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ORIGINAL RESEARCH

ASSESSMENT OF HEAVY METALS IN *MANIHOT ESCULENTA* (CASSAVA) IN SELECTED FARMS IN LAGOS STATE, NIGERIA

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Abstract:
Introduction: Anthropogenic activities by man in Nigeria especially Lagos State have induced accumulation of heavy metals in soils which invariably have resulted in the disturbance of living organism's biochemical and physiological functions.
Aims: This study assessed the level of heavy metals concentration in cassava (*Manihot esculenta*) harvested in selected farms in Lagos state
Materials and Method: Leaves, stems, tubers of cassava were obtained from Badagry and Ikorodu; and the concentrations of heavy metals content were determined using Atomic Absorption Spectrophotometric (AAS) method.
Results: The results in mg/kg showed that heavy metals concentration [Nickel (3559.67 ± 5794.16), Manganese (120.33 ± 5.51), Copper (52.10 ± 2.85 and so on] were highly bioaccumulated in leafy part of the cassava. Conversely, Sodium (11620.00 ± 820.18) and Potassium (15133.33 ± 508.46) were highly bio-accumulated in the cassava's stem while Calcium (3996.67 + 35.12) was found in high concentration in the cassava's tuber. Lead (0.03 ± 0.05) and Cadmium (0.08 ± 0.08) were of significant values in the soil of Ikorodu and lower in the soil of Badagry. Heavy metal (Ni, Mn, Cd, Mg and Na) bio-accumulation in the two different location were higher in Badagry than Ikorodu, while Zn, Fe and K were higher in Ikorodu than in Badagry but Cobalt was not detected in both sites.
Conclusion: Copper, Lead, Zinc, Manganese, Iron, Nickel, Calcium, Sodium and Potassium were above the recommended level of W.H.O. Therefore, consumption of leafy and tuber part of the cassava in both Ikorodu and Badagry areas could pose threat to animals.
To Keywords: Cassava, Heavy metals, Soil, Lagos.

All co-authors agreed to have their names listed as authors.

1. INTRODUCTION

Anthropogenic activities by man in Nigeria especially in Lagos state have induced accumulation of heavy metals in soil which invariably have resulted in the disturbance of living organisms' biochemical and physiological functions [1]. According to Davidson [2], heavy metals contamination of agricultural soils and crops in the area where smelting activities, release of industrial effluent and disposal of municipal waste occur is a major environmental concern. Such wastes are either dumped on roadsides or used as land filled. The effluents from industrial activities pollute the soil and endangering the environment as they eventually find their ways into the food chain in small quantities which accumulate across trophic levels thereby posing serious health dangers to man and other man that consume it [3].

Manihot esculenta (cassava) is one of the major food crops cultivated in Nigeria. Common products from edible portions of the cassava tubers especially garri and other related traditional meals are widely consumed by the local population and constitute one of the major local staples [3].

Heavy metals are naturally moderately present in the soil; their occurrence however, has gradually been increasing with the increase of industrialization. Forstner [4] asserts that cadmium, lead and zinc are among the most abundant heavy metals in the agriculture soils. Metals such as aluminum, arsenic, cobalt, cadmium, chromium, copper, lead, manganese, nickel and zinc have been considered as the major environmental pollutants and already been established [5].

However, the concentration of heavy metals in soil may cause serious effects on the plant growth as well as on the consumers of the plants especially cassava. Although all living organisms require a trace amount of some heavy metals, excessive level or inadequate trace amount of these elements are considered systemic toxicants that are known to induce multiple organs damage. Hence, this research work deals with the assessment of heavy metals in *Manihot esculenta* (cassava) in selected farms in Odogunyan (Ikorodu) and Morogbo (Badagry) in Lagos State, Nigeria.

2. MATERIALS AND METHODS

Cassava leaves, stem, tuber were given by farmers from odogunyan and Morogbo in Badagry and Ikorodu farms respectively. The samples (Cassava) used were harvested at the peak of the harvest period (August). The peak of the harvest period was chosen when farm crops were generally in their bloom, bearing the fact that heavy metals concentration in plant varies with the age of the plant as well as the season. By arrangement with the prospective farm owner, the crops were harvested by hand-uprooting. As described by American Health Public Association (APHA) [6]. The metals contents were determined using Atomic Absorption Spectro-photometric method (AAS) according to Skoop [7].

2.1 PREPARATION OF SAMPLES

The samples (cassava) were washed in water to remove soil and dirt, cleaned carefully; the samples were allowed to dry about 5mins, then peeled and sliced thinly before drying. All samples were dried in air oven at 60o/c for about 72 hours then cooled to ambient temperature, milled by means of mortar. The milled samples were stored in airtight plastic container until required for analysis. Digestion of samples was done using aqua right method. 0.2 mg of the sample was oven dried, weighed and put in Teflon crucible. Conc. HCl solution of 45ml and 15ml of HNO_3 solution was added up to 4/5 of the crucible 2ml of HF acid was also added. The crucible was taken to the oven and the contents digested slowly at 20oc for 45 minutes. The digested sample was then cooled. Using 250ml of volumetric flask, little distilled water was added, digested samples was poured into it and distilled water was added to make up to the mark. The digested samples were analyzed for heavy metals using the atomic absorption spectrophotometer model (AAS) Schimadu A-A6701 in an air acetylene frame starting with blank followed by samples to determine the metal ions in cassava.

3. RESULTS AND DISCUSSION

The levels of heavy metals investigated in the stem, leaf, tuber and soil of the collected samples of *Manihot esculenta* study were based on dry weight and the results are presented in the tables below. The values are given as Mean Standard Deviation. The results are mean of three replicates as presented in Table I below.

Table I: Mean values of heavy metal analysis on the leave, stem, tuber & soil of cassava (*Manihot esculenta*).

		Morogbo, Badagry division				Odogunyan, Ikorodu division			
		Parts				Parts			
		Leaf	Stem	Tuber	Soil	Leaf	Stem	Tuber	Soil
Nickel (µg/g)	Mean	3559.67	70.43	164.00	41.33	97.00	72.67	204.33	36.67
	Std. Dev	5794.16	1.69	12.17	4.73	42.04	24.21	24.01	11.59
Zinc (µg/g)	Mean	172.33	111.00	83.10	48.70	156.67	119.67	379.00	61.27
	Std. Dev	18.61	16.37	9.30	2.79	37.53	13.20	503.18	4.45
Iron (µg/g)	Mean	641.67	811.67	1105.00	355.00	741.67	841.67	1235.00	438.67
	Std. Dev	43.11	46.46	13.23	13.23	38.84	192.38	126.19	39.25
Manganese (µg/g)	Mean	120.33	20.93	38.57	43.13	71.33	34.43	36.93	44.97
	Std. Dev	5.51	3.87	2.66	1.67	13.87	3.61	27.34	2.61
Cadmium (µg/g)	Mean	0.22	0.22	0.17	0.13	0.02	0.14	0.19	0.08
	Std. Dev	0.38	0.22	0.21	0.13	0.03	0.12	0.13	0.08
Cobalt (µg/g)	Mean	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Std. Dev	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lead (µg/g)	Mean	0.01	0.02	0.01	0.00	0.01	0.00	0.02	0.03
	Std. Dev	0.02	0.04	0.01	0.00	0.02	0.00	0.03	0.05
Copper (µg/g)	Mean	40.70	24.73	23.03	14.87	52.10	18.33	19.23	12.23
	Std. Dev	1.57	0.46	1.76	1.60	2.85	6.67	3.51	2.75
Calcium (µg/g)	Mean	3451.67	1740.00	3996.67	1256.67	3041.67	1373.33	3743.33	1153.33
	Std. Dev	309.45	216.33	35.12	11.55	80.36	329.29	210.08	86.07
Magnesium (µg/g)	Mean	2086.67	1206.00	1873.33	578.33	1946.33	916.00	1476.67	503.33
	Std. Dev	32.53	51.26	75.06	35.47	80.93	64.09	153.08	17.56
Sodium (µg/g)	Mean	11620.00	14536.67	10333.33	4316.67	813.33	516.67	910.00	421.67
	Std. Dev	820.18	774.12	455.23	185.02	66.58	60.07	35.00	35.12
Potassium (µg/g)	Mean	906.67	418.33	935.00	455.00	11483.33	15133.33	10465.00	4190.00
	Std. Dev	45.09	31.82	25.98	25.00	873.69	508.46	684.78	343.95

From Table I above, the results in mg/Kg showed that Ni (3559.67±5794.16), Mn (120.33±5.51), Ca (3451.67±309.45) Mg (2086.67±32.53), Copper (52.10±2.85) were highly bio-accumulated in leafy part of the cassava from. Sodium (11620.00±820.18) and Potassium (15133.33±508.46) were highly bio-accumulated in the stem of cassava from while Calcium (3996.67±35.12) was found in high concentrations in the tuber of the cassava. Again, Lead (0.03±0.05) and Cadmium (0.08±0.08) were of significant values in the soil of Ikorodu and lower in the soil of Badagry.
With regards to heavy metal bioaccumulation in the two different locations, values of Ni, Mn, Cd, Mg, and Na were higher in Badagry than in Ikorodu. While Zn, Fe and k were higher in Ikorodu than in Badagry but cobalt was not detected at both sites.

3.1 DISCUSSION

Analysis of Variance (ANOVA) showed that Iron, Manganese, Copper, Calcium and Magnesium were significant ($P< 0.05$).

Environmental pollution by heavy metals is one of the environmental issues that have become a global problem. With the industrial development, the production and emission of heavy metals have increased. Some metals for example manganese, copper, zinc and nickel are important and beneficial to plants, and animals, but high concentrations may have effects and pose an environmental threat [8].

However, according to Eggum [9], Adewusi and Bradbury [10] and Bokanga [11], nutritionally, cassava leaf is rich in protein (14-40 %), potassium, iron, calcium, sodium, vitamin B1, B2, B6, C and carotenes but the high values recorded in this research clearly showed that probably, the crop was planted within the areas (Ikorodu and badagry) contaminated with heavy metals. This is because usually plants growing around contaminated areas take up heavy metals by absorbing minute deposits on the parts of the plants exposed to the air in the polluted environments and during nutrient uptake from contaminated soils [12].

Furthermore, as the heavy metals get accumulated over time in the soil and plants they would eventually have a negative influence on physiological activities of plants (e.g. photosynthesis, gaseous exchange, and nutrient absorption) and microorganisms responsible for soil conditioning leading to reductions in plant growths, dry matter accumulation and yield [13]. The concentration of potentially Toxic Metals in *Manihot esculenta* differ from one sampling location to the other and vary from the various parts including the soil samples as shown in Table I. The difference in concentration may be attributed to differential uptake capacity of cassava for different heavy metals through roots and their further translocation within the plant parts.

Cadmium (Cd) is an environmental pollutant that is toxic to many plant species at low concentrations [14]. It is a non-essential element in plants and it accumulates principally in the kidney and liver [15] the level of cadmium in the leaves analyzed samples has a mean of 0.22mg/kg which has exceeded the permissible limit of cadmium in cassava 0.02mg/kg. Thus, the leaf part of the plant is contaminated with cadmium of site A. While it is completely absent in the plant parts of site B. it is however present in the soil of site B 0.08mg/kg this shows that there is a factor inhibiting the uptake of cadmium by the plant.

Copper (Cu) is considered as a micronutrient for plants and plays an important role in CO_2 assimilation and ATP synthesis. Cu is also an essential component of various proteins like
plastocyanin of photosynthetic system and cytochrome oxidase of respiratory electron transport chain [16]. The level of copper in all parts of the analyzed samples ranges from 40.70mg/kg to 52.10mg/kg which has exceeded the permissible limit of cu which is 10.00mg/kg in site A while in site B the level of Cu ranges from 1.41mg/kg to 2.55mg/kg and chronic copper poisoning results in Wilson's disease, characterized by a hepatic cirrhosis, brain damage, demyelization, renal disease and copper deposition in the cornea [17].

Chromium (Cr) compounds are highly toxic to plants and are detrimental to their growth and development. Although some crops are not affected by low Cr (3.8 9 10- 41M) concentrations, Cr is toxic to higher plants at 100 1 kg-1 dry weight [18]. Since seed germination is the first physiological process affected by Cr, the ability of a seed to germinate in a medium containing Cr would be indicative of its level of tolerance to this metal with permissible limit of 1.30mg/kg according to WHO [18]. Chromium is a trace element that is important in the body. It is able to stabilize blood sugar levels, which could prevent diabetes, by using insulin efficiently. It also aids the breakdown of fats in the body and is said to increase the good cholesterol in the body while lowering the bad cholesterol.

Conversely, Cd, Cr, Pb and Ni were not detected in all the samples which probably may be attributed to the absence of industrial activities as well as low level of vehicular emission in these areas which agrees with earlier report of indicating that the samples are safe for human consumption. Iron (Fe) as an essential element for all plants has many important biological roles in the process as diverse as photosynthesis, chloroplast development and chlorophyll biosynthesis is an important mineral and it is needed to help our red blood cells deliver oxygen to the rest of the body. Iron is essential for many proteins and enzymes that maintain good health, transporting oxygen in the blood to all parts of the body as well as essential for proper functioning of the liver. The mean concentration level of Fe in the samples ranges from 641.67mg/kg to 1105.00mg/kg in site A, which is above the permissible limit of Fe in plants. While for site B the level of Fe ranges from 741.67mg/kg to 1235.00mg/kg.

Lead at high levels of human exposure there is damage to almost all organs and organ system, most importantly the central nervous system, kidneys and blood culminating in death at n excessive levels. However, in the cassava from site A no lead was detected which may be due to low level of vehicular emission compared to what was reported earlier [19].While in site B the level of Pb was discovered in the soil to be 0.03mg/kg which exceeds the permissible limit of the lead which is 2.00mg/kg which is not present in the other parts of the plant meaning there's a factor inhibiting the uptake of heavy metal by the plant lead combinations occur in cassava grown on contaminated soils. Lead poisoning is a global reality, and fortunately is not a very common clinical diagnosis yet in Nigeria except for few occupational exposures [20, 21].

Nickel uptake will boost when people eat large quantities of vegetables from polluted soils.
Plants are known to accumulate nickel and as a result the nickel uptake from cassava will be eminent. The level of Nickel in site A has a mean concentration which ranges from 3550.67mg/kg to 164.00 mg/kg which exceeds the permissible limit of Nickel in plants which is 10 mg/kg. While in site B the level of Nickel has a mean concentration of which ranges from 97.00 mg/kg to 204.33 mg/kg. However, Nickel was not found in the soil but present in other parts of trace mineral essential to all forms of life because of its fundamental role in gene expression, cell development and replication [22].

The mean concentration of level of zinc ranges from 172.33mg/kg to 83.10mg/kg in the samples collected from site A, which exceeds the permissible limits of zinc which is 3.00mg/kg recommended by WHO [18]. While for site B the mean concentration of zinc ranges from 156.67mg/kg to 91.00mg/kg.

4 CONCLUSION AND RECOMMENDATION

This research work showed that Copper, Lead, Zinc, Manganese, Iron, Nickel, Calcium, Sodium and Potassium present in the sample used were above the recommended level at both sites when compared to WHO and Codex standard [23]. Therefore, consumption of leafy and tuber part of the cassava in both Ikorodu and Badagry area could pose threat to domestic animal and man. The concentration of potentially Toxic Metals in *Manihot esculenta* differ from one sampling location to the other and vary from the various part including the soil samples as shown in tables 1. The difference in concentration may be attributed to differential uptake capacity of cassava for different heavy metals through roots and their further translocations within the plant parts. It is therefore recommended that cash crops such as cassava and related crops should not be planted close to where smelting, dredging industrial waste and other anthropogenic activities are taking place, to save the life of the consumers.

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