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Determination of Cd, Pb, Ni, and Cr in air-suspended dust in Yenagoa Metropolis in Bayelsa State.

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Abstract: Fine soil particles of aerodynamic diameter (less than 75 µm) can remain suspended and dynamic in the air for a long period of time and inhalation of metal-bearing dust can lead to several diseases; some severe ones are silicosis, fibrosis, lung cancer and cancer of the pleura (serous membrane that surrounds the lung). A case study was carried out in three market; Swali Market, Kpansia Market, and Tombia-junction Market (Bayelsa State) in order to assess the air quality by the basis of metal levels in ambient dust. People involved in commercial activities in such dusty markets, may be inhaling unhealthy levels of Cd, Pb, Ni, and Cr. Air samples were collected, preconcentrated on cupferron-activated carbon at pH 4.75, digested with nitric acid. FAAS measurements were carried out with a GBC AVANTA Atomic Absorption Spectrometer (model 908 BT) on acetylene-air flame. Analysis of samples from Swali Market gave 6.76 ng/m^3 of Cd, 41.51 ng/m^3 of Pb, 13.53 ng/m^3 of Ni, and 5.05 ng/m^3 of Cr. Analysis of samples from Kpansia Market gave 6.70 ng/m^3 of Cd, 40.89 ng/m^3 of Pb, 10.98 ng/m^3 of Ni, and 4.98 ng/m^3 of Cr. Analysis of samples from Tombia-junction gave 6.77 ng/m^3 of Cd, 40.66 ng/m^3 of Pb, 12.87 ng/m^3 of Ni, and 5.10 ng/m^3 of Cr. Samples were collected on market and non-market days and analyses results showed significant reduction (on 2-tailed independent-samples T Test; $p < 0.05$) on non-market days.

Key words: (Air, Metals, AAS, Atmosphere)

INTRODUCTION

Fine soil particles of aerodynamic diameter (less than 75 µm) can remain suspended and dynamic in the air for a long period of time. The creation of such particles is facilitated by wind and sun, especially when the soil surface is dry and bare (no vegetation cover). Such suspended particles may contain a lot of minerals[1]. Soil dust can be composed of minerals like feldspars, quartz, phyllosilicates in various crystalline forms, carbonates, sulfates, phosphates, salts, and heavy minerals like pyroxenes or amphiboles[2]**.** Dust particles of aerodynamic diameter smaller than 10 µm (PM_{10}), are capable of penetrating deeply into the lung passages to the tracheobronchial regions, where they also get trapped in a layer of mucus[3, 4]. However, respiratory dust (4 µm-diameter dust particles can get to the alveoli, (the gas-exchange region of the lungs [5].

The inhalation of mineral dust can lead to several different diseases, some severe ones are silicosis, fibrosis, lung cancer and cancer of the pleura (serous membrane that surrounds the lung). The absorption rates of metals via inhalation are significantly higher (up to 50-60%) than the absorption rates via ingestion (about 3-10%)[6]. Because of the high absorption rate, it is particularly important to determine toxic metals such as Cu, Fe, Cd, Pb, Cr, Ni, and Zn in air phases and food stuffs [7-9]. Swali, Kpansia, and Opolo Markets, which are the largest and busiest markets in Yenagoa Metropolis in Bayelsa State, has most of its land surface dry and bare, making it prone to wind erosion and consequently sellers and buyers stand the risk of inhaling metal-carrrying dust particles. The aim of this study was to determine the concentration of Cd, Pb, Ni, and Cr in the dust borne in ambient air.

EXPERIMENTAL

An Ati Unicam 929 Model flame atomic absorption spectrophotometer (FAAS) equipped with hollow cathode lamps. The acetylene–air flame in the FAAS was used as described in the manufacturer's instructions for the spectrophotometer. Metal stock solutions (1000 mg/L) were prepared from their nitrate salts (Merck, Darmstadt, Germany). Concentrated nitric acid (65 %, Merck) was used for the sample digestion. All of the chemicals used were of analytical reagent grade. Doubly distilled water was used in all preparations. All glass apparatus (Pyrex®) were kept permanently at full of 1 mol/L nitric acid when not in use.

Air samples were collected and prepared using the optimized method by Yaman and Gucer[10], Senkal *et al.*[11], Ince *et al.*[12]. Air samples were collected in January, through December. Volumes of air were collected by using an air blower at a flow rate of 1.0 m^3/minutes for sixty minutes and 120 minutes respectively Ni and (Pb, Cd and Cr). Adsorption suspension, cupferron-activated carbon at *pH* 4.75, was placed in a wash bottle and the air was passed in order to effect pre-concentration of the metals under investigation. 250 mL of this adsorption solution was filtered and the solid-phase on the filter paper was dried at 70 °C for one hour. The dried sample was digested with concentrated hot mixture of concentrated nitric acid/hydrogen peroxide with occasionally stirring. The acid mixture was removed by evaporation almost to dryness and 3.0 mL of 1.50 M of nitric acid was added to the residue, stirred, and centrifuged. And the resulting clear solution was obtained for analysis by FAAS GBC

AVANTA Atomic Absorption Spectrometer (model 908 BT). A mixture of standard solutions of Fe, Pb, Zn and Cu was prepared and calibration curves were generated.

RESULTS AND DISCUSSION

The FAAS analyses of samples from the markets of interest showed a monthly average of metal concentration within acceptable levels by EU air quality standards[13]. The results **(Table 1)** indicate good ambient air qualities in respect of the metals of interest for the annual average. The measured values are largely at variance with levels designated to be polluted; Pb (200 ng/m^3 – 600 ng/m^3), Ni (25 ng/m^3 – 50 ng/m^3), Cd (5 ng/m^3 – 10 ng/m^3) and Cr (5 ng/m^3 – 10 ng/m^3).

Table 1: Average Monthly metal concentration in ambient air

	Swali Market	Kpansia Market	Tombia Market
Cd	6.76	6.70	6.77
Pb	41.51	40.89	40.66
Ni	13.53	10.98	12.87
Cr	5.05	4.98	5.10

A comparative study of metal levels in the months of 2013 gave results that showed a common decrease in concentrations in May, June, July, September and October. This is attributable to wet deposition of dust caused by the rains. Generally, metal levels are higher in dry months (January, February, March, April, November and December) because there is so much dust in the atmosphere. These results are shown in Figure 1.

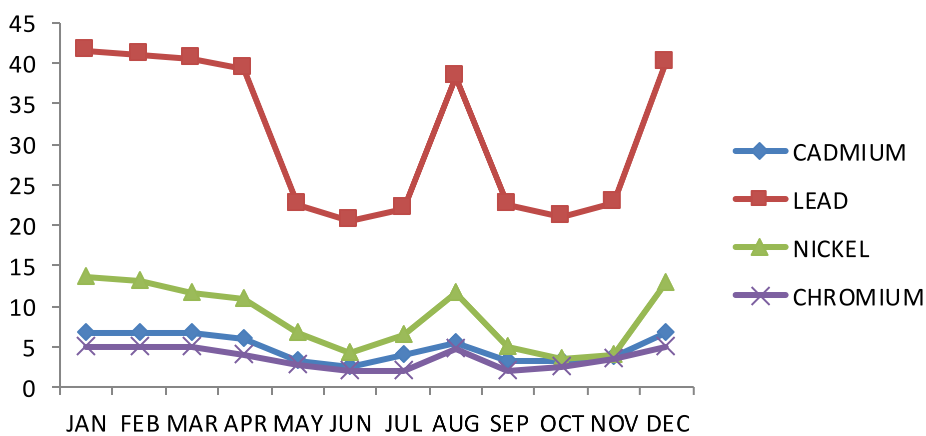

Fig. 1: Annual variation of metal levels in ambient air

Figures 2, 3, and 4 shows the analysis of samples collected on market and non-market days respectively of Swali Market, Kpansia Market and Tombia-junction Markets.

The figures show a common denominator of higher metal levels on market days compared to non-markets. These differences in metal concentration are due to high traffic movement on those days resulting in high volume of dust in the atmosphere. The significances of these differences were tested for the months January to April using a 2-tailed independent samples T Test and the results are shown in Table 2; there are significant differences between metal levels on market days and non-market days ($p<0.05$).

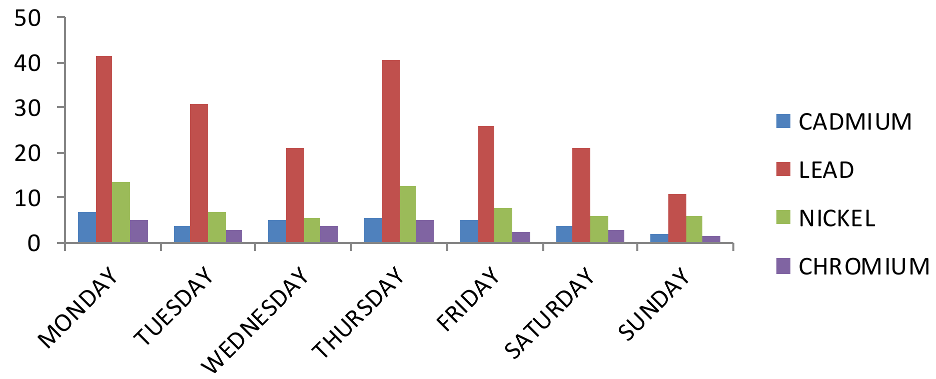

Fig. 2: Comparing ambient-air metal concentration on market and non-market days in Swali Market

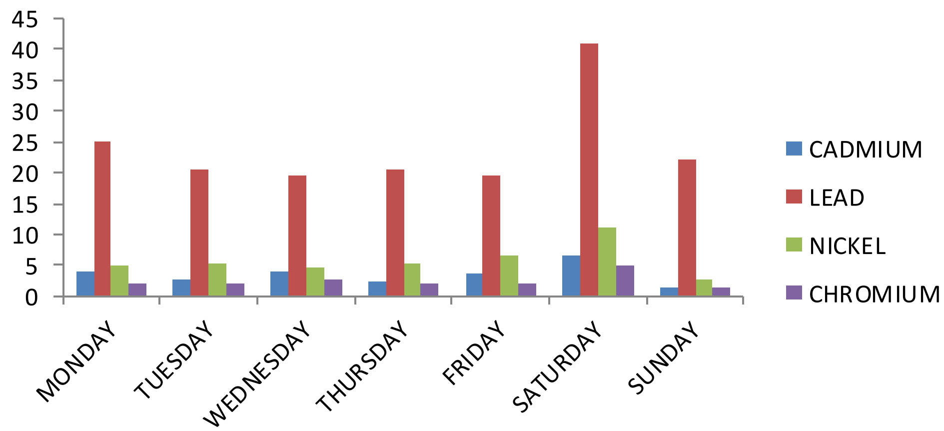

Fig. 3: Comparing ambient-air metal concentration on market and non-market days in Kpansia Market

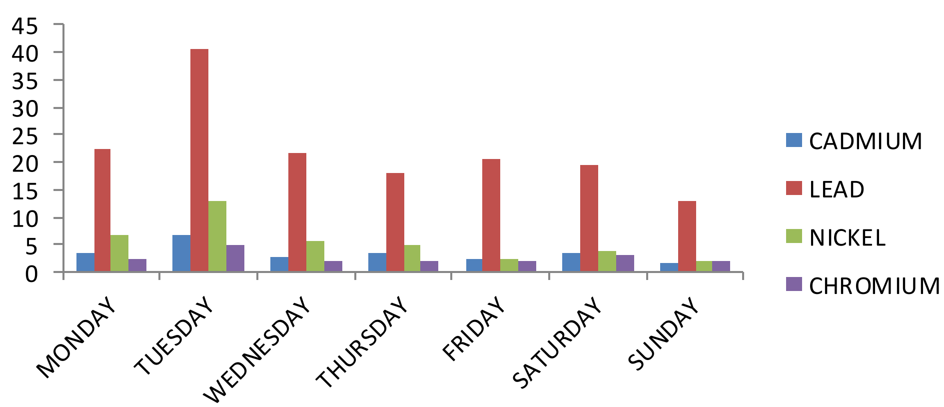

Fig. 4: Comparing ambient-air metal concentration on market and non-market days in Tombia-junction Market

Table 2: Ambient-air-metal level comparison between market days and non-market days for the three markets under study.

		N*	Sig (2-tailed) (p<0.05)
Swali Market			
Cd	Market days	2	0.073
	Non-market days	5	
Pb	Market days	2	0.008
	Non-market days	5	
Ni	Market days	2	0.001
	Non-market days	5	
Cr	Market days	2	0.041
	Non-market days	5	
Kpansia Market			
Cd	Market day	1	0.013
	Non-market days	6	
Pb	Market day	1	0.010
	Non-market days	6	
Ni	Market day	1	0.012
	Non-market days	6	
Cr	Market day	1	0.001
	Non-market days	6	
Tombia-Junction Market			
Cd	Market day	1	0.002
	Non-market days	6	
Pb	Market day	1	0.009
	Non-market days	6	
Ni	Market day	1	0.015
	Non-market days	6	
Cr	Market day	1	0.015
	Non-market days	6	

N* = number of samples. Swali market days (Mondays and Thursdays); Kpansia market day (Saturdays); Tombia-junction market days (Tuesdays)

CONCLUSION

The annual average monthly concentration of Cd, Pb, Ni, and Cr in ambient air in Yenagoa Metropolis (represented by dustiest places; Swali, Kpansia and Tombia-junction markets) are within acceptable levels in respect of EU air quality standard, that is, the atmosphere is not polluted with the metals of interest. However, significance differences exist between metal levels on market and non-market days.

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