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Evaluation of Heavy Metals Concentrations and Bioaccumulation Factors of Soils and Plants Cultivated in an Oil Producing Community in Rivers State, Nigeria

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Abstract:
This study evaluated the presence of heavy metals and the bio accumulation factors of three selected plants and soils samples. The concentrations of seven heavy metals (As, Cd, Co, Cr, Mn, Ni, and Pb) in soils and plants samples were determined using Atomic Absorption Spectrophotometer. The result showed that the heavy metals in the plants samples for As, Cd, Co, Cr, Mn, Ni, and Pb ranged from 2.49-4.85, 1.02-3.46, 0.33-1.45, 2.17-2.47, 3.56-7.51, 2.71-4.12 and 0.23-2.31mg/kg respectively and that of soils samples ranged from 2.81-3.02, 1.08-2.09, 0.15-0.94, 1.61-3.75,3.78-17.63, 2.27-3.12 and 1.35-2.23 mg/kg for As, Cd, Co, Cr, Mn, Ni, and Pb respectively. The concentrations of these heavy metals in the plant samples were compared with the permissible level given by Food and Agricultural Organization(FAO) and World Health Organization(WHO) and that of the soil samples were compared with that of maximum permissible addition (MPA) and Ministry of environment, Finland (MEF). It was observed that Pb, Cd and As levels in the plants were above the WHO/FAO level and Cd and Ni in soils were above MPA and MEF threshold. The bio accumulation factors shew that these plants can accumulate these heavy metals at different rates with Ni and As being mostly accumulated in all three samples.

1. Introduction

There are several environmental issues associated with human health. The major environmental issue is associated with petroleum exploration and production due to improper disposal of large volume of petroleum products into the environment (Scheren, Ibe and Janssen, 2002). Several imparts from Petroleum Industries in Niger Delta Nigeria especially those in Oil Producing Host Communities have pose serious environmental threats which affect their right to a healthy environment (Eaton, 1997). This makes the residence vulnerable to environmental and health hazards.

Gas flaring, Oil spillage and Waste dumping have been the most common environmental pollution in Oil Producing Communities which has contributed to the enrichment of heavy metals concentrations on the soil and plants (Otunkor and Ohwovorione, 2016). Plants growing on polluted soils have the ability to accumulate different potential toxic elements from the soil (Oguntade *eat al.,* 2013). Soil polluted with more than one heavy metal has antagonistic and synergistic effects on plants. Although, Plants require certain heavy metals for their growth, when in excess they become intolerable and tend to accumulate non-essential metals. Metals such as lead and cadmium are poisonous even when their concentrations are low in the diet (Djingova and Kuleff, 2000).

Due to inadequate lands in most Oil producing Communities in Rivers State, some edible plants such as pepper, garlic, curry, ginger, thyme, scent leaf, onions, etc, are grown in environments contaminated with poisonous substances such as heavy metals. Plants contaminated with such heavy metals may cause these metals to build up in the body when consumed and might cause various health effects (Al-Ed *et al.*, 1997). Since heavy metals cannot be broken down in plants, its study in plants is important because of the potential hazardous effect on human health due to the cumulative behavior and toxicity of heavy metals (Ozkutlu *et al.*, 2006).

This study aimed at evaluating the level of heavy metal contamination in plants and soils samples from Oil producing Community and also its bio accumulation factor.

2. Materials and Methods

2.1. Collection and Preparation of Samples

The samples were collected from two geographical areas (Rivers and Enugu State). The selected plant samples (pepper leaf, curry leaf and scent leaf) were collected from a farm land located at Okrika and a farm land in Enugu. The fresh spices were handpicked. The plants (*Capsicum spp* (pepper leaf), *Murraya koenigii* (curry leaf) and *Ocimum gratissium* (scent leaf)) were sorted out and cleaned with tap water and allowed to dry. The dried samples were ground to fine powder. For each vegetable plant sampled, Soil samples used in the cultivation of each plant samples were also collected. The samples (soils and plants) were wrapped and taken to the laboratory for analysis.

2.2. Samples Digestion

Exactly 2g of dried plant samples were digested with 650ml conc HNO_3, 80ml perchloric acid, 20ml conc H_2SO_4 and heated in a fume cupboard until a clear digest was seen. On cooling, the content of the beaker was filtered into a volumetric flask and the digest was diluted with distilled water to the 100ml mark. Similarly, 1g of soil sample was sieved, weighed and digested with 20cm^3 of (1:1) HNO_3/HCl acid into a 100cm^3 tall-form beaker which was boiled until the nitric acid mixture reduced to about 5cm^3. 20cm^3 of deionized water was added and boiled until the volume was about 10cm^3.On cooling, the suspension was filtered and the beaker and filter paper was washed with small portion of deionized water until it got a volume of about 25cm^3 and the filtrate transferred to a 50cm^3 graduated flasks and made up the mark using deionized water.

2.3. Heavy Metal Analysis

Heavy metals concentrations of plants and soils samples were determined using Atomic Absorption Spectrophotometer (AAS) at Spring Board Research Laboratory, Awka. The concentrations of heavy metals (As, Cd, Co, Cr, Mn, Ni, and Pb) determined were obtained directly from the instrument by aspirating the sample into the oxidizing air-acetylene flame.

Bioaccumulation factor

Bioaccumulation Factor (BF) is an indication of the accumulation of heavy metal in the plants at a rate faster than their metabolic or excretion rate. BF represents the ratio of metal concentration in plants to the metal concentration in the soil (Rezvani and Zaefarian, 2011)

$$BF = \frac{\text{Heavy metal in plants}}{\text{Heavy metal in soil}}$$

If BF ≤ 1 it is said to be non-hyper accumulator/non-phytoremediator. But, If BF > 1 it is referred to as hyper-accumulator/phytoremediator (Ma *et al.*,2001; Cluis, 2004).

3. Results and Discussion

S/N	Metals(mg/kg)	Sites	Plants Samples		
			Scent Leaf	**Curry**	**Pepper**
1.	**Lead(Pb)**	**R**	$2.31\pm0.04^{b,c,e}$	$0.37\pm0.01^{a,c,e}$	$0.26\pm0.02^{a,b,e}$
		E	0.02 ± 0.00^{d}	0.00 ± 0.00^{d}	0.07 ± 0.00^{d}
2.	**Cadmium(Cd)**	**R**	$1.39\pm0.11^{b,c,e}$	$3.46\pm0.11^{a,c,e}$	$1.02\pm0.01^{a,b,e}$
		E	$0.03\pm0.00^{b,d}$	$2.71\pm0.03^{a,e}$	$2.76\pm0.06^{a,d}$
3.	**Nickel(Ni)**	**R**	$4.12\pm0.03^{b,c,e}$	$2.71\pm0.03^{a,e}$	$2.76\pm0.06^{a,e}$
		E	$1.79\pm0.02^{b,c,d}$	$1.58\pm0.05^{a,d}$	$1.59\pm0.03^{a,d}$
4.	**Cobalt(Co)**	**R**	$0.33\pm0.05^{b,c,e}$	$1.45\pm0.02^{a,c,e}$	$0.34\pm0.01^{a,b,e}$
		E	$0.00\pm0.00^{b,d}$	$0.05\pm0.01^{a,c,d}$	$0.02\pm0.00^{b,d}$
5.	**Manganese(Mn)**	**R**	$3.56\pm0.32^{b,c,e}$	$7.51\pm0.02^{a,e}$	$7.37\pm0.13^{a,e}$
		E	1.50 ± 0.05^{d}	1.26 ± 0.02^{d}	1.23 ± 0.07^{d}
6.	**Chromium(Cr)**	**R**	$2.24\pm0.00^{b,e}$	$2.47\pm0.04^{a,c,e}$	$2.17\pm0.01^{b,e}$
		E	0.10 ± 0.00^{d}	0.11 ± 0.07^{d}	0.13 ± 0.01^{d}
7.	**Arsenic**	**R**	$3.61\pm0.09^{b,e}$	$2.49\pm0.26^{a,e}$	4.85 ± 0.03^{b}
		E	$1.16\pm0.16^{b,d}$	$3.68\pm0.09^{a,c,d}$	1.26 ± 0.11^{b}

Table 1: Heavy metals concentrations in plant samples harvested from Okirika (Rivers State) and Ngwo (Enugu State)
R=Rivers E= Enugu

Values are expressed as mean ± SEM of three replicates (n=3). Across rows or down the columns, values with different alphabet denotes significant difference at ($p<0.05$).
Values are expressed as mean ± SEM of three replicates (n=3). Across rows or down the columns, values with different alphabet denotes significant difference at ($p<0.05$).

Heavy metal concentration in scent leaves, curry leaves and pepper leaves were analysed and the results on table **1** shows that lead, cadmium, nickel, cobalt, manganese, chromium and arsenic in all test samples increased significantly when compared to the control. The results of heavy metal concentration in soil sample (Table 2) from which the spices were cultivated review that heavy metals in the soil used in cultivating all test samples are more than those of the control. The heavy metal concentration in the soil of scent leaf ranges from 0.15±0.03 to 17.96±0.13, curry leaves ranges from 0.94±0.06 to 3.78±0.11 and pepper leaves ranges from 0.36±0.00 to 10.92±0.06. The heavy metal concentration in the soil of scent leaf, curry leaf and pepper leaf follows this order respectively;

Mn > Cr > Ni > As > Pb > Cd > Co
Mn > Cr > As > Ni > Pb > Cd > Co
Mn > As > Ni > Cr > Pb > Cd > Co

This shew that Mn had the lowest accumulation in the soils of all the samples and Co had the least.

S/N	**Metals**(mg/kg)	**Sites**	**Plants Samples**		
			Scent Leaf	**Curry**	**Pepper**
1.	Lead(Pb)	R	$2.56\pm0.06^{b,c,e}$	$2.23\pm0.01^{a,c,e}$	$1.35\pm0.01^{a,b,e}$
		E	$0.34\pm0.02^{b,c,d}$	$0.07\pm0.00^{a,d}$	$0.09\pm0.01^{a,d}$
2.	Cadmium(Cd)	R	$2.09\pm0.02^{b,c,,e}$	$1.34\pm0.12^{a,e}$	$1.08\pm0.00^{a,e}$
		E	0.03 ± 0.00^{d}	0.33 ± 0.12^{d}	0.02 ± 0.00^{d}
3.	Nickel(Ni)	R	$3.12\pm0.07^{b,c,,e}$	$2.68\pm0.09^{a,c,e}$	$2.27\pm0.01^{a,b}$
		E	$1.86\pm0.02^{b,,d}$	$0.77\pm0.13^{a,c,d}$	1.95 ± 0.03^{b}
4.	Cobalt(Co)	R	$0.15\pm0.03^{b,c}$	$0.94\pm0.06^{a,c,e}$	$0.36\pm0.00^{a,b,,e}$
		E	0.05±0.01	0.08 ± 0.01^{d}	0.03 ± 0.01^{d}
5.	Manganese(Mn)	R	$17.63\pm0.13^{b,c,e}$	$3.78\pm0.11^{a,c,e}$	$10.92\pm0.06^{a,b,,e}$
		E	$11.14\pm0.07^{b,c,d}$	$1.15\pm0.01^{a,c,d}$	$3.38\pm0.06^{a,b,d}$
6.	Chromium(Cr)	R	$3.75\pm0.08^{b,c,,e}$	$3.04\pm0.01^{a,c,e}$	$1.61\pm0.01^{a,b,e}$
		E	$0.18\pm0.01^{b,d}$	$0.15\pm0.01^{a,c,d}$	$0.23\pm0.01^{b,d}$
7.	Arsenic	R	$2.81\pm0.09^{c,e}$	$2.84\pm0.10^{c,e}$	$3.02\pm0.02^{a,b}$
		E	$1.28\pm0.02^{b,c,d}$	$1.97\pm0.06^{a,d,}$	$1.89\pm0.12^{a,d}$

Table 2: Heavy metals concentration in the soils used for cultivating the Plant samples

R=Rivers E= Enugu

Values are expressed as mean ± SEM of three replicates (n=3). Across rows or down the columns, values with different alphabet denotes significant difference at ($p<0.05$).
Values are expressed as mean ± SEM of three replicates (n=3). Across rows or down the columns, values with different alphabet denotes significant difference at ($p<0.05$).

Heavy Metals	**Pb**	**Cd**	**Ni**	**Co**	**Mn**	**Cr**	**As**
Concentrations (mg/kg)	0.3	0.2	4.5	3.5	-	2.3	0.1

Table 3: WHO/FAO safe limits for Heavy Metals in Vegetables (mg/kg)

Metals	**Pb**	**Cd**	**Ni**	**Co**	**Mn**	**Cr**	**As**
MPA value (mg/kg)*	55	0.76	2.6	24	20	3.8	4.5
MEF Threshold value (mg/kg)**	60	1	50	20	-	-	5

Table 4: Threshold of heavy metals in soil
** MPA (maximum permissible addition)*
*** MEF (Ministry of environment, Finland)*

3.1. Results for the bio accumulation Factors

The bio accumulation factor (BF) shown on table 3 shew the potential of heavy metal accumulation of the three spices got from Okrika. The BF of Pb, Cd, Ni, Co, Mn, Cr and As from the three spices ranged from 0.193 – 0.902, 0.665 – 2.582, 1.011 – 1.32, 0.944 – 2.200, 0.202 – 1.987, 0.597 – 1.348 and 1.285 – 1.606 respectively. The result also shew that scent leaf has the highest bio accumulation factor of cobalt and the least for Mn. Curry leaf had the highest for Cd and the least for Pb while pepper leaf had the highest for Cr and the least for As.

S/N	Metals	Sites	Spices Samples		
			Scent Leaf	Curry	Pepper
1.	Lead(Pb)	R	0.902	0.659	0.193
		E	0.059	0.000	0.778
2.	Cadmium(Cd)	R	0.665	2.582	0.944
		E	0.333	1.667	0.000
3.	Nickel(Ni)	R	1.320	1.011	1.216
		E	0.962	2.052	0.815
4.	Cobalt(Co)	R	2.200	1.543	0.944
		E	0.000	0.625	0.667
8.	Manganese(Mn)	R	0.202	1.987	0.675
		E	0.135	1.150	0.364
9.	Chromium(Cr)	R	0.597	0.813	1.348
		E	0.556	0.733	0.566
	Arsenic	R	1.285	1.511	1.606
		E	0.906	0.853	0.667

Table 5: Bioaccumulation factors of heavy metals via consumptions of spices from Okrika (Rivers State) and Ngwo (Enugu State), Nigeria

R=Rivers E= Enugu

Values are expressed as mean ± SEM of three replicates (n=3). Across rows or down the columns, values with different alphabet denotes significant difference at (p<0.05).

4. Discussion

Heavy metals like Pb, Cd, Ni, Co, Mn, Cr and As were analyzed in this study. All heavy metals were present in all three plants from the test site (Okrika). Table 1 shows the results of the metals analysis of scent leaves, Curry leaves and Pepper leaves. The values of heavy metals in samples got from the test site ranged between 0.37 to 2.31 for Pb; 1.02 to 3.46 for Cd; 2.71 to 4.12 for Ni; 0.33 to 0.34 for Co; 3.56 to 7.51 for Mn; 2.17 to 2.47 for Cr and 2.49 to 4.85 for As. There was a significant increase in the heavy metals when the test samples were compared to the control. High concentration of heavy metals has been reported to affect plant growth negatively.

Lead is a toxic element for life and environment. The highest concentration for lead was found to be in scent leaves (2.31mg/kg). According to Rompala, Rutosky and Putnam (1984), lead can delay embryonic development, suppressed reproduction and inhalation of growth and kidney dysfunction. Pb concentration in scent leaves was above the permissible limit required in plants by the FAO/WHO (Table 3). The presence of Pb may be due to their cultivation in contaminated soil. Pesticides contaminated with heavy metals can result in Pb contamination in the plants when used in its cultivation (Galal-Gorchea, 1991). Research also indicates that industrial activities increase its level in the ecosystem resulting to the increase of Pb content in vegetation (Nabulo, 2004).

As revealed by the analytical results, Cd content in all three plants from the test site ranged from 1.02mg/kg in pepper leaves to 1.39mg/kg in curry leaves. The concentrations of Cd in all three samples from the test site were above the permissible level (Table 4). Taking in high concentration of Cd into the body has been said to affect organs such as liver, kidney, lungs, placenta bones and brains (Robert, 1999). Depending on its concentration, Cd can be poisonous to plants and its accumulation also depends on the species and genus as well as the soluble form of the soil (Radulescu et al., 2013). The main source of Cd in humans is food. Symptoms of Cd such as nausea, abdominal cramp, vomiting, muscular weakness and organ failure, depends on the level of exposure (Duruibe et al., 2007).

Nickel at its right level is non-toxic to human health. The permissible level for nickel is 4.5mg/kg. Test samples for all three plants were below the safety standard. High intake has been associated with cancer of the lungs and nasal cavity (Akan *et al*., 2012). This study showed a significant increase in the level of Ni in all three test samples with scent leaves having the highest Ni concentration of 4.12mg/kg. This level was still below the permissible level. Nickel in low concentration is essential in plants growth. However, in excess, it retards seed germination, nutrient absorption by root and inhibits photosynthesis (Ahmad and Ashraf, 2011).

Cobalt ranged between 0.33mg/kg to 1.45 mg/kg in the test samples and 0.00 to 0.05 in the control. There is a significant increase in the test sample with curry leaves having the highest of about 1.45mg/kg which is below the permissible level (table 4). Co occurs naturally in the environment. An increased amount may be as a result of industrial activities. Co cannot be destroyed in the environment but can only change its form or become attached to particles like soil, water and sediments. Plants accumulate very small amount of Co from the soil and gets into the human body when consumed. Co gets into the environment from exhaust, burning coal and oil. Co has beneficial effect for it is a component of vitamin B_{12} which is essential for good health (Kalagbor *et al.,* 2014). It has also used for the treatment of anemia. In contrast, exposure to Co in excess can cause asthma, pneumonia and wheezing. The cobalt content in plants depends on the species, Co content in soil and other environmental factors.

Manganese was detected in all the samples studied. The least concentration of 3.56mg/kg was observed in scent leaves while the highest concentration of 7.5mg/kg was detected in curry leaves. Mn is an essential element in both plants and animals. Because of its importance, all fertilizers contain important quantity of manganese sulphate. In plants, Mn participates in photosynthesis and as an antioxidant cofactor. In humans, manganese is necessary for bone structure, reproduction and central nervous system to function normally (Saraf and Samant, 2013). When in deficient, it causes failure in the reproductive system in both male and female. Mn level in the test samples increased significantly when compared to the control but were all within the safe limit of FAO/WHO.

Chromium (IV) is toxic compounds and is known to cause cancer (Kalagbor *et al.,* 2014. But chromium (III) is essential elements needed for the normal metabolism of fat and sugar. It is also used to manage diabetes and as a cofactor with insulin (Lokeshappa, 2012). Chromium in test sample ranged from 2.17 to 2.47 and control samples ranged from 0.10 to 0.13. The level of chromium in the test samples were below the permissible limit of 2.3mg/kg except for curry leaves (2.47mg/kg) which was slightly above. Chromium has been observed to reduce shoot and root growth, decrease the ability of plants to acquire nutrient and inhibits germination process (Panda and Patra, 2000; Nematshashi, Lahouti and Ganteali, 2012). Chromium (IV) toxicity had been reported to cause kidney damage, liver and blood cells damage through oxidation reaction (Fordham, 1996).

Arsenic has no beneficial metabolic function in humans from low to extreme level of exposure. It has been reported as carcinogenic. According to research, low level of As exposure caused nausea, vomiting and decrease in RBCs and WBC production and in plants, As toxic effect cause reduction in seed germination, reduce seedling, height, decrease fresh weight and stunted growth (Abedin, Cotter-Howells and Mechang, 2002; Cox, Bell and Kovar, 1996). Nordstom (2002) states that the main source of human exposure to As is through drinking water and it becomes part of the human food chain when crops becomes contaminated. As-based pesticides, irrigation with As contaminated water and fertilization with municipal solid waste has been sources in which As enters into the farming system (Meharg *et al.,* 2009). The result of the test sample of this study ranged from 2.49 to 4.85 and the control ranged from 1.26 to 1.68. The highest level of As contamination in the test samples was observed in pepper leaves. This research showed that the samples were above permissible level (1.0mg/kg) set by WHO.

4.1. Heavy Metals in the Soil used in the Cultivation of the Plants

The data of heavy metals concentration used in harvesting the plants of study are shown in Table 2 for scent leaves, curry leaves and pepper leaves. The results showed that all heavy metals analyzed increased significantly. The presence of Pb in the test soil ranged between 1.35mg/kg to 2.56mg/kg and the control site showed a much lower concentration of lead which ranged from 0.07mg/kg to 0.34mg/kg, the highest being that of scent leaves (2.56mg/kg) which is far below 60mg/kg toxic threshold.

The high value of cadmium in the soil indicates that this metal contaminates the soil. The level of cadmium ranged between 1.08mg/kg for pepper leaves to 2.09mg/kg for scent leaves. The values for the soils used in cultivation were higher than the recommended toxic level. This shows that the uptake of Cd in soils used in the cultivation is high indicating that the soil is contaminated by this metal.

Nikel is seen to be lowest (2.27mg/kg) in the soil used for scent leaves and highest in the soil for scent leaves (3.12mg/kg). The figure is high for the heavy metal threshold recorded by MPA and below the toxic threshold recorded by MEF (Table 4). At this level, soil used in the cultivation of curry leaves and scent leaves could be said to be toxic.

Very low levels of cobalt have been observed in all test samples. The values ranged between 0.15mg/kg to 0.94mg/kg for the test sample and 0.03mg/kg to 0.08mg/kg for the control. These values were far below the recommended threshold. The soil is therefore not contaminated by cobalt.

Manganese increased significantly in all test soil when compared to the control. Mn ranged from 3.78mg/kg to 17.63mg/kg and 1.15mg/kg to 11.14mg/kg for test and control soil respectively. Mn values in all soils samples were below the toxic threshold therefore the soil is not contaminated by Mn. The values obtained for chromium ranged from 1.61mg/kg to 3.75mg/kg for the test soils. The highest of chromium presence was 3.75mg/kg which was very close to the threshold of 3.8mg/kg by MPA. Arsenic concentration in the test soils ranged from 2.81mg/kg to 3.02mg/kg. They increased significantly from the control which ranged from 1.28mg/kg to 1.97mg/kg. Arsenic concentration in the soil was below the threshold level.

This study showed an increase level of heavy metal in all test soils when compared with the control though some were below the toxic threshold. The increase in some of these heavy metals may be due to the industrial activities going on in the test community. The results agreed with the study of Kakulu and Osibanjo (1998) and Osibanjo and Kakulu (1992) which reported an elevated level of heavy metals in sediments in Warri and Port Harcourt which may be due to the release of effluents from petroleum refineries located in those Cities. A study showed a high-level concentration of heavy metals in crops cultivated in some Oil prospective areas in Rivers State (Hart *et al*.,2005). Another study by Deekor (2002) revealed a significant release of heavy metals into the environment due to the burning of crude oil in oil wells and flow stations. Those contaminate vegetations and soils in Niger Delta regions.

4.2. Bioaccumulation

Bioaccumulation occurs when an organism absorbs toxic substances into their system. Heavy metals accumulating in soil do not remain at high level due to its constant uptake by plants (Sharma and Dubey, 2006). The accumulation of these metals depends on the plant type and also on the soil (Lasat, 2000). Table 5 showed the bioaccumulation factor (BF) of Pb, Cd, Ni, Co, Mn, Cr and As for scent leaves, curry leaves and pepper leaves. The result showed that bioaccumulation of heavy metals varied in all spices. Pb BF was

highest for scent leaves (0.902) and lowest for Pepper leaves (0.193), Cd had the highest for curry leaves (2.582) and least for scent leaves (0.665). Ni, Co, Mn, Cr and As ranged from 1.011 to 1.320; 0.944 to 2.200; 0.202 to 1.987; 0.597 to 1.348; and 1.285 to 1.606 respectively. The ability for the plants to accumulate heavy metals was observed in the following trend;
Scent leaves: Co>Ni>As>Pb>Cd>Cr>Mn
Curry leaves: Cd>Mn>Co>As>Ni>Cr>Mn
Pepper leaves: As>Cr>Ni>Cd=Co>Mn>Pb.
Bio accumulation factor is the ratio of heavy metal in plant to heavy metal in soil. If the BF>1, It can be an accumulator. If BF =1, it shows no influence but if BF <1 then the plant can be an excluder (Radulescul *et al.,* 2013). The observed values of BF were above 1 except for Pb in all three plants, Cd in scent leaves and curry leaves, Co in pepper leaves, Mn in scent leaves and pepper leaves and Cr in pepper leaves. The curry leaves bio accumulates most of the heavy metals except Cr and Pb. Pepper has the least ability to accumulate these metals.

5. Conclusion

Heavy metals like Pb, Cd, Ni, Co, Mn, Cr and As were analyzed in soil and plants samples. The study revealed that the heavy metal concentrations were significantly higher in the samples from the test site than those of the control. Heavy metals concentrations in the soils used in the cultivation of the three plants contained substantially high concentrations of heavy metals in the test soil than the control soil due to some industrial activities around the test site. Of all the heavy metals analyzed in the soil samples, only Cd and Ni were found to be at elevated concentration above the recommended values. The study also indicate that the plants cultivated in such contaminated soil have the tendency of bio accumulating some of these heavy metals and may thus transfer these toxic metals into the food chain which in turn might affect the human body when consumed. The BF of the analyzed metals showed that these plants were able to bio accumulates heavy metals at different rates with Ni and As being accumulated in all three samples. Cd and Mn in curry leaf, Co in curry and scent leaf and Cr in pepper leaf also showed BF>1. Due to their high capacity of absorption, leafy vegetables are good accumulators of heavy toxic metals. This also made vegetables useful for the remediation of polluted soils. But when taken in excess by humans it has the potential to cause negative health effect. Heavy metal analysis of the studied plants showed a variation in the concentration of heavy metals and most were found to be below the recommended safe limits by WHO/FAO except for Pb in scent leave and curry leaf, Cd and As in all three plants and Cr in curry leaf.

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