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*PB AND CU CONTAMINATIONS OF SOILS OF OCCUPATION SITES FROM BIDA IN NIGER STATE, NIGERIA

Y. A. Iyaka[1], *M. D. Yahya[2] and S. V. Ukwungwu[2].
[1]Department of Chemistry,
Federal University of Technology,
Minna, Niger State, Nigeria
*Corresponding Author E-mail; iyaka7@yahoo.com

[2]Department of Chemical Engineering,
Federal University of Technology,
Minna, Niger State, Nigeria
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Abstract

Contents of lead and copper in soils of five occupation sites that include storage battery repair, car radiator repair, welding, car spray painting and car repair within Bida in Niger State were determined using Flame Atomic Absorption Spectrophotometry technique. The lowest and the highest Pb mean concentrations of 32mgkg^{-1} and 2181 mgkg^{-1} were respectively from car repair and storage battery repair locations. The Cu concentration varied widely from 1.2 mgkg^{-1} in car repair site to 929 mgkg^{-1} in car radiator repair site. The obtained results from this study have shown that there is still need for constant monitoring of heavy metal levels in soils of urban occupational sites particularly in developing nations. This is because of the location of these sites within residential areas in order to assess their possible potential hazard to life and environment.

Key- words: *Lead, copper, pollution, soils, occupational sites.*

INTRODUCTION

The persistent accumulation of heavy metals in soils is of great concern because they constitute health threat and toxicity problem to human life and environment (Purves, 1985; Wild, 1994). Pb is prominently recognized as a major toxicant due to its adverse effects even at very low content (Agrawal et al.,1980; Ward, 1995), and known nutritional, biochemical or physiological benefits or uses or advantages have not yet been established for it (Goyer, 1996). Furthermore, Purves (1985) and Fergusson (1990) reported that it is almost impossible to find surface soils which can be reasonably described as completely free from Pb- contamination. Logan and Miller (1983), however, observed that soil contamination may be considered when concentrations of an element in soils were two-to- three times greater than the average background levels. The health concern for Pb contaminated soils arises primarily because of plant uptake, dust or soil ingestion by grazing animals and humans, particularly children (EPA, 1993; Mc Bride, 1994). Pb effects on human reproduction, loss of energy and learning ability especially in children have also been well documented (WHO, 1977; Wallace and Wallace, 1994). Cu occurs in soils as an essential trace metal, whose increase in concentration could give rise to hazardous effects on soil- plant- animal or man ecological system, particularly when the optimal range of safe exposure is exceeded (El-Hinnawi and Hashmi, 1988; Ebbs and Kochian, 1997; Iyaka and Kakulu, 2005). A common feature of Cu distribution in soil profile is its accumulation in the surface soils as bioaccumulation can result in possible toxic effects on plants and animals grazing on the plants (ATSDR, 1997). Kabata-Pendias and Pendias (1992) also reported that Cu stored in surface soils might be available to plants due to its influence on biological activities, and Alloway and Ayres (1997) suggested that consumption of herbage with greater than 10ppm Cu concentration can lead to Cu toxicity in sheep. In animals, exposure to high Cu contents has been associated with liver and kidney damage, haemolytic anaemia, as well as the developmental and reproductive damage (ATSDR, 1997). Hence, this research was conducted to examine the extent of Pb and Cu contamination of soils in the vicinity of occupational operations associated with heavy metal pollution. The study also aimed at investigating the possible impacts the enrichment of these heavy metals on studied locations may have on the environment, particularly on man.

MATERIALS AND METHOD

Soil samples were collected from five different occupational sites that include storage battery repair, car radiator repair, welding, car spray painting and car repair within Bida in Niger State. At each site, three locations were selected and within each location three sampling points described as point within the working vicinity (A), immediate surrounding 25m away (B) and immediate surrounding 50m away (C) were also chosen for sample collection. At each sampling point a stainless steel auger was used to collect five sub- samples from the surface layer at a depth of 0-15cm. The collected sub-samples were then pooled together to form a composite of each individual sample. The samples were mixed thoroughly and stored in polyethylene bags.

The soil samples were air-dried for one week, ground, passed through 2.0-mm sieve, further pulverized to a fine powder and passed through 0.5-mm sieve for the total metal content determination. The total metal analysis was carried out by the method of Anderson (1976); 5.0g of the air-dried soil was extracted with 50cm^3 of 2moldm^{-3} HNO_3 in a covered glass beaker placed in a boiling water bath for 2h. The filtered extract was then analysed for Pb and Cu contents using Unicam 969 Atomic Absorption Spectrophotometer- Solar in the flame mode.

At least one reagent blank and one duplicate sample were ran for every batch of 7 samples for background correction and to verify the precision of the method. Accuracy was however, assessed by analyzing three (3) replicates of certified reference materials, soil sample S0-1, obtained from Canada Centre for Mineral and Energy Technology (CANMET). Recoveries were satisfactory; average values being in excess of 90% for Pb and Cu analysed.

RESULTS AND DISCUSSION

The Pb contents of soil samples analysed based on locations and sampling points are shown in Table 1 , while Table 3 indicates the range and mean values of Pb in the studied sites. On the basis of the review document by Grandjean (1978), all the studied sites of this research have been identified as industries with either high Pb exposures or with insignificant Pb exposures. The lowest and highest Pb mean concentrations of 32mgkg^{-1} and 2181 mgkg^{-1} were respectively from car repair and storage battery repair locations (Table 1). The highest obtained Pb content of 4248 mgkg^{-1} in this study was also from storage battery repair site. The lowest average value of 45mgkg^{-1} and the highest mean value of 2637 mgkg^{-1} of Pb (Table 3) were from car spray painting and storage battery repair sites respectively. These high Pb contents from storage battery repair locations could probably be ascribed to the fact that battery manufacturing or recycling is one of the main sources of Pb in the environment (Alloway and Ayres, 1997; Lead Facts, 2007).

All the studied soil samples in this research had Pb concentrations higher than 10mgkg^{-1} reported by Alloway (1990) as average background Pb total content. Furthermore, the lowest mean Pb content of 45mgkg^{-1} obtained from all the sampling points of the studied sites was also higher than 40mgkg^{-1} recommended as Sweeden contamination level for Pb in rural soils (Chen *et al.*, 1999). However, about 36% of the Pb levels in the analysed soil samples are within 1.5- 80mgkg^{-1} range suggested by Ward (1995) as typical natural Pb concentration for surface soils. Romanian standards for heavy metals in soils recommended 100mgkg^{-1} of Pb as sensitive intervention level (Mihaly- Cozmuta et al., 2005) and 53% of the studied sampling points had higher values than 100mgkg^{-1}. Some analysed soil samples from storage battery repair, car radiator repair and car repair sites had Pb values higher than the industrial acceptable limit of 600 mgPbkg^{-1} recommended in Canadian Soil Quality Guidelines for the Protection of Environment and Human Health (CCME, 1999). Moreover, of great health risk concern were the average Pb contents obtained from some sampling points within storage battery repair and car radiator repair (Table 3) with values higher than 1000mgkg^{-1} soil Pb which correlates with the critical blood Pb level content of 7mcg/dl in children(USEPA,1994).

The Cu concentrations varied widely from 1.2 mgkg^{-1} in car repair site to 929 mgkg^{-1} in car radiator repair site. Nevertheless, a higher minimum content of 73.0 mgkg^{-1} of Cu had earlier been reported by Nda-Umar and Iyaka (2004) in their study of Cu and Pb levels in soils of Bida Brass industrial sites. Generally, the highest average values of Cu in the studied locations were found in storage battery repair and car radiator repair sites (Table 2). About 80% of the analysed soil samples in this study had Cu contents within 0.5-60 mgkg^{-1} range suggested by El- Hinnawi and Hashmi (1988) as the normal soil Cu levels, and the obtained mean values from seven locations were higher than 12.0mgkg^{-1} of Cu reported by Berrow and Reaves (1984) as background level for world soils. Furthermore, the obtained Cu concentrations from four sampling points were higher than recommended standard for Maximum Allowable Limits (MAL) for Cu in soils of different countries (Kabata- Pendias, 1995). However, the mean Cu levels from some sampling points within storage battery repair, car repair and particularly car radiator repair (Table 4) had values higher than 91mgkg^{-1} recommended as industrial acceptable limit in Canadian Soil Quality Guidelines for the protection of Environment and Human Health (CCME, 1999).

CONCLUSION

All the studied sites in this research are located within the residential areas and most soil samples analysed reveal some extent of contamination by Pb and Cu determined. Hence, from the public health view point there may be need for remediation particularly in the sampling sites where Pb and Cu concentrations exceeded the acceptable limit of 140 mgkg^{-1} and 63mgkg^{-1} respectively, recommended for residential areas / parklands (CCME 1999). The prevailing levels of Pb contamination in some sites also call for further assessments and research because most under privileged inner city children, especially during developmental years can mouth items from soil or dust containing Pb (Klein and Snodgrass, 1997; Mielke, 1999) which could result in health

Table 1: Pb Contents (ppm) of contaminated Soils in Bida

Study Site	Location	Sampling point			
		A	B	C	Mean
Storage battery repair	1	3576	2760	208	2181
	2	4248	408	144	1600
	3	88	88	72	83
Car radiator repair	1	136	48	40	75
	2	928	304	440	557
	3	2792	2208	312	1771
Welding	1	200	200	184	194
	2	96	88	80	88
	3	304	280	104	229
Car spray painting	1	48	136	80	88
	2	32	72	56	53
	3	56	56	24	45
Car repair	1	200	48	88	112
	2	1152	2208	816	1392
	3	32	16	48	32

Table 2: Cu Contents (ppm) of contaminated Soils in Bida

Study Site	Location	Sampling point			
		A	B	C	Mean
Storage battery repair	1	25	542	3.5	190
	2	28	96	12	45
	3	3.5	26	3.5	11
Car radiator repair	1	11	11	36	19
	2	124	108	362	198
	3	564	929	35	510
Welding	1	6.0	5.0	7.0	6.0
	2	6.0	12	39	19
	3	13	13	6.8	11
Car spray painting	1	7.0	9.0	3.5	6.5
	2	5.0	16	8.0	10
	3	5.0	5.0	5.0	5.0
Car repair	1	13	6.0	7.0	8.7
	2	42	116	12	57
	3	1.2	7.0	3.5	3.9

Table 3: Range and Mean of Pb Contents (ppm) in all the Studied Sites

Study Site		Sampling point A	B	C
Storage battery repair	Range	88-4248	88-2760	72-208
	Mean	2637	1085	141
Car radiator repair	Range	136-2792	48-2208	40-440
	Mean	1285	853	264
Welding	Range	96-304	88-280	80-184
	Mean	200	189	123
Car spray painting	Range	32-56	56-136	24-80
	Mean	45	88	53
Car repair	Range	32-1152	16-2208	48-816
	Mean	461	757	317

Table 4: Range and Mean of Cu Contents (ppm) in all the Studied Sites

Study Site		Sampling point A	B	C
Storage battery repair	Range	3.5-28	26-542	3.5-12
	Mean	19	221	6.3
Car radiator repair	Range	11-564	11-929	35-362
	Mean	233	349	144
Welding	Range	6.0-13	5.0-13	6.8-39
	Mean	8.3	10	18
Car spray painting	Range	5.0-7.0	5.0-16	3.5-8.0
	Mean	5.7	10	5.5
Car repair	Range	1.2-42	6.0-116	3.5-12
	Mean	19	129	7.5

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