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Toxic Metals up taken by Cabbage Grown in Irrigated Farmlands of Kaduna Metropolis, Nigeria

[1]W.L.O. Jimoh and [2]Mahmud Imam Mohammed
[1]Department of Pure and Industrial Chemistry, Bayero University, Kano Nigeria
[2]Department of Applied Science, College of Science and Technology, Kaduna Polytechnic

Abstract: Heavy metals such as cadmium, lead, iron and zinc were investigated in soil and lettuce obtained from irrigated farmlands of Kaduna metropolis. Concentrations of heavy metals were determined using atomic absorption spectrophotometer. The results obtained were compared with limit recommended by FAO/WHO standard (2007) so as to ascertain the extent of their pollution. The level of cadmium in cabbage ranged from 0.04-1.20 μg/g. The concentrations of lead was found to be in range of 0.61-3.87 μg/g ,these were above the limit stipulated by WHO while iron concentration ranged from 0.50-12.40 μg/g and zinc 2.72-18.53 μg/g were within the recommended limit given by the FAO/WHO standard. This suggests that consumers of cabbage grown in the studied areas might be liable to lead and cadmium toxicity as at the time of this research work. Pearson correlation shows positive correlation between soil and cabbage in these irrigation sites.

Keywords: Atomic absorption spectrophotometer, cabbage, heavy metals, Kaduna metropolis, Nigeria, soil

INTRODUCTION

Heavy metal is the term commonly adopted as a group name for the metals which are associated with pollution and toxicity. They may also include some elements which are essential for living organisms at low concentrations. Among these heavy metals, some have been found to be of greatest hazard to plants and animals which include Arsenic (As), Cadmium (Cd), Chromium (Cr),copper (Cu),Lead (pb), Nickel (Ni) and Zinc (Zn). (Alan, 1996)

Heavy metals are considered to be one of the main sources of pollution in the environment, since they have a significant effect on its ecological quality (Sastre *et al*., 2002). Heavy metals owing to atmospheric and industrial pollution accumulate in the soil and influence the ecosystem nearby (Al-Radady *et al*., 1994).

Heavy metals are harmful because of their non-degradable nature, long biological half – lives and their potential to accumulate in different body parts. Most of the heavy metals are extremely toxic because of their solubility in water. Even low concentrations of heavy metals have damaging effects on to man and animals because there is good mechanism for their elimination from the body (Arora *et al*., 2008).

Food and water are the main sources of our essential metals., these are also the median through which we are exposed to various toxic metals. Heavy metals are easily accumulated in the edible parts of leafy vegetables, as compared with to grain or fruit crops (Mapanda *et al.*, 2005). Vegetables take up heavy metals and accumulate them in their edible (Behemuka and Mubofu, 1999) and inedible parts in quantities high enough to cause clinical problems both to animals and human beings consuming these metal - rich plants (Alan, 1996).

The problem of environmental pollution due to toxic metals has began to cause concern now in most major metropolitan cities. The toxic heavy metals entering the ecosystem may lead to geoaccumulation, bioaccumulation and biomagnifications. Heavy metals like Fe, Cu, Zn, Ni and other trace elements are important for proper function of biological systems and their deficiency or excess could lead to a number of disorders. (Ward, 1995). Metals like iron copper and zinc are essential metals since they play an important role in biological systems, where lead and cadmium are non -essential metal as they are toxic even in traces.

The movement of trace metals and metalloids between the soil, plants, water and even atmosphere is part of a complex and intricately biogeochemical cycling processes in nature and is affected by several factors that are both natural and athropogenic. However, in addition to the natural weathering -pedological (geogenic) inputs, anthropogenic are said to be significantly responsible for elevated trace metals concentrations in soils (Devkota and Schmidst 2000; Frost and Ketchum, 2000; Singh *et al*., 2004; Mapanda *et al*., 2005).

Corresponding Author: Mahmud Imam Mohammed, Department of Applied Science, College of Science and Technology, Kaduna polytechnic

Heavy metals are generally present in agricultural soils at low levels, due to their cumulative behaviour rand toxicity; however, they have a potential hazardous effect not only on crop plants but also on human health (Das *et al*.,1997). Rapid urbanization and industrialization with improper environmental planning often lead to discharge of sewage effluents into the river which is subsequently used for irrigation of crops.

It has been reported that sewage effluents of municipal origin contain appreciable amount of major essential plant nutrients and therefore the fertility level of the soil are improved considerably under sewage irrigation of crop field (Rajash *et al*., 2004). Vegetables cultivated in waste water - irrigated soils take up heavy metals in large enough quantities to cause potential health risks to the consumers (Khan *et al*., 2007).

The aim of this research work is to determine the level of heavy metal (zinc, iron, lead and cadmium) in soil and cabbage grown in irrigated farmlands of Kaduna metropolis so as to ascertain the extent of their pollution and toxicity on human being.

MATERIAL AND METHODS

Sample and sampling: Cabbage samples were collected from October 2009 to February 2010 from twenty one (21) different irrigation sites of farmlands from Kaduna metropolis where they were irrigated with water from the river or pond which are sometimes contaminated. Soil samples were also randomly collected from the farm where these vegetables were grown and irrigated with water. These samples were then stored in polythene bags and taken to the laboratory and dried in an oven at 100ºC. The dried samples were ground with mortar and pestle and sieved with 2 mm sieve.

Description of the sampling sites: Soil samples for heavy metal determination were collected from twenty one (21) irrigation sites of the Kaduna metropolis. These sites were Kabala (KBL), Danmani (DMN), Rigasa (RGS), Barnawa (BNW), Makera (MKR), Kakuri (KKR), Badiko (BDK) Nasarawa (NAS, Malali (MAL), Kudenda (KUD), Kinkinau (KKN), Kawo (KWO), Unguwan Rimi (URM), Unguwan Sanusi (UNS), Tudun Wada (TDW), Doka (DKA), Unguwan Dosa (UDS), Kabala Costain (CTA), Kurmin Mashi (KMS) and Abakpa (ABK). In this research work soil sample from Rigachikun (RCK) irrigation site was taken as control site.

Sample preparation:

Cabbage samples: Five gram of the ground Cabbage samples were ashed in a muffle furnace at a temperature of 550ºC for five hours and digested with 20 cm^3 of HNO_3/H_2O_2 (2:1). The digested residues were dissolved with 50 cm^3 of distilled water and filtered in 50 cm^3 volumetric flask.

Soil sample: 20 g of the finely ground soil samples was mixed with 60 cm^3 (5:5:1) $H_2SO_4/HNO_3/HCl$ acid mixtures and the content were refluxed for 12 h. The sample was washed with 1M HNO_3 and 100 cm^3 of deonized water was also added and centrifuged. The elements (Cd, Fe, Zn and Pb) were determined using bulk scientific model VPG 210 model atomic absorption spectrophotometer (AAS).

In order to investigate the ratio of the concentration of heavy metal in a plant to the concentration heavy metal in soil, the transfer factor was calculated based on the method described by Oyedele *et al.* (1995) and Harrison and Chirgawi (1989).

$$TF = Ps\ (\mu g/g/\ St\ (\mu g/g)$$

where Ps is the plant metal content originating from the soil and St is the total content in the soil.

RESULTS AND DISCUSSION

The mean concentration of cadmium, copper and lead in soil and lettuce at various irrigation sites of the Kaduna metropolis are summarized in Table 1 to 7.

Table 1 shows Cadmium distribution of soil in the irrigation site of the Kaduna metropolis. The result shows that some sampling sites had more concentration of Cadmium than that of the control site (1.32 μg/g). Sharma *et al*. (2009) reported concentration of cadmium as 2.3μg/g in the soil which is higher than the concentration obtained in the present study.

Table 2 shows Cadmium concentration in cabbage, the mean concentrations were above FAO/WHO standard of 0.2μg/g. This implies that, the concentration of Cadmium in cabbage were above the tolerable limit in most of the sampling sites. However, there is an isolated case in Kabala where the Cadmium concentration is within the WHO limit.

The concentrations recorded in this study were lower than the range of 2.5 to 15.0 μg/g concentration of cadmium in vegetable (cabbage) as reported by Hussain *et al.* (1995)

Cadmium if accumulated through food stuff may lead to the chronic effect in the kidney and liver of human thereby causing disruption of numerous biochemical processes, leading to cardiovascular nervous, and bone disease (FAO/WHO, 2007; Jarup, 2003)

Table 3 shows Iron distribution of soil in the irrigation site of the Kaduna metropolis. The result shows that most of the sampling sites had higher concentrations of Iron than the control site (21.70 μg/g).

Table 1: Distribution of cadmium in soil from different irrigation sites of the kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
SL (KBL)	1.35	0.30	0.17	0.61	2.09
SL (DMN)	1.02	0.08	0.04	0.83	1.21
SL (RGS)	0.04	0.06	0.04	0.12	0.19
SL (BNW)	2.23	1.47	0.85	0.43	5.89
SL (MKR)	1.95	0.28	0.16	1.26	2.64
SL (KKR)	0.73	0.60	0.35	0.76	2.22
SL (BDK)	1.27	0.10	0.06	1.01	1.53
SL (NAS)	1.80	0.70	0.40	0.06	3.54
SL (MAL)	1.25	0.31	0.18	0.47	2.03
SL (KUD)	2.18	0.86	0.50	0.05	4.32
SL (KKN)	1.55	0.14	0.08	1.20	1.89
SL (KWO)	0.12	0.03	0.02	0.05	0.20
SL (URM)	ND	ND	ND	ND	ND
SL (UNS)	0.03	0.03	0.02	0.04	0.11
SL (TDW)	0.20	0.25	0.14	0.41	0.82
SL (DKA)	1.25	1.75	1.01	0.10	5.60
SL (UDS)	1.57	0.23	0.13	1.01	2.13
SL (CTA)	1.55	0.23	0.13	0.98	2.12
SL (KMS)	1.47	0.20	0.12	0.96	1.97
SL (ABK)	1.18	0.24	0.14	0.60	1.77
SL (RCK) Control	1.32	0.44	0.25	0.23	2.40

Table 2: Distribution of cadmium in cabbage from different irrigation sites of the kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
CB (KBL)	0.04	0.02	0.01	0.01	0.08
CB (DMN)	0.38	0.23	0.13	0.00	0.94
CB (RGS)	0.73	0.64	0.37	0.00	2.33
CB (BNW)	0.89	0.72	0.41	0.00	2.67
CB (MKR)	0.27	0.12	0.07	0.00	0.55
CB (KKR)	0.93	0.31	0.18	0.17	1.69
CB (BDK)	0.03	0.05	0.03	0.00	0.14
CB (NAS)	1.27	0.31	0.18	0.51	2.03
CB (MAL)	0.87	0.42	0.24	0.00	1.90
CB (KUD)	1.07	0.50	0.29	0.00	2.32
CB (KKN)	0.60	0.40	0.23	0.00	1.59
CB (KWO)	1.27	0.12	0.07	0.98	1.55
CB (URM)	0.93	0.42	0.24	0.00	1.97
CB (UNS)	0.47	0.42	0.24	0.00	1.50
CB (TDW)	0.59	0.56	0.33	0.00	1.99
CB (DKA)	1.00	0.20	0.12	0.50	1.50
CB (UDS)	0.80	0.20	0.12	0.30	1.30
CB (CTA)	0.60	0.35	0.20	0.00	1.46
CB (KMS)	0.87	0.31	0.18	0.11	1.63
CB (ABK)	0.87	0.58	0.33	0.00	2.30
CB (RCK) (Control)	0.60	0.20	0.12	0.10	1.10

Table 4 shows concentration of iron in cabbage samples. All cabbage samples analyzed for iron in this research work, shows that, their concentrations were higher than 5.28 μg/g for cabbage obtained from Rigachikun (control site), in contrast with samples from Kabala, Danmani and Badiko having lower concentration than the control site.

However, the results of iron in cabbage recorded in the present study were lower than 25.00 μg/g as reported by Onianwa *et al*. (2001). Iron is an essential nutrient element for all living cell and it plays an important role in photosynthesis and carbohydrate metabolism (Rasheed and Awadallah, 1998).

Table 5 shows Zinc concentration in soil from the irrigation site of the Kaduna metropolis. The result shows that all sampling sites had higher concentrations of Zinc than the control site (17.38 μ).Zinc concentrations for soil obtained from various sampling sites were higher than 13.56 and 16.72 μg/g for the Alau dam and Gongulon soil samples respectively as reported by Uwah *et al.* (2009).

Sharma *et al.* (2007) reported a concentration of zinc as 43.56 μg/g in the soil which is higher than the concentration recorded during the present study. Infact high concentration of zinc in the soil may be ascribed to the use of zinc in fertilizers and metal based pesticide.

Table 3: Distribution of iron in soil from different irrigation sites of the Kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
SL (KBL)	44.88	1.08	0.62	42.21	47.55
SL (DMN)	44.83	0.94	0.54	42.50	47.16
SL (RGS)	102.23	1.91	1.10	97.49	106.97
SL (BNW)	101.83	2.49	1.44	95.65	108.00
SL (MKR)	43.38	2.96	1.71	36.03	50.74
SL (KKR)	96.141	0.68	6.17	69.61	122.67
SL (BDK)	45.71	1.97	1.14	40.83	50.60
SL (NAS)	43.37	9.35	5.40	20.15	66.59
SL (MAL)	12.53	0.75	0.43	10.67	14.40
SL (KUD)	47.42	0.93	0.53	45.12	49.71
SL (KKN)	35.60	12.34	7.13	4.94	66.26
SL (KWO)	102.48	3.63	2.10	93.45	111.51
SL (URM)	104.61	.44	0.83	101.03	108.19
SL (UNS)	101.86	2.00	1.16	96.89	106.83
SL (TDW)	100.01	3.09	1.78	92.33	107.68
SL (DKA)	74.22	60.75	35.07	16.68	225.13
SL (UDS)	16.00	0.20	0.12	15.50	16.50
SL (CTA)	29.25	.65	0.38	27.63	30.87
SL (KMS)	39.52	0.97	0.56	37.10	41.93
SL (ABK)	19.50	1.54	0.89	15.68	23.32
SL (RCK) (Control)	21.70	16.15	9.33	11.42	61.82

Table 4: Distribution of iron in cabbage from different irrigation sites of the Kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
CB (KBL)	1.85	1.80	1.04	2.62	6.33
CB (DMN)	0.51	0.78	0.45	1.42	2.43
CB (RGS)	6.39	0.96	0.55	4.02	8.76
CB (BNW)	8.06	1.52	0.88	4.28	11.84
CB (MKR)	8.67	3.21	1.85	0.70	16.64
CB (KKR)	9.26	4.63	2.67	2.23	20.75
CB (BDK)	4.02	3.19	1.84	0.89	11.94
CB (NAS)	5.53	2.19	1.27	0.08	10.98
CB (MAL)	7.27	3.10	1.79	0.44	14.97
CB (KUD)	7.47	3.45	1.99	1.10	16.03
CB (KKN)	12.40	4.20	2.42	1.97	22.83
CB (KWO)	7.33	2.08	1.20	2.16	12.50
CB (URM)	12.13	3.44	1.99	3.58	20.69
CB (UNS)	11.53	7.02	4.05	0.89	28.96
CB (TDW)	10.93	2.20	1.27	5.46	16.41
CB (DKA)	10.00	5.20	3.00	2.91	22.91
CB (UDS)	8.67	3.70	2.14	0.53	17.86
CB (CTA)	11.67	5.52	3.19	2.05	25.38
CB (KMS)	7.73	4.16	2.40	2.61	18.08
CB (ABK)	8.67	0.61	0.35	7.15	10.18
CB (RCK) (Control)	5.28	3.61	2.09	3.69	14.25

Oyedele *et al*. (2008) reported lower concentration of zinc 1.03 μg/g in the soil from Ile-Ife Nigeria which is lower than the concentration of all sample analyzed for zinc in this research work.

Table 6 shows Zinc concentration in cabbage, the concentrations obtained were far below FAO/WHO standard of 60.00 μg/g. This implies that, the concentrations of Zinc in cabbage are within the tolerable limit in all the sampling sites. However, there are no isolated cases in any site.

The concentrations of zinc in cabbage recorded in this research study were higher than 2.83 μg/g for cabbage in Landhi as reported by Hashmi *et al.* (2005).

Sharma *et al.* (2009) recorded 29.6 μg/g for zinc in lady's finger which is higher than the concentration obtained in the present study.

Table 7 shows lead concentrations of soil in the irrigation sites of the Kaduna metropolis. The concentrations obtained in the analyzed samples were more than that of the control sites (3.67 μg/g). Oyedele *et al*. (2008) reported 37.9 - 42 μg/g for lead in soil which were higher than the concentration obtained in this research work.

Lead concentration for all the soil samples analyzed in this research work were found to be lower than 2.95 and 3.58 μg/g for the soil from Alau dam and

Table 5: Distribution of zinc in soil from different irrigation sites of the Kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
SL (KBL)	32.38	6.17	3.56	17.05	47.72
SL (DMN)	31.17	9.03	5.21	8.74	53.59
SL (RGS)	66.93	26.30	15.18	1.61	132.26
SL (BNW)	34.36	25.49	14.72	0.95	97.67
SL (MKR)	41.40	0.74	0.43	39.56	43.24
SL (KKR)	51.72	9.90	5.72	27.13	76.31
SL (BDK)	24.27	6.71	3.87	7.60	40.93
SL (NAS)	31.25	6.38	3.68	15.41	47.09
SL (MAL)	27.25	0.43	0.25	26.19	28.31
SL (KUD)	40.37	4.48	2.59	29.24	51.49
SL (KKN)	29.37	2.29	1.32	23.67	35.07
SL (KWO)	46.99	5.27	3.04	33.91	60.08
SL (URM)	62.91	30.13	17.40	0.94	137.76
SL (UNS)	49.39	1.63	0.94	45.35	53.44
SL (TDW)	40.84	6.18	3.57	25.50	56.19
SL (DKA)	29.79	24.66	14.24	1.48	91.05
SL (UDS)	25.32	1.61	0.93	21.32	29.31
SL (CTA)	27.87	0.63	0.36	26.31	29.42
SL (KMS)	22.43	0.70	0.40	20.69	24.17
SL (ABK)	25.60	0.58	0.33	24.17	27.03
SL (RCK) (Control)	17.38	3.70	2.14	8.18	26.58

Table 6: Distribution of zinc in cabbage from different irrigation sites of the Kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
CB (KBL)	18.53	28.31	16.35	1.81	88.86
CB (DMN)I	11.30	1.86	1.07	6.68	15.91
CB (RGS)	ND	ND	ND	ND	ND
CB (BNW)	3.67	3.19	1.84	0.26	11.59
CB (MKR)	6.00	5.38	3.11	0.37	19.37
CB (KKR)	7.30	4.35	2.51	0.50	18.10
CB (BDK)	0.73	0.64	0.37	0.86	2.33
CB (NAS)	7.53	1.50	0.87	3.80	11.26
CB (MAL)	6.63	2.31	1.33	0.89	12.38
CB (KUD)	7.10	3.12	1.80	0.65	14.85
CB (KKN)	5.00	2.03	1.17	0.04	10.04
CB (KWO)	8.03	1.78	1.03	3.62	12.45
CB (URM)	7.20	2.31	1.33	1.47	12.93
CB (UNS)	7.23	0.29	0.17	6.52	7.95
CB (TDW)	2.72	3.63	2.10	0.31	11.75
CB (DKA)	9.63	0.71	0.41	7.87	11.40
CB (UDS)	6.73	1.97	1.14	1.83	11.63
CB (CTA)	6.63	0.51	0.30	5.36	7.91
CB (KMS)	6.57	2.70	1.56	0.13	13.26
CB (ABK)	4.93	3.71	2.14	0.29	14.15
CB (RCK) (Control)	7.40	4.46	2.58	1.69	18.49

Gongulon (Maiduguri. Nigeria) as reported by Uwah *et al*. (2009), in contrast with Badiko, costain and Kurmin mashi samples had higher concentrations.

Table 8 for lead concentration in cabbage, the mean concentration for the analysed samples above FAO/WHO (2007) standard of 0.3 μg/g. This implies that, the concentration of lead in cabbage are above the tolerable limit in most of the sampling sites.

Hussain *et al*. (1995) reported 29.53 μg/g for cucumber sample obtained from Riqqa which is higher than the concentration obtained in the present research work.

However, from the results obtained in this research work consumers of such vegetables are liable to lead toxicity.

Table 9 shows percentage ash in cabbage sample. It was observed that percentage ash obtained were higher than that of the control site (25.00%) with the exception of samples from Kabala, Barnawa, Kinkinau, Doka, Ungwar sanusi, Tudun Wada Ungwar Dosa, and Kurmin marshi . All percentage ash obtained in this research work were higher than 19.61% in Amaranthus hybrids leaves as reported by Nwagu *et al.* (2000).

Table 10 shows transfer factor for heavy metal from soil to Cabbage. All transfer factor are below 1 with the

Table 7: Distribution of lead in soil from different irrigation sites of the Kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
SL (KBL)	4.17	2.88	1.66	0.98	11.33
SL (DMN)	4.00	2.84	1.64	0.05	11.04
SL (RGS)	13.23	6.64	3.84	1.27	29.73
SL (BNW)	35.46	14.26	8.23	0.03	70.88
SL (MKR)	3.20	0.20	0.12	2.70	3.70
SL (KKR)	36.47	12.57	7.26	5.24	67.70
SL (BDK)	2.17	0.96	0.55	0.22	4.55
SL (NAS)	4.67	1.89	1.09	0.03	9.36
SL (MAL)	3.80	1.64	0.95	0.27	7.87
SL (KUD)	4.95	2.23	1.29	0.59	10.49
SL (KKN)	3.47	1.00	0.58	0.98	5.95
SL (KWO)	39.78	13.64	7.88	5.90	73.66
SL (URM)	16.47	2.22	1.28	10.96	21.97
SL (UNS)	9.60	7.21	4.17	2.32	27.53
SL (TDW)	5.16	6.35	3.67	1.63	20.94
SL (DKA)	30.36	20.50	11.84	2.57	81.28
SL (UDS)	3.67	1.36	0.79	1.28	7.05
SL (CTA)	2.53	0.61	0.35	1.02	4.05
SL (KMS)	2.60	0.60	0.35	1.11	4.09
SL (ABK)	3.47	1.50	0.87	1.26	7.20
SL (RCK) (Control)	3.67	2.02	1.17	1.36	8.69

Table 8: Distribution of lead in cabbage from different irrigation sites of the Kaduna metropolis

				95% Confidence interval for mean	
Sampling sites	Mean concentration (μg/g)	S.D.	S.E.	Lower bound	Upper bound
CB (KBL)	2.67	0.84	0.49	0.58	4.77
CB (DMN)	3.34	2.02	1.16	0.66	8.35
CB (RGS)	0.61	0.20	0.12	0.11	1.11
CB (BNW)	2.73	0.42	0.24	1.70	3.77
CB (MKR)	2.00	0.60	0.35	0.51	3.49
CB (KKR)	1.28	0.79	0.46	0.69	3.24
CB (BDK)	1.16	0.14	0.08	0.80	1.52
CB (NAS)	2.87	0.31	0.18	2.11	3.63
CB (MAL)	2.93	1.42	0.82	0.59	6.46
CB (KUD)	3.43	1.36	0.78	0.06	6.81
CB (KKN)	1.73	0.46	0.27	0.59	2.88
CB (KWO)	1.73	0.76	0.44	0.15	3.61
CB (URM)	2.67	1.50	0.87	0.06	6.40
CB (UNS)	2.50	0.50	0.29	1.26	3.74
CB (TDW)	2.88	0.29	0.17	2.15	3.60
CB (DKA)	3.87	2.01	1.16	0.13	8.87
CB (UDS)	3.73	3.06	1.77	0.87	11.34
CB (CTA)	2.07	1.33	0.77	0.24	5.37
CB (KMS)	3.00	1.97	1.14	0.89	7.89
CB (ABK)	3.40	1.56	0.90	0.48	7.28
CB (RCK) (Control)	2.03	0.45	0.26	0.91	3.15

exception of Rigasa, Kakuri, Kawo, Unguwan Sanusi, Tudunwada Costain and Kurmi mashi.

The transfer factor values obtained in most of the sampling sites were lower than that obtained in Rigachikun (control site).

Francis (2005) reported a transfer factor (soil to vegetable) of 0.15, 0.85, and 0.63 for Fe, Zn and Pb, respectively. These values were lower than that obtained, in this research work. Also Lokeshwari and Chandrappa (2006) recorded 2.5 TF for Cd from soil to vegetable, this is higher than most of the value obtained for Cadmium in the present study

Table 11 shows correlation coefficient for cadmium with $p = 0.002<0.05$ for cabbage. This shows that there is significant correlation between Cadmium concentrations in soil and Cadmium concentrations in the cabbage. The correlation is strong positive with the value of $r = 0.0806$. This implies that both Cadmium concentrations in soil and Cadmium concentrations in the vegetables increase and decrease together in the same direction. As Cadmium

Table 9: Percentage ash in cabbage sample

Samples	Mean percentage Ash (%)	S.D. (%)
Kabala	15.33	2.52
Danmani	30.00	2.00
Barnawa	19.66	5.69
Makera	23.00	8,19
Badiko	20.67	3.06
Nasarawa	32.00	4.00
Malali	28.67	3.06
Kudende	29.00	6.56
Kinkinau	19.67	4.04
Kawo	32.33	4.04
Unguwan Rimi	27.33	3.06
Unguwan Sanusi	24.67	4.16
Tudun Wada	21.33	6.11
Doka	19.00	4.58
Unguwan Dosa	22.33	2.08
Costain	26.33	1.53
Kurmin Mashi	20.67	5.03
Abakpa	26.00	9.17
Kakuri	32.33	3.51
Rigasa	27.00	3.00
Rigachikun Control	25.33	3.06

Table 10: Transfer factor (TF) for each metal from soil to cabbage

Sampling Sites	Cd / (μg/g)	Fe / (μg/g)	Zn / (μg/g)	Pb / (μg/g)
Kabala	0.03	0.04	0.01	0.64
Danmani	0.37	0.01	0.46	0.84
Rigasa	18.25	0.06	0.00	0.05
Barnawa	0.39	0.08	0.11	0.08
Makera	0.14	0.19	0.21	0.63
Kakuri	1.27	0.09	0.14	0.04
Badiko	0.02	0.09	0.03	0.53
Nasarawa	0.71	0.13	0.24	0.62
Malali	0.69	0.58	0.24	0.77
Kudenda	0.49	0.16	0.18	0.69
Kinkinau	0.39	0.35	0.17	0.50
Kawo	2.35	0.07	0.17	0.04
Unguwan Rimi	0.93	0.12	0.11	0.16
Unguwan Sanusi	15.66	0.11	0.06	0.26
Tudunwada	2.95	0.11	0.32	0.56
Doka	0.80	0.13	0.27	0.13
Unguwan Dosa	0.51	0.54	0.24	1.01
Costain	0.39	0.40	0.30	0.82
Kurmi Mashi	0.59	0.20	0.30	1.15
Abakpa	0.72	0.45	0.19	0.98
Rigachikun	0.45	0.24	0.43	0.55

concentrations in soil increases, the Cadmium concentrations in the vegetables also increases and vice versa.

Table 12 shows correlation coefficient for Iron with p = 0.000<0.05 for cabbage; there is significant correlation between Iron concentrations in soil and Iron concentrations in cabbage. The correlation is strong positive with the value of r = 0.053. This implies that both Iron concentrations in soil and Iron concentrations in the cabbage increase and decrease together in the same direction. As Iron concentrations in soil increases, Iron concentrations in the vegetables also increases and vice versa.

Table 13 shows correlation coefficient for zinc p = 0.003<0.05 for cabbage. This also shows that there is significant correlation between Zinc concentrations in soil and Zinc concentrations in the cabbage. The correlation is strong positive with the value of r = 0.0655. This implies that both Zinc concentrations in soil and Zinc concentrations in the vegetables increase and decrease together in the same direction. As Zinc concentrations in soil increases, Zinc concentrations in the vegetables also increases and vice versa.

Table 14 shows correlation coefficient for lead p = 0.008<0.005 for cabbage. This shows that there is significant correlation between lead concentrations in soil and lead concentrations in the cabbage. The correlation is strong positive with the value of r = 0.571. This implies that both lead concentrations in soil and lead concentrations in the cabbage increase and decrease together in the same direction. As lead concentrations in soil increases, lead concentrations in the cabbage also increase and vice versa.

CONCLUSION

In the present study, the concentration of cadmium, iron, zinc and lead were determined in the soil and lettuce obtained from irrigation sites of Kaduna Metropolis,

Table 11: Correlation coefficients for cadmium

Vegetable Type			Cadmium concentration in vegetable sample (ug/g)
Cabbage	Cadmium concentration in soil sample (ug/g)	Pearson correlation	0.806
		Sig. (2-tailed)	0.002

Table 12: Correlation coefficients for iron

Vegetable Type			Iron concentration in vegetable sample (ug/g)
Cabbage	Iron concentration in soil sample (ug/g)	Pearson correlation	0.853
		Sig. (2-tailed)	0.000

Table 13: Correlation coefficients for zinc

Vegetable Type			Zinc concentration in vegetable sample (ug/g)
Cabbage	Zinc concentration in soil sample (ug/g)	Pearson correlation	0.655
		Sig. (2-tailed)	0.003

Table 14: Correlation coefficients for lead

Vegetable Type			Lead concentration in vegetable sample (ug/g)
Cabbage	Lead concentration in soil sample (μg/g)	Pearson correlation	0.571
		Sig. (2-tailed)	0.008

Nigeria. The result revealed that the concentration of lead and cadmium from some samples were above the recommended limit stipulated by FAO/WHO (2007) allimentarius but iron and zinc were found to be within such limit. Therefore consumption of lettuce from the study areas might result to lead and cadmium toxicity and thereby dangerous to human health.

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