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A Preliminary Assessment of Heavy Metals in Top Soils around Wurukum Abattoir, Makurdi Benue State, Nigeria

Sesugh Ande[1], Abimbola Famuyiwa[2], Moses Saviour Iorungwa[1]

[1]Department of Chemistry, University of Agriculture, P.M.B 2373, Makurdi - Nigeria

[2]Department of Science Laboratory Technology, MoshoodAbiola Polytechnic, Ojere, P.M.B 2210 Abeokuta Ogun State, Nigeria

Abstract: ***The study sought to determine the level of heavy metals in soil around Wurukum-abattoir in MakurdiLocal Government area of Benue State where high level of indiscriminate disposal of animal waste has been a concern. Soil samples aroundthe Abattoir in MakurdiMetropolitan area of Benue State were collected and analyzed to assess heavy metal levels using atomic absorption spectroscopy (AAS). Some of the physicochemical analysis of the soil samples showed a basic pHwhich ranged from 8.20-8.79 and low organic carbon content in the range of 0.01 to 1.97%. The particle size analysis gave the following results; 23-62% sand, 21-57% clay and 17-23% silt. The concentration (mg/kg) of heavy metals in the soil samples were found to be in the following range: Cd; 2.98-5.65, Fe; 14.3-36; Ni: 67.1-83.9 and Pb: 0.4-32.6. The results indicated that despite the increased human activity around the environment, the level of heavy metals were generally low when compared with some guideline values and their typical/common ranges/values in soils.. It is expected that relevant agencies would map out strategies and formulate laws that would deter users of the abattoir from indiscriminate disposal of these waste around the environment in order to avoid futureaccumulation.***

Keywords: Heavy metals, Wurukum, Abattoir, Accumulation, Pollution

1. Introduction

Many small and medium scale industries inNigerian generate waste materials which in most cases introduced into the environment indiscriminately or without any regard to proper environmental management practices. This human activity can result in pollution of nearby soil and water through surface runoffs. Heavy metals are one among the numerous pollutants that enter the environment through such human activity and are capable of affecting living organisms and other abiotic components of the ecosystem. Generally, metals lead to various metabolic alterations and undesirable changes, which in many cases may cause severe injury and health hazards. Among the majorheavy metals that pose hazards include lead, mercury, cadmium, nickel, chromium, arsenic, vanadium, silver and bismuth (Ademoroti, 1996;Alloway, 1990;Greaney, 2005 andAboho*et al*., 2010).Each of these elements were useful in our modern industrialize society andsome are by- product of the mining and refining (Greaney, 2005).

At high concentrations, all the heavy metals are toxic to both plants and animals. The WurukumAbattoir is located along Rivers Benue Bank. It is about 200meters away from the Wurukum round about. Usually there is high traffic and other automobiles activities near this area. It is however, expected that emissionof waste by these automobiles, machines are likely to pollute the soil around this area (Aboho*et al*., 2010).Mechanical works and burning of woods andtyres by people who kill animals at the abattoir daily are other ways through which heavy metals may be introduced in the soil. Due to availability of water around this area, farming activities are carried out throughout the year. Crops cultivated in this area includevegetables, sugar care, maize etc. It is therefore important to carry out some screening on the soil to ascertain the level of heavy metals in this area.

2. Materials and Methods

The chemicals used in this work were analytical grade reagents. All glassware employed as well as plastic containers used were soaked in 10% nitric acid overnight and rinsed properly with distilled water.

2.1 Sampling and sample preparation

A total of five (5) sampling points (A, B, C, D, and E) were identified around the abattoir. At each sampling point, a composite surface soil at the depth of 0-15 cm which consisted of five (5) subsoil samples were obtained by drawing a 2-metre squared grid from a centre point where random subsamples were collected within the square by the use of soil auger. These squares were approximately 50 metres apart and about 500 g of bulked sample from each sampling point was transportedpolyethylene bags to the laboratory at the Department of Chemistry, University of Agriculture, Makurdi. Samples were air-dried for 14 days and thereafter ground in a ceramic mortar using a petstle made of porcelain. The ground soil samples were then passed through a 2 mm sieve. The soil samples were further subjected to conning and quartering in order to obtain the required amount of soil for digestion and stored in polyethylene bags under room temperature.

2.2 Physicochemical parameters

2.2.1 The pH

The pH was performed according to British Standard Method, BSI (2000); about 5 g of each air-dried, sieved sample (< 2 mm) was weighed into the 50 mL centrifuge tubes, after which 25 mL of deionised water was added. The centrifuge tubes were then closed firmly and placed on the end-over-end mechanical shaker for 1 h, then removed. They were allowed to stand for 2 h. The pH was then measured in the suspensions after calibrating the pH meter with the buffer solutions (Metller Toledo, GmbH, Switzerland).

2.2.2 Organic matter (loss-on-ignition)

The organic matter content was based on the British Standard Method, BSI (2005); approximately 1.0 g of each sample (< 2 mm) was weighed into dry and pre-weighed crucible and placed in the oven, at 110 ^{0}C for 24 hours. This was then removed and placed in the desiccator and allowed to cool for some hours.The residue was placed in the muffle furnace ramped at 10 °C per minutes and held at 550 °C for 8 h and allowed to cool to about 110 °C. The crucibles containing the residues were transferred into the desiccator and allowed to cool for a few hours. They were weighed thereafter and the difference in mass obtained before and after ignition was used to estimate the % organic matter content using the following equation below:

$$\% \, LOI = \frac{(oven\ dried\ weight - weight\ after\ combustion)\ \times 100}{oven\ dried\ weight}$$

2.2.3 Particle size determination

The hydrometer method according to Bouyoucos (1962) was used for particle size determination; approximately 50 g of air dried soil sample, passed through a 2 mm mesh size sieve, was weighed and delivered into a 400 mL beaker. Exactly 50 mL of sodium hexametaphosphate solution (5%) was added alongside 100 mL of distilled water and mixed thoroughly with a stirring rod for 30 mins. The soil suspension was then transferred quantitatively into a 1 L-measuring cylinder and made up to mark with distilled water. The top of the cylinder was inverted several times for 30 mins until a uniform suspension was obtained and placed on a bench top. The time was noted, and immediately, the hydrometer was gently lowered into the suspension until it began to float. Hydrometer reading was recorded at 40 sec after the cylinder was set down. The temperature of the suspension was also measured with the thermometer. The suspension was then allowed to stand for 3 h. A second set of hydrometer and temperature readings were taken thereafter.

Blank sample: Blank sample was prepared by mixing 100 mL of 5% dispersing solution and 880 mL of distilled water in a I L measuring cylinder.

Calculations: Results were corrected to a temperature of 68 °F (20 °C); for every 1 °F above 68 °F, 0.2 units were added to the hydrometer reading of the sample. Similarly, 0.2 units were subtracted for every 1 °F below 68 °F from the hydrometer reading of the sample. The density of the blank at each reading was subtracted from the corresponding density of the sample. The percentages of clay, silt and sand were estimated using the following:

$$\begin{aligned} &Percentage\ clay\ (\%) \\ &= corrected\ hydrometer\ reading\ at\ 3\ h \\ &\times \frac{100}{weight\ of\ sample} \end{aligned}$$

$$\begin{aligned} &Percentage\ silt\ (\%) \\ &= corrected\ hydrometer\ reading\ at\ 40\,\mathrm{sec} \\ &\times \frac{100}{weight\ of\ sample} \end{aligned}$$

$$Percentage\ sand\ (\%) = 100 - (\%\ silt + \%\ clay)$$

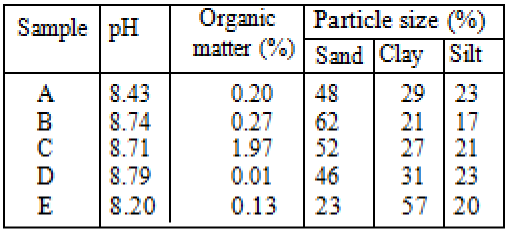
2.3 Pseudototal metal determination

Aqua regia was used as the digestion reagent, prepared by mixing concentrated HCl and HNO_3 acids for trace element analysis (obtained from Aldrich, Gillingham, UK) in the ratio of 3:1(*v/v*). A 1.0 g test portion of each sample (n = 2) was weighed into centrifuge tubes and 10 mL of freshly prepared *aqua regia* was added to the tubes containing the samples. They were placed in a fume cupboard and allowed to stand overnight. This was to allow for gaseous species arising from any vigorous reaction in the tubes to be given off, which may have increased the pressure during digestion. The digestion tubes containing the sample mixed with *aqua regia* were transferred into beakers and digested on a hot plate. At the end of the digestion, the vessels and the contents were allowed to cool, and filtered through Fisher Brand FB 59023 filter papers into 100 mL standard volumetric flasks. The sample residues were washed with deionized water (ultra-pure; 18.2 MΩ .cm; 25 °C), after which the filtrates were made up to mark with deionised water. Procedural blanks were digested alongside the samples. Digests were then transferred into transport tubes and stored in a fridge prior to analysis. They were later analyzed for cadmium (Cd), copper (Cu), iron (Fe), Nickel (Ni) and lead (Pb) using Buck model 210 VGP flame atomic absorption spectrophotometer with an air-acetylene flame.

3. Results and Discussion

The result of analysis for some of the physicochemical parameters determined for the soil samples around Wurukum abattoir are shown in Table 1for each of the samples. In the same vain, Table 2 shows the mean metal concentration of the heavy metals in the soil samples.

Table 1: Physicochemical Parameters of the Soil



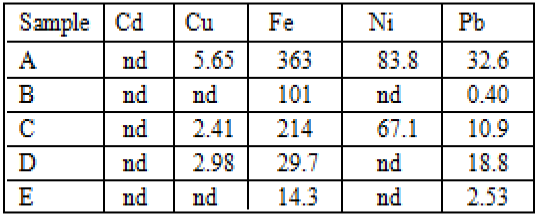
Sample	pH	Organic matter (%)	Particle size (%)		
			Sand	Clay	Silt
A	8.43	0.20	48	29	23
B	8.74	0.27	62	21	17
C	8.71	1.97	52	27	21
D	8.79	0.01	46	31	23
E	8.20	0.13	23	57	20

The result of the soil pHvalues of the metals as presented in table 1 and ranged from 8.20 -8.43, an indication that all the samples were basic. This may be attributed to washing of slaughteredccattles with detergents at all times. The pH values obtained however are higher than those obtained by (Osakwe, 2010).

Particle size distribution shows that in the five samples the sand fraction dominated with the highest values of 62% and 52% for samples B and C respectively. A higher value of 57% was observed for the clay fraction in sample E.

The organic matter of the soil samples ranged from 0.02-1.97% with sample C presenting the highest organicmatter content. Sample D showed the least amount of organic matter. It was further observed that the more the clay and silt contents, the more the organic matter level except for samples D. This agrees with the observation in (Lena and Gade, 1997).

Table 2: Concentrations (mg/kg) of Heavy Metals in the Soil Samples



Sample	Cd	Cu	Fe	Ni	Pb
A	nd	5.65	363	83.8	32.6
B	nd	nd	101	nd	0.40
C	nd	2.41	214	67.1	10.9
D	nd	2.98	29.7	nd	18.8
E	nd	nd	14.3	nd	2.53

nd= not detected

The result of the analysis shows that Cd was not detected in all the samples. This may be attributed to the absence of wastes from battries made with Cd. However, the recommended maximum permissible limit of Cd in all soil ranges from 0.01 to 0.02mg/kg.Ubwa*et al*., (2013) reported a range of 0.0035 to 0.0660 mg/kg for Cd. Copper was found in allthe samples ranged from 2.41 to 5.65mg/kg. This range falls within the typical range (2.00 to 250 mg/kg) and common value (20.0 to 30.0 mg/kg) of copper in soils. Copper was not detected in sample stations B and E probably due to concentration below the detection limit.The concentration of Fe ranged from 14.3 to 363mg/kg in all the sample points. This range is far below the typical range of 7000 to 42000 mg/kg Fe in soils (Alloway, 1990) and as well as the abundance level of the metal in the earth's soils; 38000 mg/kg (Alekseenko, V. and Alekseenko, A. 2014). The perceived high level of Fe in the study area can be attributed to the fact that animal bones would have contained some levels of Fe and when burnt could enter the soil.Nickel was found in the range of 67.1-83.8mg/kg in samples A and C.These values exceeded the result obtained by Ubwa*et al*., (2013). However Ni was not detected in the following samples; B, D and E.However, high concentration of the metal was observed in samples A and C. The values were within the typical range of Ni (2 to 750 mg/kg) but higher than the common value of (50.0 mg/kg) and abundance in the earth'ssoils (40.0 mg/kg). Lead is naturally occurring and can be found either in low or high concentrations (WHO, 1987), but toxicity ofPb has placed it as one of the environmental concern even at low concentration level. The result obtained in the study showedPb concentration ranged from 0.4 to 32.6mg/kg which is lower than the UK CLEA SGV of 450 mg/kg, as well as the Czech legislative soil limits, reported by Uprety*et al*., (2009). The Pb levels obtained in this study remained higher than the concentration reported by Ubwa*et al.,* (2013) in a similar work. Therelativelyhigh concentration of Pb in some of the samples in this present study may be attributed to lead additives to petrol and mechanical shops that usedPb batteries in the area investigated.

4. Conclusion

The results indicated that the pH values of the soil were basic with low organic carbon content and high percentage of sand fraction. Furthermore, the result of the heavy metal analysiscarried out in the study area indicated the presence of some of the metals but were generally lower or within their common and typical levels in soil but accumulation of these metals in the environment over time to levels of concern is possible. Therefore constant monitoring is required in other to prevent any environmental threat.

5. Acknowledgment

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