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Anthropogenic Sources of Heavy Metals at Aspect of Alakahia, Rivers State, Nigeria: Health Implications

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ABSTRACT
Soils in proximity to abattoirs and mechanic workshops are prone to contamination by heavy metals due to waste materials emanated from the activities as well as the use of metal-based equipment and tools. This study investigated the presence and levels of lead (Pb), zinc (Zn), nickel (Ni), iron (Fe), and copper (Cu) in soil samples collected from Alakahia abattoir and mechanic workshop in order to assess potential soil status and human health risks factors. Soil samples were collected from twelve locations at the abattoir and the mechanic workshop. Standard soil sampling procedures were followed, and the samples were analysed using atomic absorption spectrometry to determine the concentration levels of Pb, Zn, Ni, Fe, and Cu. The results were compared with world Health Organization standard. The soil samples at the abattoir and the mechanic workshop depicts elevated levels of lead (Pb) in six samples, Pb concentrations range from 0.99-11.59mg/kg which exceeds W.H.O. Standard. Zinc (5.8-46.2mg/kg) levels in soil of the study area is high in all the samples when being compared with W.H.O standard. Two soil samples from the study area displayed slight elevated nickel content of 11.40mg/kg and 10. 80mg/kg when compared with the W.H.O. standard. This suggests that Ni probably from machinery equipment and chemicals have contributed to soil contamination. Iron (Fe = 879-4,100) concentrations in the soil samples are extremely high when compared with the W.H.O standard, indicating that iron-rich materials are emitted to the environment or associated with the environments thereby causing anomaly to the soil iron. Copper (Cu = 4.5-20mg/kg) concentrations in the soil samples of the study area are elevated in six samples and exceeds the tolerable limits of WHO standard for soil. This suggests that copper-based materials may have influenced the geogenic Cu level in the soil. The results indicate that lead, zinc, nickel, and copper have percolated the soil of the study area to varying degrees, with Cu, zinc and iron exhibiting the highest pollution levels. Such heavy metal pollution poses environmental and health risk to the occupants that make use of the soil.
Keywords: Heavy Metals, Anthropogenic, Soil, Health risk.

INTRODUCTION
When heavy metals are present in elevated concentrations in the soil and in human body, it becomes toxic. Chowdhury and Chandra (1987) outlines the toxicity of some of the heavy metals to human health. Some heavy metals are essential for various biological processes in trace amounts but excessive exposure and concentrations of heavy metals have adverse health and environmental challenges.

The levels of heavy metals in the soil vary widely based on the geological location, human activities, and natural processes(geogenic). Human activities(anthropogenic) are the primary contributors to the release of anomalous heavy metals into the soil. The anthropogenic activities can be broadly categorized into industrial, agricultural, and household sources. Yan et al 2018 mentioned about different activities of man which can influence the geogenic nature of heavy metals in the soil/ environment.

Soils serve as a channel through which heavy metal contaminants can enter into plants, animals, and humans through food chain. Consuming food contaminated with heavy metals poses health risks to humans, because these elements can accumulate in body tissues over time. Alengebawy et al 2021 discussed extensively the effect of bioaccumulations of heavy metals in the body through bioavailability in the soil and to man via food chain.

Anthropogenic heavy metals can occur in abattoirs due to various factors such as use of heavy metal-based equipment and machinery, presence of lead-based paints or coatings in facilities, use of cleaning agents and disinfectants, use of car tires for singeing , singeing process used to remove animal furs can contribute to heavy metal contamination in the soil, singeing poses environmental risks due to the release of heavy metals contained within the burnt material (Ijeoma and Effiong, 2015), these heavy metals are released into the soil during singeing. Heavy metals have the potential to persist in the soil for extended periods, and affect the soil quality (Rajesekar, 2019). The anthropogenic heavy metals occurrence in mechanic workshops could be that there is heavy metal component in some automotive material used in car care such as painting, grease and degreasing materials. Udomratana et. al 2021, documented about the occurrence of lead(pb), cadmium (cd) and chromium (cr) in automobile workshops. Consistent use of chemical substances in automobile workshops can lead to incremental accumulation of heavy metals in the soil. The research is to study the concentrations and sources of heavy metals in the soil of the study area with respect to health implications.

Map showing the study area in red (Modified after Google map: 29:08:2023, 02:43)

Geologic Setting

The study area (Alakahia) is with the Niger Delta basin. The Niger Delta Basin is characterized by three Formations; The Benin Formation, Agbada Formation and the Akata Formation. The Benin Formation is characterized by sand beds and the youngest among the Akata and Agbada Formation. Benin Formation is of Oligocene in age and contains thickness of about 2000m, Agbada Formation is Eocene and it's a hydrocarbon bearing Formation, the thickness is about 3,500m while the Akata Formation of paleocene in age, the sediment is estimated to be 6,500 thickness and consist of sands, silts and clay(Tuttle et al., 2011)

METHODOLOGY

Twelve fresh soil samples were collected at the Abattoir and the mechanic workshop. Standard sampling techniques were employed in the soil collection, the fresh samples are collected in such a way that plant and animal remnants were avoided. The soil samples were placed inside a sample bag and taken to laboratory for heavy metals analysis. The analytical procedures were done using atomic absorption spectrometry. The Results were compared with similar features elsewhere and with the W.H.O standard

Results and Discussions

Table 1: Trace Element concentrations in the soil samples

Sample	Lead (Pb)mg/kg	Zinc (Zn)mg/kg	Nickel (Ni)mg/kg	Iron (Fe)mg/kg	Copper (Cu)mg/kg
Soil 1	8.15	23.76	11.40	3,304.3	19.90
Soil 2	5.95	26.66	7.80	1,843.6	16.43
Soil 3	4.87	13.64	4.03	879.78	5.83
Soil 4	<0.001	5.84	4.70	4,075.7	3.48
Soil 5	3.46	13.26	10.85	2,763.2	11.75
Soil 6	11.59	10.33	7.48	1, 227.6	14.65
Soil 7	0.45	29.66	<0.001	1, 939.0	7.31
Soil 8	<0.01	34.54	<0.001	931.34	5.80
Soil 9	<0.01	12.32	<0.001	1,310.2	4.57
Soil 10	0.99	46.29	1.24	2,847.4	38.63
Soil 11	1.65	23.66	<0.001	2,450.0	20.59
Soil 12	<0.01	33.54	<0.001	1,131.0	5.06
Range	0.99-11.59	5.8-46.2	1.2-11.4	879-4,100	4.5-20
Mean	4.63	22.80	6.80	2,058.6	12.82
W.H.O.standard	2	0.6	10	425.5	10

Lead (Pb): Lead in soil is within the range of 0.99-11.59, which is extremely high when compared with W.H.O. standard. Lead can be absorbed into the crops through the roots thereby leading to lead contamination of crops. Consuming these contaminated crops poses a significant health risk to humans and animals. Lead contamination can degrade soil quality, making it less fertile and less suitable for agriculture, it can reduce crop yields and food production (Nas and Ali, 2018). Lead in soil can leach into groundwater, surface water and pollute the aquatic ecosystems. Aquatic organisms can accumulate lead which can also affect human health through food chain. Lead exposure, especially in children, can lead to severe neurological damage. It impairs cognitive development, resulting in learning disabilities, it can have long-lasting effects on a child's development, and lowers intellectual quotient (Collins et. al, 2022). Lead interferes with the body's ability to produce haemoglobin, leads to anaemia thereby reducing the blood's ability to carry oxygen, resulting in fatigue, weakness, kidney dysfunction, other health complications like cardiovascular and urinary diseases (Marzie, 2018). Lead exposure can lead to infertility, miscarriages, developmental issues in babies born to mothers with high lead exposure, it can as well irritate the gastrointestinal tract, leading to abdominal pain, constipation, digestive issues, mood disorders such as depression, anxiety, aggressive behaviour heart, kidneys and brain damage (Spivey2007). Extremely high lead exposure can result in lead poisoning, which can be fatal if not treated promptly.

Zinc (Zn): The average concentrations of zin in the soil 22.60mg/kg. Eexcessive zinc in soil due to industrial runoff or agricultural practices can be detrimental. Excess zin in the soil has negative influence on the physiochemical properties of soil and plant development, it can result to soil pollution and harm soil biota (Wyszkowska et al 2016). Zn toxicity can result to nausea, vomiting, and impaired absorption of other essential minerals (Fosmire, 1990).

Nickel (Ni): Nickel in the soil have average concentration of 10mg/kg. Nickel concentrations in the soil can be influenced by human activities (Agricultural, industrial processes/ automobile activities). Elevated levels of Nickel can be toxic to plants, it can negatively interfere with various physiological processes of soil, leading to reduced crop growth, and plant death (Ahmad, 2011). Human exposure to Nickel primarily occurs through dietary sources (ingestion), inhalation and contact with nickel-containing materials. Excessive nickel exposure through inhalation in industrial settings or ingestion of contaminated food or water, or contact can lead to health issues such as nausea, vomiting, and diarrhea, dermatitis while chronic exposure can lead to more severe conditions like lung and nasal cancer (Giuseppe et al, 2020).

Iron (Fe): The iron concentrations in the soil samples is extensively high when compared with WHO standard, the iron content in the soil range between 879-4100mg/kg. High concentrations of Fe in soil can have negative effects on both the environment and plant growth irrespective of the fact that iron is an essential nutrient for plants but excessive levels can lead to adverse consequences such as reduced plant growth and nutrient imbalance (Noreen, 2021). Iron oxides play crucial role in soil nitrification with respect to pH of the soil (Huang, 2016). Excessive iron in the body (iron overload or hemochromatosis) can have detrimental effects, such as liver problems, heart dysfunction, thalassemia, fibrosis and pancreatic dysfunction (Wessling-Resnick, 2017)

Copper (Cu): copper concentrations are high in six soil samples but highly elevated content of copper is seen in soil sample 10 (Table 1). Copper is an essential trace element for soil health and plant growth, but it can also become problematic in excessive amounts, excess levels of copper in the soil can inhibit root growth, impair nutrient uptake, lead to chlorosis, can cause inbalance of the soil ecosystem, It can be harmful to the useful soil organisms as well as destroying nutrient cycling processes and plant death (Adrees et al., 2015).

CONCLUSION

Significant anomalous concentrations of heavy metals in the soil and human health is toxic due to their persistence, distributions and non-degradable features (Meena and Sarita, 2019). Monitoring the concentrations and genesis of heavy metals is crucial for sustainable environment and human's adaptability. Enforcement of laws by government, systematic discharge of waste, responsible agricultural and industrial practices, as well as public consciousness will assist to curtail/ stop the anthropogenic activities that emits heavy metals in the soil and environment. The concentrations of heavy metals in the soil can be determined through soil test. Soil contamination by heavy metals, particularly lead, nickel, zinc, and copper, in the vicinity of an abattoir and mechanic workshop shows the necessity of appropriate waste disposal and pollution control measures. These studies depict the needs for environmental management practices to mitigate pollution risks and protection of soil quality and public health in the study area and environment in general.

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