Cd in both plants. The results for old stadium road Control site in Table 8 shows that Fe recorded the highest mean concentrations of 97.44µg/g and 96.43µg/g in both *Carica papaya* and *Talinum triangulare* respectively, while Cd recorded the lowest mean concentration (0.03µg/g) in *Carica papaya* and Ni recorded the lowest (0.03 µg/g) in *Talinum triangulare.* These results in Table 5-8 have revealed that Fe recorded the highest mean metal concentration at all the locations and in both plants. This is in agreement with the report by Amusan *et al*[16]., during a similar research on plants from some rural and municipal dumpsites within Ife, Nigeria. This could be attributed to the availability of the metal in the earth's crust, at dumpsites and its high utilization by plants. The low concentrations of Cd in both plants which consequently indicates its low level of utilization is in agreement with the report by Udosen *et al*[13]. in *Manihot utilissima* obtained from a municipal dumpsite, in Nigeria. This maybe attributed to the low level of the metal in the earth's crust and as a non-essential element for plants.

Relative Standard Deviations (RSD) of Heavy Metal Contents in Carica papaya and Talinum Triangulare

Studies have indicated that the best technique for evaluating the variations of variables in environmental research is the application of relative standard deviations [38,13] . At Use Offot dumpsite, Pb and Ni recorded the highest RSD value of 24% while Zn recorded the lowest value of 7% in *Carica papaya* but in *Talinum triangulare* Zn recorded the highest RSD value (33%) and Ni recorded the lowest value of 9%. Samples of *Carica papaya* and *Talinum triangulare* collected at Use Offot Control site indicated their respective highest RSD values of 82 and 60% both in Cd, while their lowest RSD values of 5 and 3% were recorded by Cu and Fe respectively. At old stadium road dumpsite, *Carica papaya* recorded its highest RSD value (62%) by Pb while *Talinum triangulare* , the highest RSD value 19% was recorded also by Pb. The lowest RSD recorded by both samples by Cd was 2% each. Results obtained at old stadium road Control site indicated that Cd recorded the highest RSD value (67%) in *Carica papaya* while Ni recorded the highest RSD value (90%) in *Talinum Triangulare*. At the same site too, Fe recorded the same and lowest RSD value (2%) in both samples.

The general results shown in Table 5-8 have indicate that the highest RSD value (90%) was recorded by Ni and this was closely followed by 82% recorded by Cd and 62% by Pb. While Fe at all the sites recorded very low RSD values. These observations maybe attributed to the availability and scarcity respectively of these metals in the environment which also affect their pattern of distribution adversely. This low RSD value exhibited by Fe is in agreement with the report by Udosen[13] *et al*., in *M. utilissima* obtained from a municipal dumpsite in Uyo, Nigeria.

Conclusion

This research work has revealed that plants grown on dumpsites soils can accumulate more of the toxic metals than plants grown on the normal agricultural soils; therefore efforts should be intensified to discourage the practice of cultivating at dumpsite soils. Moreover, the difference in commercial and industrial activities between the municipality and rural area has resulted in the elevated metal levels at the municipal dumpsites. Consequently, plants grown on municipal wastes dumpsites have higher metal contents than their counterparts at rural dumpsites. Hence, the use of municipal dumpsite soils as a source of manure for vegetables which is a common practice in many cities in Nigeria should be noted as a devastating tradition. Although, recycling and sorting of wastes before dumping can also help to reduce the metal load at dumpsite soils.

Proper education and legislations on the handling of wastes in the society should be intensified to forestall wastes related problems along the food chain. Furthermore, modern wastes disposal facilities should be acquired by the authorities concern and appropriate waste disposal sites chosen by experts to avoid indiscriminate dumping of wastes within our cities.

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