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HEAVY METALS PRESENCE IN STREET DUST OF IKEJA AREA OF LAGOS - STATE, SOUTHWESTERN - NIGERIA.

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ABSTRACT

This research reports the results of Heavy metals content of Street dust in Ikeja Area of Lagos state. The dust samples were collected randomly four times a month August - December, 2021 at ten different locations in Ikeja Area. Samples were obtained by sweeping surface dust into plastic waste packer using plastic brush and transferred into pre-labeled polythene bags. The samples collected at each location were filtered through 75 µm stainless steel sieve, weighed and digested with appropriate amount of HNO_3 and H_2O for 2 hours. The concentrations of Heavy metals were analyzed using using Atomic Absorption Spectrophotometer (AAS) PG - 990. Results of the analysis showed that the percentage contribution of each Heavy metal at Ikeja Area were: Zn - 62.12 %, Pb - 26.47 %, Cu- 8.34 %, Ni - 2.23 % and Cd - 0.84 % . The most abundant pollutant Heavy metal was Zn - 2445.53 mg/kg while the least was Cd - 33.1 mg/kg. The most polluted site is Ikeja Industrial Area (ll) - 654.48 mg/kg while the least polluted site is Ayodele Diyan Street (AL)- 150.50 mg/kg with percentage contributions 16.60 % and 3.82 % respectively. The sequence and distribution follows the pattern : Zn > Pb > Cu > Ni > Cd . There is a significant difference in the levels of each heavy metal in the dust of Ikeja ($P_v < 0.05$). The concentration of Heavy metal obtained exceeded the recommended limits of the Federal Ministry of Environment (FME), European communities (EC) and United Nations Environmental Programme (UNEP) permissible level for Heavy metals in the dust suggesting that the study area is polluted.

KEYWORDS: Dust, Environment; Atomic Absorption Spectrophotometer (AAS), Significant difference (SD).

INTRODUCTION

The presence of Heavy metals (Zn, Pb, Ni, Cu and Cd) in the environment beyond the acceptable limits is a serious concern to the environmentalists. Dusts are fine solid particles. It consists of particles in the atmosphere from various sources such as soil, dust lifted by wind and pollutions. Street dust is a fine powder inform of fine sand or earth which can be found in the street. Direct inhalation of the fine dust by people traversing the streets and those residing in the vicinity could be by ingestion through hand-to-mouth, eating poorly washed fruits and vegetables and dermal exposure are the routes of human exposure to road dust (Lorenzo *et al.*, 2011). Street dust being a useful indicator of environmental quality in urban area was used to determine heavy metals in street dust.(Amato *et al.*, 2009; Lu *et al.*, 2010). Street dust contamination has received much attention in recent years (Sezgin *et al.*, 2004; Jiries (2003)). The term Heavy metal may refer to any metallic substance with relatively high density and such a substance is toxic at low concentrations. Although, Heavy metals are naturally occurring elements that are found in the earth's crust, most environmental contamination and domestic and agricultural use of metals and metal-containing compounds (Herawati *et al.*, 2000 and He *et al.*,2005). Examples of heavy metals include inc(Zn), Nickel (Ni),Copper (Cu), M*ercury* ***(Hg),*** Cadmium ***(Cd) ,*** Chromium ***(Cr),*** Thallium ***(Tl), and*** Lead ***(Pb).*** Heavy metals are group of non-biodegradable pollutants. They are not readily detoxified and removed by metabolic activities once they are available in the environment. This may subsequently lead to their buildup to toxic levels or bioaccumulation in the ecosystem (Lawal *et al.,* 2011). Heavy metals are natural components of the earth's crust. Reported source of heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric source (He *et al.,* 2005). They cannot be degraded or destroyed. Heavy metals are dangerous because they tend to bio-accumulate (Bawuro *et al.,* 2018). To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g Copper, Lead, Zinc) are essential to maintain the metabolism of the human body.

However, at higher concentrations they can lead to poisoning. Heavy metals can thus penetrate into the human body and pose a great threat to human (Aeolian *et al.,* 2008; Lu *et al.,* 2010). Anthropogenic activities release significant amount of harmful pollutants such as heavy metals, the presence of which above the threshold limits in the atmosphere poses adverse ecosystem and human health threats (Wolterbeek, 2002). For example, human exposure to heavy metals can result in a variety of negative health effects such as cancer and kidney disorder (Itoh *et al.,* 2014; Lin *et al.,* 2013**).** Heavy metals in street dust may originate from anthropogenic sources such as petroleum, diesel and coal combustion, as well as industrial activities and natural geochemical processes such as weathering (Liu *et al.*,2007; Mostafa *et al.,* 2009). Some heavy metals are nutritionally essential for a healthy life whereas large amounts of any of them may cause acute or chronic toxicity (Coen *et al.,* 2001). However, some others (like As, Cd, Pb, and methylated forms of Hg) have been reported to have no known bio - importance in human biochemistry and physiology and consumption even at very low concentrations can be toxic (Jomova and Valko, 2010). Although, there are enormous studies on the levels of Heavy metals on Street dust in the world (Kui, Cai and Chang, Li (2019), Lu *et al.,* 2010; Ahmed *et al.*,2015, Faiz *et al.*,2009; Al – Khashman (2004) & (2007); Addo *et al.,* 2012) but currently there are little or no literature on Heavy metals on Street dust in Lagos State, particularly in Ikeja Area. Therefore, the main objectives of the present study were to : (1) assess and evaluate the levels of Heavy metals on Street dust of Ikeja Area (2) determine the baseline levels of Heavy metals (3) determine whether there are significant differences in the levels of Heavy metals in each of the study areas. It is hopeful that this study will provide the percentage contributions of each Heavy metal to pollution in Ikeja.

Table 1 : Sampling sites, Characteristics and their Coordinates in Ikeja Area.

LOCATION/ SITES	CODE	LATITUDE	LONGITUDE	SITE DESCRIPTION
Ojulowo street	OS	N6.59644	E3.3412	It is a residential area with a micro finance bank, carpentry, spraying and painting workshops. Smoking of cigarette and marijuana is also prominent on this street.
Abeokuta street	AS	N6.59876	E3.33924	It is a residential Area with low human activity.
Oyelola street	OYS	N6.59793	E3.33719	It is a residential area with high commercial activities, there are Mechanic workshops.
Awolowo road	AR	N6.59607	E3.33853	It is a major road with high commercial activities such as sales of cellular phone stores, fast food joints, Car spare parts shops and high vehicular activities.
Ikeja under bridge	IUR	N6.59644	E3.3412	It is a major road with high commercial activities such as sales of cellular phone stores, fast food joints, spare part stores, hairdressing salons and vehicular activities and smoking is also prominent under bridge.
Agege Motor road	AMR	N6.59547	E3.33583	It is an major express road with high commercial and vehicular activities.
Ladipo Oluwole street	LOI	N6.61489	E3.34084	It is an industrialized area with industries such as Mouka foam, Chelsea gin, pure water production lots of ware houses.
Oba Akran road	OAI	N6.61027	E3.33603	It is an industrialized area with industries such as Dangote, Newbisco, Nigerite, textile production companies, vita foam, Guinness and lots of banks and high vehicular activities
Ayodele Diyan street	AI	N°6.6132	E°3.34174	It is an industrial area with no commercial activities
Ikeja Industrial area	II	$N^0$6.61104	$E^0$3.33761	It is an industrialized area with most industries.
YCT Botanical garden (control)	BG (CTL)	$N^0$6.51626	$E^0$3.37369	There is little or no Anthropogenic activity. A site where different agricultural crops and plant are grown.

MATERIALS AND METHOD

Selection of Sampling Sites

The eleven sites including the control site were carefully chosen based on accessibility, availability of open spaces and of course area with maximum influence from anthropogenic activities such as vehicular traffic density, human activities as well as industrial activities. The geo-referencing was carried out by using GPS MAP 76S (Garmin).

Sampling Location

The study was conducted in the following areas of Ikeja (N°6.61489 and E°3.34174 - N°6.59547 and E^0 E°3.3363) Lagos State which include the residential areas : Ojulowo street (OS), Abeokuta street (AS) and Oyelola street(OYS) ; Major roads - Agege motor road (AMR), Awolowo way (AR) and Ikeja under bridge (IUR) and Industrial Areas - Ladipo Oluwole Street
LOI), Ayodele diyan street (AI), Oba Akran Industrial Area (OAI) and Ikeja Industrial Area (II).

Sample Collection

Dust samples were collected from eleven sites within the study area, at least 100m apart, four times a month from August to December, 2021. Samples were collected in the morning while the dust has settled well throughout the night and before heavy morning traffic movement that can disrupt the dust. The samples were randomly collected from both sides of the road by sweeping surface dust into plastic waste packers using plastic brush and transferred into pre- labeled polythene bag. All irrelevant materials such as cigarette ends, papers, plastics etc. were carefully hand-picked. Thereafter, samples collected at each location were filtered through 75µm stainless steel sieve. The samples were then taken to the laboratory for further treatment and analysis.

PREPARATION AND ANALYSIS OF ROAD SIDE STREET DUSTS

Digestion of dust Samples for Heavy Metals

2.0g of sieved dust was weighed using an analytical balance and transferred into a conical flask for digestion. 30ml nitric acid and 10ml concentrated hydrochloric acid prepared in the ratio 3:1 was added. The solution was mixed thoroughly and heated on magnetic heated stirrer, then refluxed at 90ºc for 20minutes. After the disappearance of brown fumes, the digested solution was cooled and then filtered through Whatman type 589/2 filter paper. The filtrate was diluted to $50cm^3$ with de-ionized water. The metal contents in the filtrate were determined using an atomic absorption spectrophotometer (AAS) PG-990.

STATISTICAL ANALYSIS

Data were analyzed using SPSS version 20.0 Results were expressed as mean ± standard deviation. Student t-test and ANOVA was used to test for the difference in mea values between groups.

Table 2: Heavy metals content in street dust from Industrial Areas in Ikeja (mg/kg).

Locations	Pb Mean ± SD	Zn Mean ± SD	Cu Mean ± SD	Cd Mean ± SD	Ni Mean ± SD
IUR	50.81 ± 0.12^c	173.51 ± 13.18^b	23.94 ± 4.77^b	2.97 ± 0.80^b	6.73 ± 1.18^b
AMR	39.96 ± 2.48^b	343.59 ± 16.15^d	38.67 ± 2.82^c	2.31 ± 0.43^b	7.52 ± 0.84^b
AR	93.33 ± 2.45^d	214.86 ± 4.17^c	15.91 ± 2.05^b	0.07 ± 0.03^a	7.75 ± 0.15^b
C	0.95 ± 0.46^a	3.43 ± 0.23^a	0.74 ± 0.06^a	0.04 ± 0.00^a	0.04 ± 0.01^a
F – Statistics	$F_{3,8}$ = 466.132; $p < 0.001$	$F_{3,8}$ = 174.487; $p < 0.001$	$F_{3,8}$ = 28.737; $p < 0.001$	$F_{3,8}$ = 11.205; $p = 0.003$	$F_{3,8}$ = 25.473; $p < 0.001$

NB: Industrial areas with the same superscript across heavy metals are not significantly different at 5%

Table 3: Heavy metals content in street dust from Major roads in Ikeja (mg/kg).

Locations	Pb Mean ± SD	Zn Mean ± SD	Cu Mean ± SD	Cd Mean ± SD	Ni Mean ± SD
OAI	101.36 ± 5.89^a	476.12 ± 5.89^d	44.60 ± 5.89^c	1.19 ± 0.01^c	12.39 ± 0.69^d
II	378.60 ± 69.40^b	217.32 ± 11.66^c	25.05 ± 1.85^b	22.96 ± 0.12^d	10.54 ± 0.69^{cd}
AI	20.99 ± 4.46^a	98.73 ± 0.69^b	19.05 ± 0.12^b	0.86 ± 0.01^b	9.12 ± 0.69^{bc}
LOI	55.63 ± 0.64^a	206.23 ± 5.89^c	37.41 ± 0.69^c	0.15 ± 0.01^a	7.61 ± 0.69^b
C	0.95 ± 0.46^a	3.43 ± 0.23^a	0.74 ± 0.06^a	0.04 ± 0.00^a	0.04 ± 0.01^a
F – Statistics	$F_{4,10}$ = 24.373; $p < 0.001$	$F_{4,10}$ = 761.668; $p < 0.001$	$F_{4,10}$ = 37.623; $p < 0.001$	$F_{4,10}$ = 37087.285; $p < 0.001$	$F_{4,10}$ = 58.937; $p < 0.001$

NB: Industrial areas with the same superscript across heavy metals are not significantly different at 5%

Table 4: Heavy metals content in street dust from Residential Areas in Ikeja (mg/kg).

Locations	Pb Mean ± SD	Zn Mean ± SD	Cu Mean ± SD	Cd Mean ± SD	Ni Mean ± SD
OS	99.91 ± 1.06^c	221.3 ± 0.56^c	17.08 ± 0.19^b	0.59 ± 0.06^b	6.49 ± 0.41^b
OYS	39.28 ± 0.38^b	224.75 ± 0.84^c	74.41 ± 1.42^d	1.57 ± 0.05^c	9.94 ± 0.51^c
AS	162.03 ± 1.44^d	119.88 ± 43.68^b	32.86 ± 0.70^c	0.71 ± 0.31^b	10.00 ± 0.36^c
C	0.95 ± 0.46^a	3.43 ± 0.23^a	0.74 ± 0.06^a	0.04 ± 0.00^a	0.04 ± 0.01^a
F – Statistics	$F_{3,8}$ = 5605.463; $p < 0.001$	$F_{3,8}$ = 22.928; $p < 0.001$	$F_{3,8}$ = 1577.788; $p < 0.001$	$F_{3,8}$ = 158.023; $p = 0.001$	$F_{3,8}$ = 25.473; $p < 0.001$

NB: Residential areas with the same superscript across heavy metals are not significantly different at 5%

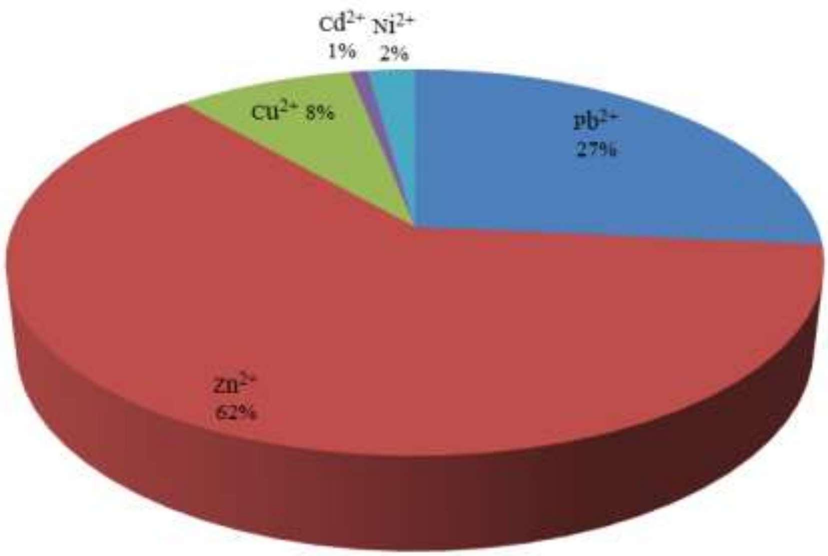

Figure 1: Percentage contribution of Heavy Metals in Ikeja Area

Table 5: *Mean concentration of Heavy metals in street dusts of Ikeja and other selected cities of the world (mg/kg).*

CITY	Pb	Zn	Cu	Cd	Ni
Ikeja (this study)	**104.37**	**244.95**	**32.90**	**3.31**	**8.81**
Ottawa (Rasmussen *et al.*, 2001)	68.00	184.00	188.00	19.00	0.60
Madrid (De Miguel *et al.*, 1997)	1927.00	476.00	188.00	144.00	-
Oslo (De Miguel *et al.*, 1997)	180.00	412.00	123.00	41.00	1.40
Mutah (Manasreh *et al.*, 2010)	143.00	132.00	69.00	1.70	1.30
London(Schwar *et al.*, 1988)	1030.00	680.00	155.00	-	3.50
Kuala Lumpur (Ramlan *et al.*, 1988)	2466.00	344.00	35.50	-	2.90
Birmingham(Charlesworth *et al.*, 2003)	48.00	534.00	466.90	41.10	1.60
Amman((Jiries (2003))	976.00	401.00	249.60	16.30	1.10
Kavala(Christoforidis *et al.*, 2009)	386.90	354.80	172.40	67.90	0.20
Tehran (Mohsen *et al.*, 2012)	257.40	873.20	225.30	10.70	34.80

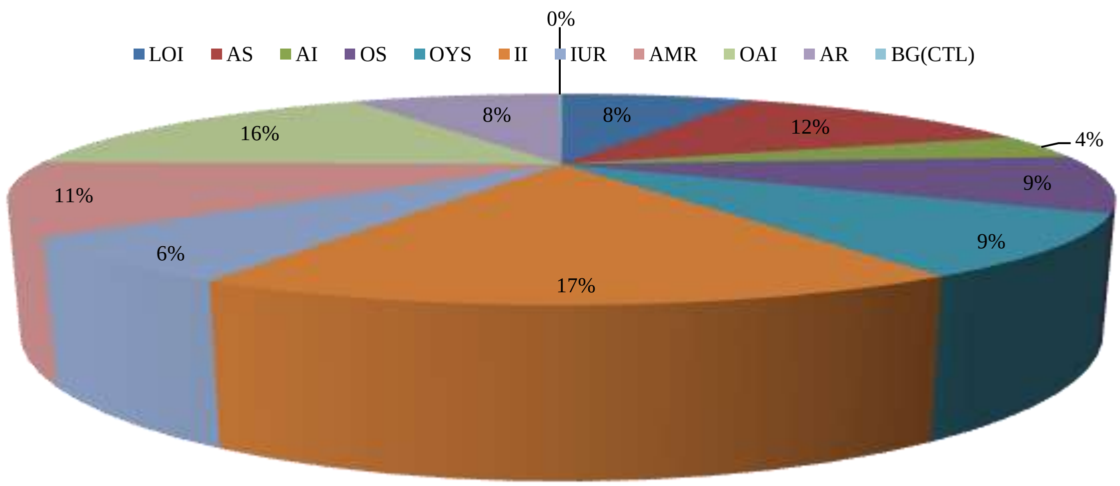

Figure 2: *Percentage contribution of each site to pollution in the study Area.*

Figure 3: *GIS Map showing the levels of Heavy metals in Ikeja Area.*

RESULTS AND DISCUSSION

Table 6: Mean Concentration of Heavy Metals (mg/kg) of all the sites in Ikeja Area for August - December, 2019.

Sample Location/ Sites	Pb	Zn	Cu	Cd	Ni	Total	Percentage %
LOI	55.70	206.23	37.41	0.155	7.61	307.09	7.78
AS	162.03	273.11	32.86	0.44	10.00	478.43	12.13
AI	22.38	98.73	19.05	0.86	9.12	150.50	3.82
OS	99.915	221.30	17.08	0.59	6.49	345.37	8.76
OYS	39.30	224.75	74.41	1.57	9.94	349.97	8.87
II	378.60	217.32	25.05	22.96	10.54	654.48	16.60
IUR	50.81	173.51	23.94	2.97	6.73	257.95	6.54
AMR	39.96	343.59	38.66	2.31	7.52	432.05	10.96
OAI	101.36	476.12	44.60	1.196	12.39	635.66	16.12
AR	93.33	214.86	15.91	0.07	7.75	331.91	8.42
BG(CTL)	0.80	3.25	0.57	0.12	0.02	4.77	0.12
Total	1043.73	2449.53	328.97	33.10	88.09	3943.41	
Average	104.3727	244.96	32.90	3.31	8.81		
Percentage %	26.47	62.126	8.34	0.84	2.23		

The most polluted site in Ikeja is Ikeja Industrial Area- 654.48 mg/kg; 16.60 %. This is as a result of anthropogenic activities going in and around the site such as the release of gases from near by industries, fumes from generators and numerous heavy duty vehicles / traffic and commercial activities in and around the site while the least polluted site is Awolowo road 150.50 mg/kg ; 3.82 %. The most abundant heavy metals is Zinc - 2449.53 mg/kg; 62.12 % while the least abundant heavy metal is Cadmium- 33.10 mg/kg ; 0.84 % (Figure 1). This can be attributed to the versatile use of Zinc in form of Zinc oxide present in paints, rubber tyres, cosmetics, pharmaceuticals, wearing of brake lining of vehicules, lossess of oil and cooling liquids from automobile, corrosion of galvanized steels, scrap iron bars, and improper disposal of industrial waste in the area. There is a significant difference in the levels of Zinc metal in Ikeja Industial Area compared to other sites. The highest heavy metals Zn -476.12 mg/kg ; Cu- 44.60 mg/kg and Ni- 2.39 mg/kg were recorded at Oba Akran Industrial site while the highest concentration of Pb - 378.60 mg/kg and Cd - 22.93 mg/kg were recorded at Ikeja Industrial site. The highest presence of lead in Ikeja Industrial site may be due to the high Industrial, commercial, automobile and vehicular activities in the area, spillage of petroleum products, smoking of cigarettes, paint chips from the walls of industrial buildings, careless discards of lead acid batteries used in automotive as well as the use of industrial grade and non-domestic paints by the surrounding industries. The level of Lead in Ikeja Industrial site significantly different ($p < 0.05$) from all other sites. The highest concentration of Copper and Nickel at Oba Akran Industrial site may be due to the manufacturing of electrical cables, mining of metal, production of cans and the use of pesticides, combustion of fossil fuels, smelting of metals, vehicular emission, traffic congestion and industrial processes that uses these metals or their compounds fuel combustion from generators as well as frequent bush burning in that surrounding. The level of Nickel at Oba Akran Industrial site is significantly different from all other sites ($p < 0.05$). At the Industrial Areas, the highest concentration of Zn - 476.12 mg/kg; Cu- 44.60 mg/kg and Ni- 12.39 mg/kg were recorded at Ikeja Industrial Area (II) while the concentrations of Pb-378.60 mg/kg and Cd-22.96 mg/kg were recorded at Oba Akran Industrial Area (OAI) (Table 2). At the Major roads, the highest concentration of Pb - 93.33 mg/kg and Ni- 7.75 mg/kg were recorded at Awolowo road (AR). Similarly, Zn - 343.59 mg/kg and Cd- 2.97 mg/kg were recorded at Ikeja under bridge (IUR) while the highest concentration of Cu - 38.67 mg/kg were recorded at Agege motor road (AMR) (Table 3). At the Residential Areas, the highest concentration of Zn - 224.75 mg/kg; Cu- 74.41 mg/kg and Cd - 1.57 mg/kg were recorded at Oyelola street (OYS) while the concentrations of Pb-162.03 mg/kg and Ni -10.00 mg/kg were recorded at Abeokuta street (AS) (Table 4). There is a significant difference between the levels of Zn, Pb, Cu, Cd and Ni in Industrial, Major roads and Residential Areas ($P_V < 0.05$). There were progressive increase in the level of bioaccumulation of these heavy metals from August to December, 2019. The high significant levels of Zn, Pb and Cu obtained in the samples from Ikeja is an indication of their concentration in the dust while the low concentration of Cadmium Cd and Nickel Ni suggest low contributing factors to their spread and as well as dust inability to preferentially accumulate these metals (Table 6). There is significant variation in the level of heavy metals in the study area. ($P_v < 0.05$) (Table 1).

The pattern of distribution and degree of bioaccumulation of Heavy metal content of Ikeja dust is as follows: Zn > Pb > Cu > Ni > Cd, with the mean concentration of - 244.95, 104.37, 32.90, 8.81 and 3.3 mg/kg respectively (Figure 3). The trend and percentage contribution of each site to pollution of Ikeja dust is as follows: II – 16.60 % > OAI -16.12 % > AS-12.13 % > AMR -10.96 % > OYS - 8.87 % > OS- 8.76 % >AR- 8.42 % > LOI- 7.78 % > IUR- 6.54 % > AL- 3.82 % > BG(CTL) -0.13 % (Figure 2). The result of this research agrees with the results obtained in some Nigerian cities and other cities in the world.

The results also showed that concentration of Heavy metals depends on the nature of activities in the sites (Adie *et. al.* 2014 ; Ekpo *et. al.*, 2012 ; Mohsen *et al.*, 2012; Christoforidis *et al.*, 2009; Lu *et al.*, 2010; Karbassi *et al.*, 2005 ; Ojiodu *et. al.*, 2017; 2018a, 2018b).

Though, the concentrations of Zinc and Nickel in Ikeja dust is high compared to the levels in other cities of the world but Lead , Cadmium and Copper levels are Comparable (Table 5). This may be due to differences in vehicular and human activities (burning / dumping of waste), environmental management policies and technologies employed, frequency of city street cleaning and local meteorological conditions such as rains, temperature, windspeed which can affect the Heavy metals in the dust (Mohsen *et al.*, 2012). The level of heavy metals in the study area were far greater than the recommended limits of the Federal Ministry of Environment (FME), European Communities (EC) and United Nations Environmental Programme (UNEP) permissible level for heavy metals in the atmosphere (EC, 2006).

The concentration of heavy metals in all the sites was higher than the control value(Table 6). This may be due to the fact that the control environment is an area with little or no anthropogenic activity.

CONCLUSIONS

The high levels of Zn - 62.12 %, Pb - 26.47 %, Cu- 8.34 %, Ni - 2.23% and Cd - 0.84 % obtained in the dust samples from Ikeja area could be attributed to the emission originating from gases released from near by industries, wearing of brake lining, lossess of oil and cooling liquids, corrosion of galvanized steels, scrap iron bars, wearing of tyres, improper disposal of sewage, industrial waste, vehicular / commercial activities and industrial processes that uses these metals or their compounds within and around Ikeja area . The low concentration of Cadmiun Cd suggest low contributing factors to their spread and as well as the dust inability to preferentially accumulate this metal. Therefore, there is need for constant environmental Monitoring of the Ikeja due to the high concentration heavy metal pollution which could be very hazardous to human and plants existence.

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