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Determination of Potentially Toxic Elements in Soil, Pumpkin Leaves (Telfairia Occidentalis) and Maize (Zea Mays) Around Artisanal Refining Sites in Odagwa Etche

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Abstract
Potentially toxic element (PTEs) pollution of the soil is an important issue because of deity intake, the negative impact of the potentially toxic elements causes myriad to health through the ecosystem. This study was undertaken to determine the potentially toxic elements in soil, *telferia occidentalis* and *zea mays* around illegal refining sites in Odagwa Etche. The soil, vegetable and maize samples were taken from different farmland close to where illegal refining activity takes place, the samples were digested and filtration by gravity was used to collect the filtrate. Analyses were done using Atomic Absorption Spectrophotometer, the results of analysis for potentially toxic elements in soil ranged from lead (Pb); 16.00 to 9.46(mg/kg), Cd; 5.485 to 3.505mg/kg, Zn; 13.09 to 8.14mg/kg, As; 9.375 to 6.2mg/kg, Cr; 0.62 to 0.34mg/kg and Ni; 10.324 to 9.149mg/kg. for vegetable samples the value varied from 1.755 to 0.025mg/kg for lead (Pb); 0.61 to 1.51 mg/kg for Cd; 6.3 to 3.16mg/kg for Zn and 0.915, to 0.105mg/kg for Cr, 5.24, to 2.225 mg/kg for As and 7.032, to 6.404 for Ni and for maize the mean value varied from 1.69, to 0.07mg/kg for Pb, 0.54, to 0.65 mg/kg for Cd, 4.63 to 3.355mg/kg for Zn, 1.12, to 0.04mg/kg for Cr, 1.135 to 0.135 for As and 1.457, to 2.012mg/kg for Ni respectively. The result of the analysis was further compared with the national and international standard and this revealed that some of the PTEs were above the DPR and WHO while maize was below the acceptable limit. The pollution load index was used to ascertain the levels of pollution by PTEs which indicate that the soil and vegetable samples were highly polluted while the maize samples were unpolluted.

Keywords: Potentially Toxic Elements, Soil, *Telfairia Occidentalis, Zea Mays*, Odagwa Etche, Rivers State

Introduction

The environmental contamination by potentially toxic elements is a vax issue, rapid industrialization has impacted effectively the pollution of the environment by heavy metals (HMs) into humus and rivers (Hoodaji et al., 2010; Mojiri et al., 2018). The reduced strength of the soil system results from the amounts of PTEs in the topsoil of the different land uses which causes many pollution problems and undermines human wellbeing. Therefore, topsoil contamination by PTEs is an important issue in the surrounding management area. Potentially toxic elements are environmental pollutants that cannot decompose and remain in the surroundings for a long period which may be deposited on the surfaces and then taken up into the tissues of the pumpkin leaf. potentially toxic element is taken up by Plants from dump sites on the parts of the plants exposed to air pollution into the environment which pollute the soils (Singh et al., 2010; Sharma et al., 2008). Humans are endangered to PTEs by various means, the uptake of polluted vegetables and water enters the human body through the food chain (Harmanescu et al., 2011; El-Hamiani et al., 2015). Potentially toxic elements are environmental pollutants, non-decomposing which remain in the surroundings for a long period, they are deposited on the surfaces and then taken up into the tissues of the vegetables. Potentially toxic element is taken up by Plants by absorbing them from dumpsites on the parts of the plants exposed to a polluted environment through the air to the polluted soils (Singh et al., 2010; Sharma et al., 2008). Contaminated plants can cause various health issues, including discomfort, disabilities, and depletion of essential nutrients in humans and animals (Franklyn et al., 2020). Odagwa Etche is a community that has been noted for artisanal refining activities which may have negatively impacted the soil and food crops grown therein, therefore

there is a need for the study. This study is therefore aimed at the determination of the concentrations and contamination factors of potentially toxic elements in soil, vegetable (*Telfaira occidentalis*) and maize (*Zea mays*) around artisanal refining sites in Odagwa Etche.

Material and Methods

The studied farmlands were undertaken where artisanal refining activities take place in Odagwa. Odagwa is a community in Etche of Rivers State, Nigeria. The community comprises Odagwa Kwu and Odagwa Isi Miri all in Etche, L.G.A. Etche is a nation found in the Niger Delta of Nigeria. currently, its people comprise Etche and Omuma, of the 23 Local Government Areas of Rivers State. It is located between latitude $4^{0}52'30'N$ and $5^{0}14'30'N$ and longitude $7^{0}0'0'E$ and $7^{0}11'0'E$. The local government covers a $774.7km^2$ area with a population projection of 359,500 in 21/03/2022. Samples of *Zea mays* and *Telfaira Occidentalis* were gathered from several farms near artisanal refining sites in Odagwa Etche using hand gloves into a precleaned and labelled polythlene bag before it was taken to the Laboratory, Ignatius Ajuru University of Education for examination. With the aid of a plastic trowel, soil samples were gathered from the same farm where vegetable and maize samples were collected, it was sealed in a polythlene bag and transported to the school Laboratory, Ignatius Ajuru University of Education for examination. Sample treatment. After weighing the soil samples and oven-drying them for three to four hours to remove moisture and debris, the fresh samples (Zea mays and Telfaira Occidentalis) were cleaned with de-ionized water to remove air pollutants. The dried samples were then pulverised using an electronic blender and sieved through 20um to get a uniform size. Each sample was labelled with the method it was collected from a different farm and stored in a plastic container for additional analysis.

Sample digestion and investigation for PTEs.

Twenty (20) ml concentration of H_2SO_4, 20ml of HNO_3 and 10ml of $HCLO_4$ were measured and mixed in a flat bottom flask, 2g of the samples (vegetable leaves, maize, and soil) were weighed and put into a conical flask labelled accordingly, ten (10) ml of mixed acid solution was measured and poured into each flask and it was swirled for proper mixing. The samples were digested using a Kjeidahl device in a distillation chamber, the residue was discarded while the extract was transferred into a 100ml flat bottom flask, distilled water was added to make it up to the graduation mark, and sample bottom was used to collect the analyte for additional examination using atomic absorption spectrometer.

Results

Table 1. Mean levels of PTEs in humus from the three selected Farm lands in Odagwa Etche

Metals	FARM 1	FARM 2	FARM 3	WHO	DPR
Pb	16.00	12.165	9.46	1.00	2.00
Cd	5.485	4.465	3.505	0.8	0.02
Zn	13.09	11.335	8.14	5.0	0.60
Cr	0.62	0.58	0.34	1.00	1.30
As	9.375	4.325	6.2	4.5	1.00
Ni	10.324	16.06	9.149	35	10.0

Table 2. mean level of PTEs in *telfairia/occidentalis* from three farm lands in Odagwa Etche

Metals	FARM 1	FARM 2	FARM 3	WHO	DPR
Pb	1.755	1.555	0.025	0.2	2.00
Cd	0.61	0.22	1.51	0.02	0.02
Zn	6.3	5.875	3.165	0.6	0.60
Cr	0.915	1.15	0.105	2.30	1.30
As	5.24	2.185	2.225	1	1.00
Ni	7.032	6.405	6.404	1.50	1.00

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Table 3. The levels of PTEs in *Zea mays* sample from three farm lands in Odagwa Etche

Metals	FARM 1	FARM 2	FARM 3	WHO	DPR
Pb	1.69	0.235	0.07	0.20	2.00
Cd	0.54	0.315	0.65	0.02	0.02
Zn	4.63	4.57	3.355	0.6	0.60
Cr	1.12	1.00	0.04	2.30	1.30
As	1.135	0.195	0.135	1	1.00
Ni	1.457	3.13	2.012	1.50	1.00

Table 4: Contamination factor and PLI of PTEs in soil, vegetable and maize samples of farm lands in Odagwa Etche

PTEs	soil			vegetable			maize		
	FARM 1	FARM 2	FARM 3	FARM 1	FARM 2	FARM 3	FARM 1	FARM 2	FARM 3
Pb	0.8	0.608	0.473	0.087	0.077	0.001	0.084	0.011	0.00
Cd	18.28	14.88	11.68	2.033	0.733	5.033	1.8	1.05	2.166
Zn	2.908	2.518	1.808	1.4	1.305	0.703	1.028	1.015	0.745
Cr	0.007	0.006	0.003	0.01	0.012	0.008	0.012	0.011	0.00
As	0.234	0.108	0.155	0.131	0.054	0.055	0.028	0.004	0.003
Ni	0.152	0.236	0.134	0.103	0.094	0.094	0.021	0.046	0.029
PLI	9.66	7.35	6.28	0.10	0.03	0.10	0.05	0.03	0.04

The result of the analysis of PTES around artisanal refining sites in Odagwa Etche is summarized in Tables 1-3. In the research data, the amount of Pb, observed for soil is 16.00 - 9.46 while vegetable and maize values are 1.755-0.025 and 1.69 - 0.07, the value is above the WHO standard except for farm 3, the contamination makes it unfit for consumption. This implies that the higher concentration of potentially toxic elements recorded in this study is a result of continuous refining activities which changes the soil pH, Nutrient composition and soil texture in the soil.

Discussion

The observed value for this study is significantly higher when compared to (Nwoke & Edori, 2020b). Nickel was detected in all sampling locations, the mean level ranged from 10.324 - 9.149 in the soil while vegetable and maize values were 7.032- 6.404 and 1.457 -2.012 respectively. The values were higher than the DPR/WHO value, the observed value of Zinc in soil was observed to be 13.09- 8.14 while vegetable samples were 6.3- 3.165 and 4.63-.355 respectively. The observed value was higher than the DPR/WHO value, the observed value in this study is higher when compared to Doherty et al. (2012) on the determination of the concentration of PTEs in pumpkin leaf, bitter leaf, water leaf, fluted pumpkin and spinach.

Cadmium (Cd) has been listed as an endocrine-disrupting substance and exposure to this toxic metal through regular consumption of contaminated vegetables may lead to the development of prostate cancer, it has deleterious health effects because it can be absorbed via the alimentary tract across the placenta and elicit cell membrane and DNA damage. Cd was observed in this study to be 5.485- 3.505 in soil, 0.61- 1.51 for vegetables and *Zea mays* to be 0.54-0.65 making it unfit for consumption. Adedotum, (2018) recorded Pb concentration to be 157.0± 39.8 which is higher compared to this work. Also, Nwoke and Edori (2020a) reported on the pollution amount of the soil by heavy metal from Rumuagholu farmland within the dumpsite in Rivers State, Nigeria. The values of Pb, Cr, Ni, Cd, ranging from 1.47± 0.03 -0.94± 0.02 Pb, Cr 2.71± 0.4 - 1.81±0.69, Ni 1.88±0.03 - 1.42± 0.08 and Cd 0.47±0.22 - 0.21±0.19 all are significantly lower when compared to this present study in soil samples. The level of arsenic recorded in this study ranged from 9.37 - 6.2 for soil samples, 5.24 -2.225 and 1.135 - 0.135, for vegetables and maize. These values were significantly higher when compared to the WHO standard, the observed value aligns with

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Abdulhameed et al. (2018) they reported on the determination of the presence of the amount of several PTEs pollution by pesticides in pepper, tomato and onion grown on the farm and human risk involved with the feeding. Chromium is known for its toxicity, in this study it is observed that Cr value(mg/kg) in soil, vegetable and maize recorded 0.62- 0.34, 0.915- 0.105 and 1.12 -0.04 mg/kg. they were all lower than the maximum allowable limit recommended by WHO.

The contamination for Pb ranged from 0.8- 0.473 while for vegetables, the value were 0.087- 0.001 and 0.084- 0 for maize. The value obtained after analysis shows the soil is highly contaminated with lead (Pb) while vegetables are moderate and maize has a low degree of contamination when compared with the chart interval for contamination. Contamination factors for this work are in agreement with Franklyn et al. (2020) on Pb, Cd, Zn and Ni contamination and the result shows that the study area is contaminated. The result of the contamination factors concerning Cd, Zn, Cr, As and Ni shows high contamination in soil and vegetables and low in *Zea mays* on contamination interval which varies from small level ($Cf<1$), average level ($1\leq Cf<3$), significant level ($3\leq Cf<6$) and severity level ($Cf\geq 6$). The CF value for Cd and Zn ranged from 18.28- 11.68 and 2.908- 1.808 in the soil sample while the value for vegetable and maize ranged from 2.033- 5.033 Cd and 1.4- 0.703 Zn respectively, 1.8- 2.166 Cd, 1.028- 0.745 for Zn. The value of contamination factors observed for Ni and As varied from 0.152- 0.134 and 0.234- 0.155 for soil while vegetable and maize ranged from 0.103- 0.098 Ni and 0.131- 0.055 As, 0.021-0.029 Ni and 0.028-0.003 As. These values showed that the soil and vegetables are contaminated while maize shows a low degree of contamination.

Conclusion

The results of this study have shown that the soil, vegetables and maize in three farmlands near artisanal refining sites in Odagwa Etche were highly accumulated with potentially toxic elements, the following conclusion is made. The PTEs in the soil were higher than the maize with a significant difference. The mean concentration of the potentially toxic elements Cd, Ni, As, Cr and Pb in the maize and vegetable exceeded the DPR/WHO acceptable limit. Zn-level vegetables and maize were within the limit of WHO which indicates their safety for consumption though Zn is an essential mineral. The increase in the level of the potentially toxic elements in the crops (maize and vegetables) may be due to the artisanal refining activities taking place around the farm area. The result of the contamination factor/PLI showed that the soil was polluted, and selected food crops were highly accumulated with potentially toxic elements thus continuous consumption could pose a serious threat to the people in Odagwa Etche.

Recommendation

Based on the findings, statistical data have shown that the selected food crops are highly polluted with PTEs, urban villages live by farming and therefore the process of the artisanal refining sites is to be checked to reduce the level of pollution in soils and farmers should be advice not to farm in the polluted lands.

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