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Pedelogical Properties of Three Sub-Urban Vegetable Gardens in Akwa Ibom State, Nigeria

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***Abstract* – Vegetables form staple foods within most households in Akwa Ibom State. Consequently, due to increasing market and household demands vegetable gardens are ubiquitous across most rural and urban landscapes within the state. The present study was conducted to determine different soil characteristics within three sub-urban commercial vegetable gardens. In addition, presence of heavy metals was analyzed both in the soil and the vegetables grown within the three gardens. The three dominant leafy vegetables analysed include: Telfairia occidentalis Hook. F., Gnetum africanum Welw. and Talinum triangulare (Jacq.)Willd. Results obtained showed that the heavy metals concentration of the soil within the different vegetable garden locations were not significant (P = 0.05). Also, the level of the heavy metals in the leaves of the vegetables was low and did not exceed World Health Organisation permissible concentration range except for iron (180-832mg/kg). Observations made from this study, is indicative of little or no incidence of heavy metal loading, thus pollution levels are minimal within the environment. But, the high iron content could likely become a public health concern. However, the current value may be attributed to the geological profile of the area as no visible foundry/industry was noted around the study site. Invariably, consumption of vegetables from these gardens is reasonably safe and current practices of cultivation by the farmers should be encouraged.**

***Keywords* – Heavy Metals, Pollution, Public Health, Soil.**

I. Introduction

Vegetables and fruits are generally known to be a good source of vitamins, minerals and fiber, and human beings are usually encouraged to consume them for the benefit of their health. However, these plants, depending on where they are planted and how they are handled after harvest, are known to contain some essential and toxic metals over a wide range of concentrations. This is due to the fact that most plants absorb metals from contaminated soil as well as from deposits on parts of the plants exposed to the air from polluted environments [1]. In the recent past, the increasing demand for food safety has stimulated research on the risk associated with the consumption of food items that have been contaminated by pesticides, heavy metals and toxins [2]. Plants accumulate these toxins in their tissues; including roots, stems, bark and leaves e.g. [3]-[5]. In turn, bio-accumulated toxins get bio-magnified across different trophic levels as plants act as primary producers within any ecosystem. Thus, humans as tertiary consumers are ultimately exposed to heavy metal poisoning if not early detected within the food chain [6].

In Akwa Ibom State, as in most rapidly urbanized state within Sub-Saharan Africa, scarcity of land suitable for commercial agricultural purposes is a grave issue, especially within and around the Capital City. It is general practice for farmers to either cultivate old dumpsites or use surface soils obtained from dumpsite as manure to enhance crop production; thus, increasing the risk of metal contamination and pollution. With the high demand for vegetable staples in the state and the evidence of metal accumulation in green leafy vegetables [6], it is critical that research on heavy metals is conducted periodically. In this light therefore, the overarching aim of the present research was to assess the heavy metal status of vegetables grown within three different commercial gardens in Ibesikpo Asutan in Akwa Ibom State, Nigeria.

II. Methods

2.1 Study Area:

The study was conducted in three leafy vegetable gardens located in Ikot Ada Akpan village in Ibesikpo Asutan Local Government Area, Akwa Ibom State. The Local government and shares boundaries with Uyo Capital City, Uruan, Nsit Ibom, Nsit Atai and Nsit Ubium Local Government Areas [7].

2.2 Plant Samples Collection:

The leaves used in this study were harvested from mature plants cultivated in three different gardens in Ibesikpo Asutan L.G.A. These were;

- *Talinum triangulare* (Jacq.)Willd. [Garden 1]
- *Gnetum africanum* Welw. [Garden 2] and
- *Telfairia occidentalis* Hook. F. [Garden 3]

At each garden, a total of 63 (21 leaves per species) young, tender, fresh and equal sized leaves were harvested and brought to the laboratory for heavy metals assay. The harvested leaves were placed under running tap to wash off the dirt. The leaf samples in each of the groups were air dried to remove the moisture and water droplets simultaneously. They were then dried to constant weight in an oven maintained at 105ºC, and pulverized to fine powder using a laboratory grinder. The ground leaves were collected into well labeled polythene bags and placed in a desiccator. Three grammes of each sample were carefully weighed into clean platinum crucible and ashed at 450- 500ºC then cooled to room temperature in a desiccator. The ash was dissolved in 5ml of 20% hydrochloric acid and the solution was carefully transferred into a 100ml volumetric flask. The crucible was well rinsed with distilled water and transferred to the flask and made up to the mark with distilled water and shaken to mix well. The resulting sample solutions were then taken for the determination of the heavy metal concentrations using Atomic Absorption Spectrophotometer (AAS). The result given is the mean of three estimations and was analyzed statistically using the Student t-test.

2.3 Soil Sample Collection:

Soil samples from each garden within the study area were collected in a concentric formation at a rooting depth of 1.35m from 9 different points (3 from each site for consistency purposes) and stored in Ziploc® bags prior to digestion and analysis. The texture quality of all the soil samples was fine to medium sand.

Samples were ground, mixed, and divided into fine particles that could pass through a 0.5-mm sieve. Soil samples were digested by adding 2 g of soil to 15ml of concentrated nitric acid and perchloric acid at a ratio of 1:1, and allowed to stand for 135 min until the mixture became colorless. The samples were filtered and washed with 15 ml of deionized water, and the filtrate was made up to 100 ml in a standard flask. Six heavy metals (lead, manganese, iron, chromium, cadmium, and nickel) were determined at their respective wavelengths using an atomic absorption spectrophotometer (AAS). All soil analysis was carried out in the Soil Science Department of the University of Uyo, Uyo, Akwa Ibom State, Nigeria. The result given is the mean of three estimates and was analyzed statistically using the Student t-test.

III. Results

Table I shows description of the vegetables examined in this study. It records the botanical names, vernacular names, common names, family and part used for the three common vegetables cultivated in each of the gardens within the study area.

Table I: Description of Plant Species within Study Area

Family	Plant Species	Common name	Ibibio name	Part used
Cucurbitaceae	*Telfairia occidentalis* Hook. F.	Fluted pumpkin	Uböng	Leaf
Gnetaceae	*Gnetum africanum* Welw.	African salad	Afang,	Leaf
Portulacaceae	*Talinum triangulare* (Jacq.) Willd.	Water leaf	Mmöng-möng ikong	Leaf and stem

Table II shows the mean characteristics of the soil properties of the three gardens. With respect to particle size, the sand fraction was the most abundant. The pH values were close to 7.0 levels, with high available phosphorus. Calcium was the most abundant cation and Sodium the least abundant cation.

Table II: Characteristics of Soil within Study Area

Parameter	Garden1 [*Talinum triangulare*]	Garden 2 [*Gnetum africanum*]	Garden 3 [*Telfairia occidentalis*]
pH	6.80^{a}	6.9^{a}	7.20^{a}
Electrical conductivity	0.13^{a}	0.066^{b}	0.100^{a}
Organic Matter	6.70^{a}	4.77^{b}	2.93^{c}
Total Nitrogen	0.17^{a}	0.12^{b}	0.06^{c}
Available phosphorus	61.44^{a}	66.30^{a}	28.47^{b}
Calcium	5.20^{a}	2.80^{b}	4.40^{c}
Magnesium	2.40^{a}	1.10^{b}	1.70^{c}
Sodium	0.06^{a}	0.07^{a}	0.05^{a}
Potassium	0.16^{a}	0.19^{b}	0.15^{a}
Exchangeable acidity	2.56^{a}	2.80^{a}	2.26^{b}
ECEC	10.38^{a}	6.86^{b}	8.56^{a}
Base saturation	75.34^{a}	59.18^{b}	73.60^{a}
Sand	80.8^{a}	82.8^{a}	78.80^{b}
Silt	9.70^{a}	3.70^{a}	7.60^{a}
Clay	9.50^{a}	13.50^{b}	13.60^{b}

Notes: * Columns with same superscript are not significantly different

Table III shows the metal accumulation within soil samples of the three gardens of the study area. Of the three gardens, garden 2 (i.e. *Gnetum africanum*) had the highest concentration of Zinc (55.13 mg/kg). Mercury was the least concentrated metal (0.38 – 0.47mg/kg), while Iron was the most abundant of all metals.

Table III: Concentration of heavy metals in Three Garden Soils

Garden	Metals				
	Zn (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Hg (mg/kg)	Fe (mg/kg)
Garden 1	42.20^{a}	9.67^{a}	21.38^{a}	0.38^{a}	180.94^{a}
Garden 2	55.13^{b}	11.68^{b}	33.72^{b}	0.47^{b}	832.94^{b}
Garden 3	52.11^{b}	10.95^{b}	29.68^{a}	0.43^{b}	583.06^{c}

* Columns with same superscript are not significantly different

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Table IV shows the metal accumulation in the sampled leaves of each plant species within the study area. *Gnetum africanum* had the highest concentration of Zinc (81.00 mg/kg) while *Talinum triangulare* (62.40mg/kg) had the least. Mercury was the least absorbed metal (range 0.2 – 0.33mg/kg). Iron concentration was more in the plant tissues when compared to other trace metals.

Table IV: Concentration of Metals in Three Leafy Plants

Plant Species	Metals				
	Zn (mg/kg)	Cu (mg/kg)	Mn (mg/kg)	Hg (mg/kg)	Fe (mg/kg)
T. triangulare	62.40[a]	9.93[a]	30.00[a]	0.20[a]	175.09[a]
G. africanum	81.00[b]	13.98[b]	45.20[b]	0.33[a]	140.03[a]
T. occidentalis	75.19[c]	12.03[c]	39.80[c]	0.30[a]	206.36[a]

* Columns with same superscript are not significantly different

IV. Discussion

The sand content of the soil was more than 70 percent in all instances and can be described as sandy loamy soils which favour the cultivation of the three plant species dominant in the area. However, from interviews and results obtained soils within the study area use organic manures such as chicken and goat dung, including decaying oil palm bunch as nutrient enrichments rather than inorganic fertilizers. [8] Showed that prolonged use of inorganic fertilizer is associated with deterioration of soil texture leaving a high leaching effect low pH of the soil. Additionally, soils of the study area contained medium to high quantities of organic carbon, which also could be related to the organic nutrient enrichment used within these gardens. The high organic matter might be due to the use of different organic fertilizers which increases the fertility status of the soil and is associated with a characteristic liming effect. It is this liming effect and nutrient availability that enhances plant development. The liming effect is believed to come from the biodegradation of organic materials such as palm bunch, straw bedding and poultry litter which release calcium, magnesium and potassium into the garden soil. The liming effect herein observed, thus explain the connectivity existing between the cations exchange capacity and pH [9], [10].

Based on the pH values recorded in this study, the moderate value of ECEC is not unprecedented. Studies have shown that the ECEC of soil denotes the concentration of nutrient cations present in soil solution which could be taken up by plants. Also, [11] opined that nutrient uptake is dependent on a constellation of soil factors including soil pH and ECEC. For instance metal mobility has been shown to decrease with increasing soil pH due to precipitation of hydroxides, carbonates or formation of insoluble organic complexes [12], [13].

The concentration values of the heavy metals in the soils of this area apart from that of iron were generally within acceptable limits of the World Health Organisation (WHO) standards. In addition to this, the low values of metals such as Cu, Mn and Zn in these soils may be related to plant uptake, which is well documented in literature. However, Iron (Fe) exceeded the acceptable limits in the plants. Generally most of the heavy metals are less available to plants under weakly acidic and alkaline conditions [14]. This probably accounts for the low concentration level of trace metals observed in this study. The concentration values of the soils reflect low anthropogenic influences and also, may be connected to the source of irrigation water, non-utilization of fertilizers and low industrial emissions within the area.

V. Conclusion

The present study has established the variability in soil properties of three sub-urban gardens. The mean concentrations of metals in the samples from the gardens were found to be within their normal concentrations in soils and plants with Iron as an exception. The variability in metals concentration maybe linked to low anthropogenic influences and good farming practices, and should be encouraged across the region. However, due to the rapid urbanization within the capital city it is important that periodic monitoring of soil contaminants be conducted to avoid future metallic accumulation.

References

[1] N. E. Okoronkwo, J. C. Igwe, E. C. Onwuchekwe, "Risk and health implication of polluted soils for crops production", African Journal of Biotechnology 4(13), pp.1521-1524, 2005.

[2] J. P. F. D'Mello, Food safety: Contaminants and toxins, CABI Publishing, Cambridge, .pp. 85 – 89, 2003.

[3] F. E. Uboh., M. I. Akpanabiatu, E. E. Edet, I. E. Okon, "Distribution of heavy metals in fluted pumpkin (*Telfairia occidentalis*) leaves planted at different distances away from the traffic congested highways", International Journal of Advanced Biotechnology and Research 2(2), pp. 250-256, 2011.

[4] D. E. Vwioko, G. O. Anoliefo, S. D. Fashemi, "Metal Concentration in Plant Tissues of *Ricinus communis* L. (Castor Oil) Grown In Soil Contaminated With Spent Lubricating Oil", Journal of Applied Science & Environmental Management, 10 (3), pp. 127 – 134, 2006.

[5] M. Ataabadi, M. Hoodaji, P. Najafi, (2010). Heavy Metals Biomonitoring by Plants Grown in an Industrial Area of Isfahan' Mobarakeh Steel Company, Journal of Environmental Studies 35 (52)

[6] F. O. Ogbemudia, I. N. Bassey, O. Kekere, E. D. Udo, "Concentrations of heavy metals in three commonly used medicinal vegetables in Akwa- Ibom state", Scientific Journal of Environmental Sciences,1(2), pp. 21-29, 2012.

[7] Akwa Ibom State Government, AKSG, "Geography and Location about Akwa Ibom State", 2008. [Online]. Available: http:// *www.aksgonline.com*. [Accessed: December 17, 2013].

[8] M. O. Akoroda, "Ethnobotany of *Abelmoschus Esculentus* Among Igbos of Nigeria", Economic Botany 44 (1), pp. 21-39, 1990.

[9] A. O. Isichei, A. J. Morton, F. Ekeleme, “Mineral Nutrient Flow from an Inselberg in South-Western Nigeria”, Journal of Tropical Ecology, 6, pp. 479 – 492, 1990.

[10] E. O. Mbong, F. O. Ogbemudia, J. E. Okon, U. B. Umoren, “Evaluation of concentration of heavy metals in leaf tissues of three improved varieties of *Manihot esculenta* crantz.E3 Journal of Environmental Research and Management 4(3), pp. 0214-0218, 2013.

[11] G. Fleming, P. Parle, “Heavy metals in soils, herbage and vegetables from an industrialized area west of Dublin city, Irish Journal of Agriculture, 16, pp. 35-48, 1977.

[12] C. J. Smith, P. Hopmans, F. J. Cook, “Accumulation of Cr, Pb, Cu, Ni, Zn and Cd in soil following irrigation with untreated urban effluents in Australia, Environmental Pollution 94 (3), pp. 317-323, 1996.

[13] B. J. Alloway, D. C. Ayres, Chemical Principles of Environmental Pollution, 2nd ed., Black Academic and Professional Publication, pp. 190-217, 1997.

[14] R. Hess, B. Schmids, Zinc Supplement Overdose can have Toxic Effects, Journal of pediatrics Hematology/Oncology, 24: 562 - 584, 2001.