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Short Communication

Lead, zinc and pH concentrations of Enyigba soils in Abakaliki Local Government Area of Ebonyi State, Nigeria

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The concentrations of lead (Pb) and zinc (Zn) were quantitatively determined in surface and sub-surface soils in Enyigba, Ebonyi State, Nigerian's major lead mining area using atomic absorption spectrophotometer. pH status of the soils was similarly determined. The survey was conducted to establish a base line pollution index for lead and zinc in Enyigba soil as an exogenous source of these metals among food crops. Agricultural soil samples were collected from the study area from each point about 2 km apart. Both surface and sub-surface soil were collected. The mean concentrations of lead (23.37 ± 0.16 mg/l) and zinc (2.02 ± 0.77 mg/l) in surface soil were significantly higher than the mean values of 3.64 ± 3.3 mg/l and 1.39 ± 0.30 mg/l respectively found in the sub-surface. The soil recorded a pH mean value of 7.0 ± 0.02. Trace element can affect the yield of crops and their composition; thus the determination of the elemental status of all cultivated soil has to be made in order to identify yield-limiting deficiencies of essential micronutrient and polluted soils. Lead is relatively unavailable to plants when the soil pH is above 6.5, while availability of zinc decreases with increasing soil pH due to increased adsorptive capacity.

Key words: Lead, zinc pH, surface and sub-surface soil.

INTRODUCTION

The environment contains diverse impurities and contaminants. These impurities are the by-product of both human activities and industrial activities (FAO series, 2002). The magnitude or concentration of these impurities varies from one part of the environment to another. Heavy metals form the bulk of these impurities and it comprises of essential metals like iron, manganese, copper zinc and non-essential and toxic metals like arsenic, cadmium, lead and mercury (Moore and McHyres, 1997). Soil constitutes part of vital environmental, ecological and agricultural resources that has to be protected for the world's increasing population.

All soils contain measurable concentrations of the essential trace elements, as well as other trace elements which are not essential for the plant and animals (non-essential elements), but the concentrations can vary considerably. In some cases they can be very low. Trace element in soils are derived from the agrochemical weathering of the rock fragments on which the soil was formed (the soil parent material) together with the inputs from atmospheric deposition and input from agricultural activities such as livestock manures, fertilizers and agrochemical sprays. Soils on river flood plains will also have received trace element from flood water and sediments. All of these sources and input can vary greatly in magnitude and result in soil having wide range of total trace element concentrations. The extent to which the total concentrations of a trace element such as lead and zinc, in a soil is available for uptake by plants or movement down the soil profile depends on a range of soil properties. Alkaline, calcareous and heavily limed soil tends to be more prone to zinc deficiency than neutral or slightly acidic soil.

Base line data for the occurrence of heavy metals as contaminants are needed as one of the criteria for assessment of critical heavy metal levels in agricultural

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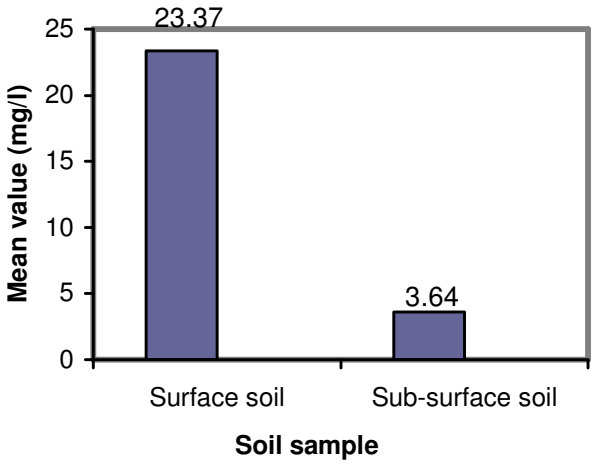

Figure 1. Mean concentrations of lead in Enyigba soils.

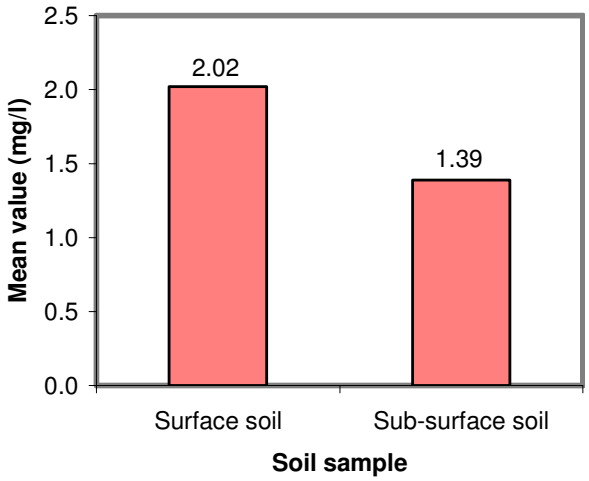

Figure 2. Mean concentrations of zinc in Enyigba soils.

soils. Over the last two decades, the study of the sources, fluxes and pathway of elements in the surface environment has been the interest of both national and international research communities as a response to concern about pollution. Enyigba is a mining village in Abakaliki local government area, 14 km south of Abakaliki town of Ebonyi state. The Enyigba lead and zinc mine was intermittently mined from 1925. Mining operations ceased due to low economic returns; however there is renewed interest to recommence mining. This study focuses on determining the levels of lead, zinc and pH in Enyigba soils.

MATERIALS AND METHODS

Sample collection and treatment

Soil samples were collected from 30 different randomly selected sites in Enyigba community. A distance of 2 km separated each of the sampling sites. Both surface and sub-surface soil (30 cm below the surface) were collected at each site, thus, making a total of 60 soil samples. Samples were collected in labeled polyethene bags and subsequently dried in an electric oven at 110°C for 12 h. Dried soil samples were ground in a mortar and sieved to below 2.0 mm mesh sieve size. About 0.5 g of the sieved soil were weighed in a crucible and transferred into a muffle furnace and ashed at 550°C for 3 h. The samples were then leached with 65 ml of 1.0 M hydrochloric acid and the leachate analyzed with an Atomic Absorption Spectrophotometer (AAS).

Similarly, in pH determination 50 ml deionized water was added to 10 ml dry soil sample, and stirred with a glass rod. Each sample preparation was left to stand overnight and measurement was made with an Orion 920A pH meter with deionized water as the solvent.

RESULTS AND DISCUSSION

Figure 1 represents the mean concentrations of lead (Pb) in the surface and sub-surface soils, while Figure 2 showed the mean value of zinc (Zn). Table 1 represents the range and mean values of lead (Pb) and zinc (Zn) in the surface and sub-surface soils of Enyigba, Ebonyi State, Nigeria. Lead (Pb) was detected in the surface and sub-surface soils. The surface soil had the range of 1.05 - 251.44 mg/l and mean concentration of 23.37 ± 0.16 mg/l, while sub-surface soil revealed 0.65 - 13.15 mg/l and 3.64 ± 3.03 mg/l, respectively. Similarly, the quantity of zinc (Zn) found in the surface soil recorded a range of 1.05 - 4.77 mg/l and a mean concentration of 2.02 ± 0.30 mg/l while sub-surface soil gave 0.75 - 1.97 mg/l and 1.39 ± 0.30 mg/l. Lead (Pb) was evenly distributed except with sporadic elevated level at some sites in the Enyigba village. The high levels of lead (Pb) 251.44 mg/l, 152.56 mg/l,53.68 mg/l, 44.21 mg/l,34.73 mg/l and 33.36 mg/l obtained at some site were expected because of the lead - zinc ore deposit and the on-going mining activity. At 5% confidence level ($p > 0.5$) it was discovered that mean concentration of lead (Pb) in surface soil were significantly higher than the mean concentrations in sub-surface soil. The lead in Enyigba village usually accumulates as local concentrations in soils. Pb levels in agricultural soil ranged from 2 – 30 mg/l (Browen, 1979; Webber et al., 1984), but it is 10 – 99 mg/l with a mean of 50 mg/l in Abakaliki steam sediments (Olade, 1987). The range of lead found at chadian loamy and clay soil is 20 – 45 mg/l (Aubert and Pinta, 1997). The range of 1.05 - 251.44 mg/l obtained at Enyigba soil is low compared to the 218 - 10,900 mg/l and 51 - 21,565 mg/l recorded in urban vicinity in the U.S and in an old mining area (Chaney, 1980; Troye et al., 1980).

There was some significant variation in the quantity of zinc (Zn) recorded in the soils. The quantity found in the surface soil was higher than the concentrations in sub-surface soil but below the toxic level. The mean concentrations of 2.02 ± 0.77 mg/l and 1.39 ± 0.30 mg/l obtained in the soil of Enyigba village were low compared to the 3.43 ± 4.22 ppm and 2.28 ± 1.57 ppm, respectively obtained in surface and sub-surface soil in Itakpe Kogi state (Ezeonu et al., 2002). pH range and mean value for

Table 1. Range and mean values of lead (Pb) and zinc (Zn) in surface and sub-surface soils Enyigba, Ebonyi State, Nigeria.

Soil sample	Pb (mg/l)		Zn (mg/l)	
	Range	Mean value	Range	Mean value
Surface soil	1.0 - 251.44	23.37±0.16	1.05 - 4.77	2.02±0.30
Sub-surface soil	0.65 - 13.15	3.64±3.03	0.75 - 1.97	1.39±0.30

Enyigba soil were 6.60 – 7.06 and 7.0, respectively, indicating that the soil is neutral. The availability of nutrients for plants is directly influenced by soil pH. Since vegetables, grasses and ornamentals have been established to do best in slightly acidic soils with pH 5.8 - 6.4 (CU-DA Bulletin, 1994), it means that these categories of crop will not grow well in the study area unless something is done to reduce the pH value of the soil.

Natural soils like the one in the study area, generally do not contain phosphorus, a primary view nutrient, and may not support the growth of vegetables, certain grasses and ornamentals. To grow such crops certain measures like addition of aluminum sulphate or sulphur have to be adopted to reduce the pH value. Data obtained from this analysis compared with data in the literature showed that the soils of the people of Enyigba village were polluted with lead. The values obtained in surface soils were significantly high compared with the WHO permissible limit.

Human activities due to deposition of compost and incineration as manure including the natural occurrence of rock or ore bodies with high levels of trace elements tend to increase the lead and zinc level in agricultural soils of Enyigba village. In the absence of mining operations, increased industrial activities or augmented use of manures and commercial fertilizers, it is not likely that adverse temporal or spatial variations will occur in these soils in the near future. However, future industrial or mining activities in this area are liable to result in soil acidification by increasing input of acid atmospheric component such as sulphur dioxide and ammonium ions.

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