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Heavy metal levels in palm oil samples harvested from selected anthropogenic sites within Amansea in Anambra State

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ABSTRACT
Studies were carried out to investigate the levels of selected heavy metals (Pb, Cd and Cu) in the palm oil samples harvested around anthropogenic sites within Amansea in Anambra State. Standard experimental procedures and instrumentation were employed in the study. The palm oil samples harvested from the studied anthropogenic sites (dump site, abattoir and auto-mechanic workshop) had mean Pb values ranged from 0.214 – 0.488μg/g while its level in the soil sample locations was 0.136-0.704 μg/g. The palm oil samples harvested from the control environment had mean Pb values of 0.096 μg/g while 0.136 μg/g was the value of Pb in the control soil samples. Cd was not detected in the palm oil samples at the auto-mechanic and control sample locations while at the other studied locations its mean values ranged from 0.064 - 0.143 μg/g. Additionally, the mean values of Cd in the soil samples from the dumpsite and abattoir ranged from 0.084 – 0.191 μg/g. The mean range of Cu in the palm oil samples from the studied anthropogenic sites was 0.986 - 1.763 μg/g while the palm oil samples from the control environment had mean Cu of 1.592 μg/g. The mean range of Cu in the soil samples was 1.394 – 4.948 μg/g and 2.092 μg/g in the control soil samples. The palm oil and soil samples harvested around the dumpsite had significantly higher mean values of the investigated heavy metals than what was obtained in the other studied locations. Strong advocacy against the dangerous and unsavoury practices by the people that contaminates the very vegetation that provides our primary food sources with heavy metals, is critical to mitigating the undue exposure to poisonous metals through fruits and food consumption.

Keywords: Palm oil samples, Soil samples, Anthropogenic sites and Heavy metals.

1. INTRODUCTION
Human activities overtime have endangered our environment affecting both the flora and fauna, through the discharge and emissions of toxic air. liquid or solid waste materials. This waste materials that may be in organic or inorganic form have advertently and inadvertently contributed to more than 50% of man's health

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concerns through his consumed food, water and air (Okeke *et al*., 2020; Aniobi *et al*., 2022; Okeke *et al*., 2023). Human activities such as indiscriminate inorganic fertilizer application, burning of solid waste materials, dumping of untreated wastes on land and in waterways, auto-mechanic workshop and abattoir businesses sited near areas with intense farming activities have deepened the contamination of the environment with contaminants of concern such as heavy metals. Food materials, water and the air component contaminated with heavy metals pose a grave concern to the wellbeing of man and his environment (Okeke *et al*., 2018; Ezeh *et al*., 2019; Ezeagwu *et al*., 2023). Accordingly, Aniobi *et al*., (2019), stated that an environment with intense anthropogenic activities risk undue exposure to heavy metals through food, water and air. The risk of undue and prolonged exposure to heavy metals such as Cd, Pb, Hg, As and Cu to the human body is very concerning as described by (Okeke and Okeke, 2015; Aniobi et al., 2022). Amansea, a satellite town at the exit point of Anambra State, has palm fruits in abundance and produce palm oil in huge quantities amidst increased anthropogenic activities. The population of people of this area has increased recently due to the relative peace enjoyed by the people and this has resulted in the boom of economic activities in palm oil production, abattoir, motor repairs and vehicle depots among others. Therefore, the need to evaluate the effect of this activities (including waste disposal at dumpsites) on the heavy metal levels in the soil and palm oil produced within this area (town) guided this research.

2. MATERIALS AND METHODS

The palm oil samples were gotten from ripened palm fruits situated at the studied anthropogenic sites within Amansea. The samples were neatly and clearly labelled on collection and extraction. The soil samples were collected within depths 0 – 30cm from the anthropogenic sites that the ripened palm fruits had been harvested. The surface debris of the soil samples was removed, air – dried, ground and sieved.

Digestion

About 2g each of the sample was weighed into a 250ml beaker containing 5ml of Conc. HNO_3 and $HCLO_4$ and mixed in the ratio of 3:2 respectively. The digestion temperature rose to 150^{o}C and was steadied at that temperature for 4hr, with evolution of white fumes signaling the completion of the digestion process. The digest was cooled and diluted with de-ionized water and filtered into a 50ml volumetric flask and made up to mark. Triplicate digestion procedure was conducted for the entire samples (soil and palm oil), together with reagent and stored in laboratory condition prior to analysis. Levels of the heavy metals (Pb, Cd and Cu) were determined in the samples using Hitachi Z- 500 flame atomic absorption spectrophotometer. Quality control measures was carried out to reduce the risk of metal contamination.

Statistical Analysis

The data obtained were expressed in mean ± standard deviation and subjected to one way analysis of variance (ANOVA) at 5% confidence level using SPSS 23.0.

3. RESULTS AND DISCUSSIONS

Lead

The result of Table 1 shows that the mean Pb levels in the palm oil samples harvested near abattoir, around dumpsite, auto-mechanic workshop and an area with low human activities (control) were 0.204 ± 0.076, 0.488 ±0.055, 0.302 ± 0.051 and 0.096 ±0.020 respectively. This result indicated that palm oil samples harvested around the dumpsite had the highest mean Pb values while the palm oil samples from the area with low human activity (control) was the lowest as shown in Figure 1.

The findings of this research agreed with the reports of Okeke et al., (2018); Okeke et al., (2020), that food materials harvested from areas with intense anthropogenic activities risk contamination with heavy metals at concerning levels. The mean Pb levels in the palm oil samples harvested from the studied locations differed significantly. The palm oil samples had mean Pb values within the threshold limits.

The result of Table 2 shows that soil samples collected around the abattoir site, dumpsite, auto-mechanic workshop and a low human activity area (control) had 0.453 ±0.062, 0.704 ±0.081, 0.298 ±0.022 and 0.136 ±0.020 respectively as mean Pb values. Soil samples collected around the dumpsite had the highest mean value while the control soil samples had the least mean Pb value as shown in Figure 2.

Table 1: Mean heavy metal levels in the palm oil samples harvested from the anthropogenic sites within Amansea axis in Anambra State.

Sample / Metal(µg/g)	Near Abattoir	Near Dumpsite	Around auto-mechanic w/shop	Around a low human activity area (control)	F test p value	WHO STD (WHO, 2014)
Pb	0.214±0.076	0.488±0.055	0.302±0.051	0.096±0.020	0.02	0.5
Cd	0.064±0.010	0.143±0.036	-	-	0.02	0.5
Cu	1.763±0.252	3.506±0.179	0.986±0.240	1.592±0.076	0.01	10

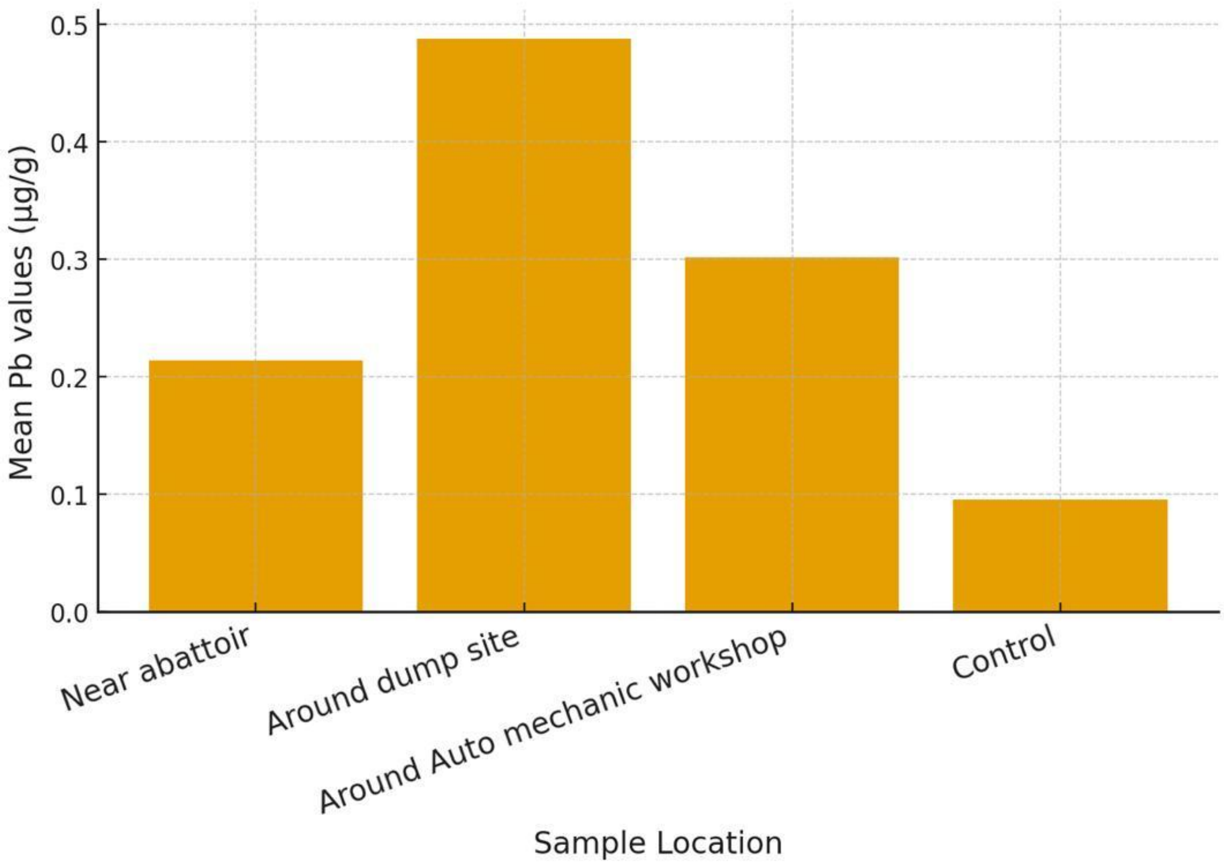

Figure 1: Bar chart representation of the mean Pb values in the palm oil samples harvested from the studied anthropogenic sites.

Table 2: Mean heavy metal levels in the soil surroundings of the investigated anthropogenic areas

Sample / Metal(µg/g)	Near Abattoir	Near Dumpsite	Around auto-mechanic w/shop	Around a low human activity area (control)	F test p value	WHO STD (WHO, 2014)
Pb	0.453±0.062	0.704±0.081	0.298±0.022	0.136±0.020	0.01	0.5
Cd	0.084±0.010	0.191±0.013	-	-	0.02	0.5
Cu	2.992±0.346	4.948±0.281	1.394±0.166	2.092±0.551	0.01	10

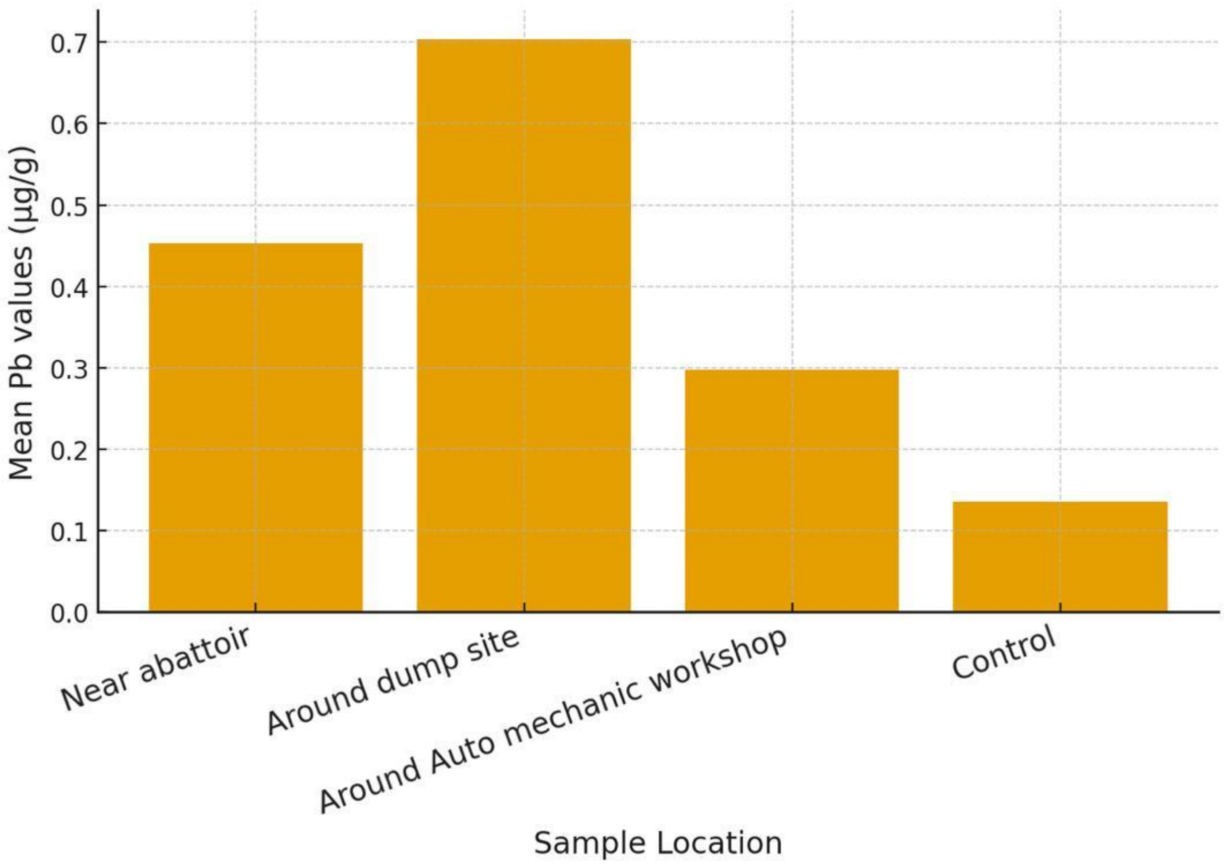

Figure 2: Bar chart representation of the mean Pb values in the soil samples collected at the studied anthropogenic sites.

This result therefore shows that anthropogenic activity in a given environment may influence the heavy metal contamination and distribution in such an environment.

Only the soil samples collected around the dumpsite was above the metal's (Pb) threshold limit. The mean Pb values in the soil samples differed significantly. The remarkably higher mean Pb values in the soil samples compared to the palm oil samples across the studied anthropogenic sites showed that the contaminated soil samples greatly influenced the metal's bioaccumulation in the palm oil samples and, that implies that crops and vegetables, contaminated with heavy metals has soils where the plants grew as its chief source of heavy metal contamination. The mean Pb value of 0.43 ±0.08µg/g reported by Okeke et al., (2020) in the soils around Nnobi abattoir compared very well with the value obtained for Pb in the soil samples around the abattoir in Amansea.

Cadmium

The result of Table 1 shows that the mean Cd values in the palm oil samples harvested around the abattoir site and dumpsite were 0.064 ±0.010 and 0.143 ±0.036 µg/g respectively. Cadmium was not detected in the palm oil samples harvested around the auto-mechanic workshop and the area with low human activity (control) as shown in Figure 3.

The Cd values in the palm oil samples harvested from the two anthropogenic sites of detection differed significantly, which might be due to the varying activities within the two locations. The mean Cd values in the palm oil samples were within the threshold limit. The result of Table 2 shows that soil samples around Amansea abattoir and dumpsite had mean Cd values of 0.084 ±0.010 and 0.191 ±0.013 µg/g respectively. The soil samples around the dumpsite had a significantly higher mean Cd value compared to the soil samples around the abattoir (see Figure 4) and this significant variation in the Cd values could have arisen from the un-regulated, non- profiled and indiscriminate disposal of all kinds of waste at the dumpsite, which influenced the very high Cd contamination. The mean values of Cd in the investigated soil samples were within the threshold limit.

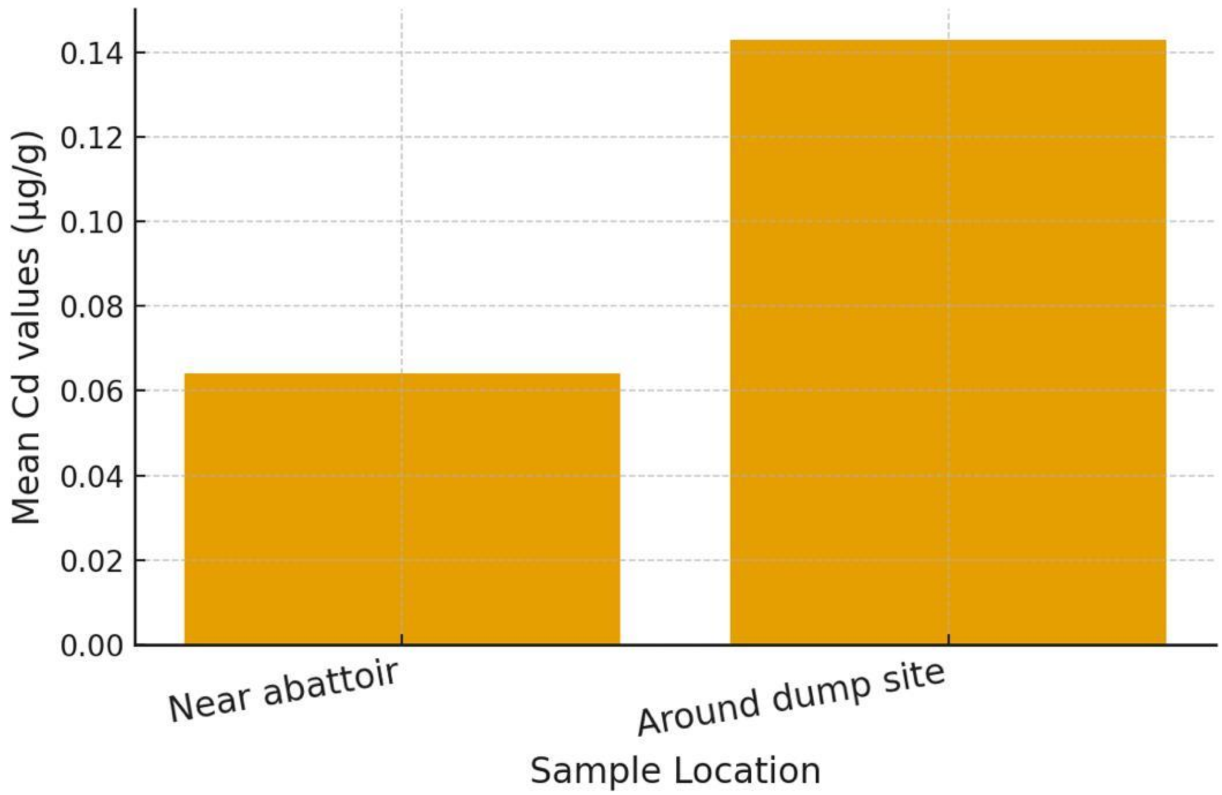

Figure 3: Bar chart representation of the mean Cd values in the palm oil samples harvested from the studied anthropogenic sites.

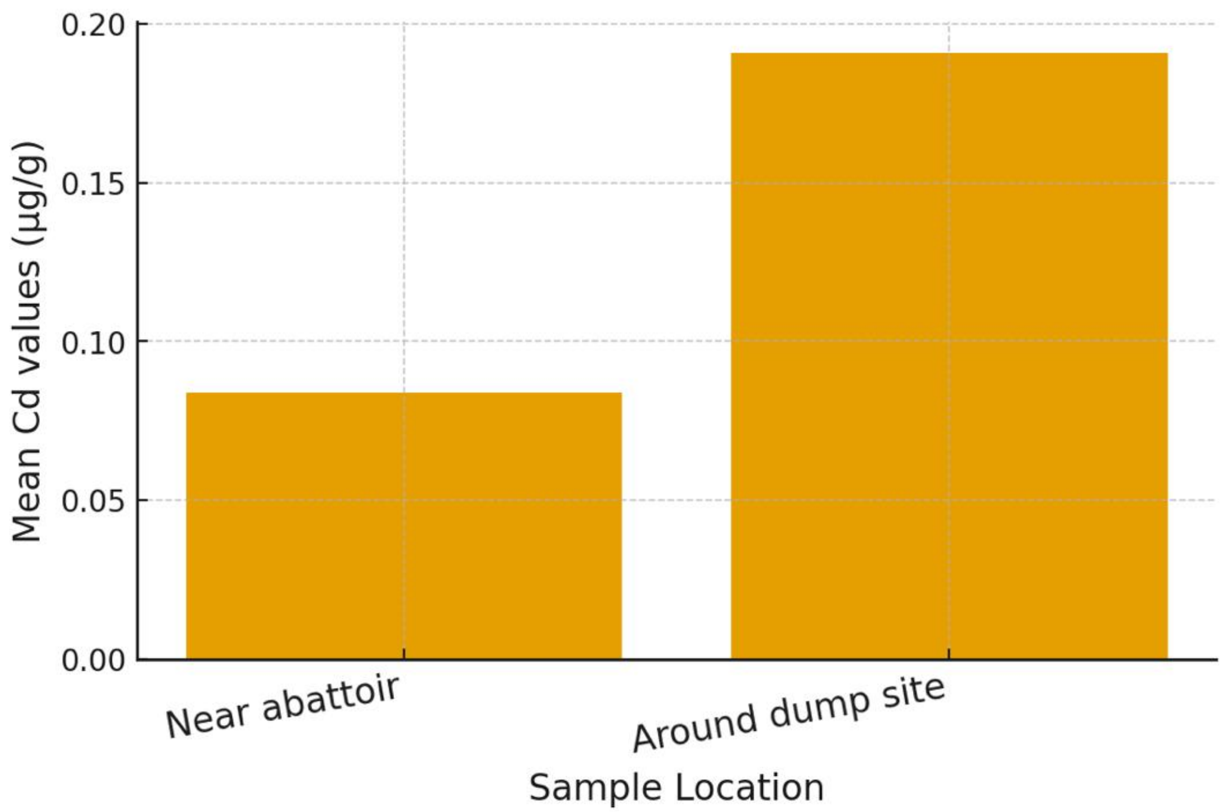

Figure 4: Bar chart representation of the mean Cd values in the soil samples collected at the studied anthropogenic sites.

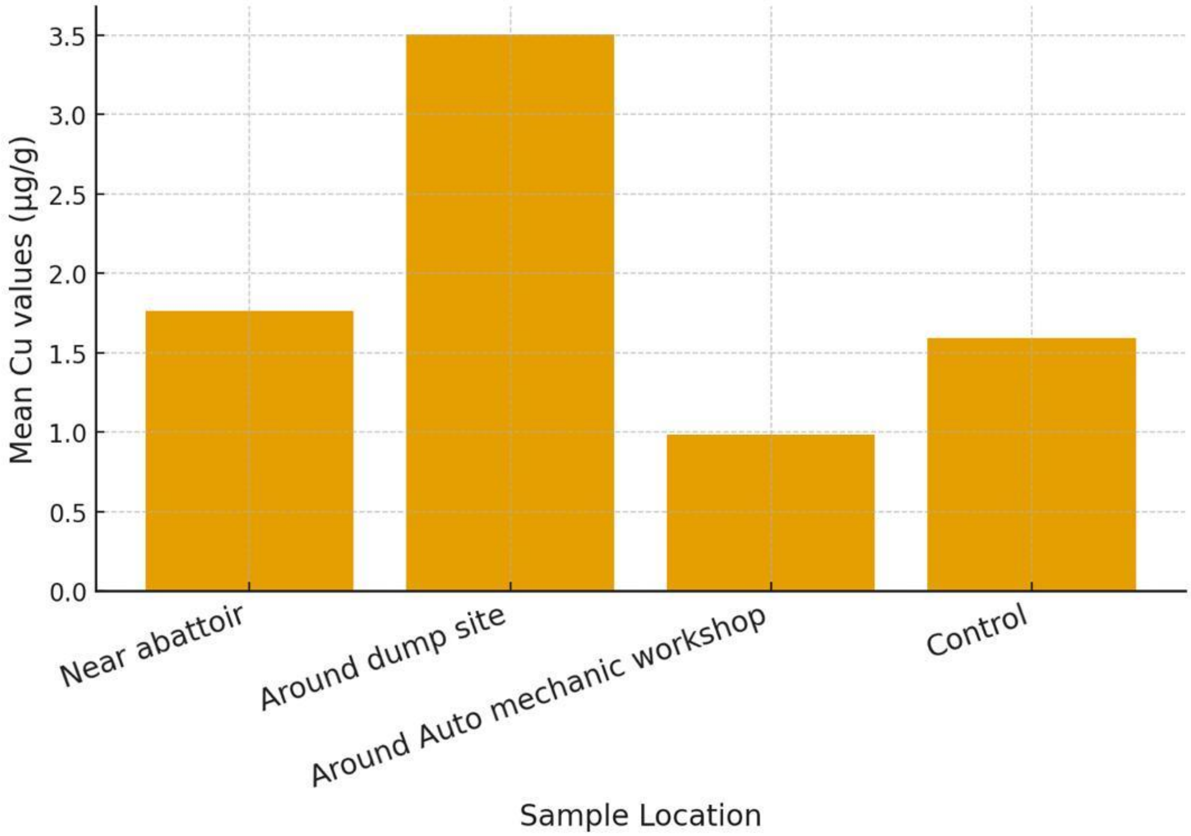

Figure 5: Bar chart representation of the mean Cu values in the palm oil samples harvested from the studied anthropogenic sites.

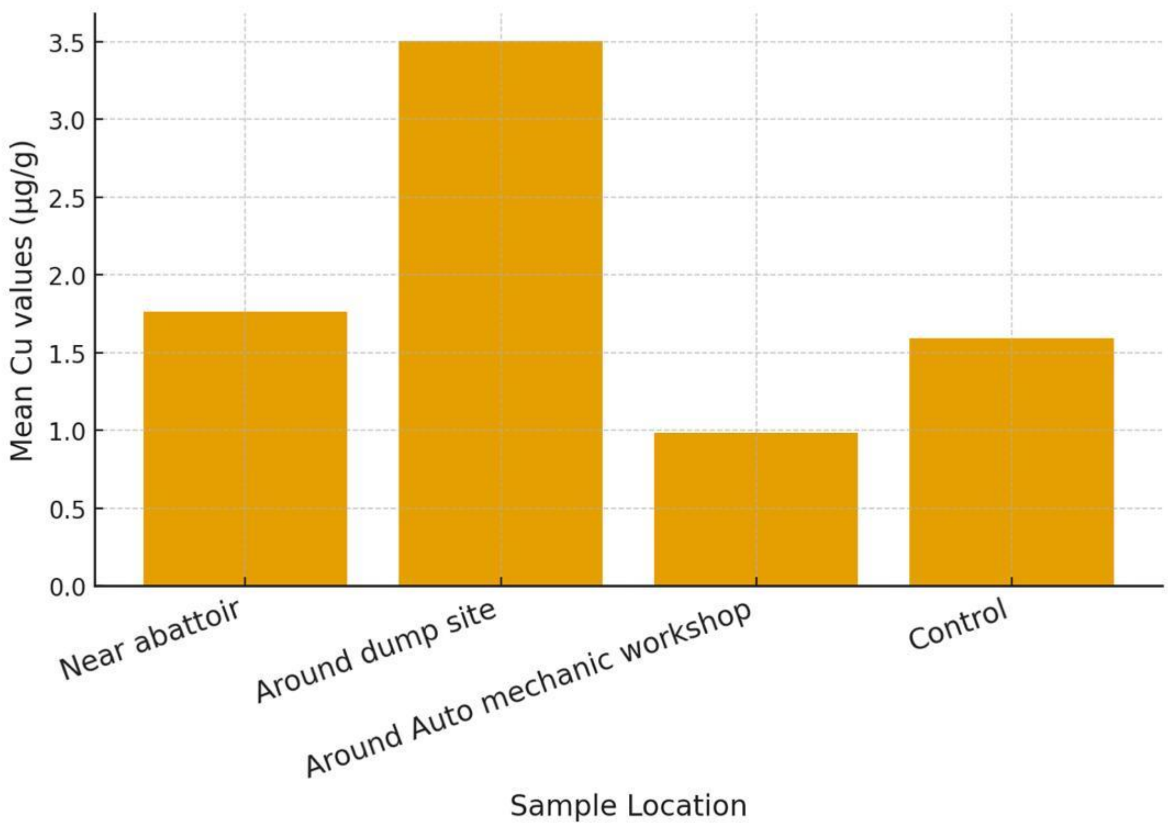

Figure 6: Bar chart representation of the mean Cu values in the soil samples collected at the studied anthropogenic sites.

Copper

The result of Table 1 shows that the mean Cu values in the palm oil samples harvested around Amansea abattoir, dumpsite, auto-mechanic workshop and a low human activity area (control) were 1.763 ±0.252, 3.506 ±0.179, 0.986 ±0.240 and 1.592 ±0.076 μg/g respectively. The palm oil samples harvested around the dumpsite had the highest mean Cu value and the least mean value of Cu was recorded for the palm oil samples around the auto-mechanic workshop as shown in Figure 5.

Unregulated waste depositions around the dumpsite could have accounted for the observed significantly higher mean Cu value compared to the reported values of the metal in the palm oil samples from the other locations. The palm oil samples had mean Cu values within the threshold limit. The result of Table 2 shows that the soil samples collected around Amansea abattoir, dumpsite, auto-mechanic workshop and a low human activity area (control) had mean Cu values of 2.992 ±0.346, 4.948 ±0.281, 1.394 ± 0.166 and 2.092 ±0.551 μg/g respectively. Soil samples collected around Amansea dumpsite had a significantly higher mean Cu value than what was reported for the metal in the other sample locations as shown in Figure 6.

The relatively high mean Cu value reported for the soil samples within the area with low human activity (control) could have arisen from water run-off and diffused air particulate deposition. The mean Cu values in the soil samples collected at different locations were within the threshold limit. Okeke et al., (2020), reported a significantly higher mean Cu value of 24.09 ±0.20 μg/g in the soil samples around Nnobi abattoir than what this study got for the metal in the soil samples around Amansea abattoir.

4. CONCLUSION

The investigated heavy metals (Pb, Cd and Cu) were at non -toxic levels in the palm oil samples harvested around the studied locations. Palm oil samples harvested around Amansea dumpsite had the highest bioaccumulation of the studied metals when compared to the metals level in the palm oil samples from the other locations. Similarly, the soil samples collected around the dumpsite bio accumulated higher mean values of the studied metals compared to the values of the metals in the soil samples from other locations. Consequently, the mean Pb value of the soil samples collected around the dumpsite was at toxic level. The food and environment within Amansea might face an undue heavy metal contamination that might adversely affect the quality of agricultural produce, unless relevant authorities step in to control the anthropogenic activities herein.

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Informed consent

Not applicable.

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Ethical approval

In this article, the product ethical regulations are followed as per the ethical committee guidelines of Department of Scientific and Industrial Research, National Research Institute for Chemical Technology, Zaria – Kaduna State, Nigeria; the authors observed the heavy metal levels in palm oil samples harvested from selected anthropogenic sites within Amansea in Anambra State. The "brand name" of the product is not mentioned in content and also the "brand image" not displayed as figure in the article. The product ethical guidelines are followed in the study for observation, identification & experimentation.

Conflict of Interest

The author declares that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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