Determination of Heavy Metals in Leaves of *Mangifera Indica, Psidium Guajava* L. and *Anacardium Occidentale* L. in Trikania Industrial Area, Kaduna-Nigeria.

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ABSTRACT

Concentrations of cadmium, chromium and zinc in leaves of Mangifera indica (Mango), Psidium guajava L. (Guava) and Anacardium occidentale L. (Cashew) grown in Trikania around the industrial area, were determined by atomic absorption spectrophotometry. The differences in the bioaccumulation of the metals varied. The leaves showed considerable accumulation of zinc with cashew leaves having 0.38mg/kg which is above the FAO/WHO recommended limit. Chromium and cadmium concentrations in all the leaves were below the FAO/WHO recommended limit. The levels of the metals in the leaves samples was in the order Zn > Cr > Cd.

INTRODUCTION

The presence of heavy metals in the environment due to industrial, agricultural, domestic and commercial activities has created serious pollution problems[4,5] because of their toxicity, bio-accumulating tendency, threat to human life and the environment[1]. Though heavy metals occur naturally in all areas and soils, some are indeed essential for humans, plants & animals. Their concentrations are naturally low and usually not hazardous in non-urban areas with little or no environmental disturbance and past or present human activity[2]. However, any place subjected to human activity is likely to have heavy metals at elevated levels in the environment. While there is no cause for alarm, in some cases, trace heavy metals may accumulate to an extent that may pose health risk. Of all the 'sinks' for atmospheric pollutants i.e. man, animals, plants, water and soil, plants have higher capacity to take up metals from soil or atmosphere than their physiological needs. While this may not have any adverse effect on the plant itself, it may expose the consumer to higher intake of the metals[3]. Several studies have revealed that 60-80% of heavy metal toxicity found in urban areas were the results of consuming contaminated foods or drinks rather than air pollution[3].

The deposition of particulate metals present in dust on leaves or fruits promotes chemical as well as physical injuries directly or indirectly[12]. The trees can take up trace heavy metals from soil, water or air and retain them for long time. Accordingly, these plants act as bio-monitors in the assessment of heavy metals contamination by means of their bio-

accumulative properties and this concept has gained wide acceptance[13].

The leaves of *Manifera indica* (Mango), *Psidium guajava* L. (Guava) and *anacardium occidentale* L. (cashew) though not edible, but are all used in medicinal applications. The leaves and bark of cashew are commonly used to relieve toothache and sore gums and the boiled water extract used as mouthwash, dried mango leaves are used as remedy for Diarrhea and chronic dysentery and as mouthwash for gum problems. While guava leaves are said to be packed with anti-oxidants, anti-bacterial and anti-inflammatory agents. The leaves are used as natural pain reliever, herbal remedy for diarrhea, dysentery, vomiting, nausea, stomach ache, bronchitis, toothache etc. and are also beneficial to diabetics according to a research conducted by the Yakult Central Institute Japan.

The heavy metals that may be present in these leaves when released can lead to serious health concerns because of their potential for being toxic.

Intake of cadmium through diet is associated with higher risk of breast and prostate cancer[6] and osteoporosis in humans[7]. It is also an endocrine disruptor. Some studies have shown that it can interact with different hormonal pathways, which can lead to cardiovascular diseases[8].

The toxicity of chromium is attributable to the Cr (VI) form. It can be absorbed by the lungs and gastrointestinal tract. When inhaled, chromium compounds are respiratory tract irritants. The lethal or sub lethal doses of Cr (VI) compounds cause hematological effects in humans and reproductive and developmental effects. One study showed wives of stainless steel welders were at higher risk of spontaneous abortions[9].

Free zinc ion may be much more toxic biologically than is generally realized[11]. Zinc induces damage to living organisms and essential enzymes involved in metabolism[10]. Ingestion of soluble Zinc salts may cause abdominal irritation resulting in nausea and vomiting and is listed as a carcinogen by occupational safety and Health Administration (OSHA), European Union (EU) and other standard organizations.

Trikania is a residential cum-industrial area which lies along the western by-pass in Chikun Local Government Area of Kaduna state, Nigeria. A number of companies reside at the area. These companies include the International Beer and Beverage Industry (IBBI), Sunglass , Unifoam, motor cycle assembling plant, flour mill companies etc. These metals are selected for investigation because of their potential as pollutants and the likelihood of their release and emission into the atmosphere through the industrial activities of these companies. This study therefore attempts to monitor the concentration of Cd, Cr and Zn in the leaves of mango, guava and cashew trees in Trikania to ascertain the potential risk posed to the inhabitants of the area.

MATERIALS AND METHOD

Samples, Collection and Storage

Three leaf samples from each tree type were collected at random within the study area and

packed separately. The samples were then washed with distilled water and air dried for 5 weeks. The dried leaves were then ground to powder and stored in clean propylene sample bottles.

Sample Digestion

The samples were digested with nitric acid and perchloric acid.

Blank solution was prepared using 5ml of nitric acid.

Sample Analysis

The digests were analyzed by atomic absorption using Cole UV-750 atomic absorption spectrophometer.

RESULTS AND DISCUSSION

The dry – weight trace metal contents (Tables 1- 3) in leaves of mango, guava and cashew of the study area showed that cadmium is present in the leaves samples analyzed. However the concentration of cadmium in all the samples is below the FAO/WHO guideline limit (0.20 mg/kg) and the average cadmium content varies in the order cashew> mango> guava> with the average cadmium values as 0.007, 0.006 and 0.001mg/kg respectively.

Table 1. Dry weight of trace metal contents in mango leaves in Trikania, Kaduna

Trace metals (mg/kg)	Samples		
	M – 1	M – 2	M – 3
Cd	0.009	0.005	0.004
Cr	0.01	0.00	0.00
Zn	0.07	0.01	0.04

Table 2. Dry weight of trace metal contents in guava leaves in Trikania, Kaduna

Trace metals (mg/kg)	Samples		
	G – 1	G – 2	G – 3
Cd	0.000	0.000	0.003
Cr	0.03	0.04	0.03
Zn	0.07	-0.03	0.06

Table3. Dry weight of trace contents in cashew leaves in Trikania, Kaduna.

Trace metals (mg/kg)	Samples		
	C – 1	C – 2	C – 3
Cd	0.009	0.006	0.006
Cr	0.03	0.03	0.01
Zn	0.40	0.26	0.48

The varying amounts of cadmium in the leaves sample is shown graphically in figure 1 using their mean concentrations.

The profile of the average chromium content in the leaves samples were found to be in the order guava > cashew> mango with values as 0.033, 0.0233 and 0.0033 mg/kg respectively.

The mean plot is shown graphically in figure 2. Chromium concentrations in the samples are below the Califor nia regulators recommended guideline of 0.06 mg/kg.

The presence of zinc in the leaves samples is significant with the average zinc content in the order cashew> mango> guava with values as 0.38, 0.040 and 0.033 mg/kg respectively.

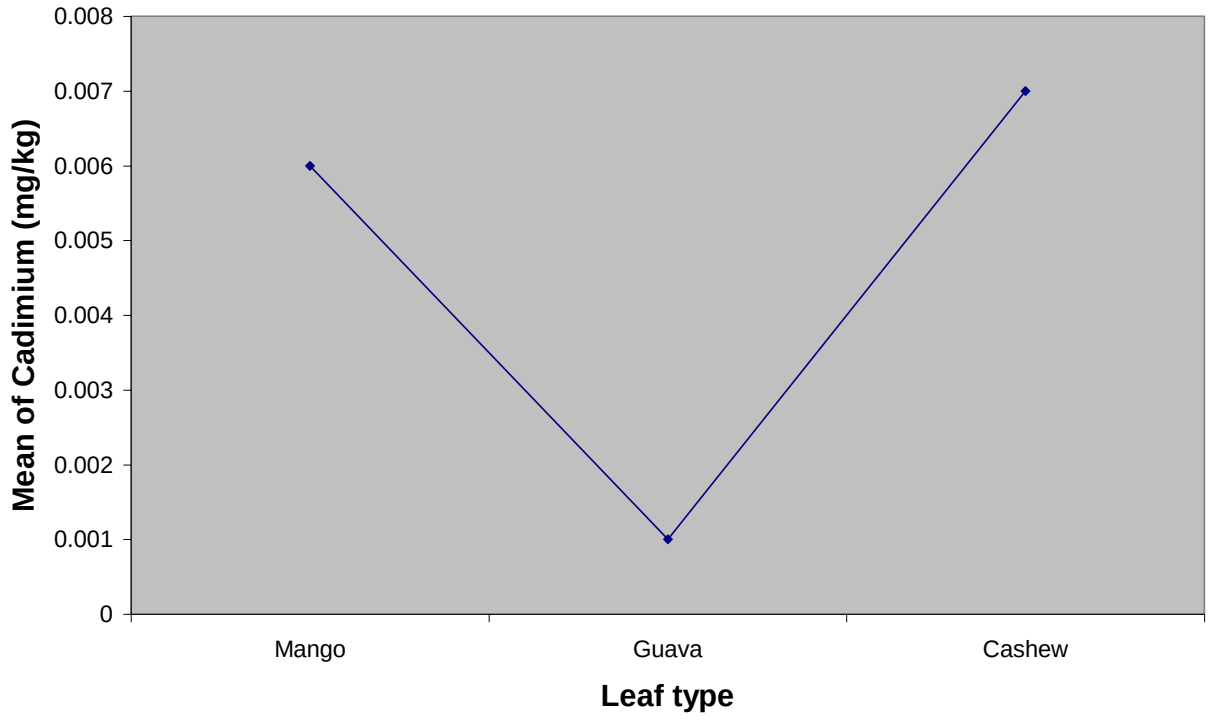

Figure 1: Mean cadmium concentration in leaves samples of Trikania.

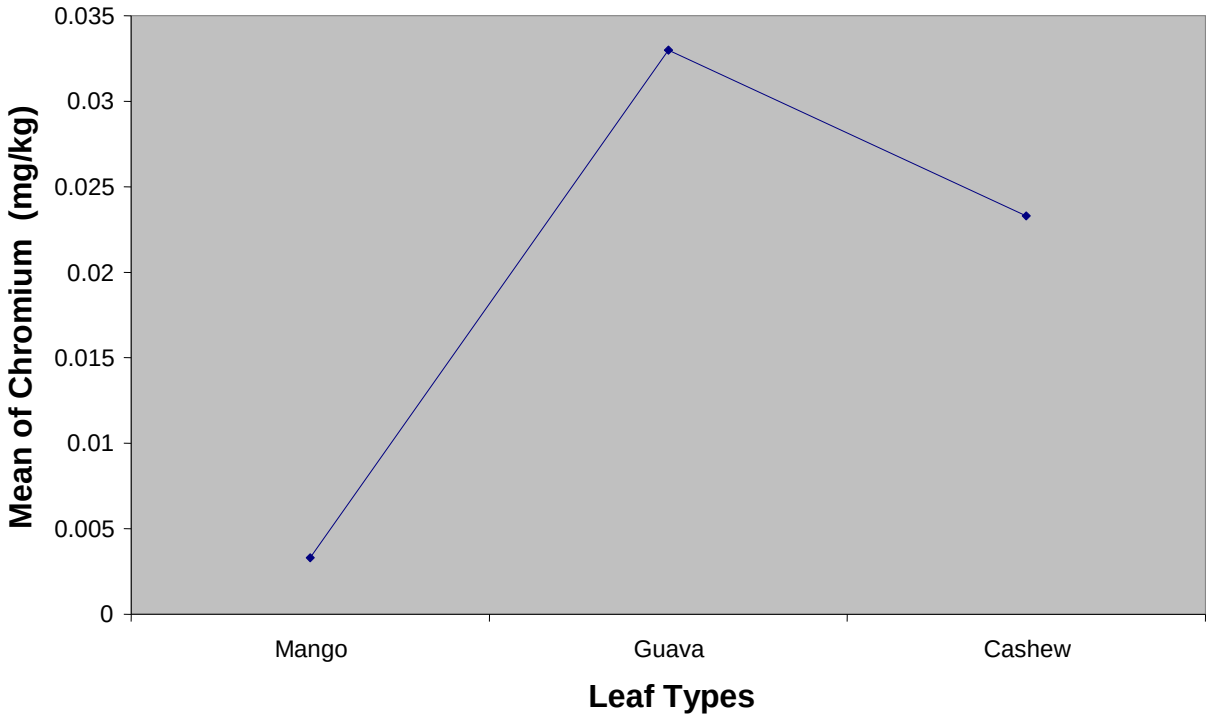

Figure 2: Mean chromium concentration in leaves samples of Trikania

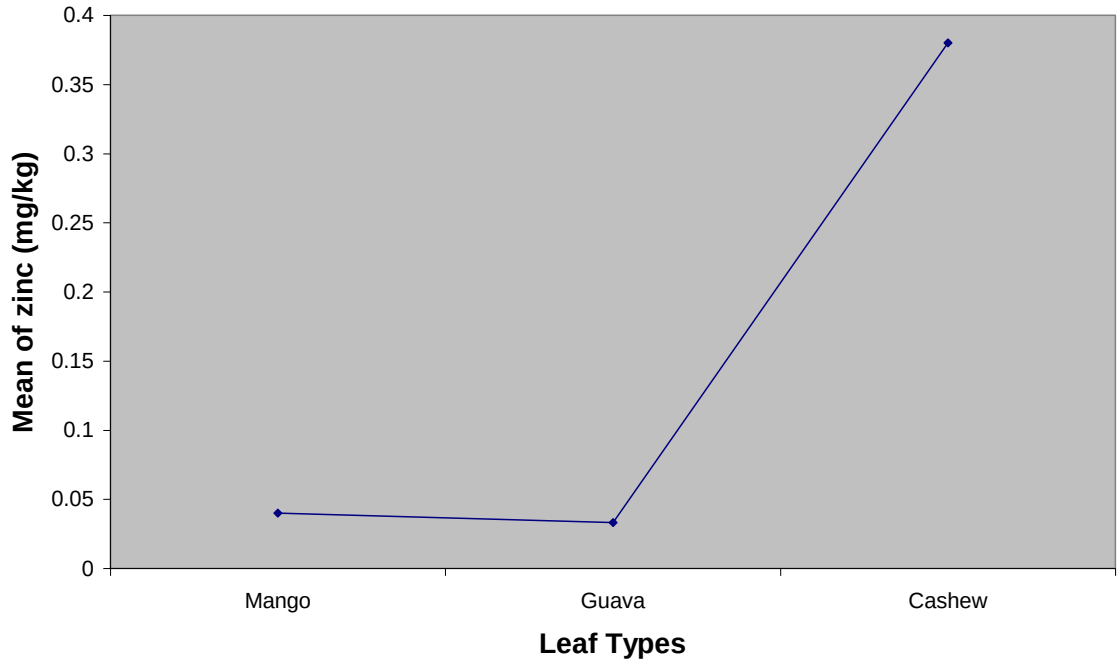

Figure 3: Mean zinc concentration in leaves samples of Trikania

The zinc concentration in cashew leaves is above the FAO/WHO recommended guideline limit i.e 0.3 mg/kg. The mean plot of zinc is displayed graphically in figure 3.

Descriptive statistics (Tables 4, 5 and 6) shows the concentration of cadmium, chromium and zinc in the samples.

The descriptive statistics for cadmium (Table 4) shows the 95% confidence band for mango lies between –0.013 and 0.020, guava lies between – 0.003 and 0.005 while cashew lies between 0.003 and 0.011 and from the ANOVA (table 7) it shows that P = 0.271 > 0.05, we therefore accept the null hypothesis and conclude that cadmium is present in mango, guava and cashew leaves.

The descriptive statistics for chromium (Table 5) shows the 95% confidence band for mango lies between -0.011 and 0.018 guava lies between 0.019 and 0.048 and cashew lies between -0.005 and 0.052. The ANOVA for chromium (table 8) shows that P = 0.011 <0.05, we therefore reject the null hypothesis and conclude that chromium is not equally present in all the leaves samples (Figure 2) this is displayed graphically.

Table 4: Descriptive statistics for Cadmium

Sample locations	Leaves	N	Mean	SD	Std Error	95% Confidence Interval	
						Lower bound	Upper bound
Trikania	Mango	3	0.003	0.007	0.004	-0.013	0.020
	Guava	3	0.001	0.002	0.001	-0.003	0.005
	Cashew	3	0.007	0.002	0.001	0.003	0.011
	Total	9	0.004	0.004	0.001	0.000	0.007

Table 5: Descriptive statistics for Chromium

Sample locations	Leaves	N	Mean	SD	Std Error	95% Confidence Interval	
						Lower bound	Upper bound
Trikania	Mango	3	0.003	0.006	0.003	-0.011	0.018
	Guava	3	0.033	0.006	0.003	0.019	0.048
	Cashew	3	0.023	0.012	0.007	-0.005	0.052
	Total	9	0.020	0.015	0.005	0.008	0.032

The descriptive statistics for zinc (Table 6) shows the 95% confidence band for mango lies between -0.035 and 0.115, guava lies between -0.103 and 0.170 and cashew lies between 0.103 and 0.657. The ANOVA for zinc (Table 9) shows that P = 0.002 < 0.05, we therefore reject the null hypothesis and conclude that zinc is not equally present in all the leaves samples. This is displayed graphically (Figure 3).

Table 6: Descriptive statistics for Zinc

Sample locations	Leaves	N	Mean	SD	Std Error	95% Confidence Interval	
						Lower bound	Upper bound
Trikania	Mango	3	0.040	0.030	0.017	-0.035	0.115
	Guava	3	0.033	0.055	0.032	-0.103	0.170
	Cashew	3	0.380	0.111	0.064	0.103	0.657
	Total	9	0.151	0.183	0.061	0.010	0.292

Table7: ANOVA for Cadmium

Sample locations	Sources of variation	Sum of square	df	Mean square	F	Sig.
Trikania	Between groups	0.000	2	0.000	1.636	0.271
	Within groups	0.000	6	0.000		
	Total		8			

Table 8: ANOVA for Chromium

Sample locations	Sources of variation	Sum of squares	df	Mean square	F	Sig.
Trikania	Between groups	0.001	2	0.001	10.500	0.011
	Within groups	0.000	6	0.000		
	Total	0.002	8			

Table 9: ANOVA for Zinc

Sample locations	Sources of variation	Sum of squares	df	Mean square	F	Sig.
Trikania	Between groups	0.236	2	0.118	21.66	0.002
	Within groups	0.0.33	6	0.005		
	Total	0.268	8			

CONCLUSION

The concentration and mode of distribution of the studied metals in mango, guava and cashew leaves in Trikania were significantly different. The leaves showed considerable accumulation of zinc in cashew leaves 0.38mg/kg which is above the FAO/WHO recommended guideline limit. i.e 0.30mg/kg. The concentration of cadmium in all the leaves samples was below the FAO/WHO guideline limit chromium concentration were also below the California regulators recommended guideline. The results generally indicate some level of pollution thus appropriate measures must be taken in order to curb the menace posed by the metals.

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