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Relationship between Transfer Factor and Enrichment Factor from the Soil and Vegetable Grown In Irrigated Farmlands of Kaduna Metropolis Nigeria

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ABSTRACT: *The objective of this study was to examined how transfer factor and enrichment factor affect soil and consequently the vegetable grown in the irrigated farmlands of Kaduna metropolis.The transfer factor (TF) of heavy metals from soil to vegetables such as spinach,tomatoes,cabbage and lettuce. For spinach samples, TF values were below 1 with the exception of samples from Kawo (2.45 for Cd) and Rigachikun (1.11 for Cu). For tomatoes samples are also below 1 with the exception of samples from Rigasa (17.25 for Cd),, Kawo (1.56 for Cd), Unguwan Sanusi (3.00 for Cd) and Tudun wada (1.60 for Cd). All TF for cabbage samples are below 1 with the exception of samples from Rigasa (18.25 for Cd), Kakuri (1.27 for Cd), Kawo (2.35 for Cd) and Unguwan Sanusi (15.66 for Cd). For lettuce samples the TF values are below 1 with the exception of samples from Rigasa (2.66 for Cd),Malali (1.01 for Cd, 1.03 for Fe and 1.17 for Cu),Kawo (1.48 for Cd).In a situation whereby the TF values were below 1 showing that heavy metals accumulated in their edible portion (leaves) are less compared to that of the soil (that is, absorb small amount of metal from the soil.).Enrichment factors for heavy metals such as Cd,Fe ,Zn ,Cu and Pb in soil was also determined.If > 1 the plant absorbs high amont of heavy metal from the soil.(concentration of heavy metal in plant is higher than that of the soil.) Cadmium from Malali and Unguwan Dosa samples occurred with EF values greater than 1.5 suggesting anthropogenic. The enrichment factor for Zinc shows that samples from Malali and Unguwan Dosa are moderatly enriched. Enrichment factors (EF) for copper showed that samples from Barnawa ,Malali and Unguwan Dosa are moderately enriched and as such they are from anthropogenic source. The enrichment factor for lead are as follows, Kakuri (2.2), Kawo (2.3), Barnawa (2.1) and Doka (2.4) suggesting that they are from anthropogenic source.The EF for iron are mostly from natural source.When the concentrations of heavy metal accumulated in the plants were higher in concentration than that obtained in the soil, will result to such plant to act as bioremidiator*

KEYWORDS: *Heavy Metals, Soil, Vegetable, Atomic Absorption Spectrophotometer (AAS),Transfer factor (TF), Enrichment factor (EF), Kaduna Metropolis, Nigeria.*

I. INTRODUCTION

Heavy metals are among the major contaminant of food supply and are considered as problem to the environment (Zaidi *et al, 2005*). Heavy metals contamination may occur due to irrigation with contaminated water, the addition of fertilizers, metal based pesticides, industrial emissions, transportation, harvesting process and storage. Advancement in technology has lead to high levels of industrialization leading to the discharge of effluent bearing heavy metals into our environment.The sources of heavy metals in plants are their growth media from which heavy metals are taken up by roots. Although some heavy metals such as Cu, Zn, Mn, Fe etc are essential in plant nutrition, many heavy metals do not play significant role in the plants physiology. Plants growing in a polluted environment can accumulate the toxic metal at high concentration thereby causing serious risk to the human health when consumed (Kabata – Pendias, 1984, Alloway, 1990, Vousta *et al*, 1996). Heavy metals have been excessively released into the environment due to rapid industrialization and have created a major global concern (Wan Ngah and Hanafiah, 2008). Unlike organic waste, heavy metals are non-biodegradable and they can be accumulated in living tissues, causing various diseases and disorders, therefore, they must be removed before discharge (Namasivayam and Ranganathan, 1995).Industrial products that are used in homes and which have been produced with heavy metals are other sources of human exposure to such heavy metals. Mercury exposure is through disinfectants, antifungal agents, toiletries, creams and organo-metallics (McCluggage, 1991). Cadmium exposure is through nickel/cadmium batteries and artist paints; lead exposure is through wine bottle wraps, mirror coatings, batteries, paints and tiles.Major categories of soil pollutions include nutrients (fertilizers, sewage sludge), acids, heavy metals, radioactive elements and organic chemicals, herbicides, insecticides and other pesticides).

Many of these pollutants are continuously discharged into the soil through land waste disposal, inputs from the atmosphere and irrigation by municipal waste water on a daily basis (Radojevic and Bashkin, 1999).There are many sources of trace metals contaminants that can be accumulated in soils. The burning of fossils fuels, smelting and other processing techniques release into the atmosphere which can be carried for miles and later deposited on the vegetation and soil. Lead and nickel are gasoline additives that are released into the atmosphere and carried to the soil through rain and snow. (Holmgen *et al*, 1993; Igwe *et al*, 2005). Other identifiable sources include atmospheric deposition of manure, fertilizers, pesticides and industrial discharge (Holgate, Irrigation is the artificial means of water supply to the agricultural crops ranging from surface irrigation, micro sprayer and low-head barber irrigation. Irrigation is design to permit farming in arid regions and offset drought in semi-arid or semi humid regions.The purpose of irrigation is to introduce water into the part of the soil profile that serves as the root zone, for the subsequent uses of the crop. Domestic waste water contains metal from metabolic waste, corrosion of water pipes and consumer products. Industrial effluents and water slug may substantially contribute to the metal loading (Zapella, 2003).Vegetable constitute an important part of the human diet since they contain carbohydrates, proteins, as well as vitamins, minerals and trace elements (Dastane, 1987). Human beings are encourage to consume more vegetables and fruits, because they are good source of vitamins, minerals, fibres and also beneficial to their health. However, these plants contain both essential and toxic metals over a wide range of concentrations.The aim of this research work is to determine the level of some heavy metals from soil that is transferred to the plants and to correlate the origin of such pollution due to human activities.

II. MATERIALS AND METHODS

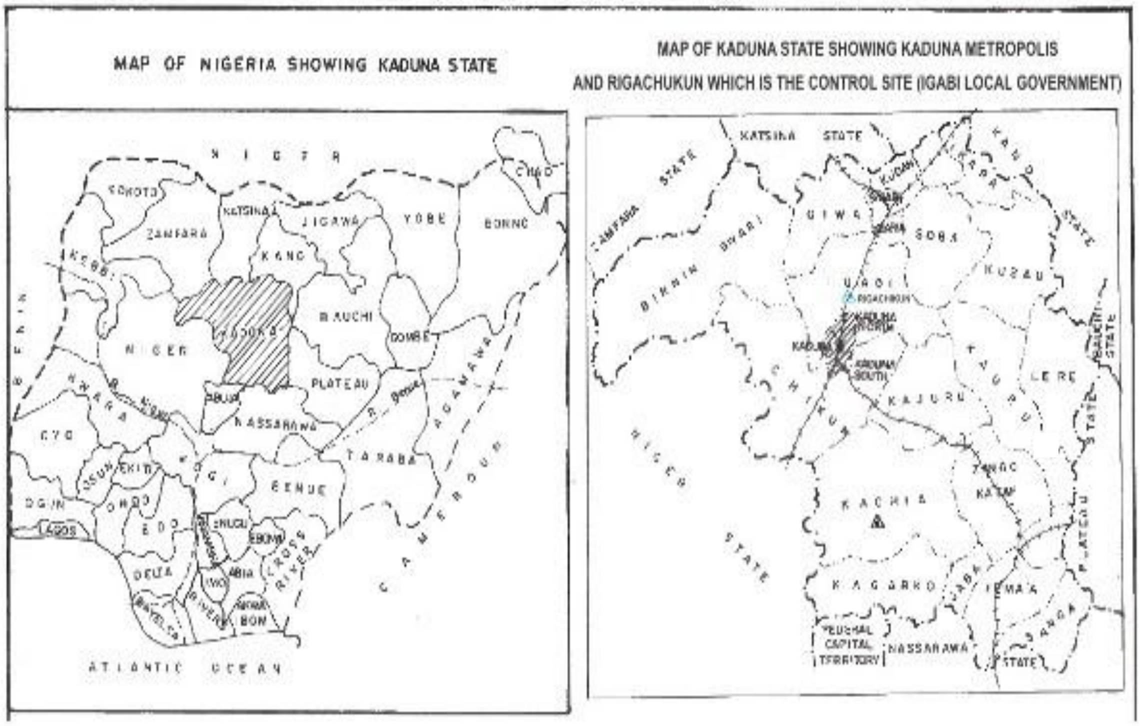
Sample and Sampling:

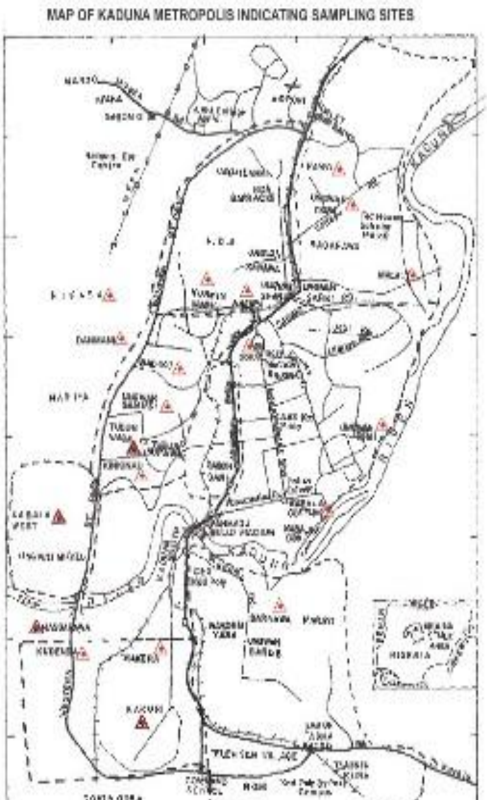
Vegetables such as Spinach, Cabbage, Tomatoes and Lettuce samples were collected from twenty one (21) different irrigation sites of the farmlands of the Kaduna metropolis where they were irrigated with water from the river or pond which are sometimes contaminated. Soil samples were also randomly collected 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 105^0c.The dried samples were ground with mortar and pestle and sieved with 2mm 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.

Map of the Sampling points and the control sites


MAP OF NIGERIA SHOWING KADUNA STATE
MAP OF KADUNA STATE SHOWING KADUNA METROPOLIS
AND RIGACHUKUN WHICH IS THE CONTROL SITE (IGABI LOCAL GOVERNMENT)


MAP OF KADUNA METROPOLIS INDICATING SAMPLING SITES
LEGEND

SAMPLE PREPARATION

Vegetable samples

5g of the ground Vegetable samples were ashed in a muffle furnace at a temperature of 550^0c for five hours and digested with $20cm^3$ of HNO_3/H_2O_2 (2:1). The digested residues were dissolved with 50cm of distilled water and filtered in $50cm^3$ volumetric flask.

Soil samples:

20g of the finely ground soil samples was mixed with $60cm^3$ (5:5:1) $H_2SO_4/HNO_3/HCl$ acid mixtures and the content were refluxed for 12 hours. The sample was washed with 1M HNO_3 and $100cm^3$ of deionized water was also added and centrifuged. The elements 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 (μgg^{-1}/ St (μgg^{-1})
Where Ps is the plant metal content originating from the soil and St is the total content in the soil.
The enrichment factor (EF) has been calculated to derive the degree of soil contamination and heavy metal accumulation in soil and in plants growing on contaminated site with respect to soil and plants growing on uncontaminated soil (Kisku *et al*., 2000).According to Ergin *et al*., (1991) and Rubio *et al.*, (2000) the metal enrichment factor (EF) is defined as follows:

$$EF = \frac{\left(\frac{M}{Fe}\right) sample}{\left(\frac{M}{Fe}\right) background}$$

Where M = Metal Concentration in soil sample and EF is the enrichment factor. $(M/Fe)_{sample}$ is the ratio of metal and $(M/Fe)_{background}$ is the ratio of metals and Fe concentration of a background. The background concentrations of metals were taken from an undisturbed area.
Five contamination categories are recognized on the basis of the enrichment factor as follows:
EF<2 is deficiency to minimal enrichment
EF<2-5 is moderate enrichment
EF<2-20 is significant enrichment
EF20-40 is very high enrichment
EF>40 is extremely high enrichment
(Sutherland 2000)

III. RESULTS AND DISCUSSION

n order to ascertain the extent of heavy metals contamination of the soil, an enrichment factor was computed so also transfer factor which is the ratio of the concentration of heavy metal in a plant to the concentration of heavy metal in soil. The movement of trace metal and metalloids between the soil, plant,water and even atmosphere is part of a complex and intricately interrelated biogeochemical cycling processes in nature and is affected by several factors that are both natural and anthropogenic.However in addition to the natural weathering – pedological (geogenic) input, anthropogenic activities are said to be significantly responsible for elevated trace metals concentration in soil (Devkota and Schmidt, 2000; Frost and Ketchum 2000, Sigh *et al.,2004; Mapanda et al., 2005.*).The mean transfer factor for the vegetables(spinach, tomatoes, cabbage and lettuce) and the enrichment factor the various irrigation sites of Kaduna metropolis are summarized in Table 1.0 and 2.0

Table 4: Mean for all the transfer factor(TF) for the whole vegetable in irrigation sites.

	SPINACH (μg/g)					TOMATOES (μg/g)					CABBAGE (μg/g)					LETTUCE (μg/g)				
SAMPLING SITES	Cd (μgg^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})	Cd (μgg^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})	Cd (μgg^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})	Cd (μgg^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})
KBL	0.12	0.30	0.41	0.41	0.88	0.31	0.20	0.60	ND	0.87	0.03	0.04	0.01	ND	0.64	0.07	0.41	0.57	0.75	0.82
DMN	0.09	0.21	0.18	ND	0.81	0.09	0.17	ND	ND	0.80	0.37	0.01	0.46	ND	0.84	ND	0.06	0.59	0.20	0.24
BNW	ND	0.05	0.27	ND	0.12	17.25	0.06	0.05	0.65	0.12	18.25	0.06	ND	ND	0.05	2.66	0.14	0.17	0.78	0.27
MKR	0.01	0.11	0.06	ND	0.05	0.26	0.31	0.04	0.05	0.05	0.39	0.08	0.11	0.04	0.08	0.37	0.05	0.21	0.06	0.04
BDK	0.51	0.22	0.18	0.38	0.50	0.47	0.15	0.11	0.53	0.50	0.14	0.19	0.21	0.40	0.63	0.37	0.22	0.15	0.32	0.74
NAS	0.92	0.05	0.30	0.51	0.14	1.01	0.11	0.11	0.34	0.14	1.27	0.09	0.14	0.19	0.04	0.04	0.13	0.01	0.02	0.11
MAL	ND	0.22	0.02	ND	0.63	0.29	0.13	ND	0.38	0.63	0.02	0.09	0.03	ND	0.53	0.37	0.26	0.19	0.55	ND
KUD	0.71	0.12	0.16	0.83	ND	0.74	0.17	0.31	0.57	ND	0.71	0.13	0.24	0.44	0.62	0.26	0.19	0.18	0.54	0.61
KKN	0.58	0.65	0.26	0.86	0.48	0.52	0.65	0.31	0.56	0.48	0.69	0.58	0.24	0.74	0.77	1.01	1.03	0.31	1.17	0.61
KWO	0.58	0.22	0.25	0.52	0.31	0.35	0.21	0.15	0.55	0.31	0.49	0.16	0.18	0.59	0.69	0.51	0.28	0.16	0.49	0.74
URM	0.47	0.23	0.23	3.63	0.56	0.65	0.24	0.23	0.77	0.56	0.39	0.35	0.17	0.47	0.50	0.73	0.25	0.18	0.58	0.49
UNS	2.46	0.06	0.19	0.23	0.07	1.56	0.05	0.16	0.16	0.07	2.35	0.07	0.17	0.17	0.04	1.48	0.09	0.11	0.13	0.05
TDW	0.73	0.06	0.10	0.13	0.23	0.93	0.08	0.12	0.13	0.23	0.93	0.12	0.11	0.25	0.16	ND	0.08	0.16	0.11	0.21
DKA	0.80	0.08	0.10	0.34	0.23	3.00	0.06	0.11	0.39	0.23	15.66	0.11	0.06	0.62	0.26	ND	0.17	0.31	0.08	0.13
UDS	1.00	0.08	0.31	0.16	0.34	1.60	0.12	0.01	ND	0.34	2.95	0.11	0.32	0.07	0.56	1.00	0.11	0.05	0.11	0.48
CTA	0.96	0.11	0.21	0.31	0.13	1.06	0.05	0.24	0.35	0.13	0.80	0.13	0.27	0.25	0.13	1.09	0.16	0.19	0.34	0.09
KMS	0.64	0.56	0.26	1.00	0.85	0.59	0.48	0.38	0.70	0.85	0.51	0.54	0.24	0.63	1.01	0.38	0.41	0.30	0.63	0.49
ABK	0.47	0.34	0.26	0.48	0.75	0.39	0.24	0.28	0.95	0.75	0.39	0.40	0.30	1.00	0.82	0.34	0.32	0.31	0.89	0.71
KKR	0.36	0.37	0.28	0.67	0.97	0.56	0.24	0.35	0.58	0.97	0.59	0.20	0.30	1.07	1.15	0.45	0.22	0.37	0.64	0.83
RGS	0.68	0.46	0.19	0.73	1.00	0.78	0.33	0.30	1.00	1.00	0.72	0.45	0.19	0.94	0.98	0.85	0.39	0.22	0.97	0.96
RCK	0.36	0.41	0.18	1.11	0.67	0.76	0.42	0.36	1.00	0.67	0.45	0.24	0.43	0.94	0.55	0.48	0.43	0.24	1.18	0.89

	SPINACH (ug/g)					TOMATOES (ug/g)					CABBAGE (ug/g)					LETTUCE (ug/g)				
SAMPLING SITES	Cd (μgg^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})	Cd (μg g^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})	Cd (μg g^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})	Cd (μgg^{-1})	Fe (μgg^{-1})	Zn (μgg^{-1})	Cu (μgg^{-1})	Pb (μgg^{-1})
KBL	0.12	0.30	0.41	0.41	0.88	0.31	0.20	0.60	ND	0.87	0.03	0.04	0.01	ND	0.64	0.07	0.41	0.57	0.75	0.82
DMN	0.09	0.21	0.18	ND	0.81	0.09	0.17	ND	ND	0.80	0.37	0.01	0.46	ND	0.84	ND	0.06	0.59	0.20	0.24
BNW	ND	0.05	0.27	ND	0.12	17.25	0.06	0.05	0.65	0.12	18.25	0.06	ND	ND	0.05	2.66	0.14	0.17	0.78	0.27
MKR	0.01	0.11	0.06	ND	0.05	0.26	0.31	0.04	0.05	0.05	0.39	0.08	0.11	0.04	0.08	0.37	0.05	0.21	0.06	0.04
BDK	0.51	0.22	0.18	0.38	0.50	0.47	0.15	0.11	0.53	0.50	0.14	0.19	0.21	0.40	0.63	0.37	0.22	0.15	0.32	0.74
NAS	0.92	0.05	0.30	0.51	0.14	1.01	0.11	0.11	0.34	0.14	1.27	0.09	0.14	0.19	0.04	0.04	0.13	0.01	0.02	0.11
MAL	ND	0.22	0.02	ND	0.63	0.29	0.13	ND	0.38	0.63	0.02	0.09	0.03	ND	0.53	0.37	0.26	0.19	0.55	ND
KUD	0.71	0.12	0.16	0.83	ND	0.74	0.17	0.31	0.57	ND	0.71	0.13	0.24	0.44	0.62	0.26	0.19	0.18	0.54	0.61
KKN	0.58	0.65	0.26	0.86	0.48	0.52	0.65	0.31	0.56	0.48	0.69	0.58	0.24	0.74	0.77	1.01	1.03	0.31	1.17	0.61
KWO	0.58	0.22	0.25	0.52	0.31	0.35	0.21	0.15	0.55	0.31	0.49	0.16	0.18	0.59	0.69	0.51	0.28	0.16	0.49	0.74
URM	0.47	0.23	0.23	3.63	0.56	0.65	0.24	0.23	0.77	0.56	0.39	0.35	0.17	0.47	0.50	0.73	0.25	0.18	0.58	0.49
UNS	2.46	0.06	0.19	0.23	0.07	1.56	0.05	0.16	0.16	0.07	2.35	0.07	0.17	0.17	0.04	1.48	0.09	0.11	0.13	0.05
TDW	0.73	0.06	0.10	0.13	0.23	0.93	0.08	0.12	0.13	0.23	0.93	0.12	0.11	0.25	0.16	ND	0.08	0.16	0.11	0.21
DKA	0.80	0.08	0.10	0.34	0.23	3.00	0.06	0.11	0.39	0.23	15.66	0.11	0.06	0.62	0.26	ND	0.17	0.31	0.08	0.13
UDS	1.00	0.08	0.31	0.16	0.34	1.60	0.12	0.01	ND	0.34	2.95	0.11	0.32	0.07	0.56	1.00	0.11	0.05	0.11	0.48
CTA	0.96	0.11	0.21	0.31	0.13	1.06	0.05	0.24	0.35	0.13	0.80	0.13	0.27	0.25	0.13	1.09	0.16	0.19	0.34	0.09
KMS	0.64	0.56	0.26	1.00	0.85	0.59	0.48	0.38	0.70	0.85	0.51	0.54	0.24	0.63	1.01	0.38	0.41	0.31	0.89	0.71

ABK	0.47	0.34	0.26	0.48	0.75	0.39	0.24	0.28	0.95	0.75	0.39	0.40	0.30	1.00	0.82	0.34	0.32	0.37	0.64	0.83
KKR	0.36	0.37	0.28	0.67	0.97	0.56	0.24	0.35	0.58	0.97	0.59	0.20	0.30	1.07	1.15	0.45	0.22	0.22	0.97	0.96
RGS	0.68	0.46	0.19	0.73	1.00	0.78	0.33	0.30	1.00	1.00	0.72	0.45	0.19	0.94	0.98	0.85	0.39			
RCK	0.36	0.41	0.18	1.11	0.67	0.76	0.42	0.36	1.00	0.67	0.45	0.24	0.43	0.94	0.55	0.48	0.43	0.24	1.18	0.89

Table 2.0 Enrichment factor of heavy metals in soil from irrigated farmlands of Kaduna metropolis

Sampling sites	Elements				
	Cd	Zn	Cu	Pb	Fe
Kabala	0.5	0.9	0.5	0.5	1.11
Danmani	0.4	0.7	0.7	0.5	1.15
Rigasa	0.01	0.8	0.2	0.8	1.22
Barnawa	0.4	0.4	2.6	2.1	2.37
Makera	0.7	1.2	1.2	0.4	0.84
Kakuri	0.1	0.7	0.2	2.2	1.49
Badiko	0.5	0.7	0.6	0.3	1.51
Nasarawa	0.7	0.9	1.1	0.6	1.11
Malali	1.6	2.2	2.1	0.2	0.37
Kudenda	0.8	1.1	1.1	0.6	0.94
Kinkinau	0.3	1.0	1.1	0,6	0.97
Kawo	0.1	0.6	1.2	2.3	1.75
Unguwan Rimi	ND	0.8	1.3	0.2	1.33
Unguwan sanusi	0.01	0.6	0.5	0.1	1.65
Tudun wada	0.1	0.5	1.5	0.3	1.98
Doka	0.3	0.5	1.2	2.4	1.99
Unguwan Dosa	1.6	2.0	2.0	1.3	0.51
Costain	0.9	1.2	0.9	0.5	0.84
Kurmin mashi	0.6	0.7	0.9	0.4	0.74
Abakpa	1.0	1.6	1.1	1.0	0.61

Table 1.0 above shows the transfer factor of heavy metals from soil to vegetables such as spinach,tomatoes,cabbage and lettuce. For spinach samples, TF values were below 1 with the exception of samples from Kawo (2.45 for Cd) and Tudun wada (1.00 for Cd), Unguwan dosa (1.00 for Cu), Abakpa (1.00 for Pb) and Rigachikun (1.11 for). For tomatoes samples are below 1 with the exception of samples from Rigasa (17.25 for Cd), Kakuri (1.01 for Cd), Kawo (1.56), Unguwan Sanusi (3.00), Tudunwada (1.60) , Doka (1.06),

Abakpa (1.00 for both Cu and Pb) and Rigachikun (control) (1.00 for Cu). All TF for cabbage samples are below 1 with the exception of samples from Rigasa (18.25 for Cd), Kakuri (1.27 for Cd), Kawo (2.35 for Cd), Unguwan Sanusi (15.66 for Cd), Tudunwada (2.95), Costain (1.00 for Cu) and Kurmi mashi (1.07 for Cu and 1.15 for Pb). For lettuce samples are below 1 with the exception of samples from Rigasa (2.66 for Cd),Malali (1.01 for Cd, 1.03 for Fe and 1.17 for Cu),Kawo (1.48 for Cd) , Tudun wada(1.00 for Cd),Doka (1.09 for Cd) and Rigachikun (control) 1.18 for Cu.).In situation whereby the TF values were below 1 showing that heavy metals are accumulated in their edible portion (leaves) are less compared to that of the soil (that is, absorb small amount of metal from the soil.)This is because of cytogenic make – up as well as other unknown factors are responsible for different pattern of transfer of metal to the plant. Also metal and bioavailability as well as possible synergism or antagonism between trace elements and their transfer from soil to the vegetable which occur extensively. (Fergusson, 1991; Chaney *et al.*,2000; McLaughlin *et al.*, 2000; Smith, 1996.). Some samples had concentrations above or equal to 1 (≥ 1). This indicates that, the concentrations of heavy metal accumulated in the vegetables were higher in concentration than that obtained in the soil. This is due to the fact that metal transfer factor in plant species is a crucial factor in determining the metal distribution in different plant tissues (Xiong, 1998). A number of factors including anatomical, biochemical and physiological factor (Salt *et al.*,1995) contributing to heavy metal accumulation and distribution in the upper vegetable parts .

Metal are mobile and up taken by root cells from soil, bound by cell wall and then transported across the plasma membrane. Along with cationic nutrient., plant transporters are also involved in shutting potentially toxic cations across plant membrane (Maser *et al*.,2001; Singh et al., 2003). The tolerance of plants to increasing levels of toxic elements resulting from the extrusion of toxic elements or their metabolic tolerance to specific elements. The major mechanism in tolerant species of plants appears to be compartmentalization of metal ions i.e. sequestration in the vacuolar compartment, which excludes them from cellular sites where processes such as cell division and respiration occur, thus proving to be as effective protective mechanism (Chaney *et al*., 1997; Hall,2002; Lee *et al*;1977).In this study enrichment factor (EF) was used to assess the level of contamination and the possible anthropogenic impact in soil from the irrigation sites of Kaduna metropolis. It has been established that, heavy metals sometimes occur from natural source and is refer to as indigenous lithogenic source, while some occur due to pollution caused by human activities to the soil thereby increasing its concentration and is refer to as anthropogenic sources. The study of heavy metal content in irrigation soils provides baseline information on the anthropogenic impact of environmental pollution in farmland of Kaduna metropolis. Toxic heavy metals entering the ecosystem may lead to geo – accumulation, bio – accumulation and bio – magnifications resulting into negative influence on physiological activities of plant (e.g photosynthesis gaseous exchange and nutrient adsorption.).

Table 2.0 shows enrichment factors for heavy metals such as Cd,Fe ,Zn ,Cu and Pb in soil. Cadmium from Malali (1.6) and Unguwan Dosa (1.6) samples occurred with EF valued greater than 1.5 suggesting anthropogenic. The enrichment factor for Zinc shows that samples from Malali (2.2) and Unguwan Dosa (2.0) are moderatly enriched. Enrichment factors (EF) for copper showed that samples Barnawa (2.6), Malali (2.1) and Unguwan Dosa (2.0) are moderately enriched and as such they are from anthropogenic source.The table also showed enrichment factor for lead in which it has the following, Kakuri (2.2), Kawo (2.3), Barnawa (2.1) and Doka (2.4) suggesting that they are from anthropogenic source.The EF for iron are mostly from natural source. All these prediction were made in accordance with Zhang and Li (2002).Environment and human health impact of toxic trace metal contamination is a function of mobility and phytoavailalability The movement of heavy metal down the soil profile is often evident in high applications of heavy metals, usually in sewage sludge, in soils with low organic matter and clay contents, acidic conditions and when high rainfall or irrigation water rules have been applied. The movement occurs through soil macropores or cracks which is also referred to as preferential flow (Dowdy and Volk, 1983).

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IV. CONCLUSION

By virtue of the results obtained from enrichment factor(EF) and transfer factor (TF) it has been established vividly that enrichment factor is strongly related to the transfer factor (i.e absorption of heavy metals from soil to plant). Since heavy metals are accumulated in the soil and transfer to the vegetable (plant) were either from natural source or from the human activities known as anthropogenic source as revealed from the study of enrichment factor (EF). It has been established that anthropogenic source is the soil contamination by heavy metals which are cause by various sources of agricultural origin, sewage sledges, fertilizers,(more especially phosphate fertilizer) , mining materials, herbicides and pesticides (Adrano,1985)

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