TRACKING LEAD (Pb) IN THE ENVIRONMENT OF JAKARA, KANO STATE, NIGERIA

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Abstract

Lead is considered a toxic substance that is already available in environment and has health impacts. The objective of the present study is to track the availability of lead in the environment of Jakara, Kano State, Nigeria. Lead was tracked in water, soil, and vegetables including lettuce, spinach, and onion. Study methodology involved taking random samples from water, soil, and vegetables at Jakara. Samples were prepared and assayed by atomic absorption spectrometry. Study findings showed that the mean concentration of lead in water was 0.115±0.023 mg/l, while it was in soil 2.46 ±0.95 µg/g. The mean concentration of lead in both lettuce and spinach was the same (22.95+ 3.28 mg/kg), and in onion was 19.67 ±3.28 mg/kg .

Conclusions: the present study showed that there is a lead contamination of Jakara region by heavy metal (lead). This contamination is evident in water, soil, and vegetables.

Keywords: Heavy meals, lead, Jakara, Nigeria, water, soil, vegetables

Introduction

From a chemical point of view, lead (Pb) has an atomic number of 82 and atomic mass of 207. It is the heaviest non-radioactive metal that naturally occurs in substantial amounts in the earth's crust (Madyiwa, 2006). Pb is the most common among the heavy metals and its most abundant isotope is 208Pb. Other stable lead isotopes also exist. Lead has two oxidation states Pb^{2+} and Pb^{4+}. Pb^{2+} dominate environmental chemistry. There is a great similarity in the ionic sizes of Pb^{2+} and Ca^{2+} such that Pb^{2+} may proxy for Ca^{2+} (Johannesson, 2002; Madyiwa, 2006).

Clearly, lead is a systemic poison and there is convincing evidence that lead appears to have virtually no toxicological threshold (Todd et al, 1996; Finkelstein et al, 1998). Negative impacts on the development of children appear to be evident at blood lead levels at or below the level of medical concern (10 ug/dL = 100 ug/L = 0.48 umol/L).

It has been suggested that sources of heavy metals to the environment are mainly direct deposition from mining and industrial processes as well as waste water from mining activities, industrial and domestic processes (Madyiwa, 2006). Furthermore, heavy metals can contaminate agricultural soils through a variety of sources among which are land application of biosolids, fertilisers, livestock manure, agrochemicals, irrigation water to the land and from atmospheric deposition. Some worries about accumulation of heavy metals in agricultural soils come from their possible negative impacts on soil fertility and large potential to accumulate in the human chain (McLaugh *et al*.,1999; Gray *et al*., 2003). Various studies pointed to the considerations that lead is a good indicator of contamination in soils because it appears in gasoline, car components, lubricants, industrial and incinerator emissions (Adriano, 1986; Alloway, 1990; Li *et al*, 1999).

Madyiwa (2006) showed that Pb is a mineral found deep within the earth and mined together with silver deposits. It has various salts in nature such as sulphate ($PbSO_4$), carbonates ($PbCO_3$) and sulphide (PbS), which make the principal ore of Pb, known as galena. Impurities in the ore include silver and gold. It has also been found that lead ores produce oxides when heated, and Pb is considered as the most significant toxin of the heavy metals. Production of Pb can also be found in the radioactive decay of uranium ^{208} and actinium ^{207} (Sax and Lewis, 1987).

It has been estimated that about 99% of the Pb that enters the adult human body and 33% that enters a child's body are excreted in about two weeks. Accordingly, Pb poisoning is of much concern in children because they are susceptible to developmental delays secondary to Pb toxicity (ATSDR, 1999b; Amfo-Otu, 2007).

It has been shown that Pb levels in human body increased over time (Elson and Haas, 2003; Madyiwa, 2006). Furthermore, the excessive content of metal like Pb in food has also been found to be associated with a number of diseases, especially with cardiovascular, kidney, nervous as well as bone diseases (Jarup, 2003; Eslami *et al*, 2007). Several studies pointed to potential effects of a high Pb level in the environment to be associated with blood Pb level, intelligence and behavior (Bellinger *et al*., 1990; Dietrich *et al*., 1990; Li *et al*, 2001). In young children, Pb poisoning may cause permanent damage to the central nervous system and reduces intellectual capabilities (Madyiwa, 2006). It is also suspected to causes high blood pressure and hypertension in adults (Madyiwa, 2006).

Gastrointestinal symptoms (cramping, colicky abdominal pain, nausea, vomiting, and black stool) often present first. Neurological symptoms follows and can range from headache and confusion to stupor, coma and seizures. In severe cases, oliguria and acute renal failure may occur (Lewis, 1997).

The effect of lead on blood is extensive and ranges from sub clinical effects such as inhibition of the enzyme d-aminolevulinic acid dehydratase (ALAD), erythrocyte zinc protoporphyrin (ZPP) elevation, Increased urinary d-aminolevulinic acid (ALA), reduced hemoglobin production and frank enemia (Goyer, 1996; Levin and Goldberg, 2000). Even in adults, ALAD inhibition is evident at 100ig/L of lead in blood.

Slight enzymuria (e.g. of N-acetyl-B-glueosaminidase, NAG) can be detected for blood lead levels in the range 300-400sg/L (Goyer, 1996), and appears to be reversible. Acute lead poisoning can also result in reversible damage to the proximal tubules that include aminoaciduria, glucosuria, hyperphospaturia, and enzymuria. By contrast, chronic high exposure to lead over many years (blood levels > 500.tg/L) has led to interstitial nephritis and fibrosis, which results in reduced glomular filtration rate, azotemia (increase in blood urea nitrogen, BUN, and serum creatinine) and tubular reabsorption of uric acid. The latter effect may be responsible for the occurrence of gout (Levin and Goldberg, 2000). Permissible limit of lead in soil is 2.5pg/g (UNESCO/WHO/UNEP, 1992), in water are 0.01mg/I, 0.05mg/I and 0.015mg/I by WHO (1993), ECIUK (1980) and USEPA limits respectively. While in vegetables their permissible limits are 0.1mg/kg (ANZFA), 2.5mg/kg (PFA) and 0.3mg/kg limits.

Jakara

Jakara irrigation land is located at Jakara along Jakara Bridge Dala local government of Kano state Nigeria, the source of water to the land are from the effluents from Kano metropolises, abattoir and gutters from the town (Adamu and Dawaki, 2008).

Methodology

Sampling

A total of 12 soil samples and 8 water samples were collected randomly. A total of nine vegetable samples were collected randomly from each site which includes three lettuces (lectuca sativa), three spinach (spinacia oleracea.l.) and three onions (allium cepa).

The soil samples were air dried, mechanically ground and sieved to obtained <2mm fraction of soil. Soil samples were digested as described by Allen et al (1974) and used for the analysis of lead using atomic absorption spectrophotometer. Digestion steps were applied as described by Allen et al (1974).

Two grams of soil samples are weighed and wet with one to two drops of water, the sample was digested slowly in a digestion block for one hour after addition 2cm^3 of sulphuric acid and 4cm^3 of nitric acid. The digestion was finally diluted and filtered in 50ml volumetric flask and make up to mark with distilled water. The solution was used for lead determination.

Water samples were collected randomly in plastic containers and digested for elemental analysis using atomic absorption spectrometry.

To a 100cm3 of water sample, l0 cm^{3}of conc. HNO3 were added and boiled slowly on a hot plate to evaporates to about 50cm^3, after cooling another 5cm^3 of nitric acid was added and returned the beaker to the hot plate and covered with a glass. Continuing heating was supplied with further addition of nitric acid and completed the digestion when slight colored solution was observed. The beaker wall and watch glass was washed down with distilled water and filtered the solution in to 100ml volumetric flask and diluted to mark with distilled water. The filtrate was used for the analysis of heavy metal.

Plant samples were put through a three washing sequence (Reuter et al, 1983), air dried, weighed and placed in a muffle furnace to form an ash which was used for acid digestion (Miller, 1998). Plant digest were used for lead analysis by atomic absorption spectrophotometer.

Analysis of edible fauna and flora material practically requires ashing of the dry material. Atomic absorbance spectrophotometer offers the advantage that, the ash mostly dissolved in dilute hydrochloric acid can be analyzed directly (Bernard, 1985). Ashing with addition of nitric acid gives very satisfactory results and was adopted (AOAC 1990).

Statistical analysis

Data were analyzed using SPSS version 20. Data were presented as means and standard deviations.

Results

As shown in table 1, the mean concentration of lead in soil of Jakara is 2.46 ±0.95 µg/g, and the range of concentration varied between 1.5-3.42

µg/g. The mean concentration of lead in water of Jakara is 0.115±0.023 mg/l, and the range of concentration varied between 0.092-0.138 mg/ml.

Table 1: Lead concentration in soil and water at Jakara (Nigeria)

	Soil (µg/g)	Water (mg/l)
Lead (Mean +SD)	2.46±0.95	0.115±0.023
Range	1.5-3.42	0.092-0.138

Data presented in table (2) showed that the mean concentration of some vegetables at Jakara including lettuce, spinach and onion. The mean concentration of lead in both lettuce and spinach was the same (22.95+ 3.28 mg/kg) within the same range 19.67-26.23 mg/kg. The mean concentration of lead in onion was 19.67 ±3.28 mg/kg and the range of concentration varied between 16.93-22.95 mg/kg.

Table 2: Lead concentration in some vegetables of Jakara (Nigeria)

	Lettuce (mg/kg)	Spinach (mg/kg)	Onion (mg/kg)
Lead (Mean +SD)	22.95±3.28	22.95±3.28	19.72±3.28
Range	19.67-26.23	19.72-26.23	16.93-22.95

Discussion

In the present study, lead concentrations in water, soil and vegetables samples were monitored in order to provide a tool for estimating the level and source of contamination of lead, and to highlight its toxicological effects to human health. Mean lead concentration in water samples was 0.115±0.023 mg/l. The mean lead concentration at Jakara exceeds WHO (1993) limit (0.01mg/l), EC/UK (1980) limit (0.05mg/l) and US EPA (1992) limit (0.015mg/l).

Lead concentration at Jakara soil samples ranged from 1.5 ug/g to 3.42 ug/g with a mean of 2.452 ug/g. This shows that at Jakara, lead concentration did not exceed UNESCO/WHO/UNEP (1992) limit (2.5 ug/g). Other studies showed that lead concentration is less than that reported by Anthony and Balwart (2006) at Boloro Australia which has a mean of 363 ug/g.

Lead concentrations in lettuce samples was evident at Jakara in which the mean lead concentrations in lettuce was 22.95mg/kg. By comparing lead concentration with that of various studies, lead concentrations in lettuce are less than that obtained by Anthony and Balwart (2006) at Boloro, 54mg/kg.

The mean of lead concentration in spinach samples at Jakara was 22.95mg/kg. Compared with other related studies, the mean concentration of lead in spinach is less than that reported in Port kembla (Anthony and Balwart, 2006) .

The mean Lead concentration in onion bulbs at Jakara was 19.672mg/kg. It was less than that reported in Port kembla (Anthony and Balwart, 2006).

Conclusion

The present study showed that there is a lead contamination of Jakara region by heavy metal (lead). This contamination is evident in water, soil, and vegetables.

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