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Assessment of pollutants Cu, Cd and Pb in heavy vehicular areas of Bauchi metropolis, north eastern: Nigeria by complexometric titration

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Abstract
Analysis of heavy metals content of air in heavy vehicular areas of Bauchi metropolis namely Awalah, Muda Lawal, Gidan Mai, Wunti, ATBU, and Central Market were carried out for some heavy metals (Cu, Cd and Pb) using complexometric titration with EDTA. Results of the analysis showed that the six sites have the following range of mean concentration: Cu 0.12-1.81mg/l, Cd 0.04-1.12mg/l and Pb 0.01-1.47mg/l. The heavy vehicular areas are significantly different from those obtained from the control site. The contamination intensity of lead were Strong very strong at Awalah, Muda Lawal, Gidan Mai, Wunti and Central Market; Cadmium and Copper were moderate strong at Muda Lawal and Central Market using geoaccumulation classification. These suggested that heavy vehicular areas contributes to heavy metals contamination of the environment.

Keywords: Heavy vehicular emission, complexometric, EDTA, geoaccumulation index, pollution

1. Introduction

Vehicular emission remains a threat to environmental health which is expected to increase reasonably as vehicle ownership increases in the world UN, (1998). Heavy metals represent a class of omnipresent pollutants, with toxic potential, in some cases even at low exposure levels, Popesscu, (2011) [1]. However, high vehicle traffic was proven to be one of the important heavy metals emissions sources. Zinc, copper and lead are three of the most common heavy metals emitted by vehicle traffic, totaling at least 90% from the total emitted quantity. Also, vehicle traffic is responsible for the emission of some small quantities of other metals, like nickel and cadmium, EPA, (2007) [7]. In urban areas the population is very numerous and the vehicle traffic is relatively high, so the exposure of people to the traffic related concentrations is significant. In most developing countries of the world vehicular growth has not been checked properly by environmental regulating authorities leading to increased levels of pollution (Han, and Naeher, 2006) [3]. This situation is alarming and is predicated on the poor economic disposition of developing countries. Poor vehicle maintenance culture and importation of old vehicles, which culminates in an automobile fleet dominated by a class of vehicles known as ‘’super emitters’’ with high emission of harmful pollutants, has raised high this figure of emission concentration (Ibrahim, 2009) [4]. Factors indicated to be responsible for the heavy metal variations in samples include wind force and direction (Soltan, *et al.* 2005) [5].

2. Materials and Methods

2.1 Study Area and Site location

Bauchi state lies between latitudes 9^{o} 3 north of the equator and longitudes 8^{o} 5 and 11^{o} 00 east of the Greenwich meridian. The study was conducted on six locations of heavy vehicular emission within Bauchi metropolis viz: Awalah, Muda Lawal, Gidan Mai, Wunti, ATBU, and Central Market and control.

2.2 Sample collection: The air samples were collected in Nov/Dec, 2013 and Jan/Feb, 2014 and the samples were collected from 7:30am – 6:30pm for the total of 5 days in each month of the years.

2.3 Sampling of Air: The absorbing device used was an adsorption tube, packed with activated charcoal and twelve centimeter, (12cm) diameter funnel. The air sampler was hanged in the locations selected for the study. In this technique, the desired gaseous contaminant in air was collected by closely contacting with the corresponding absorbent solution (H_2O_2).

The amount of the pollutant adsorbed is proportional to the surface area of the adsorbent, the physiochemical characteristic of the adsorbent, the temperature and the pressure maintained in the sampling train. When the activated charcoal was used as an adsorbent the pollutant adsorbed was leached with a suitable solvent and the solution was analyzed using Complexometric titration method (Vogel, 2006) [6].

2.4. Sample Analysis

2.4.1 Determination of Copper, Cu, using xylenol orange as indicator

25cm^3 portion of copper ion solution was pipette into 250cm^3 conical flask, 50cm^3 distilled water was used to dilute it and 3 drops of xylenol orange added. The solution turned blue, powdered hexamine was added and the solution turned red. The solution was titrated with 0.05M EDTA and the solution turned purple which showed the end point and the concentration of copper was calculated

2.4.2 Determination of Chromium, Cr, using xylenol orange as indicator

25cm^3 of the cadmium ion solution was diluted with 250cm^3 of distilled water and 3 drops of xylenol orange indicator was added, one drop of H_2SO_4 was added, where the colour of the solution turned to yellow, powdered hexamine was added with agitation until the colour turned deep red. The resulting solution was titrated with 0.05M EDTA slowly near the end point to a colour change from red to yellow. The concentration of cadmium was calculated.

2.4.3 Determination of lead, Pb, using xylenol orange as indicator

25cm^3 portion of the lead ion solution was pipitted into a 250cm^3 volumetric flask, diluted with about 25cm^3 of distilled water and 3 drops of the indicator solution were added, the colour of the solution is red, a very dilute nitric acid is added cautiously and with stirring, until the solution turned yellow, powdered hexamine was added until the colour was intensely red. The solution was titrated with EDTA solution until the colour changed to lemon yellow and the concentration of lead ion was calculated.

3. Results

Table 1: Mean concentration of heavy metal in the air samples in mg/l

	Cu	Cd	Pb
Season 1			
Awalah	0.65±0.04	0.05±0.02	0.03±0.00
Muda Lawal	1.47±0.31	0.53±0.11	1.16±0.04
Gidan Mai	0.45±0.06	0.15±0.03	0.12±0.01
Wunti	1.34±0.61	0.31±0.10	1.31±0.02
ATBU	0.67±0.11	0.34±0.00	0.56±0.01
Central Market	1.44±0.05	0.41±0.31	1.27±0.03
Control	0.12±0.03	0.04±0.01	0.01±0.00
Season 2			
Awalah	0.81±0.16	0.26±0.04	0.96±0.11
Muda Lawal	1.81±0.06	1.12±0.02	1.23±0.00
Gidan Mai	0.34±0.10	0.51±0.01	0.78±0.04
Wunti	0.64±0.04	0.36±0.00	1.47±0.05
ATBU	0.52±0.01	0.33±0.05	0.52±0.03
Central Market	1.23±0.00	0.22±0.06	1.33±0.02
Control	0.16±0.05	0.14±0.13	0.05±0.01

3.1 Contamination Index (Igeo)

To quantify the degree of pollution in the air samples the geo accumulation index (Igeo) was calculated by the relationship below

$$Igeo = \ln (Dn/1.5) \times Cn$$

Dn = measured concentration of heavy metals in the air sample in ppm

Cn = measured concentration of heavy metals in the control air sample in ppm

1.5 = background matrix correction factor.

Table 2: Geoaccumulation index of heavy metals season 1

Location		Igeo	
	Cu	Cd	Pb
Awalah	1.28	-0.18	0.69
Muda Lawal	2.10	2.18	4.35
Gidan Mai	0.92	0.91	2.08
Wunti	2.00	1.64	4.47
ATBU	1.31	1.73	3.62
Central Market	2.07	1.92	4.44

Table 3: Geoaccumulation index of heavy metals for season 2

Location		Igeo	
	Cu	Cd	Pb
Awalah	1.22	0.21	2.55
Muda Lawal	2.02	1.67	2.80
Gidan Mai	0.35	0.88	2.34
Wunti	0.98	0.54	2.98
ATBU	0.77	0.45	1.94
Central Market	1.63	0.04	2.88

Table 4: Geoaccumulation classification

Geoaccumulation Index Igeo	Igeo class	Contamination intensity
>5	6	Very strong
>4-5	5	Strong – very strong
>3-4	4	Strong
>2-3	3	Moderate - strong
>1-2	2	Moderate
<0-1	1	Uncontaminated - moderate
<0	0	Practically uncontaminated

(Agyarko *et al*, 2010) [2]

The result of Table shows that the heavy metals concentration with the highest value are Cu (1.47 mg/l) Cd (0.53 mg/l) and Pb (1.16 mg/l) all at Muda lawal market.

Table shows that the heavy metal concentration with highest being Cu (1.81mg/l) at Muda lawal, Cd (1.12 mg/l) at Wunti and Pb (1.48mg/l) at Muda lawal.

4. Discussion

Copper is an essential micronutrient required by plant and animals for their growth. The normal range of copper falls within 1.12- 1.18mg/l. The result of the geoaccumulation index computed showed the pollution intensity was moderate-strong at Muda Lawal and Central Market; moderate at Awalah, Wunti, and ATBU; Uncontaminated – moderate at Gidan Mai for season 1. While moderate- strong at Muda Lawal; moderate at Awalah and Central Market; Uncontaminated – moderate at Gidan Mai, Wunti and ATBU for season 2.

Cadmiun is a toxic metal having neither in human body nor in animals or plant it is present in fossil fuel such as coal and oil. This present study indicates the mean concentration of range of cadmium in the sample of air falls within 0.53-1.12mg/l. The result of the geoaccumulation index computed showed the pollution intensity was moderate- strong at Muda Lawal, moderate at Wunti, ATBU and Central Market, Uncontaminated – moderate at Gidan Mai, Practically uncontaminated at Awalah, for season 1. While moderate at Muda Lawal; Uncontaminated – moderate at Awalah, Gidan Mai, Wunti, and ATBU; Practically uncontaminated at Central Market.

Lead is mostly found in automobile batteries in sufficient amount. This present study indicates the mean concentration of range of cadmium in the sample of air falls within 1.16-1.48mg/l. The result of the geoaccumulation index computed showed the pollution intensity was Strong-very strong at Muda Lawal, Wunti, and Central Market, Strong at ATBU; moderately strong at Gidan mai and Uncontaminated – moderate at Awalah for the first season. For the second season, moderately strong at Awalah, Muda Lawal, Gidan Mai, Wunti and Central Market; Moderate at ATBU.

Conclusion

The results of the metal for Cu only Gidan Mai showed strong correlation; for Cd only Gidan Mai and ATBU showed strong correlation and for Pb only ATBU and Central Market showed strong correlation.

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