Assessment of Heavy Metals Presence in Selected Dumpsites within Igboora, Oyo State, Nigeria

Abstract

This study was carried out to evaluate the level of Cd, Pb, and Cr in some selected dumpsites within Igboora, Ibarapa Central Local Government of Oyo State.Soil samples were collected from Abattoir, Oja Igboora, Oja Oba, New Abattoir and Towobowo dumpsites. The control samples were collected at 20m away from each of the dumpsites. The samples were collected at two different sampling depths- 0-20cm and 20-40cm. The samples were replicated three times. All the data collected were analyzed using Genstat Statistical Package and means separated using Least Significant Difference (LSD). The results obtained revealed that the highest amount of Pb,Cd,Cr (232.99 mg kg^{-1},28.53 mg kg^{-1} and 53.67 mg $kg^{-1)}$, respectively were recorded at Abattoir dumpsite. The quantity of lead in the selected dumpsites increased with the sampling depth. However, Cd and Cr values reduced with the sampling depth. All the values observed were significant at 5% level of probability. The value of Pb and Cd, recorded in all the dumpsites including the control sites were above the maximum limit recommended by WHO. Attention should therefore be paid to the presence of heavy metals in this area as crops grown in soils around these dumpsites could accumulate the metals and eventually get to food chain when such crops are consumed. Similarly, the fact that they were detected both at the upper layer and sub-soil means they could contaminate the ground water around this area.

Keyword: Dumpsites, Environment, Heavy metals, Pollution,Soil depth.

Introduction

Waste disposal has been identified as a serious global environmental issue resulting in heavy metal pollution of the soils, water and crops. Heavy metals are metals with a specific gravity higher than 5 g cm^{-3}. The common heavy metals in the environmental are Copper (Cu), Nickel (Ni), Chromium (Cr), Lead (Pb), Cadmium (Cd), Mercury (Hg), Iron (Fe) and Arsenic (As) [1]. Some heavy metals, such as iron and nickel are essential to the survival of all forms of life at low concentrations [1]. However, heavy metals like Pb, Cd, and Hg are toxic to living organisms not only in high concentration but also in low concentrations. Thus, they contribute to metabolic abnormalities in living organisms particularly consumers of food from plants and other crops grown from contaminated soil [1].

Hussain *et al.* [2] observed that waste generation alongside its disposal has become a serious problem of urbanization and industrialization in the world today. Due to demographic growth, lifestyle change and rapid urbanization, waste is on the rise in cities of developing countries [3]. This has resulted in environmental pollution, specifically in developing countries where important efforts towards developed waste management and disposal practices have not been made at high level [4]. On the other hand, with the rising influence of advanced technology in developed countries, more municipal solid wastes and wastewaters are being produced and need treatment and proper disposal.

Nigeria is one of the developing countries in the world having most her cities and towns with inappropriate waste management scheme [5, 6]. In recent times, high level of refuse produced in the cities daily as a result of human activities is detrimental to human health [5] and most of these refuses generated as a result of expansion in agricultural and industrial sectors are not properly recycled. It was discovered that many Nigerians lack proper waste disposal and as a result of this, proper waste or refuse management has pose a major challenge to the country [7]. Waste disposal management remains one of the major challenges in the developing countries. Wastes, if not properly disposed of, could lead to contamination of surface and groundwater in its immediate environment [8].

One of the major problems of refuse dumpsite is air pollution and this could have negative influence on people's health in rural and urban areas [9]. Improper management of organic and inorganic waste materials in dumpsites could also affect soil composition and impact adversely on flora and fauna [10].

Rapid increase in population and industrialization in Nigeria have resulted in a dramatic increase in the generation of solid waste [11]. Meanwhile, waste generation and disposal have been identified as one of the factors responsible for high concentration of heavy metals in the environment [12]. Heavy metals which include Cd, Co, Pb, Cr, Zn, Mn and Ni are of major concern due to their potential harm to living organisms [10]. For instance, Pb is known to interfere with the functioning of mithochondria thereby impairing respiration, and also causes constipation, swelling of the brain, paralysis and can as well lead to death [13].

Dumpsites have been identified as one of the major threats to groundwater resources receiving a mixture of municipal, commercial and mixed industrial wastes. The depressions into which solid wastes are often dumped include valleys and excavations. Studies on the effects of unlined waste dumps on the host soil and underlying shallow aquifers have shown that soil and groundwater system can be polluted due to poorly designed waste disposal facilities [14].

It is essential to protect soil, surface and groundwater contamination due to leachates percolation in and around the dumpsite [15]. This becomes imperative as the heavy metals present in the dumpsite might be injurious to the health of people that consumes the water from boreholes and wells around as well as crops grown on such soils. Crops or vegetables cultivated in polluted environments are known to accumulate these toxic metals and the food chain is extensively affected after the exposure of heavy metals through the following pathway: soil-plants/vegetables- human body [16].

In Nigeria, refuse are littered with heaps of illegal dumping sites which include refuse like used cans, pins, polythene bags, used syringes from pharmaceuticals and so on. The particles of these materials are leached into nearby wells and rivers contributing significantly to their heavy metals' concentrations and thus harmful to human life and the environment. Igboora just like many cities in Nigeria is well known for open refuse dumping. Thus, it has become very imperative to investigate the heavy metals presence around these dumpsites to be able to know whether their concentration could pose a major threat to wells around this area and whether plants grown on soils around the dumpsites are safe for human consumption. This study, therefore, aims at assessing the presence of Lead (Pb), Cadmium (Cd) and Chromium (Cr) at different sampling depths in selected dumpsites within Igboora town, Oyo State.

Materials and Methods

Five open dumpsites located within Igboora, Ibarapa Central Local Government of Oyo State, Nigeria were selected for this study. The five locations with longitude and latitude include: Abattoir (7^o26'97''N 3^o16'52.2''E), Oja-Igboora (7^o26'97''N3^{o}16'52.2''E), Oja-Oba, (7^o26'27.7''N3^{o}16'24.4''E), New Abattoir (7^o26'26.6''N3^{o}16'19.3''E) and Towobowo (7^o25'49.3''N3^{o}17'22.7''E). Two Sampling depths have been selected for the following reasons: the soil depth (0 – 20 cm) is the average crop land plow layer in the study area, and the soil depth (20 – 40cm) constitute the average depth to which nutrient and clay particles are leached in a high rainfall area and fine roots of tree have a role in nutrition addition and recycling. Three soil samples were randomly collected from each dumpsite including the control which was collected at about 20m away from each of the dumpsites. The samples collected were air dried and passed through a 2mm sieve.The dried soil samples were digested using 10ml of 2:1 by volume of nitric – perchloric acid until dense white fumes appeared. The digest was allowed to cool and some quantity of distilled water was added to the digest. The solution was then filtered into a 50ml volumetric flask and diluted to volume. The amount of Cd, Pb and Cr in the digest was then determined using atomic absorption spectrophotometer (AAS). All the data collected were analyzed using Genstat statistical package and means separated using Least Significant Difference (LSD) at 5% level of probability.

Results and Discussion

Amount of heavy metals at the selected dumpsites

The results in Table 1 showed the amount of heavy metals across the selected dumpsites in Igboora. The highest amount of Pb(232.99mg kg^{-1}) was recorded at Abattoir and Oja Igboora control, while the lowest value was recorded at Oja Oba control (10.42 mg kg^{-1}). Across the selected dumpsites, Abattoir has the highest amount of Cd (28.53mgkg^{-1}), while the lowest value (9.60mgkg^{-1}) was recorded at Oja –Oba control. It is important to note, that the amount of both Pb and Cd recorded in all the dumpsites including their controls were above the maximum recommended limit of 70 and 1.10 mg kg^{-1}, respectively for Pb and Cd by World Health Organization (WHO).The observed concentration was in line with the report of Saheed *et al*. [10] that Pb and Cd in soil around dumpsites in Ibadan were above WHO maximum permissible level. The highest amount of Cr (53.67mg kg^{-1}) was recorded at Abattoir while the lowest amount (12.01 mgkg^{-1}) was recorded at Oja-Igboora. The highest values of the metals recorded in some of the control sites may as well be attributed to the topography area which might have encouraged the mobility of these metals from the dumpsite (upper slope) to the control site (lower slope). Singh and Kumar [17] identified topography and runoff among factors influencing concentrations of heavy metals in the soil around waste dumpsites.

Table 1: Amount of heavy metals at the selected dumpsites (mg kg^{-1})

Location	Pb	Cd	Cr
Abattoir	50.62	28.53	53.67
Control	232.99	22.59	29.65
New Abattoir	13.09	19.56	13.57
Control	10.52	10.22	12.11
Oja Igboora	87.92	18.57	12.01
Control	232.99	22.59	29.65
Oja Oba	12.63	17.03	12.53
Control	10.42	9.60	18.44
Towobowo	136.43	25.42	17.61
Control	104.30	16.71	22.19
LSD	0.02	0.02	0.02

Impact of sampling depth on the amount of heavy metals at the selected dumpsites

The impact of sampling depths on the amount of heavy metals at the selected dumpsites is provided in Table 2. The result showed that the amount of Pb increased with depth. This corroborated the finding of Saheed *et al*. [10]who reported an increase in Pb concentration withincreasing sampling depth. The upper layer (0 -20cm) of the soil had 76.85 mgkg^{-1}while the sub-soil (20 - 40cm) had 101.53mgkg^{-1}. Cadmium (Cd) and Chromium (Cr) on the other hand reduced with depth. In other words, the amount of Cd and Cr were highest in the upper layer of the soil compared to the sub-soil. All the values were significantly different at 5% level of probability. Similarly, the amountsof Pb in all the dumpsites were higher than that of the control except from Abattoir and Oja-Igboora. Similar trend was observed for Cd except Oja-Igboora, while Cr was higher than the control at Abattoir and new Abattoir only. It is important to note that Pb, Cd and Cr are toxic metals that affect living organisms not only in high concentration but also in low concentration. The implication is that the presence of these metals at the upper layer and sub-soil should be of great concern as there could be uptake by plants grown on this soil and seepage into the groundwater.

Table 2: Impact of sampling depth on the amount of heavy metals at the selected dumpsites (mg kg^{-1})

Depth (cm)	Pb	Cd	Cr
0-20	76.85	21.19	23.40
20-40	101.53	16.97	20.89
LSD	0.01	0.01	0.01

Impact of location and sampling depth on the amount of Pb, Cd and Cr metals at theselected dumpsites

The results presented in Table 3 showed the impact of different dumpsites and sampling depths on the amount of Pb, Cd and Cr. The results showed that the highest value of Pb (218.85mgkg^{-1}) in the upper layer of the soil was recorded at Towobowo dumpsite, while the lowest (8.12mgkg^{-1}) was at the control at Oja-Oba. The results may be because the dumpsite is close to the popular Towobowo market in Igboora. The highest content of Pb from this site could be as a result of dumping of various wastes generated from the market both degradable and non-degradable. The highest value of 327.96mgkg^{-1} Pb was recorded in the sub-soil of both Abattoir and Oja-Oba control while the control at New Abattoir had the lowest value of Pb(8.4mgkg^{-1}). The amount of Cd in the upper part of the soil was highest at the Towobowo dumpsite (36.65mgkg^{-1}) while the lowest value was recorded at Oja-Oba control (11.84mgkg^{-1}). However, highest value of Cd (27.52mgkg^{-1}) was recorded at Abattoir dumpsite under the Sub-soil, while the control at New Abattoir had the lowest value of 6.88mgkg^{-1}. All these values were significantly different at 5% levels of probability. In the same vein, the highest value of Cr in the upper layer of the soil was recorded at Abattoir dumpsite, while the lowest value of 12.52mgkg^{-1} was recorded at the New Abattoir dumpsite. Also, the Cr value of 39.31mgkg^{-1} was the highest in the sub-soil of the dumpsite at Abattoir, while the lowest value of 8.54 mg kg^{-1}was recorded at Oja-Igboora dumpsite. The above findings corroborate the findings of Okoronkwo *et al*. [18] who reported higher concentration of Pb, Cd and Cr in the soil of waste dumpsite of Uturu, Nigeria.Generally, the concentration of Pb and Cd were above the permissible maximum level of these metals in soil as recommended by WHO except for Pb at Oja Oba (8.12 - 8.52 mg kg^{-1}). On the other hand,the concentration of Cr was below the 65 mg kg^{-1} permissible level in the site, and at different sampling depth except at the upper layer of Abattoir dumpsite (68.02 mg kg^{-1}).

Table 3: Impact of location and sampling depth on the amount of Pb, Cd and Cr metals at selected dumpsite (mg kg^{-1})

Location	Pb		Cd		Cr	
	Depth (cm)		Depth (cm)		Depth (cm)	
	0-20	20-40	0-20	20-40	0-20	20-40
Abattoir	49.85	51.39	29.53	27.52	68.02	39.31
Control	138.02	327.96	23.12	22.05	28.51	30.79
New Abattoir	10.68	15.49	18.10	21.02	12.52	14.61
Control	12.60	8.44	13.55	6.88	13.41	10.81
Oja Igboora	122.69	53.15	19.35	17.79	15.47	8.54
Control	138.02	327.96	23.12	22.05	28.51	30.79
Oja Oba	8.52	16.73	16.14	17.91	15.84	9.22
Control	8.12	12.71	11.84	7.36	17.43	19.45
Towobowo	218.85	54.04	36.65	14.19	16.77	18.44
Control	61.14	147.46	20.52	12.90	17.48	26.89
LSD	0.03	0.03	0.03	0.03	0.02	0.02

Conclusion

The study showed that the highest amount of heavy metals (Pb, Cd and Cr) observed in all the dumpsites assessed could be as a result of anthropogenic activities of improper waste disposal in the area. Also, the metals are affected by the sampling depth, as Pb increased with depth, while Cd and Cr reduced with depth. The interaction effects of location and sampling depth showed that the highest amount of Pb was at the upper layer of Towobowo. However, it is important to note that these metals are toxic to living organisms including human beings either at low or high concentration. Attention should therefore be paid to the presence of heavy metals in these locations as crops grown in soils around the dumpsites could accumulate the metals and eventually get to food chain. Thus, the consumption of such crops could become detrimental to human health. Similarly, the fact that the heavy metals were detected both at the upper layer and sub-soil means they could contaminate the ground water around these areas.Further study is therefore recommended to evaluate the plants as well as the wells around these areas for the presence of heavy metals in them and relate such data with the WHO standard in order to ensure well-being of the populace.

Type of Article: Original Research Article

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