ISSN 2350-1030

International Journal of Recent Research in Physics and Chemical Sciences (IJRRPCS)
Vol. 9, Issue 1, pp: (1-3), Month: April 2022 – September 2022, Available at: www.paperpublications.org

Fractionation of Heavy Metals in soil from the Vicinity of a Plastic Manufacturing Company in Enugu Metropolis

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***Abstract*: Contaminated soil with heavy metals may be an environmental hazard and sources of exposure. In order to estimate the effects and potential risks associated with elevated heavy metal concentrations in the study area, the fraction of total metals that is bioavailable was identified using the modified Tessier sequential extraction procedure and the atomic absorption spectrometer (AAS). The extent of pollution of soil environment was evaluated using, contamination factor (CF), geochemical accumulation index (Igeo), pollution load index (PLI), degree of contamination (CD) and the total enrichement factor (R). Obtained results show that the mean concentration values of heavy metals were 30.404, 4.073, 339.00, 60.00, 209.00, 49.66, 27.60, 486.00, 48.10, and 0.0072 mg/kg for Fe, As, Mn, Cu, Zn, Cr, Pb, Hg, Ni and Cd respectively. The trend of metals mean concentration in the study area is Fe>As>Hg>Mn>Zn>Cu>Cr>Ni>Pb>Cd; in the control area the trend is As>Fe>Mn>Zn>Hg>Cu>Ni>Cr>Pb>Cd. The concentrations of Hg, Zn, Cu, Ni, As, and Mn in the study area exceeded the world thresholds limits of 0.05, 50, 36, 35, 0.39 and 12 mg/kg respectively according to WHO and FAO standard which poses a great risk to humans and the environment.**

***Keywords*: Heavy metals, Pollutant, Carcinogenicity, Hazard, Toxicity, Environment, Genotoxicity.**

1. INTRODUCTION

Heavy metals are substances with high electrical conductivity, malleability and luster, which voluntarily lose their electrons to form cations. Metals are found in the earth's crust and their compositions vary among different localities, resulting in spatial variations of surrounding concentrations. The metal distribution in the atmosphere is monitored by the properties of the given metal and by various environmental factors (Khalifi and Hamza Chaffai, 2010). Heavy metals are generally referred to as those metals which possess a specific density of more than 5g/cm^3 and adversely affects the environment and living organisms (Jarup, 2003).

These metals are quintessential to maintain various biochemical and physiochemical functions in living organisms when in very low concentrations, however they become noxious when they exceed certain threshold concentrations. Although it is acknowledged that heavy metals have many adverse health effects and last for a long period of time, heavy metal exposure continues and is increasing in many parts of the world (Jaishanker et al., 2013). Heavy metals are significant environmental pollutants and their toxicity is a problem of increasing significance for ecological, evolutionary, nutritional and environmental reasons (Nagajyoti et al., 2000). The most commonly found heavy metals in industrial waste water includes arsenic, cadmium, chromium, copper, lead, nickel and zinc, all of which are detrimental to human health and the environment (Lambert et al., 2000). Heavy metals enter the surroundings by natural means and through human activities.

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2. MATERIAL AND METHOD

Sampling:

Thirty soil samples of topsoil, 10cm, 20cm, 30cm and 40cm depth of soils at 20 meters, 50 meters, 100 meters away from the factory was collected with an auger (Albanese et al., 2007) and the control soil samples was collected 200 meters away from the study area. The samples were placed in clean polyethylene bags, sealed and properly labeled for easy identification, and transported to the laboratory for pre-treatment and analysis.

Sample Analysis:

The soil samples were digested in digestion hood at 200℃ for 1 hour using a mixture of 69% trioxonitrate V and 37% HCl with volume ratio of 5:1. After adding 2ml of hydrogen peroxide, to the cold digested mixture, it was filtered out through whatmans No 42 filter paper to a 100ml volumetric flask and finally diluted to the mark with distilled water. The filtrate obtained were analyzed for the total content of each heavy metal using Flame atomic absorption spectrophotometer model 210 VGP. The sequential extraction of trace elements was carried out on the principle of selective extraction as per Tessier et al (1979) while the pollution indices were calculated using relevant equations.

Statistical analysis:

The data obtained during the analysis were subjected to a limited treatment with common statistical tools, e.g. standard deviation, correlation and regression analysis. The analysis was done using standard statistical software in a P.C.

3. RESULTS AND DISCUSSION

The results of this study are shown in table 1. In this table, the concentration in mg/kg of the individual heavy metals Fe, As, Mn, Cu, Zn, Cr, Pb, Hg, Ni, Cd in soil samples from the study area as analyzed using atomic absorption spectrophotometer are presented.

Table 1: Result of the total metal analysis of soil sample from the study area

Metals	Mean (mg/kg)	SD	Range (MIN - MAX) mg/kg
Fe	30,404	37.3	23016.4 – 38458
As	4,073.1	111.6	565.92 – 789.24
Mn	339	142	22.77 – 149.94
Cu	60	16.5	19.92 - 728.25
Zn	209	193.6	75.33 - 859.95
Cr	49.66	34.7	22.77 - 170.83
Pb	27.6	7.9	9.79 - 41.08
Hg	486.6	229.3	132.7 - 5016.2
Ni	48.1	11.3	29 - 68.2
Cd	0.0072	0.02	0 - 0.09

It is found from the results that the variation of heavy metals concentration in the study area was due to irrigation of the soil with industrial waste water and other agronomic practices. The higher standard deviation reveals higher variations in heavy metal distributions from the point source of discharge to the adjacent areas. Among the different metals examined in the soil sample, the concentration of Fe was the highest and variation in its concentration was several times higher than those reported by Yaun, Y. et al (2017). Average concentration of metals in the soil samples from the study area was higher than that in the control soil samples.

4. CONCLUSION

In conclusion, all the indices more or less revealed that the study area was seriously affected by different metals. High concentrations of heavy metals in soils around industrial facilities originate from anthropogenic source which is associated with unrestricted solid release and untreated or poorly treated fluid waste from these industrial facilities. To control soil contamination, legislative measures must be taken legally binding the individual industries, forbidding discharge of untreated or poorly treated industrial effluents. Immediate steps including regular monitoring of toxic metals in the agricultural soil is needed to check the environmental quality. Waste water discharged from the industries could be recycled for the remediation of pollution in a sustainable and eco-specific way.

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