Chemistry Research Journal, 2017, 2(5):148-152

Available online www.chemrj.org

Research Article

ISSN: 2455-8990
CODEN(USA): CRJHA5

Analysis of Cu and Pb Contamination of Soil and Earth Worm Casts in Kwande Metropolis, Benue Sate-Nigeria

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Abstract Soil and Earthworm casts from waste dumpsite around mechanic village in Kwande Local Government were collected and analyzed for Copper (Cu) and Lead (Pb) using Atomic absorption spectrophotometer. The analysis of soil and cast sample around mechanic village gave the concentration (mg/Kg) of copper as 5.21, 5.20, 5.10,5.02, 4.18 and 5.20, 5.19, 4.99, 4.81, 4.13 respectively. Similarly, the analysis of Lead in soil and cast sample around an active dump site gave the concentration (mg/Kg) as 0.21, 0.15, 0.09, 0.05, 0.03 and 0.20, 0.14, 0.07, 0.04, 0.02 respectively. It was observed that, soil samples collected further away from the site had low concentration of the metal in both soil and cast with the soil having a relatively higher concentration than that of the cast. The overall results showed that earthworm cast can be used as bioindicators for copper and lead pollution.

Keywords Earthworm, Copper, Lead, earthworm cast

1. Introduction

Risk assessment in metal contaminated soils is frequently done by performing bioassay. In certain cases, however, more information on the biochemical responses other than bioassay may be required to help elucidate the mechanisms involved in metal availability to biota. Earthworms play an important role in soil macro fauna biomass and they are extremely important in soil formation, principally by consuming organic matter, fragmenting it, and mixing it intimately with soil mineral particles to form water-stable aggregates underscoring the particular bioaccumulation ability of earthworms which is essential for any bio-monitoring organism [1-2].

A bio-monitoring method would be appropriate to evaluate metal toxicity, because of its sensitivity and availability for unknown metabolites. Organisms such as fish, snails have been employed as bio-monitors. Although this approach is useful and promising, it also somewhat limited, because it could be available only for a specific combination of a living organism with certain substances. Hence, the need unearth the right living organisms as bio-monitors for each type of assessment [3].

To establish a bio-monitoring system using earthworms, effects of various chemical pollutants on earthworms have been studied. The accumulation of both natural and depleted uranium in earthworms was analyzed to evaluate the corresponding biological effects [4]. Casting occurs when earthworms ingest soil and leaf tissue to extract nutrients, and then emerge from their burrows to deposit the feacal matter (casts), as mounds of soil on the surface. Earthworms cast consists of mixed inorganic and organic materials from the soil that are voided after passing through the earthworm intestine. Total cast production is an indicator of burrowing and soil turnover, because 99.9% of ingested material isegested as casts[5-7].

Mostly, earthworms were proven to be good biological indicators, they can be sampled easily, have a wide distribution range and strongly accumulate pollutants. Their limited mobility means that they are representatives of a precise site, which makes them suitable for monitoring the impact of contaminants. The presence of contaminants in earthworms poses a serious risk of secondary poisoning of vertebrate predators due to biomagnifications [8]. The processof a cast production and/or earthworm bioturbation causes soil mixing and surface casting and may also contribute to a redistribution of contaminants in the soil profile [9-11]. Deep burrowing species can bring polluted soil from deeper layers to soil surface and may increase metal availability in soil [12].

The term heavy metal refers to any metallic chemical element that has a relatively high density (greater than 5) in its elemental form and is toxic or poisonous at low concentrations. Examples are chromium (Cr), cadmium (Cd), Arsenic (As), Thallium (Tl), Copper (Cu) etc.

Heavy metals find their way into the environment through a lot of human activities. Among these are: Through emission from the rapidly expanding industrial areas, mine tailings disposal of high level metal waste, leaded gasoline and paints, land application of fertilizers, animal manure, sewage sludge, pesticides, waste water irrigation, coal combustion residues, spillage of petrochemicals, and atmospheric deposition [13].

2. Materials and Methods

2.1. Study Area

Kwande Local Government is located in Benue State within the middle belt region of Nigeria. The area under study is located in the Eastern Nigeria borderlines. It is bounded to the North by Ushongo and Katsina-Ala Local Government to the South East by Republic of Cameroon, to the South by Cross River state and to the East by Taraba State respectively. It has a population of 6,248,697 people during the 2006 National Population Census house and head count [10]

2.2. Apparatus and Reagents

Beakers (250 cm^3), Hydrochloric acid, distilled water, volumetric flask (500 mL), measuring cylinder (20 mL), porcelain mortar, filter papers, spatula, weighing balance, stop watch, sample bottles, funnels, stirrer.

2.3. Sampling Analysis

Earthworm casts deposited on top of the soil, as well as soil sample were collected at an active waste dump site located at mechanic village in Adikpo the major town in Kwande Local Government Area, which is one of the 23 Local Government Areas in Benue State.

Sampling was performed at the area surrounding the dump site, on approximately 100 m^2 area. Earthworm cast samples were collected from 5 sampling points in a research grid of 5-25m.

At each sampling location an average of 5-10 casts were collected in 5m to create a composite sample. About 5 sampling points soil were collected from 5-25m.

The same process was carried out in mechanic village to obtain earthworm cast and soil samples.

Earthworm casts samples and soil samples were prepared in the manner in accordance with the method described by [13-16]. This air-dried samples were gently crushed in a porcelain mortar, sieved through a 2mm mesh sieve and pulverized prior to chemical analysis. All samples were collected and analyzed in June 2015. The powdered earthworm casts as well as soil samples were analyzed for Cu and Pb. Exactly 4.22 mL of HCl was measured into a 500 mL capacity volumetric flask containing distilled water and made to the mark with distilled water.

Next, about 20mL of the prepared solution was measured into 25mL beaker containing the sample and stirred for 20 minutes to attain a uniform distribution and the mixture was allowed to settle for 3 minutes the mixture was filtered with whatman No. 42 filter paper and 5mL of the digested sample was made up to 100 mL with de-ionized water in a volumetric flask and 10 mL of this solution was used to evaluate the concentration of the metals using flame atomic absorption spectrophotometer (Buck scientific 200 A). Soil and earthworm cast samples were determined in the same manner [17-19].

3. Results and Discussion

3.1. Results

The tables below show the results of soil sample and earthworm cast obtained from mechanic village and waste dump site. Where A, B, C, D and E represent the distance of 5,10,15,20 and 25 m away from the site, whereas test 1,2 and 3 represent the concentration of the metal in the site

Table 1: Result of concentration of lead in soil sample around the active dumpsite

Pb (mg/kg)	A	B	C	D	E
Test 1	0.21	0.15	0.09	0.05	0.03
Test 2	0.19	0.18	0.10	0.04	0.02
Test 3	0.19	0.16	0.09	0.03	0.03

Table 2: Result of concentration of Lead in cast sample around the dump site

Pb (mg/kg)	A	B	C	D	E
Test 1	0.20	0.14	0.07	0.04	0.02
Test 2	0.18	0.17	0.11	0.05	0.03
Test 3	0.18	0.16	0.09	0.04	0.04

Table 3: Result of concentration of Copper in soil samples around the mechanic village

Cu (mg/kg)	A	B	C	D	E
Test 1	5.21	5.20	5.10	5.02	4.18
Test 2	5.41	5.28	5.12	5.11	5.00
Test 3	5.89	5.83	5.00	5.16	4.13

Table 4: Result of concentration of Copper in Earthworm casts samples around the mechanic village

Cu (mg/kg)	A	B	C	D	E
Test 1	5.20	5.19	4.99	4.81	4.13
Test 2	5.13	5.18	5.05	5.00	4.89
Test 3	5.67	5.85	5.10	4.15	4.11

3.2. Statistical analysis

In order to get consistent results, the mean of replicate count was calculated and appropriate statistical assessment was undertaken because the samples were randomly selected.

Table 5: Soil samples from mechanic site

Sample	1	2	3	Mean±SD
A	5.20	5.41	5.89	5.50±0.34
B	5.21	5.28	5.89	5.44±0.35
C	5.10	5.12	5.00	5.07±0.06
D	5.02	5.11	5.16	5.10 ± 0.07
E	4.18	5.00	4.13	4.44± 0.49

Table 6: Cast sample around mechanic village

Sample	1	2	3	Mean±SD
A	5.20	5.13	5.67	5.33 ± 0.29
B	5.20	5.19	5.85	5.41 ± 0.31
C	4.99	5.05	5.10	5.05 ± 0.06
D	4.81	5.00	4.15	4.90 ± 0.54
E	4.13	4.89	4.11	4.38 ± 0.41

Table 7: Soil sample around Dump site

Sample	1	2	3	Mean±SD
A	0.21	0.19	0.20	0.20 ± 0.50
B	0.15	0.18	0.16	0.16 ± 0.03
C	0.09	0.10	0.09	0.09 ± 0.01
D	0.05	0.04	0.03	0.04 ± 0.01
E	0.03	0.02	0.03	0.03 ± 0.01

Table 8: Cast sample from waste dump site

Sample	1	2	3	Mean±SD
A	0.20	0.18	0.18	0.19 ± 0.01
B	0.14	0.17	0.16	0.16 ± 0.02
C	0.07	0.11	0.09	0.09 ± 0.02
D	0.04	0.05	0.04	0.04 ± 0.06
E	0.02	0.03	0.04	0.03 ± 0.01

4. Discussion

In table 1 and 2 the result clearly showed the maximum and the minimum concentration of metal as obtained in soil from waste dump site and from earthworm cast. The maximum concentration of the Pb metal was found to be 0.21 mg/kg and the minimum concentration was observed to be 0.02mg/kg for the soil sample and 0.20 mg/kg maximum for earthworm cast with 0.02 mg/kg as minimum.

The steady decrease in the concentration of lead metal in both samples is an indication that the contamination of the land and cast were as a result of the activities of man in spilling oil that is contaminated with lead at the mechanic site. This is vested on the ground that the decrease in concentrations is directly proportional to the distance away from the mechanic site in either sample.

In tables 3 and 4 which show the results of copper contamination in the soil and cast samples, the same trend was noticed even as the concentrations were higher.

It must be recalled that microbial communities consist of a complex assembly of organisms at a given time in a given space, each having different metabolic characteristic and physiological requirement and driving at least one of the multiple reactions involved in organic matter transformation. Understanding the connectivity between microorganisms, organic matter, and environmental parameters is thus of pivotal importance for better evaluation of carbon dynamics in terrestrial ecosystems and for addition of an ecological approach to carbon cycle models. Metal contamination in agricultural soils could affect such carbon flow.

Also, soil pH is an important factor in the uptake of copper and lead by plants growing in contaminated soils. In the field, however, it is only rare that there is likely to be an event that results in such a catastrophic decrease in soil pH.

As a result it is advisable to site farm lands at reasonable distance from such contaminated soils as plants can take up these metals.

In comparing the result obtained from mechanic village around the dump site, it clearly reveal that the metal with the highest concentration was found to be in soil sample from both mechanic village and waste dump site, the metal with lowest concentration was observed to be in cast sample. The low concentration of both metals in the earthworm cast could be attributed to the inability of the earthworm to completely eject the toxic metals as cast.

Table 5 shows the result of concentration of metal as obtained in the soil sample from mechanic village and the maximum concentration was found to be 5.89 mg/kg and minimum concentration was observed to be 4.13 mg/kg.

Table 5,6,7 and 8 clearly indicates the mean and standard deviation of the results obtained from mechanic village around the waste dump site as the samples were randomly collected.

5. Conclusion

Soil contamination has been hidden behind the scene as much emphasis has been placed on air and water quality over time. It should be recalled that the quality of soil is directly linked with food contamination as plants would directly absorb and are harvested and consumed. In this research, values of the heavy metals determined in mechanic site were comparable to the values obtained in waste dump site. This suggests that the concentration of the heavy metal in mechanic site(soil sample and cast sample) were not as a result of dump site,(i.e. the values in mechanic site are much higher than that of dump site) this could be as a resultof less anthropogenic activity in waste dump site.

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