American Chemical Science Journal
5(1): 11-16, 2015, Article no.ACSj.2015.002
ISSN: 2249-0205

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Assessment of Toxic Elements in Onion Farms in Northern Nigeria

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Authors' contributions

This research work was carried out in collaboration between both authors. Author ISS designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Author NK managed the sample collection, digestion and analysis of the study. The literature search was done by both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ACSj/2014/10210
Editor(s):
(1) Nagatoshi Nishiwaki, Kochi University of Technology, Japan.
(2) Narayan S. Hosmane, Department of Chemistry & Biochemistry, Northern Illinois University, USA.
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Reviewers:
(1) Anonymous, Nasarawa State University, Nigeria.
(2) Deusdedit Kibassa, Institute of Human Settlement Studies (IHSS), Ardhi University, Tanzania.
(3) Anonymous, Misurata university, Libya.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=649&id=16&aid=5956

Original Research Article

Received 19th March 2014
Accepted 24th July 2014
Published 5th September 2014

ABSTRACT

This research has examined the levels of four toxic elements (lead, cadmium, manganese and iron) from four different locations of onion farms in Aliero metropolis of Kebbi State Nigeria in West Africa. The metals were analysed by atomic absorption spectrometry (AAS). The concentration of metals at the four sampling points, designated as A, B, C, D, follows the order: iron (D 65.588ppm > A 47.577ppm> B 7.927 > C 5.585), lead (A 2.321ppm > D 0.784ppm > C 0.517ppm > B 0.148ppm), manganese (A 1.552ppm > D 1.237ppm > C 1.070ppm > B 0.148ppm and cadmium B 0.008ppm > D 0.005ppm > C 0.004ppm > A 0.003ppm. Iron in all samples had higher concentration than the rest metals, while cadmium had the lowest concentration. However, the concentration of all the metals was below the WHO recommended limits.

Keywords: Toxic metals; onion; soil; farm.

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1. INTRODUCTION

Pollution of the environment is caused by man introducing substances or energy liable to cause health hazards to humans, harm to the ecological system, and damage to structures and interfere with legitimate use of the environment [1].

In developing countries such as Nigeria toxic element pollution of the soil environment in recent years has been of a great concern due to their toxicity and accumulative behavior [2,3].

These elements contrary to other pollutants are non-biodegradable and they undergo eco biological cycles in which water and the soil are the main pathways [4]. The major pathways these toxic metals get into the soil is through human and industrial activities like mining, manufacturing, and the use of synthetic products such as pesticides, paints, batteries, industrial waste, and land application of industrial or domestic sludge. This can result in heavy element contamination of urban and agricultural soils causing a serious environmental pollution [5]. Potentially contaminated soils may occur at old landfill sites (particularly those that accepted industrial wastes) [6]. Old orchards that used insecticides containing arsenic as an active ingredient, fields that had past applications of waste water or municipal sludge, areas in or around mining waste piles and tailings, industrial areas where chemicals may have been dumped on the ground, or in areas downwind from industrial sites [7].

Plants need essential metals known as micronutrients such as Fe, Cu, Zn and Ca for their proper growth and yield, which mostly absorbed from the soil where they are grown, of which onion is not an exception. However, plants may absorb some heavy elements such as Pb, Cd, men and others that exist in the soil [8]. These metals can get to animals and humans, directly or indirectly from the plants.

These heavy elements like lead and cadmium are very toxic and harmful to human health even at low concentration. Long time exposure to heavy elements is normally chronic. Acute (immediate) poisoning from the elements is rare through ingestion or dermal contact, but is possible. Lead is known to induce renal tumours, reduce cognitive development, increase blood pressure and cardiovascular disease risk for adults, while cadmium may induce kidney dysfunctions, osteomalacia and reproductive deficiencies [9]. The purpose of this research was to determine the concentration of iron, lead, cadmium and manganese in the soils where onions are cultivated in the northern part of Nigeria, and compare it with the WHO recommended values in order to help enlighten the farmers and the consumers of the probable health risk. The elements were analysed using Unicam 969 atomic absorption spectrophotometer.

2. MATERIALS AND METHODS

2.1 Sampling Location

Soil samples were collected from onion farms around Aliero metropolis (Fig. 3). Aliero is one of the 21 local governments in Kebbi state (Fig. 2), located in the southeast of Kebbi State on latitude 12º16′42″N and 12.27833ºN and longitude 4º27′6″E and 4.45167ºE. The people put more emphasis on vegetation, especially onion and paper. The town has the largest onion market in northwest Nigeria (Fig. 1) and is a major producer of onions in Nigeria. The residents are known for bone setting across West and Central Africa. Aliero town is surrounded by mango trees.

2.2 Sample Collection

Soil samples were collected from onion farms around Aliero metropolis (Fig. 3). Soil samples were collected at four different points using random sampling method. Top soil at (2 - 10cm depth) was taken into different envelops using a stainless hand trowel which was cleansed very well before taking another sample [10,11]. The samples were collected in the month of April 2013. This is because then farmers have finished harvesting their crops. The samples were kept in desiccators in the laboratory prior to their preparation due to the fact that the soil is already dried.

2.3 Sample Preparation and Digestion

The soil samples were crushed using porcelain mortar and pestle, then sieved with 2mm plastic sieve to obtain fine soil particles [12]. The digestion was done according to Fatoki, 1996 [13], 1g of each of the dried and sieved soil samples were taken into separate 250cm^3 beakers and 10cm^3 of Conc. HNO_3 was added. Each mixture was covered with a watch glass and refluxed for 45minutes. The watch glass was removed from each beaker before heating the mixtures to dryness. 10cm^3 of aqua-regia (mixture of HNO_3 and HCl in a ratio 1:3) was added to each beaker and the heating process continued to dryness. 10cm^3 of 1M HNO_3 solution was added and the suspensions after cooling were filtered using Whatman No. 42 filter paper into separate 50cm^3 volumetric flasks and diluted to their marks.

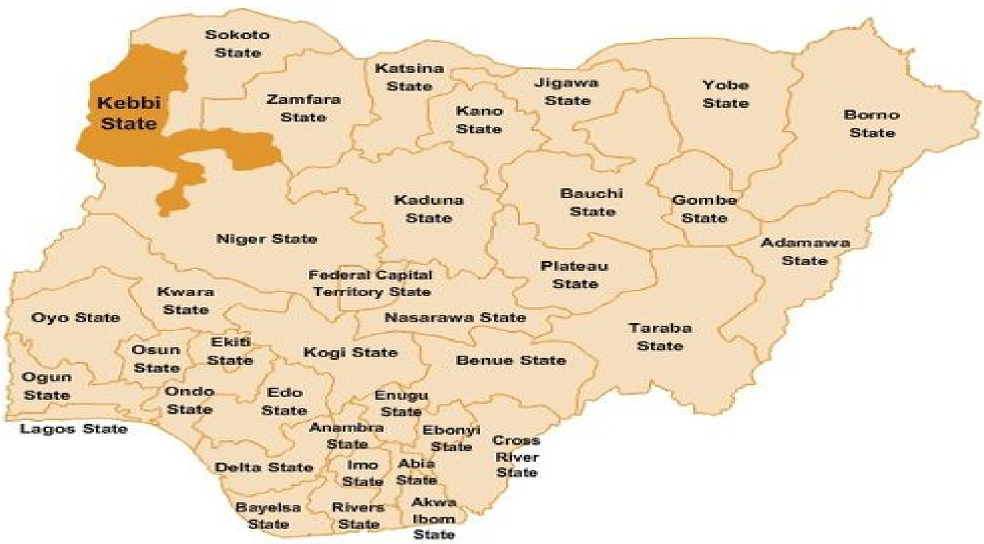

Fig. 1. Map of Nigeria showing Kebbi State

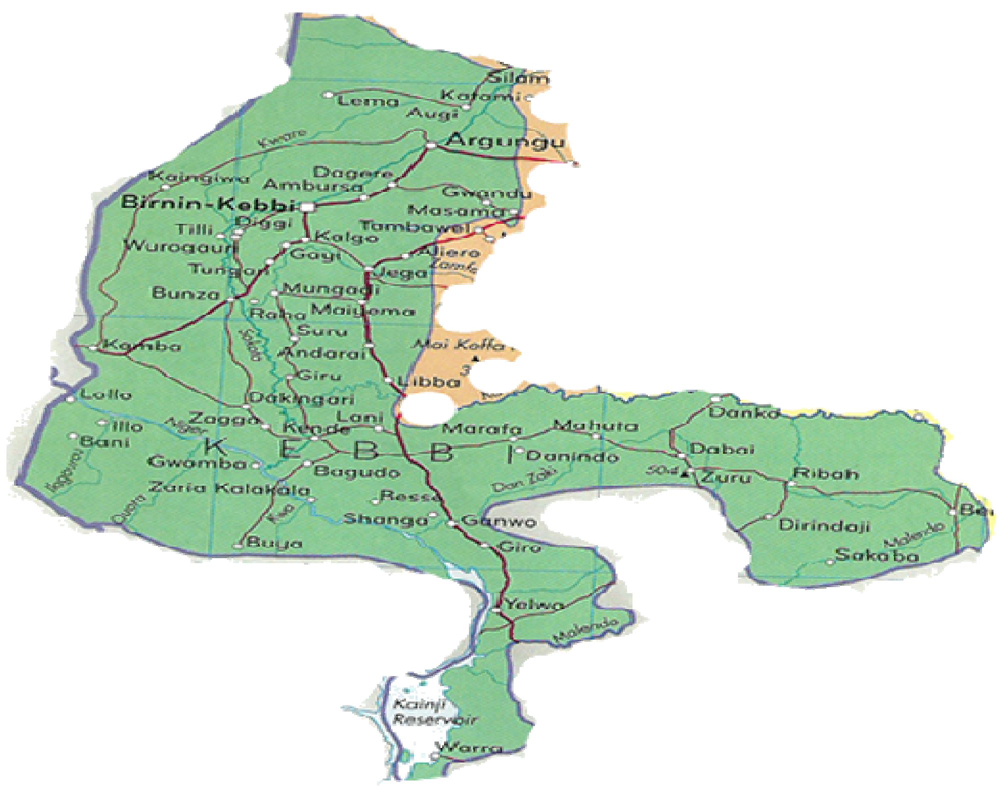

Fig. 2. Map of Kebbi state showing all its local governments and major towns

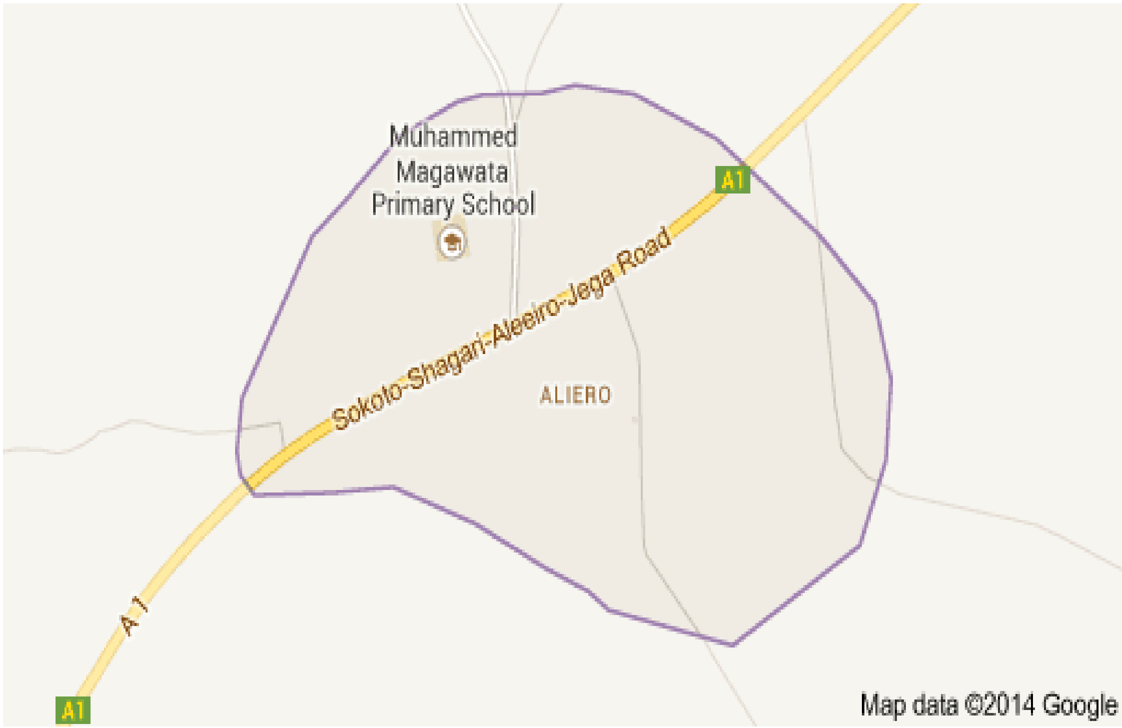

Fig. 3. Map of Aliero metropolis

The acid digestion, which involves heat was done to destroy the matrix of the sample, liberate the metal content and help avoid elemental lost and minimize contamination risk which is the goal of every digestion process [14]. The soil heavy elements were determined using Unicam 969 Atomic Absorption Spectrophotometer (AAS).

2.4 Statistical Analysis

Data obtained were analyzed using descriptive statistics for the mean and standard deviation, one way ANOVA was used to test for significant differences in the concentration of heavy elements in the soil.

3. RESULTS AND DISCUSSION

Soil needed by man for the cultivation of crops used for both humans and animals is threatened by heavy element contaminants; hence this has become a major concern to farmers and soil scientist because of its negative effect on human health. Orientation is therefore needed to reduce the risk.

In this study, the results (Table 1) revealed that in all the sample cadmium concentration was higher in sample B (0.008ppm) and lowest in sample A (0.003ppm) and it was the lowest in all the samples. This could be an indication of the absence of crystal rocks at the horizon of the surface soil analysed [15].

Lead concentration (Table 1), has the highest value in sample A (2.321ppm) and the lowest in sample B (0.148ppm) but yet the level in all the samples is low and may likely not pose much health hazard to human through the onion consumption. This could be as a result of the absence of industrial, mining or smelting activities in the study area, as these are usually the greatest source of anthropogenic adding of heavy elements in soils [16]. The iron level is remarkably higher in the entire four samples (Table 1), with sample D has the highest value (65.588ppm) and the lowest (5.585ppm) in sample C. This could be as a result of the iron bed under the ground. Yet the iron concentration in the soil of the study area has been below the critical contamination levels for agricultural soils stated by WHO (Table 1) [17]. Manganese concentration is lower than the WHO permissive limits according to the analysis (Table 1). Despite its higher value in sample A (1.552ppm) and the lowest value in sample B (0.834ppm) [18].

Table 1. Concentration of heavy elements (ppm) compared with WHO limits

Soil samples	Pb	Cd	Fe	Mn
Sample A	2.321±0.01	0.003±0.04	47.577±0.02	1.552±0.02
Sample B	0.148±0.01	0.008±0.02	7.927±0.00	0.834±0.01
Sample C	0.517±0.04	0.004±0.02	5.585±0.01	1.070±0.04
Sample D	0.784±0.02	0.005±0.01	65.588±0.02	1.237±0.04
WHO limits	100	3.00	18.00	300

4. CONCLUSION

This study reveals that all the heavy elements detected in farm land soils in Aliero metropolis of Nigeria are below the critical contamination level of agricultural soils and this implies better management, especially in sorting out the non biodegradable parts of solid waste dumping used as compost manure.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=649&id=16&aid=5956