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Determination of The Concentration of Selected Heavy Metals in Dust Particles Within The Automobile Brownfield Areas of Damaturu L.G.A, Yobe State, Nigeria

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ABSTRACT

This research work studied determination of the concentration of selected heavy metals in dust particles within the automobile brownfield areas of Damaturu L.G.A, Yobe state, Nigeria. Dust samples were collected from selected automobile workshops sites (Maiduguri, Gujba, Potiskum and Gashua road) in Damaturu, Yobe State at different locations (A,B,C, D and E). Heavy metals such as Pb, As, Se, Fe and Cd were determined. A Simple Random Sampling method was adopted for the study. Further analysis were carried out using mean standard deviation and ANOVA. Mean concentrations of heavy metals in dust samples ($mgkg^{-1}$) ranged from 1.24 ± 0.40- 8.65 ± 0.51, 0.58 ± 0.63 - 2.31 ± 0.31, 1.62 ± 0.06 - 29.18 ± 0.84, 1.08 ± 0.32- 80.52 ± 1.31, 0.66 ± 0.41 – 5.38 ± 0.38 for Pb, As, Se, Fe and Cd respectively.

To evaluate the significance of heavy metals concentration of dust in the study area, ANOVA ($P>0.05$) was conducted involving different variations in contamination across the sites (A, B, C, D and E) as samples were collected and variations across the various sites were also recorded. The analysis of variance for heavy metals concentration in dust was also found to be significant ($P>0.05$) at all the location except Arsenic at site B. Highest concentration was recorded at sites A, C, D, and E for Lead (Pb), Arsenic (As), Selenium (Se), Iron (Fe) and Cadmium (Cd) respectively. Although, the main source of these heavy metals is the exhaust from motor vehicles. Other sources such as road side deposition of motor engine oil, battery wastes, car tires, the presence of iron benders, welders and electricians discharging metals with the environment and indiscriminate dumping of refuse on the environment could also contribute significantly.

The results indicated that dust qualities varied between slightly contaminated to highly polluted status. This showed that the heavy metal contamination of the dusts do not call for an alarm; however proactive measures must be taken to minimize accumulation of these metals in the environment. The study recommended that a healthy environmental talk should be given to automobile operators to enhance their performance by ensuring safety in their practices. Orientation on safe waste handling and disposal methods should be given from time to time and automobile workshops should be assessed regularly to ensure compliance to environmental rules and regulations in order to avoid health related problems as a result of excess exposure.

Keywords: Heavy metals, Dust, Concentration, Particles, Automobile, Workshops

INTRODUCTION

Dusts are tiny solid particles scattered or suspended in the air. The particles are "inorganic" or "organic", depending on the source of the dust. The inorganic dusts can come from grinding metals or minerals such as rock or soil, example are silica, asbestos, and coal. The organic dusts originate from plants or animals; an example of organic dust is dust that arises from handling grain. These dusts can contain a great number of substances. Aside from vegetable or animal component, organic dusts may also contain fungi or microbes and the toxic substances given off by microbes (Verma, 2018). In an industrial city the air may contain more than 3 million particles per cu cm (more than 50 million per cu in), but above the middle of the ocean or in high mountains the count may be just a few thousand per cu cm. Dust consist of solid matter or particulate in the form of fine powder (less 100 μm), lying on the ground or on the surface of objects or blown about by natural forces or mechanical forces (Adekola & Dosumu, 2001). The size of dust particles varies from about half a micrometer to several times this size. The particles remain suspended in the air for long periods of time and may be carried great distances. Therefore, the urban environment is composed of varying concentrations of trace elements from a vast array of anthropogenic sources as well as from natural geochemical processes (Shakourn & El-Table, 1995).

The increase in heavy metal concentration of the ecosystems in Nigeria is attributed to an increase in automobile activities (Adewole & Uchegbu, 2010). These automobile workshops are found in clusters of open plots of land in the vicinity of urban towns and cities (Nwachukwu et al., 2010, & 2011). Within the clusters are people who specialize in electrical aspects of auto repairs, while others engage in repairs of brakes and steering, automatic or standard transmission engine, and spray painting, recharging of auto batteries, welding and soldering etc. Each of these activities generate various types of waste (gasoline, diesel, used engine oil and paint) which are disposed off or surrounding areas. Pollution effects of mechanic site activities in Nigeria have received limited attention even though these activities have been shown to produce harmful wastes. Therefore, there is need to continually monitor their nature, volume, direct harmful effects and current methods of disposal as well as potential impacts on the environment (Udebuani et al. 2011). These heavy metals pose a greater risks for human health and the environment. Heavy metals are usually non-degradable and their homeostasis mechanism is not well understood. Thus, elevated levels of heavy metals are a potential threat to life. They may accumulate in the fatty tissues of the human body and affect the central nervous system. They may also disrupt the normal functioning of the body's internal organs and sometimes act as cofactors in other diseases (Tong & Lam, 2000).

Due to accelerated industrialization and urbanization, nearly half of the population in the world now lives in urban agglomerations. These intensive activities resulted in increasing quantities of contaminants into the urban environment. Consequently, a variety of environmental problems have cropped up and toxic metal pollution has become a major issue, especially in urban air, soils and road dust (Bilos et al., 2001; Madrid et al., 2002; Han et al., 2006). Toxic metals in urban areas are a subject of great concern, due to their non-biodegradable nature and long residence time. The prolonged presence of the contaminants in the urban environment, particularly in road dust, and their close proximity to the human population significantly increase the exposure of the urban population to metals via inhalation, ingestion, and dermal contact (Mielke et al., 1998; Abrahams, 2002). Dust composition has a potential effect on human health. Urban surfaces receive deposits from sources such as vehicular emissions, industrial discharges, domestic heating, waste incineration, and other anthropogenic activities through atmospheric transport and local activities (Bris et al., 1999; Christoforidis & Stamatis, 2009; Glorennec et al., 2012; Mingkui & Hao, 2009). Both outdoor and indoor dust have different compositions and are likely to pose health problems through direct inhalation (principally the finest particle sizes e.g. <10 μm) and unintentional consumption due to hand-to-mouth contact by children.

Various studies have identified the sources and impacts of heavy metals, for example, Hossain (2006). Maria-Ema, et al. (2012); Calderon et al. (2013) reported that pregnant women and children are the most susceptible to the negative health impacts of heavy metals. Pb, for example, has a wide range of sources of exposure especially, through human activities such as mining, burning fuels and industrial processes (WHO, 2014). It is also found in petrol, paints, battery production, solders, stained glass making, some cosmetics and traditional medicines and when lead pipes are being used for water delivery (WHO, 2014). There have been efforts at the international level to eliminate these heavy metals in products and processes, for example, Global Alliance to Eliminate Lead

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Paint, Global Mercury Partnership, Bamako Convention, Basel Convention. In many developing countries because of the economic situation, latest technologies designed to reduce exposure to these heavy metals are not affordable or available. Furthermore, deficiencies in enforcement as in the case across sub-Saharan Africa (SSA) and Nigeria have led to importation and usage of obsolete technologies and even banned (across many high income countries) products/chemicals. This has further exacerbated exposure to heavy metals and other contaminants across the region. It has therefore become imperative to determine the levels of these heavy metals concentration in dust particles within the automobile mechanic clusters in Damaturu, Yobe state. The increase in the number of mechanic workshops and activities in Nigeria due to the large inflow of 'Fairly Used' vehicles into the country in the late 1990s have contributed greatly to the pollution experienced within and around these workshops. Several studies have been carried out on soil and street dust from industries and some manufacturing companies while very little research has been carried out on dust particles and its concentration in automobile workshops. Therefore, there is no record of research on the concentration of heavy metals in dust particles in the study area. By considering the above statement, there is the need to determine of the concentration of selected heavy metals in dust particles within the automobile brownfield areas of Damaturu L.G.A, Yobe State, Nigeria. The specific objectives of the study were to:

i. examine the presence of the selected heavy metals i.e. Lead (Pb), Arsenic (As), Selenium (Se), Iron (Fe) and Cadmium (Cd) in dust particles within the automobile brownfield areas of Damaturu L.G.A.,
ii. determine the concentrations of selected heavy metals i.e. Lead (Pb), Arsenic (As), Selenium (Se), Iron (Fe) and Cadmium (Cd) in dust particles within the automobile brownfield areas of Damaturu L.G.A using Atomic Absorption Spectroscopy (AAS).

MATERIALS AND METHODS

Description of the Study Area

The study was conducted at Damaturu Metropolis. Damaturu is located between latitude 110 43' and 37" North of Equator and longitudes 110 58' and 26" East of prime meridian and elevation of 456m above sea level [10]. It is located in the semi-arid region of Nigeria with a tropical continental climate and a population of 88,014 according to the 2006 census [11]. The area is characterized by a short period of rainfall (June - October) and a long dry season (November - May). The mean daily maximum temperature ranges from 29.20C in (July and August) to 450C in (March and April). Annual rainfall ranges from 500mm to 1000mm, usually from June to September [11]. Damaturu LGA is bordered in the North by Tarmuwa LGA, Kaga LGA of Borno state by the East, Gujba LGA by the South and Fune LGA by the West respectively. Figure 1.0: Schematic map of Damaturu town, showing sample collection points (Automobile workshops)

Study Design and Population

A simple random sampling method was adopted for the study. The study population is defined as mechanic operators and this includes auto mechanics, panel beaters, wielders, painters, rewires, battery chargers and vulcanizes.

Sample Collection

Samples were collected across the study area from four (4) automobile workshops at five (5) different points; A, B, C, D and E. Simple random sampling was adopted based on the available resources to conduct the work and the spread of the workshops across the study area. . The dust were collected to determine the presence and concentration of heavy metals. The dust was collected in four different locations at the automobile units totaling twenty (20) samples. Samples that were collected include tree leaves, surface of parked cars. The samples were collected randomly from the selected area and placed in labelled polythene bags and was taken to laboratory for analysis.

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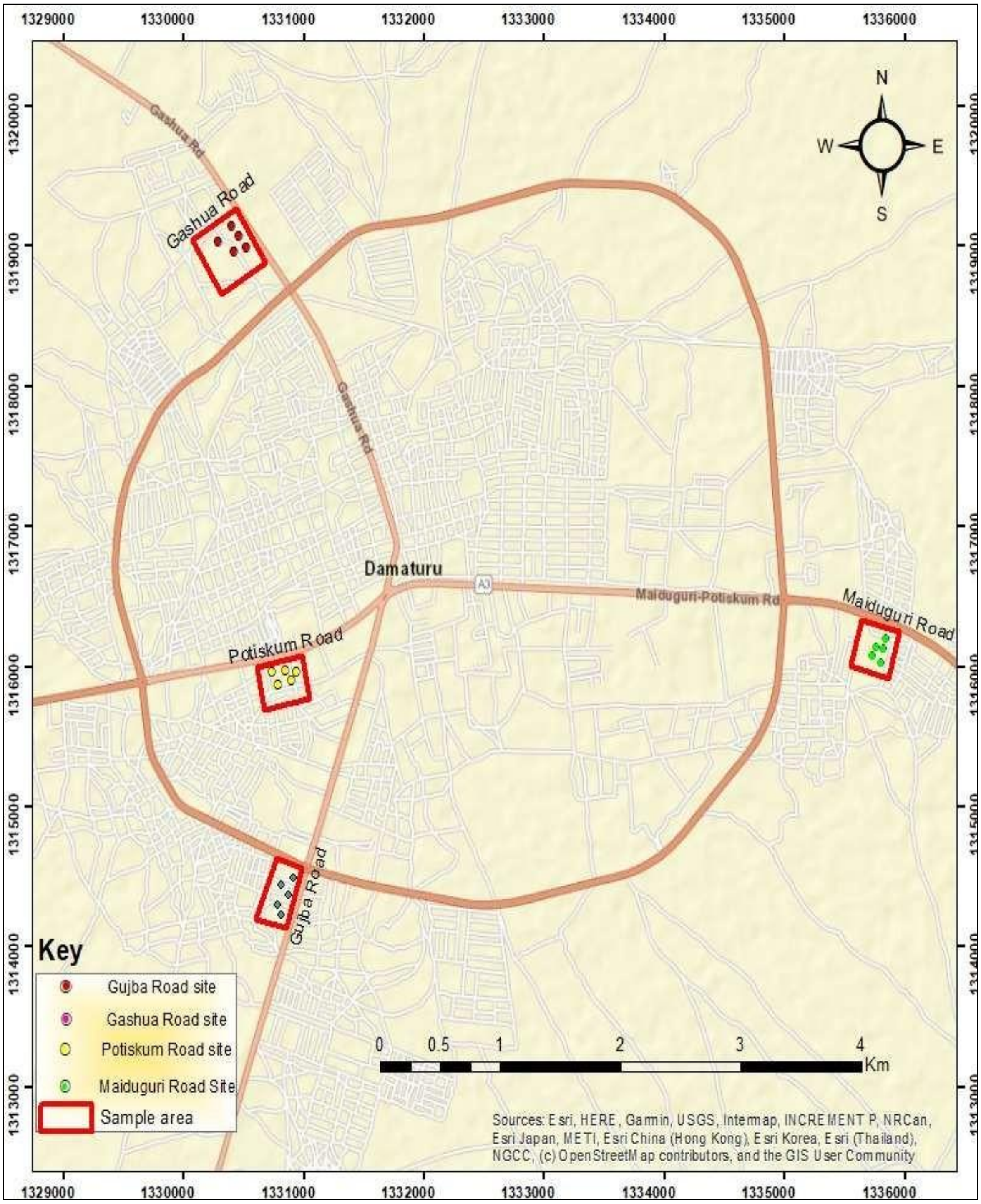

Figure 1.1: Schematic map of Damaturu town, showing sample collection points (Automobile workshops)

Sample Treatment/Digestion

The samples were allowed to dry using hot oven and then ground into fine powder using a porcelain mortar and pestle. 200mg of each sample was weighed into a clean plastic container (microwave tube) and 6.0ml of 65% HNO_3, 2.0ml of hydrochloric acid and 2.0 ml of hydrofluoric acid were added and allowed to stand for five minutes. The plastic container (microwave tube) was then covered and placed into microwave digester and digested. The digestion was carried out at 120°C for 15min and then ramped to 160°C for 10min, 180°C for 20mins, and then 200°C for 30minutes. The digestion was followed by cooling at room temperature in the microwave. The Potential presence of heavy metal in chemicals which were used in digestion were determined. Blanks were used simultaneously in each batch of the analysis to authenticate the analytical quality. The digested samples were diluted with deionized water to a total volume of 30ml.

Determination of Heavy Metal Contents in Dust using Atomic Absorption Spectroscopy (AAS)

The instrument was calibrated using series of working standards. The working standard solutions of each metal were prepared from standard solutions of their respective metals and their absorbance were taken using the AAS. Concentration of the metal ions present in the sample was determined by reading their absorbance using AAS (Buck scientific model 210GP). Three replicate determinations were carried out on each sample. The metals were determined by absorption /concentration mode and the instrument readout was recorded for each solution. The same analytical procedure was employed for the determination of elements in digested blank solutions and for the spiked samples.

Data Analysis

Data collected were analyzed using Microsoft Office Excel. Data collection and analysis was generally instrument specific, since most of the instruments used have an inbuilt software. Further analysis were carried out using mean, standard deviation and analysis of variance (ANOVA).

RESULTS AND DISCUSSION

The results from the analysis of dust samples were recorded and presented in this section. Results of heavy metals analysis in dust samples from different locations are presented in Tables 1.1 and 1.2 as well as Figures 1.2 to 1.5 respectively. However, the results revealed the presence of the investigated metals in varying quantities, from negligible amounts to appreciable concentrations.

Iron (Fe) Concentration in the Dust

Result for dust concentration at different sites and location is presented in table 1.1. The mean concentration of Fe in Maiduguri road ranged between 4.30±0.31- 11.42±0.74 mg/kg, though the element was not detected at sites B and D. The highest concentration was recorded at site C (11.42±0.74 mg/kg). In every mechanical workshop there are various sections that deal with either filling or welding of these metals and paveling of vehicle bodies. Iron fillings from this metal works, exhaust emissions from vehicles, oil spillage of gasoline, diesel, wastes from car batteries, engine oil and lubricating oils, coupled with rusting of non-coated metals have all collectively contributed to the presence of these element. The mean concentration of Fe in Gujba road ranged between 5.51±0.39- 11.57±0.40 mg/kg. The highest concentration was recorded at site D (11.57±0.40 mg/kg) and site A (11.16±0.60 mg/kg) respectively. Moreover, the mean concentration of Fe in Gashua road ranged between 1.08±0.32- 40.79±0.51 mg/kg. The highest concentration was recorded at site C (40.79±0.51 mg/kg) which indicates high deposition of the element in the area. The mean concentration of Fe in Potiskum road ranged between 6.25±0.04- 80.52±1.31 mg/kg. The concentration of the element varies with the different sites at the locations, though the element was not detected at site B. The highest concentration was recorded at site E (80.52±1.31 mg/kg) which indicates high deposition of the element in the area.

The study implies that the higher concentration of Fe in the study area is not worrisome because it is not harmful to the inhabitants of the selected sites while the lower values of the concentrations recorded at different locations in the study area indicates low heavy metals in dust which might be as a result of low garage activities at the site. According to International Agency for Research on Cancer (IARC) classifies iron and steel as founding exposures of Group 1 substances, which are considered carcinogenic to humans, hematite and ferric oxides are listed as Group 3 substances, which are considered not classifiable as a carcinogen to humans (IARC, 1987). However, the job exposure matrix of automobile workshops showed simultaneous exposures to some chemicals and dusts may have occurred, thus making it difficult to distinguish the individual effects of pure iron oxide to the risk of lung cancer mortality.

The analysis of variance (ANOVA) for Fe concentration in Maiduguri Road as shown in table 1.2 showed significant different ($P>0.05$) in site A with a significant value recorded at 5.09^{c} respectively, but no significant different ($P<0.05$) was observed between sites C and E with a recorded value of 11.42^{d} and 4.29^{d}. No Fe concentration was recorded at sites B and D. The result of the analysis in Gujba road showed no significant different ($P<0.05$) between sites A and D with values recorded at 11.16^{b}, and 11.57^{b} respectively, but a significant different ($P>0.05$) was observed in sites B and other sites with values recorded at 6.00[c] and 5.51[e]. This indicates that there are variation with regard to the elements at different sites and the highest concentration indicate high garage activities in the site. No Fe concentration was recorded at sites E. In Potiskum road, the result showed no significant different ($P<0.05$) between sites A and E with values recorded at 20.50[a], and 80.52[a] respectively, but a significant different ($P>0.05$) was observed between sites C and the other sites with values recorded at 22.03[b] and 6.25[d]. The result in Gashua road, revealed that there is no significant difference ($P<0.05$) between sites B, C and D with values recorded of 14.62[a], 40.79[a] and 21.25[a] respectively, but a significant different ($P>0.05$) was observed between sites A and E with values recorded at 1.08[d] and 6.03[c].

Lead (Pb) Concentration in the Dust

The mean concentration of Pb in Maiduguri road ranged from 1.24±0.40- 3.06±0.13 mg/kg. The concentration of the element recorded at different sites shows variation in respect of the values recorded. At site A and C similar values were recorded of 3.06±0.13 mg/kg and 3.36±0.09 mg/kg and the values recorded at sites B and D were also similar of which 1.24±0.40 mg/kg and 1.25±0.22 mg/kg recorded, while at site E, no value was recorded for lead concentration. The mean concentration of Pb in Gujba road ranged from 2.27±0.90- 4.21±0.17 mg/kg. The concentration of the element recorded at different sites shows variation in respect of the values recorded. At site A and D similar values were recorded of 4.21±0.17 mg/kg and 4.11±0.32 mg/kg and the values recorded at sites B and C were also similar of which 2.27±0.90 and 2.87±0.13 mg/kg was recorded, while at site E, no value was recorded for lead concentration. The results indicates that Pb concentration varies with regard to different sites of a given location. The mean concentration of Pb in Potiskum road ranged from 3.05±0.04- 6.16±0.12 mg/kg. The concentration of the element recorded at different sites shows variation in respect of the values recorded. At site A 5.78±0.33mg/kg was recorded, at site C a value of 6.16±012 was recorded and at site D a value of 3.05±0.04 mg/kg was recorded while no values were recorded at site B and E. The results varies at different sites of a given location. This indicates that the heavy metals in dust take their origin from sources such as vehicles repair unit, battery charging, iron-bending, vehicle painting and panel beating and emissions and or discharges from engine oils. The mean concentration of Pb in Gashua road ranged from 3.05±0.05- 8.65±0.51 mg/kg. Higher concentration was recorded at site D with a value of 8.65±0.51 mg/kg. The results indicates that Pb concentration might be as a result of the high density of the heavy metal deposition due to oil spillage at the location. Lower value was recorded at site B (3.05±0.05 mg/kg) indicates low heavy metals in dust which might be as a result of low automobile activities.

The study implies that the sample collected at different locations differs whereas in some site the no concentration of the element was recorded as a result of the variation on the use of Pb occurring substances in the automobile workshops. The exposure to Pb occurs mainly via inhalation of lead-contaminated dust particles or aerosols, and ingestion of lead-contaminated food, water, and paints (ATSDR, 1999). Lead (Pb) absorption is influenced by factors such as age and physiological status. In human body, the greatest percentage of Pb is taken into the kidney, followed by the liver and the other soft tissues such as heart and brain, however, the Pb in the skeleton represents the major body fraction (Flora et al., 2006). The nervous system is the most vulnerable target of Pb poisoning. Headache, poor attention spam, irritability, loss of memory and dullness are the early symptoms of the effects of lead exposure on the central nervous system (CDC, 2001; ATSDR, 1999).

Analysis of variance for Pb concentration in Maiduguri road showed no significant different ($P<0.05$) between sites A, B and C with values recorded at 3.06 [c], 1.24[c] and 3.36[c] respectively, while no value was recorded at site E. This is an indication that there are variability between the sites in respect of the element. In Gujba road, the analysis showed no significant different ($P<0.05$) between sites A, B and D with values recorded of 4.21[c], 2.27[c] and 4.11[c] respectively. Highest concentration was recorded at site A. No concentration of the element was recorded at site E. The result of analysis in Potiskum road showed no significant different ($P<0.05$) between sites A and C with values recorded at 5.78[a], and 6.16[a] respectively, but a significant different ($P>0.05$) was observed between site D. There was no Pb concentration recorded at sites B and E. The analysis for Pb concentration showed no significant difference ($P<0.05$) between sites C, D and E with values recorded at 6.06[a], 8.65[a] and 3.08[a] respectively, but a significant difference ($P>0.05$) was observed between sites A and B with value recorded at 4.36[b] and 3.05[b]. The high concentration of the elements at the sites indicates that there was a lots of automobile activities at the site while the low values recorded indicates low activities within the automobile workshops.

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Table 1.1 Concentrations (mg/kg) of Heavy Metals in Dust particles with respect to location and Sites using mean standard deviation (SD)

Location	Dust sites	A	B	C	D	E
		Pb	As	Se	Fe	Cd
Maiduguri road	Point A	3.06±0.13	1.08±0.06	29.18±0.84	5.10±0.91	0.66±0.41
	Point B	1.24±0.40	0.92±0.08	ND	ND	0.78±0.41
	Point C	3.36±0.90	1.17±0.24	ND	11.42±0.74	3.64±0.75
	Point D	1.25±0.22	1.01±0.00	19.77±0.80	ND	0.69±0.29
	Point E	ND	1.18±0.10	1.62±0.06	4.30±0.31	0.93±0.45
Gujba road	Point A	4.21±0.17	1.22±0.09	ND	11.16±0.60	2.40±1.01
	Point B	2.27±0.90	1.01±0.04	ND	6.00±0.07	0.99±0.46
	Point C	2.87±0.13	1.03±0.08	8.29±0.99	5.51±0.39	3.14±1.09
	Point D	4.11±0.32	0.92±0.22	ND	11.57±0.40	3.96±0.59
	Point E	ND	1.28±0.39	5.28±0.62	ND	2.16±0.65
Potiskum road	Point A	5.78±0.33	1.55±0.24	ND	20.50±0.53	4.82±0.66
	Point B	ND	0.58±0.63	ND	ND	4.03±0.57
	Point C	6.16±0.12	2.31±0.31	ND	22.03±0.38	4.77±0.59
	Point D	3.05±0.04	1.28±0.21	ND	6.25±0.04	3.20±1.09
	Point E	ND	1.31±0.26	ND	80.52±1.31	4.26±0.23
Gashua road	Point A	4.36±0.17	1.08±0.04	ND	1.08±0.32	4.28±0.44
	Point B	3.05±0.05	1.31±0.22	ND	14.62±0.78	3.93±0.78
	Point C	6.06±0.44	1.77±0.18	ND	40.79±0.51	5.38±0.38
	Point D	8.65±0.51	1.66±0.23	ND	21.25±0.64	4.76±0.61
	Point E	3.08±0.05	0.79±0.18	ND	6.03±0.36	4.41±0.23
WHO/FOA		100 mg/kg	20 mg/kg	10 mg/kg	50,000 mg/kg	3.0 mg/kg (EC)

Key: Point A, B, C, D and E; sample collection point within a particular workshop.

ND = Not Detected

Cadmium (Cd) Concentration in the Dust

Table 1.1 showed the mean concentration of Cd in Maiduguri road ranged between 0.66±0.41- 3.64±0.75 mg/kg. The highest concentration was recorded at site C (3.64±0.75 mg/kg). This study suggests that may be the combustion of fuel (especially diesel) and oil/lubricants, which are known to contain trace levels of cadmium, may be a significant source of Cd as found in dust within the area, while lower value was recorded at site A (0.66±0.41 mg/kg). The mean concentration of Cd in Gujba road ranged between 0.99±0.46- 3.96±0.59 mg/kg.

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Highest concentration was recorded at site D (3.96±0.59 mg/kg). This indicates high deposition of the element in the area while lower value was recorded at site B (0.99±0.46 mg/kg) which indicates low heavy metals. In Potiskum road, the mean concentration of Cd ranged between 3.20±1.09- 4.82±0.66 mg/kg. The highest concentration was recorded at site A (4.82±0.66 mg/kg). This indicates high deposition of the element in the area while lower value recorded at site B (3.20±1.09 mg/kg). The mean concentration of Cd in Gashua road ranged between 3.93±0.78- 5.38±0.38 mg/kg. The highest concentration was recorded at site C (5.38±0.38 mg/kg). This indicates high deposition of the element in the area while lower value recorded at site B (3.93±0.78 mg/kg). The lower values recorded indicates low heavy metals in dust which might be as a result of low automobile activities at the various sites.

The implication here is that high Cd concentration has an adverse effect over our health status even though the values recorded were not injurious. The main routes of exposure to Cd are via inhalation or cigarette smoke, and ingestion of food. Skin absorption is rare. Human exposure to Cd is possible through a number of several sources including employment in primary metal industries, eating contaminated food, smoking cigarettes, and working in cadmium-contaminated work places, with smoking being a major contributor (IARC, 1993; Paschal et al., 2000). Other sources of Cd include emissions from industrial activities, including mining, smelting, and manufacturing of batteries, pigments, stabilizers, and alloys (ATSDR, 2008). Several epidemiologic studies have documented an association of chronic low-level cadmium exposure with decreases in bone mineral density and osteoporosis (Akesson et al. 2006; Schutte et al., 2008). Exposure to Cd is commonly determined by measuring Cd levels in blood or urine.

In Maiduguri road, the result of the analysis of variance (ANOVA) for Cd in dust as shown in table 1.2 showed no significant differences ($P<0.05$) in sites A, B and C and E with values recorded of 0.66^{d}, 0.78^{b} and 3.64^{b} and 0.93^{d} respectively. The result of the analysis in Gujba, Potiskum and Gashua road showed no significant different ($P<0.05$) were observed and recorded at the whole sites respectively. This indicates that there are variation of values of the element recorded at different sites but the values were not statistically significant.

Table 1.2 Concentrations (mg/kg) of Heavy Metals in Dust particles with respect to location and Sites using ANOVA

Heavy Metals	Dust sites	Locations				SEM
		Maiduguri Road	Gujba Road	Potiskum Road	Gashua Road	
Pb	Point A	3.06^{c}	4.21^{b}	5.78^{a}	4.36^{b}	0.40^{*}
	Point B	1.24^{c}	2.27^{b}	0.00^{d}	3.05^{b}	0.41^{*}
	Point C	3.36^{c}	2.87^{c}	6.16^{a}	6.06^{a}	0.38^{*}
	Point D	1.25^{d}	4.11^{b}	3.05^{c}	8.65^{a}	0.67^{*}
	Point E	ND	ND	ND	3.08^{a}	0.32^{*}
As	Point A	1.08^{b}	1.13^{b}	1.55^{b}	1.08^{b}	0.19^{*}
	Point B	0.92^{a}	1.01^{a}	0.58^{a}	1.31^{a}	0.11^{NS}
	Point C	1.17^{c}	1.03^{c}	2.31^{a}	1.77^{b}	0.17^{*}
	Point D	1.01^{b}	0.92^{b}	1.28^{ab}	1.66^{a}	0.09^{*}
	Point E	1.18^{b}	1.28^{b}	1.31^{b}	0.79^{b}	0.14^{*}
Se	Point A	29.18^{a}	ND	ND	ND	3.12^{*}

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	Point B	ND	ND	ND	ND	0.26^{*}
	Point C	ND	8.29^{a}	ND	ND	0.89^{*}
	Point D	19.72^{a}	0.00^{b}	ND	ND	2.52^{*}
	Point E	1.62^{b}	5.28^{a}	ND	ND	0.55^{*}
Fe	Point A	5.09^{c}	11.16^{b}	20.50^{a}	1.08^{d}	1.76^{*}
	Point B	0.00^{d}	6.00^{c}	0.00^{d}	14.62^{a}	1.57^{*}
	Point C	11.42^{d}	5.51^{e}	22.03^{b}	40.79^{a}	3.21^{*}
	Point D	0.00^{e}	11.57^{b}	6.25^{d}	21.25^{a}	1.87^{*}
	Point E	4.29^{d}	ND	80.52^{a}	6.03^{c}	8.12^{*}
Cd	Point A	0.66^{d}	2.40^{c}	4.82^{ab}	4.28^{b}	0.52^{*}
	Point B	0.78^{b}	0.99^{b}	4.03^{a}	3.93^{a}	0.44^{*}
	Point C	3.64^{b}	3.14^{b}	4.77^{ab}	5.38^{a}	0.31^{*}
	Point D	0.69^{c}	3.96^{ab}	3.20^{b}	4.76^{a}	0.42^{*}
	Point E	0.93^{d}	2.16^{c}	4.26^{b}	4.41^{b}	0.45^{*}

Key: Point A, B, C, D and E; sample collection point within a particular workshop

Mean within each row with different superscripts are shows significantly differences* ($P>0.05$)

NS: Means no significant difference ($P<0.05$)

ND: Not Detected

Selenium (Se) Concentration in the Dust

The mean concentration of Se in Maiduguri road ranged between 1.62 ± 0.06 - 29.18 ± 0.84 mg/kg. The highest concentration was recorded at site A (29.18 ± 0.84 mg/kg) which indicates high deposition of the element in the area, while lower value recorded of 1.62 ± 0.06mg/kg indicates low heavy metals in dust particles. No result was recorded at sites B and C. The non-availability of the element at the sites indicates lack of automobile dust at the places where the dust have been collected. The high concentration of Se in the dust samples may be attributed to metal construction works, iron bending and welding of metals, which is a common practice along the major streets and automobile workshops in Damaturu.

The mean concentration of Se in Gujba road ranged between 5.28 ± 0.62- 8.29 ± 0.99 mg/kg. The concentration of the element varies with the different sites at the location, though selenium was not detected at sites A, B and D. The highest concentration was recorded at site C (8.29 ± 0.99 mg/kg). The concentration of Se in Potiskum and Gashua road was not detected in all the different sites of the locations where the dust samples were collected. This might be an indication that dust emanated from the automobile workshops was not containing the element.

This implies that the Se concentration was lower in all the locations despite the fact that there is a lot of automobile activities in the sampled locations. An excess of Se is harmful. Prolonged intake of this element at a dose higher than 1000 µg per day may induce toxic symptoms such as nausea, dizziness, fatigue, hair loss, metallic aftertaste in the mouth, and irritation of the airways.

These symptoms are part of a disease called selonosis. The safe dose of selenium supplementation for adults is 50-70 µg per day (Kise et al., 2004). High Se concentration induce the development of depressions, anxiety and

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also some diseases of affluence such as a stroke or cardiovascular diseases. Furthermore, deficiencies of Se and vitamin C may cause nutritional muscular dystrophy (Żarczyńska et al., 2012).

Table 1.2 revealed the analysis of variance for Se concentration in Maiduguri road showed no significant different (P<0.05) in sites A and D with values recorded at 29.18^{a}, and 19.72^{a} respectively, but significant differences (P>0.05) was observed in site E. Highest concentration was recorded at site A (29.18^{a}) and lowest value recorded at site E (1.62^{b}). However, no Se concentration was recorded at sites B and C. The result of the analysis in Gujba road showed no significant different (P<0.05) between sites C and E with values recorded of 8.29^{a}, and 5.28^{a} respectively. No Se concentration was recorded at sites A, B, C D and E in Potiskum and Gashua road where the dust samples were collected.

Arsenic (As) Concentration in the Dust

Mean concentration of As in Maiduguri road ranged between 0.92 ± 0.08 - 1.18 ± 0.10 mg/kg as shown in table 1.2. The highest concentration was recorded at site E (1.18 ± 0.10 mg/kg) which indicates high deposition of the element in the area. The sources of As in dust is believed to be from car component, tyres abrasion, brushing, bearing metals and brake dust respectively. The mean concentration of As in Gujba road ranged between 0.92 ± 0.22- 1.28 ± 0.39 mg/kg.

The highest concentration was recorded at site E (1.28 ± 0.39 mg/kg). In Potiskum road, the mean concentration of As ranged between 0.58 ± 0.63- 2.31 ± 0.31 mg/kg. The highest concentration was recorded at site C (2.31 ± 0.31 mg/kg). The mean concentration of As in Gashua road ranged between 0.79 ± 0.18- 1.77 ± 0.18 mg/kg. The highest concentration was recorded at site C (1.77 ± 0.18 mg/kg). The low values recorded is an indication of low heavy metals in dust which might be attributed to low automobile workshop activities.

The implication of the study is that As values is lower than the observed values known to cause severe health problems. Human exposure at these sites may occur by a variety of pathways, including inhalation of dusts in air, ingestion of contaminated water or soil, or through the food chain (Tchounwou & Centeno, 2008).

Contamination with high levels of As is of concern because it can cause a number of human health effects, increased risks of lung and bladder cancer and skin changes have been reported in people ingesting the element in drinking water at a concentration of 50µg/liter, or even lower. Exposure to high As concentration in the automobile workplace by inhalation can also cause lung cancer. Several epidemiological studies have reported a strong association between arsenic exposure and increased risks of both carcinogenic and systemic health effects (Tchounwou et al. 2003).

In Maiduguri road, the analysis of variance for As concentration showed no significant difference (P<0.05) in sites A, D and E with values recorded at 1.08^{a}, 1.01^{a} and 1.18^{a} respectively, but significant different (P>0.05) was observed between sites B and C with value recorded of 0.92^{a} and 1.17^{c}. Highest concentration was recorded at site E (1.18^{a}) and lowest value recorded at site B (0.92^{a}). The result in Gujba road showed significant different (P>0.05) between site B and C with value recorded of 1.01^{a} and 1.03^{c} respectively, but no significant difference (P<0.05) was observed in sites A, D and E with values recorded of 1.13^{b}, 0.92^{b} and 1.28^{b}. Highest concentration recorded at site E (1.28^{b}) and lowest value recorded at site D (0.92^{b}).

The result of the analysis in Potiskum road showed no significant different (P<0.05) in sites A, B, C and E with values recorded at 1.55^{b}, 0.58^{a}, 2.31^{a} and 1.31^{b} respectively, but there is a significant difference (P>0.05) in site D with a value of 1.28^{ab} . Highest concentration recorded at site C (2.31^{a}) and lowest value recorded at site B (0.58^{a}). The analysis of variance for Arsenic concentration in Gashua road showed no significant differences (P<0.05) in sites B and D with values recorded at 1.31^{a}, and 1.66^{a} respectively, but significant different (P>0.05) was observed in sites A, C and E with value recorded at $1.08^{b,}$ 1.77^{b} and 0.79^{b}.

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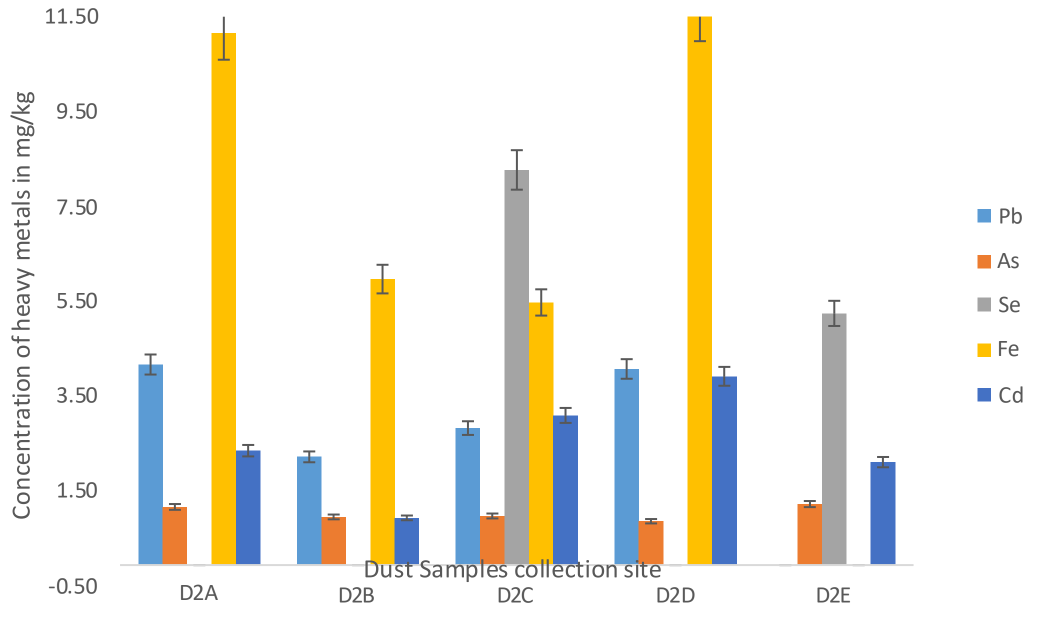

Figure 1.2: Heavy metals amount in dust samples collected at Maiduguri road automobile workshop

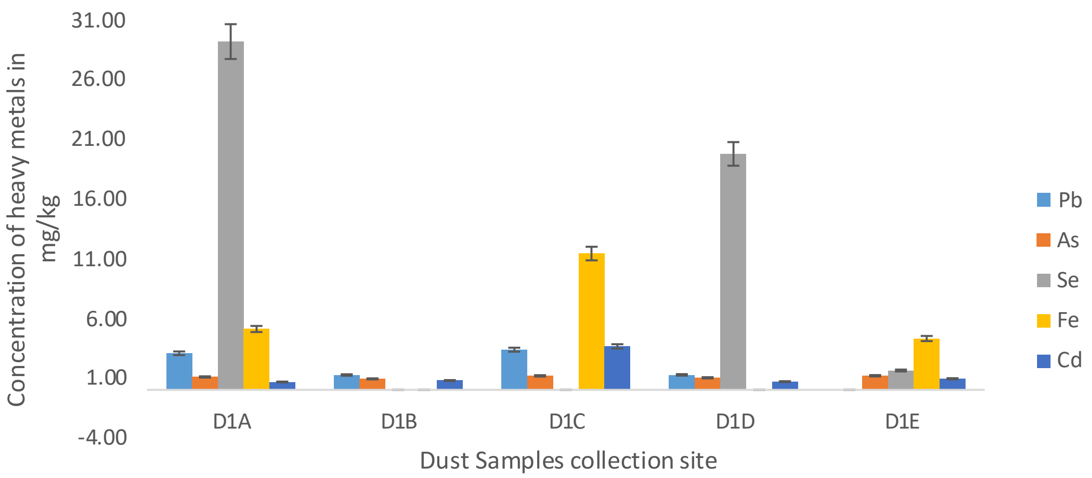

Figure 1.3: Heavy metals amount in dust samples collected at Gujba road automobile workshop

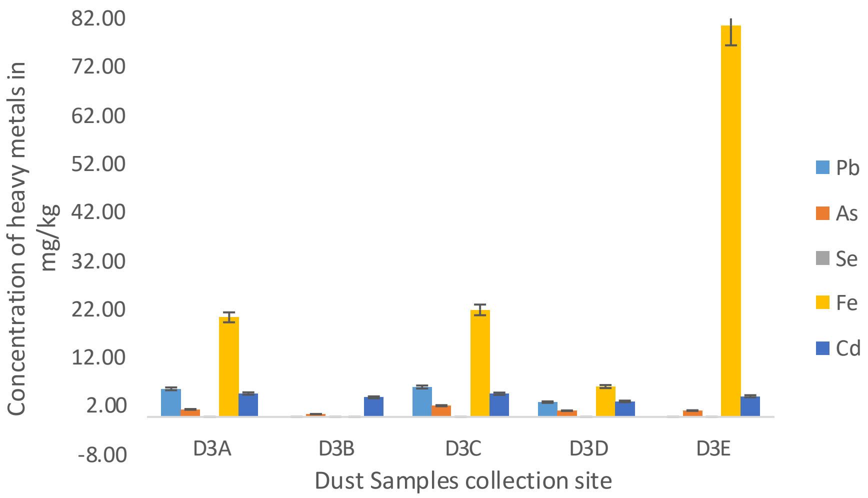

Figure 1.4: Heavy metals amount in dust samples collected at Potiskum road automobile workshop

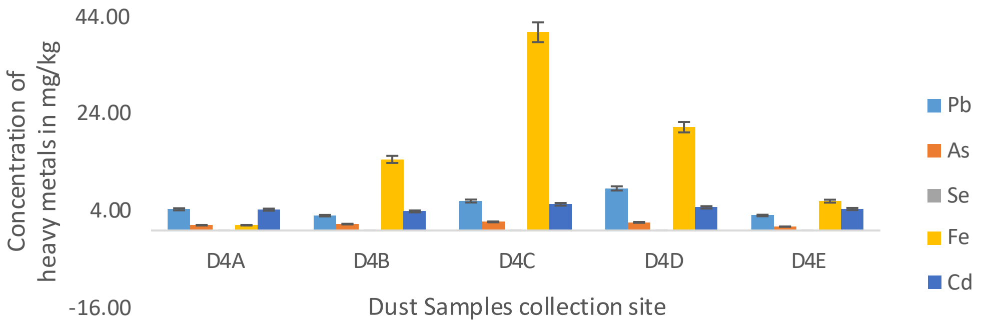

Figure 1.5: Heavy metals amount in dust samples collected at Gashua road automobile workshop

CONCLUSION

Dust are important environmental components whose quality we cannot afford to compromise and treat with levity. This study was concluded that the concentrations of heavy metals in dust cannot cause severe harm. Even though the concentration of some heavy metals in dust were above that of the control and regulatory procedures because it indicates high contamination in some sites. Mean concentrations of heavy metals in dust samples (mgkg^{-1}) ranged from 1.24$\pm$0.40 - 8.65$\pm$0.51, 0.58$\pm$0.63 - 2.31$\pm$0.31, 1.62$\pm$0.06 - 29.18$\pm$0.84, 1.08$\pm$0.32 - 80.52$\pm$1.31, 0.66$\pm$0.41 – 5.38$\pm$0.38 for Pb, As, Se, Fe and Cd respectively. Despite the indications of dust contamination in some sites, a higher percentage of the automobile workshops have a positive attitude towards ensuring environmental protection and sustainability. The analysis of variance for heavy metals concentration in dust was also found to be significantly different ($P>0.05$) at all the location except Arsenic at site B. Highest concentration was recorded at sites D, C, A, E and A for Lead, Arsenic, Selenium, Iron and Cadmium respectively. This indicates that the heavy metals in dust take their origin from sources such as vehicles repair unit, battery charging, iron-bending, vehicle painting and panel beating and emissions and or discharges from engine oils. From the outcome of this research, conclusion can be drawn that the quality of the dust in these automobile workshops have been polluted and exposure to such dust particles particularly through ingestion for a long time may posed serious health effects.

RECOMMENDATIONS

The research made the following recommendations:

i. Healthy and environmental friendly talks should be given occasionally to automobile operators to enhance their performance to be more safety conscious and embrace environmentally friendly practices.
ii. Orientation on safe waste handling and disposal methods should be given from time to time.
iii. Automobile workshops should be assessed regularly to ensure compliance to environmental regulations.

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