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DETERMINATION OF HEAVY METALS CONCENTRATION IN SOILS FROM FARMLANDS WITHIN ASHANGWA RICE MILL, LAFIA LGA, NASARAWA STATE-NIGERIA

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ABSTRACT

Heavy metals (HMs) are natural environmental composition, but their geochemical processes and biochemical equilibrium have been transformed by haphazard use for human purposes. The aim of this research was to determine the concentrations of HMs (Cr, Zn, Fe, Pb and Cd) from soil samples of selected farmlands within Ashangwa Rice Mill, Lafia LGA, Nasarawa State. The concentrations of HMs irrespective of a particular farmland ranged as follows: (Cr: 0.022 – 0.555, Pb: 0.200 – 0.857, Fe: 0.311 – 0.890, Zn: 0.100 – 0.809 and Cd: 0.014 – 0.565 mg/kg). The concentration of heavy metals in the soils were compared with FAO/WHO and US EPA maximum allowable limit and the results showed that only Cd from soil sample of farmland 1 (30 m away from rice mill) was above the US EPA maximum allowable limit of 0.480 mg/kg but the rest of the studied metals were below FAO/WHO and US EPA standards. The concentrations of HMs at sites 30 m away were higher than those of 45 and 60 m away from the rice mill but site 45 m away was just relatively higher than that of 60 m.

Keywords: Concentrations, determine, maximum allowable limit, environmental constituents, indiscriminate use.

INTRODUCTION

Sources of heavy metals in the environment can be both natural/geogenic/lithogenic and anthropogenic. The natural or geological sources of heavy metals in the environment include weathering of metal-bearing rocks and volcanic [1]. The anthropogenic sources of heavy metals in the environment include mining, industrial and agricultural activities [1].

The plant accumulation of HMs from soils at elevated concentrations may result to a serious health risk taking into consideration food-chain consequences. Use of food crops stained with HMs is the main food chain route for human exposure [2]. Heavy metals become poisonous when they are not metabolized by the human system and amass in the soft tissues [2].

Cadmium is a well-known HM toxicant with a specific gravity 8.65 times higher than water. The major organs for Cd toxicity have been identified as liver, placenta, kidneys, lungs, brain and bones [2]. Lead and its derivatives are industrial toxic substances that have been widely used by humans for centuries and therefore play an important role in environmental pollution. Lead is a highly toxic metal that enters biological systems by mixing with respired air and nutrients from the air, water

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and soil. When the carcinogenic effect is examined, human studies are insufficient regarding lead exposure and increased cancer risk. In animal studies, kidney tumors were reported in rats and mice orally exposed to lead. [3]. Iron toxicity in plants is connected to Fe^{2+} uptakes from roots and translocation to leaves via transpiration. It is the reduction of Fe^{2+} and Fe^{3+} through microbial activities which give indications of iron toxicity [4]. Excess concentration of Fe+2 result in the formation of free radicals that disturb cellular structures and membrane damage [5]. Chromium (VI) is much more toxic than chromium (III) for both acute and chronic exposure. The respiratory tract is the primary target organ for Cr(VI) after inhalation exposure by humans [6]. The EPA concluded that only Cr(VI) should be categorized as a human carcinogen. Animal researches indicate that Cr(VI) causes lung tumors with respiratory exposure. The EPA listed Cr(VI) as Group A, a recognized human carcinogen, for inhalational exposure. There is no data on the carcinogenic potential of Cr(III) compounds. The EPA classified Cr(III) as group D [6]. Disturbances in Zn and Cu metabolism, including a low Zn/Cu ratio, low Zn levels, or high Cu levels, have been attributed to autism spectrum disorders. Excellent derivations of dietary zinc include red meat, poultry, beans, nuts, seafood (especially oysters), whole grains, and dairy products [7]. The aim of this research was to determine levels of heavy metals (Cr, Pb, Fe, Zn and Cd) from soils of farmlands within Ashangwa Rice Mill of Ashige District, Lafia Local Government Area, Nasarawa State, Nigeria.

MATERIALS AND METHODS

***Chemicals and Reagents*:** All reagents used were of analytical grade supplied by the British drug house (BDH), May and Beaker (M and B) unless otherwise stated. All working samples were prepared using appropriate reagents [8].

***Sample Collection and Preparation*:** The soil samples were collected from fifteen (15) sample sites: four farmlands of 30, 45 and 60 meters away from the Rice Mill area and a control site (30, 45 and 60 m apart), very far from the Rice Mill area free from anthropogenic pollution activities. Five random samples in each site were collected using clean stainless steel trowel of 15 cm depth. The collected soil sub-samples were thoroughly mixed, pooled together to make a composite of each soil sample and unwanted debris removed.

***Acid Digestion*:** One gram (1 g) of the soil sample was weighed into a 50 mL digestion flask. Analar grade of nitric acid, and concentrated hydrochloric acid was used for the digestion (aqua regia, 1:3), that is, 5 mL of concentrated HNO_3 and 15 mL of concentrated HCl [8]. The digest was filtered through whatman filter paper No. 42. Each filtrate was collected in 100 mL volumetric flask and made up to the mark with deionized water [8]. Concentration of Pb, Cr, Cd, Zn and Fe were determined

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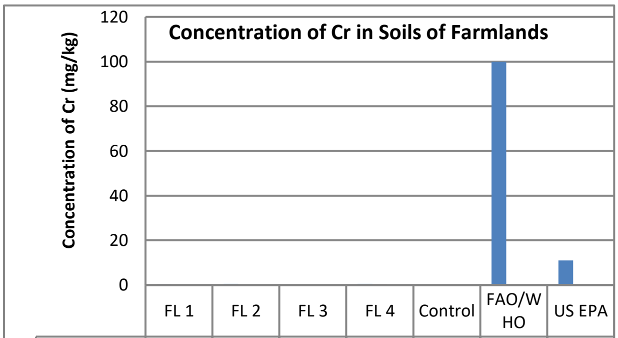
using Atomic Absorption Spectrometer (model AA240FS) [8].

RESULTS AND DISCUSSION

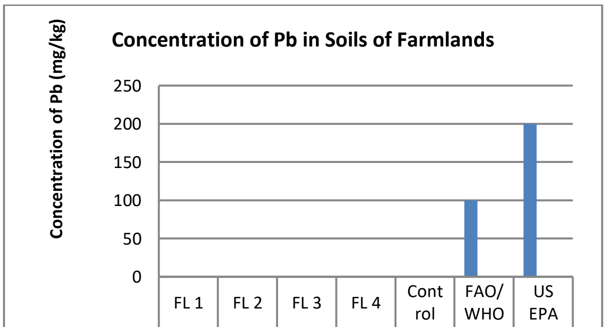
The concentrations of heavy metals from soils of farmlands are given in Figures 1 to 5. Concentration of HMs was of the following decrease order based on the distances in each farmland as distance was increased away from rice mill: 30 meters > 45 meters > 60 meters. Concentration of HMs in control site was the lowest amongst the studied sites and made not much difference based on distances. The sum of HMs based on distance in different farmlands for different HMs did not follow a particular pattern. For Cr, the order was Farmland 2 (1.177 mg/kg) > Farmland 4 (1.117 mg/kg) > Farmland 1 (0.921 mg/kg) > Farmland 3 (0.130 mg/kg), order for Pb: Farmland 2 (2.110 mg/kg) > Farmland 3 (1.427 mg/kg) > Farmland 1 (0.954 mg/kg) > Farmland 4 (0.936 mg/kg), order for Fe: Farmland 3 (2.409 mg/kg) > Farmland 4 (2.054 mg/kg) > Farmland 2 (1.627 mg/kg) > Farmland 1 (1.190 mg/kg). order for Zn: Farmland 3 (2.235 mg/kg) > Farmland 2 (1.419 mg/kg) > Farmland 4 (0.713 mg/kg) > Farmland 1 (0.441 mg/kg) and order for Cd: Farmland 1 (1.465 mg/kg) > Farmland 4 (1.009 mg/kg) > Farmland 2 (0.851 mg/kg) > Farmland 3(0.099 mg/kg). The concentration of heavy metals in the soils were compared with FAO/WHO [9] and US EPA [10] maximum allowable limit and the results showed that only Cd from soil sample of farmland 1 (30 m away from rice mill) was above the US EPA maximum allowable limit of 0.480 mg/kg but the rest of the studied metals were below FAO/WHO and US EPA standards [9, 10]



	FL 1	FL 2	FL 3	FL 4	Control	FAO/WHO	US EPA
30 metres	0.365	0.555	0.058	0.487	0.022	100	11
45 metres	0.311	0.314	0.038	0.333	0.023		
60 metres	0.245	0.308	0.034	0.297	0.022		

Figure 1: Concentration of Cr in Soils of Farmlands

The concentrations of Cr as given in Figure 1, irrespective of a particular farmland ranged from 0.022 to 0.555. The mean concentration of Cr from the 4 farmlands was 1.115 mg/kg. This was similar to a study carried out by mohammad *et al.* [11] at Nasarawa west (1.140 mg/kg), but much lower than results of works by Nwoke and Edori [12] in Rivers State (2.59 mg/kg) plus Tian *et al.* [13] in China (153.33 mg/kg).



	FL 1	FL 2	FL 3	FL 4	Control	FAO/WHO	US EPA
30 metres	0.389	0.857	0.608	0.397	0.201	100	200
45 metres	0.286	0.631	0.417	0.287	0.201		
60 metres	0.279	0.622	0.402	0.252	0.2		

Figure 2: Concentration of Pb in Soils of Farmlands

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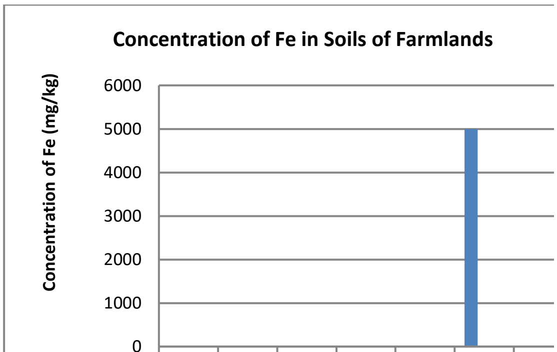
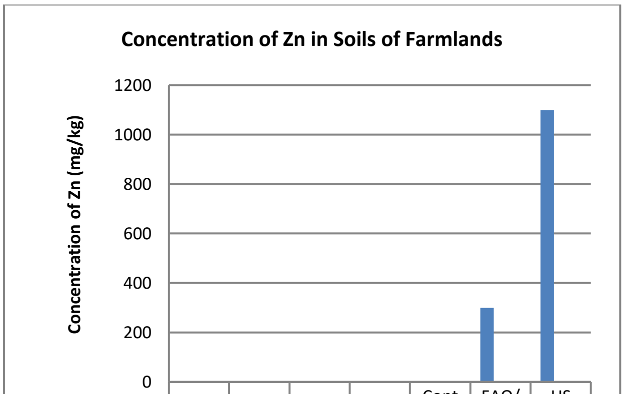
The concentrations of Pb as shown in Figure 2, regardless of a particular farmland ranged from 0.200 to 0.857. The mean concentration of Pb from the 4 farmlands was 1.809 mg/kg. This was similar to a research carried out by Nwoke and Edori [12] in Rivers State (1.710 mg/kg) but far lower than a study done by Tian *et al*. [13] in China (32.36 mg/kg).



	FL 1	FL 2	FL 3	FL 4	Control	FAO/WHO	US EPA
30 metres	0.472	0.653	0.89	0.841	0.313	5000	0
45 metres	0.362	0.498	0.76	0.612	0.311		
60 metres	0.356	0.476	0.759	0.601	0.314		

Figure 3: Concentration of Fe in Soils of Farmlands

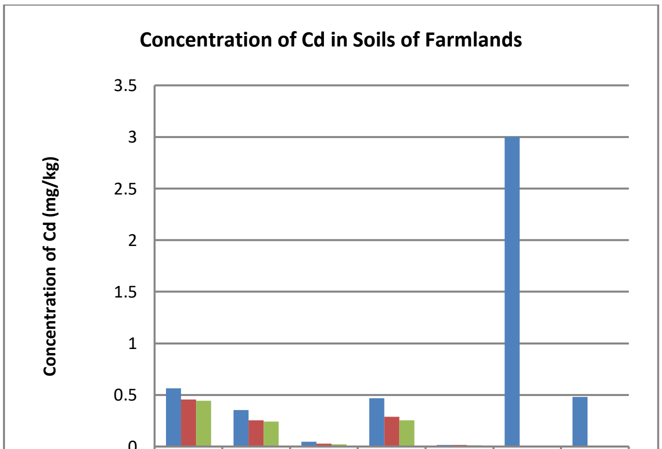
The concentrations of Fe as shown in Figure 3, without respect to a particular farmland ranged from 0.311 to 0.890 mg/kg. The mean concentration of Pb from the 4 farmlands was 2.427 mg/kg. This was lower than a research carried out by Mohammad *et al.* [11] at Nasarawa West (18.36 mg/kg).



	FL 1	FL 2	FL 3	FL 4	Control	FAO/WHO	US EPA
30 metres	0.219	0.564	0.809	0.328	0.101	300	1100
45 metres	0.113	0.434	0.731	0.198	0.1		
60 metres	0.109	0.421	0.695	0.187	0.102		

Figure 4: Concentration of Zn in Soils of Farmlands

The concentrations of Zn as given in Figure 4, irrespective of a particular farmland ranged from 0.100 to 0.809 mg/kg. The mean concentration of Zn from the 4 farmlands was 1.602 mg/kg. This was lower than a research carried out by Mohammad *et al.* [11] at Nasarawa West (94.000 mg/kg).



	FL 1	FL 2	FL 3	FL 4	Control	FAO/WHO	US EPA
30 metres	0.565	0.355	0.048	0.467	0.017	3	0.48
45 metres	0.455	0.253	0.028	0.289	0.016		
60 metres	0.445	0.243	0.023	0.253	0.014		

Figure 5: Concentration of Cd in Soils of Farmlands

The concentrations of Cd as given in Figure 5, regardless of a particular farmland

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ranged from 0.014 to 0.565 mg/kg. The mean concentration of Cd from the 4 farmlands was 1.141 mg/kg. This was higher than a study carried out by Mohammad *et al.* [11] at Nasarawa West (0.068 mg/kg), but lower than a work done by Tian et al. [13] in China (3.88 mg/kg).

CONCLUSION

With the exception of Cd which had 0.565 mg/kg, higher than the maximum permissible limit of US EPA (2020) farmlands soils standard of 0.48, the rest of the studied HMs were below the maximum permissible limit of both FAO/WHO [9] and US EPA [10]. Regular studies of heavy metals concentrations should be done on the study area in order to monitor the progress of their continuous accumulation on soils. This will help to know when to mitigate the contents of these heavy metals on soils of farmlands.

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