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LEAD AND COPPER IN KADUNA STREET DUST PARTICULATE MATTERS

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ABSTRACT

The levels of lead and copper in Kaduna street dusts collected from a variety of situations are reported Wide range concentrations of the two metals were observed in street dust particulate from different parts of the municipality The mean lead and copper concentration of the investigated were 74 19µgg^{-1} and 46.13µgg^{-1} respectively. The results commensurate with highly dispersed materials of local origin. Significant correlation between lead and copper indicated that these metals in the residential areas are affected by automobile exhaust emissions and that the residential areas have other sources of these pollutants

KEYWORDS Lead, copper, street dust, Kaduna

INTRODUCTION

Heavy metals occur naturally in all areas and soil of the world. Some are essential for humans, plants and animals and are ingested in food, water, and air. They are in trace concentrations levels and are usually not hazardous in non-urban areas and with little or no record of past or present human activity (Hodel and Chang, 2004). However, any place subjected to human activity is likely to have trace elements at elevated levels in the soil and street dust (Hodel and Chang, 2004). While there may be no cause for alarm, in some cases these trace elements may accumulate to a level that they may become advisable to take measures that ensure they will not pose any health risk thus making trace element status of street dust an important subject of scientific investigation when it is suspected to be polluted with heavy metals (Domingo and Kyuma, 1983). Street dusts are composed of car exhausts and wind transported particles or particulate matter deposited onto urban roads and pavement dust that accumulate on curbs as a result of vehicle - induced turbulence and building construction work (Loredo et al., 2003; Sezgin et al., 2004).
The urban environment is composed of varying concentrations of trace elements from a vast array of anthropogenic sources (Hodel and Chang, 2004) as well as from natural geochemical processes. The entry of pollutants into the urban atmosphere may occur in form of gases, particles, or aerosols (Magnus, 1993). The transport of heavy metals from the atmosphere to soil and vegetation take place by dust fall, wet or dry deposition and gas adsorption processes (Andersen et al., 1978).These are likely to have environment and socio economic impacts as they are usually present as trace element anomalies whose mapping reveal the general distribution of pollution in an area (Loredo et al., 2003).

In the residential areas of a city and in the absence of other major sources, the association of Pb-Cu-Zn-Ba can be used to evaluate the contribution of traffic than using Pb content alone due to increase in the use of unleaded petrol. (De Miguel et al., 1999). Other elements used to trace emission sources of urban suspended particles are Cd-Ni for traffic (De Miguel et al., 2001) Industrial sources are specifically site related some climatic factors such as local weather conditions and wind pattern at the site cause considerable variation in the concentration of heavy metals in street dust (Loredo et al., 2003).

The biological, chemical and physical effects of pollutants are direct function of their concentrations and composition. Particular pollutants attack specific sites or organs of the body and disease may develop as a result of exposure to such pollutant. Toxic metals such as arsenic, cadmium, lead and mercury prevalent in nature due to their high industrial use, have direct effects on the central nervous system and may cause acute renal failure (Duffus, 1980; Chowdhury and Chandra, 1991)

Lead is a non-essential element and its natural concentrations are not high in the environment. Lead is used as antiknock agents in petrol as tetramethyllead and tertraethyllead Atmospheric lead is an important component of street dust particulate (Ewers and Schlipköter, 1991). The source of lead in urban soils is the fallout of engine exhaust from vehicles burning leaded gasoline. Some specialty paints may still contain lead and the improper disposal of leaded batteries is another source (Hodel and Chang, 2004). Lead may be inhaled from the atmosphere and its intoxication may result in the onset of lead poisoning (Posner *et al.*, 1978). In adult the symptom of lead poisoning are abdominal pain, constipation, vomiting, asthma, prostheses, diarrhea and impairment of central nervous system function. Mild symptoms include tiredness slight abdominal pain or discomfort, anorexia, irritability, paleness and nausea (Posner *et al.* 1978).

Copper is essential to life despite being inherently toxic at high concentrations Its salts are poisonous when they are ingested through misguided or suicidal intent It is both essential and potentially toxic to living things if there is too much in the environment (Scheinberg and Sternlieb, 1984; Scheinberg, 1991) This paper reports the lead and copper concentrations in Kaduna street dust along residential, commercial and industrial areas with a view to determining their level of pollution

MATERIALS AND METHODS

In the preparation of solutions, analytical reagent grade chemicals and distilled-deionized water were used. All glass wares were washed with detergent and rinsed with water before immersion in 10% nitric acid solution They were further rinsed with distilled-deionised water before drying in the oven at 105^{0}C All weighing were done on Mettler Toledo AB54 analytical weighing balance.

Study Area

Kaduna is an industrial city located on the southern end of the high plains of northern Nigeria, bounded by parallels 9^{0}03^{1}N to 11^{0}32^{1}N, and extends from the upper River Mariga on 60051E to 8^{0}48^{1}E on the foot slopes of the scarp of Jos Plateau (Udo, 1970) (Fig1)

Climate

Kaduna experiences a typical tropical continental climate with distinct seasonal regimes, oscillating between cold to hot dry and humid to wet. These two seasons reflect the

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influences of tropical continental and equatorial maritime airmases which sweep over the entire country. However, in Kaduna, the seasonality is pronounced with the cold to hot dry season which is longer than the rainy season (Bello, 2000).

Sampling Zones and Bio indication network

The entire municipality was divided into eight mapping units of 10km^2 to avoid spatial variability Fig.1 shows the map of Kaduna metropolis.

Sampling

Eight hundred samples were collected between October 2003-April 2004 from different zones with different degrees of pollution. Dust particulate samples were collected from pavements, curbs, intersections such as round about, T-junctions and free ways using a plastic brush and tray (Loredo *et al*; 2003; Yeung *et al*. 2003) and were stored in plastic bags (Ayodele and Gaya, 1998).Kaduna municipality was subdivided into eight sampling zones. Each zone was further subdivided into large squares from where samples were collected. At each sampling site street dusts were collected. Sampling was carried out between Oct 2004 and May 2005 and at the period of highest air pollution in the municipality with consequent highest concentrations of the particulate matters.

Zones b comprising Abakpa, Hayin-Banki, Unguwar Shanu, Abakpa, Kurmin Mashi zone c-Tudun wada comprising Unguwar Sunusi, Tudun wada, and Tudun nupawa and zone d-Kabala comprising Mando, National eye centre, Rigasa, Kabala West and Unguwar Muazu are predominantly commercial /residential areas. Zone d Kudenda is an industrial area. Zone f is also a commercial/residential area. Zone g comprising Unguwar Rimi and Kabala Costain is a predominantly residential area. Zone h Kawo comprising Kawo and Rafinguza is a commercial /residential area while zone I is the Central market a predominantly commercial centre.

Reference Materials

No street dust reference material was available but soil samples taken 2 metres below the surface in Kaduna Polytechnic Botanical Garden were used as primary reference material (Fergusson, 1987; Fergusson and Simmonds, 1983; Fergusson et al., 1980; Ayodele and Gaya, 1994)

Sample Treatment

All dust samples were oven-dried at 105°C to a constant weight (Ayodele and Gaya, 1998) and were sieved through a 250mm mesh (Li and Shuman, 1996, Ayodele and Gaya, 1994; Loredo *et al*. 2003). [illegible]g of each sample was digested with 20cm^3 of 6M nitric a[illegible] (Fergusson, 1987) and was filtered through acid washed Whatman 540 filter paper into a 50cm^3 volumetric flask and was diluted to mark with water (Ayodele and Gaya, 1998). The resultant solution was analysed for Cu and Pb.

RESULTS AND DISCUSSION

Results of the analysis are discussed using the frequency distribution patterns for the metals in the dust particulate samples. Then mean concentrations and coefficient of variations were used to assess their levels and to identify those that were soil derived and those from other anthropogenic sources.

The frequency distribution pattern for lead in Kaduna metropolis street dust is as shown in Fig 2a. The distribution is multimodal showing a jigsaw pattern and is skewed towards high frequency of low concentration with a mean of 74.19 ugg^{-1} and coefficient of variation of 78.1%. This data is similar to those reported by Howari *et al* (2004) in the Jordan street dust.

The frequency distribution pattern for lead in zone b is as shown in Fig.2b.The distribution is skewed towards high frequency of low concentration with a mean of 65.11 ugg^{-1} and co-efficient of variation 15.28%. Sources of lead in this zone could be due to burning of garbage, painted wood, weathering of lead containing paints and as fallout of engine exhaust from vehicles burning leaded petrol (Hodel and Chang, 2004). The frequency distribution pattern for lead in zone c is as shown in Fig 2c The distribution is skewed towards high frequency of high concentration with a mean of 43.05μgg^{-1} and coefficient of variation of 36.25%. The sources of lead could be from vehicles burning leaded petrol, from burning of garbage, weathering of old houses and equipment containing lead-based paints and illegal dumping of lead batteries (Ayodele and Gaya, 1994; Hodel and Chang, 2004). The frequency distribution pattern for lead in zone d is as shown in Fig 2d. The distribution is skewed towards high frequency of high concentration having a mean of 54.91μgg^{-1}and coefficient of variation of 23.30%. The sources of lead are similar to those in zone c. The frequency distribution pattern for lead in zone e is as shown in Fig 2e. The distribution is skewed towards high frequency of high concentration with a mean of 183.01μgg^{-1}and coefficient of variation of 19.30%. The presence of lead in this zone is due to high traffic volume i.e from exhaust emissions, automobiles, companies using specialized paints that contain lead and from burning of materials containing lead (Ayodele and Gaya, 1994).

The frequency distribution pattern for lead in zone f is as shown in Fig 2f. The distribution is skewed towards low frequency of high concentration with a mean of 28.51 ugg^{-1} and coefficient of variation of 39.02%. The source of lead could be from exhaust emissions, burning of materials containing lead and from the earth crust.

The frequency distribution pattern for lead in zone g is as shown in Fig 2g. The distribution is skewed towards low frequency of high concentration with a mean of 20.905μgg^{-1} and coefficient of variation of 50.44%. Source of lead are from exhaust emissions, weathering of old buildings containing lead paints and burning of materials containing lead. The frequency distribution pattern for lead in zone h is as shown in Fig 2h, a residential commercial area. The distribution is skewed towards high frequency of high concentration with a mean of 60.11μgg^{-1} and coefficient of variation of 20.17%. Source of lead here could include fallout from engine exhaust, weathering of leaded materials, from burning of garbage and materials containing lead and improper dumping of lead batteries (Ayodele and Gaya, 1994, Hodel and Chang, 2004). The frequency distribution pattern for lead in zone I a commercial centre experiencing high traffic flows and sales of different commodities is as shown in Fig 2i. The distribution is skewed towards high frequency of high concentrations with a mean of 144.81μgg^{-1} and coefficient of variation of 37.16%. The sources of lead include exhaust emissions, burning of garbage and weathering of materials containing lead and of course from soil resuspension (Loredo *et al*., 2003). The mean lead concentration in all the zones was above that of the reference soil sample. Values obtained for Kudenda and central market were above the maximum allowable limit, thus they can be said to contain high levels of lead in their dusts. Abakpa, Tudun Wada, Kabala West, Sabon Tasha and Kawo zones had values that were above the normal content interval but were nevertheless below the maximum allowable limit. Unguwar Rimi zone had the least lead concentration in the street dust particulate being predominantly a residential area.

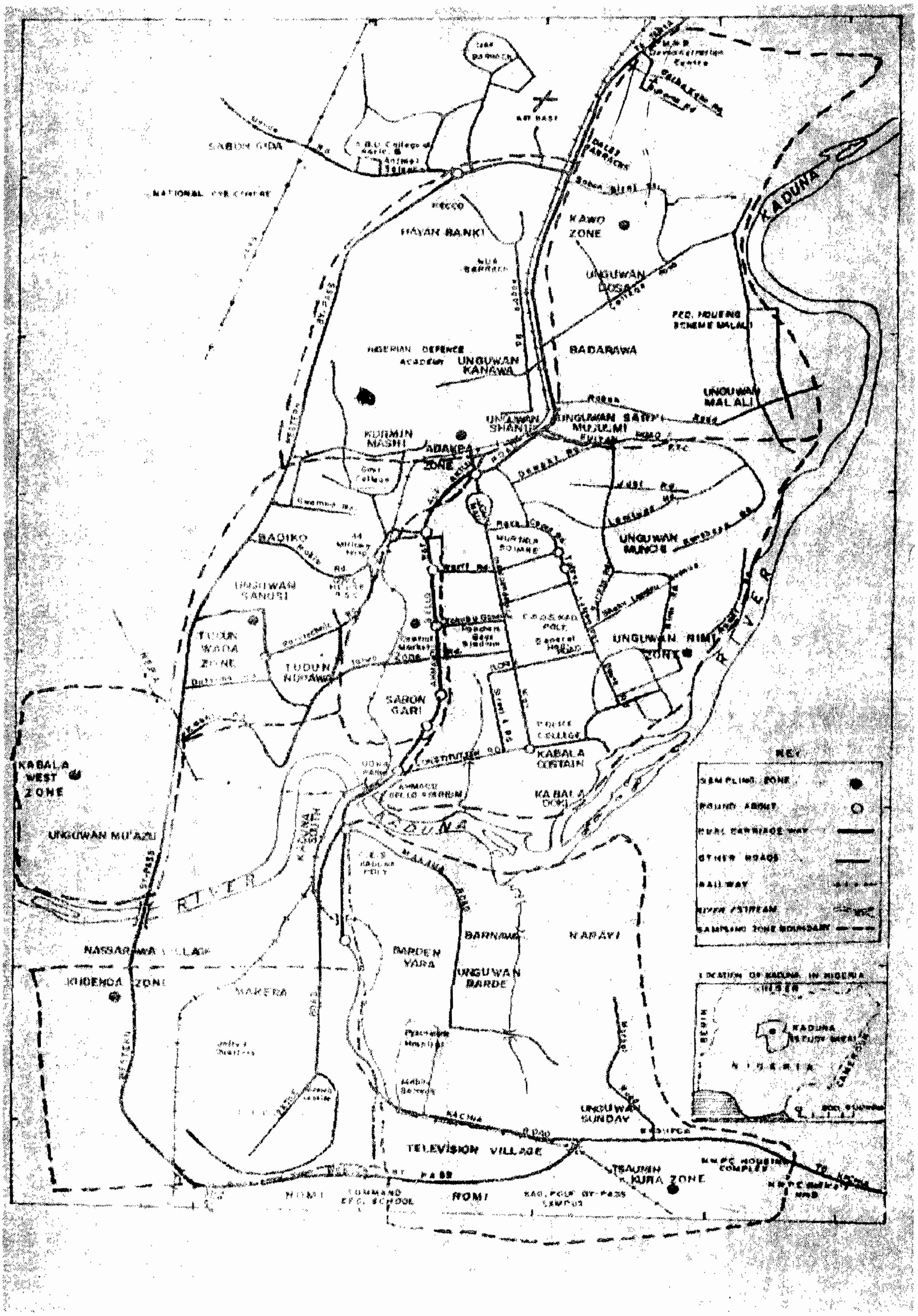

Fig1: showing the map of Kaduna metropolis.

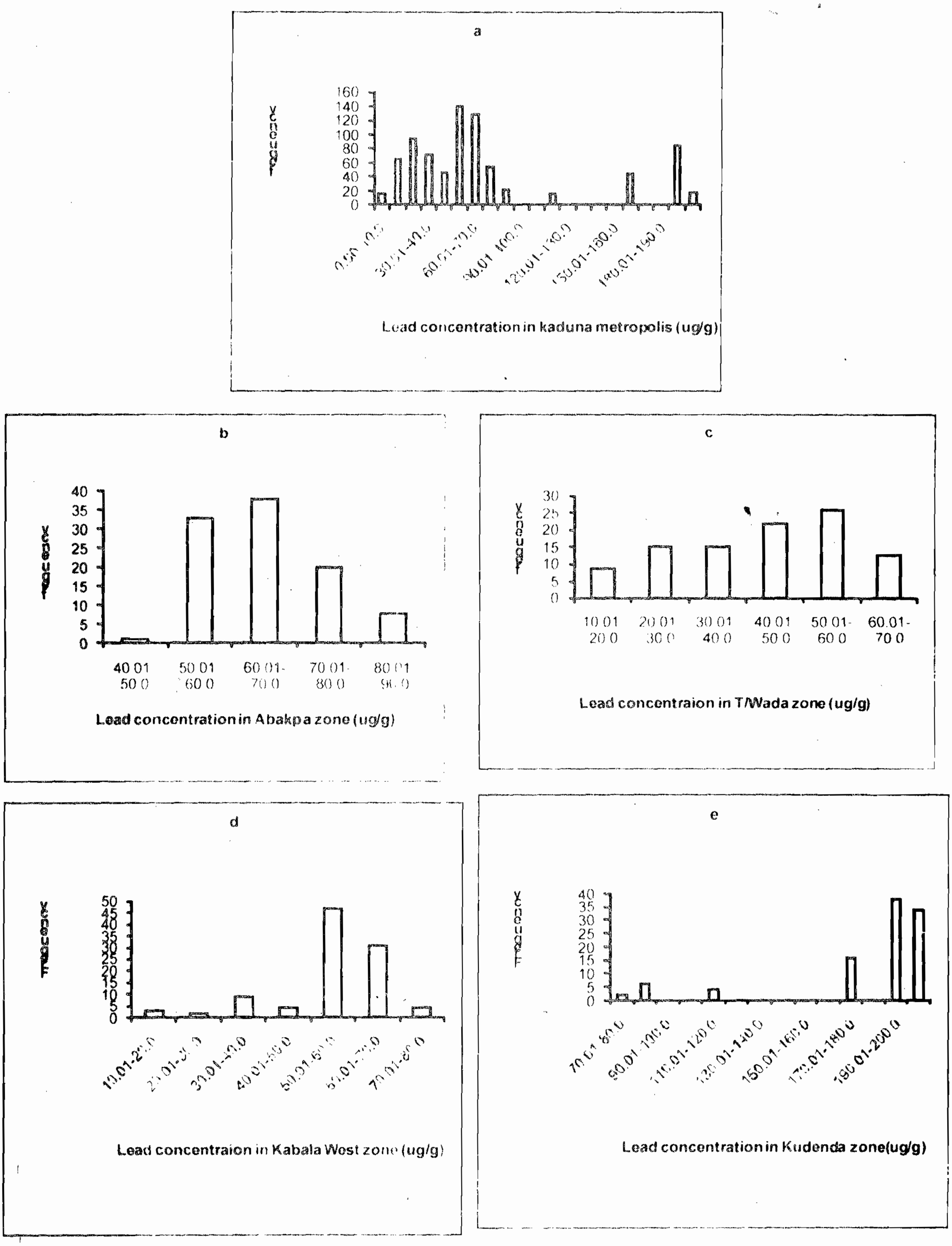

Fig 2 a-e Frequency distribution of Lead Concentrations in zones a-e

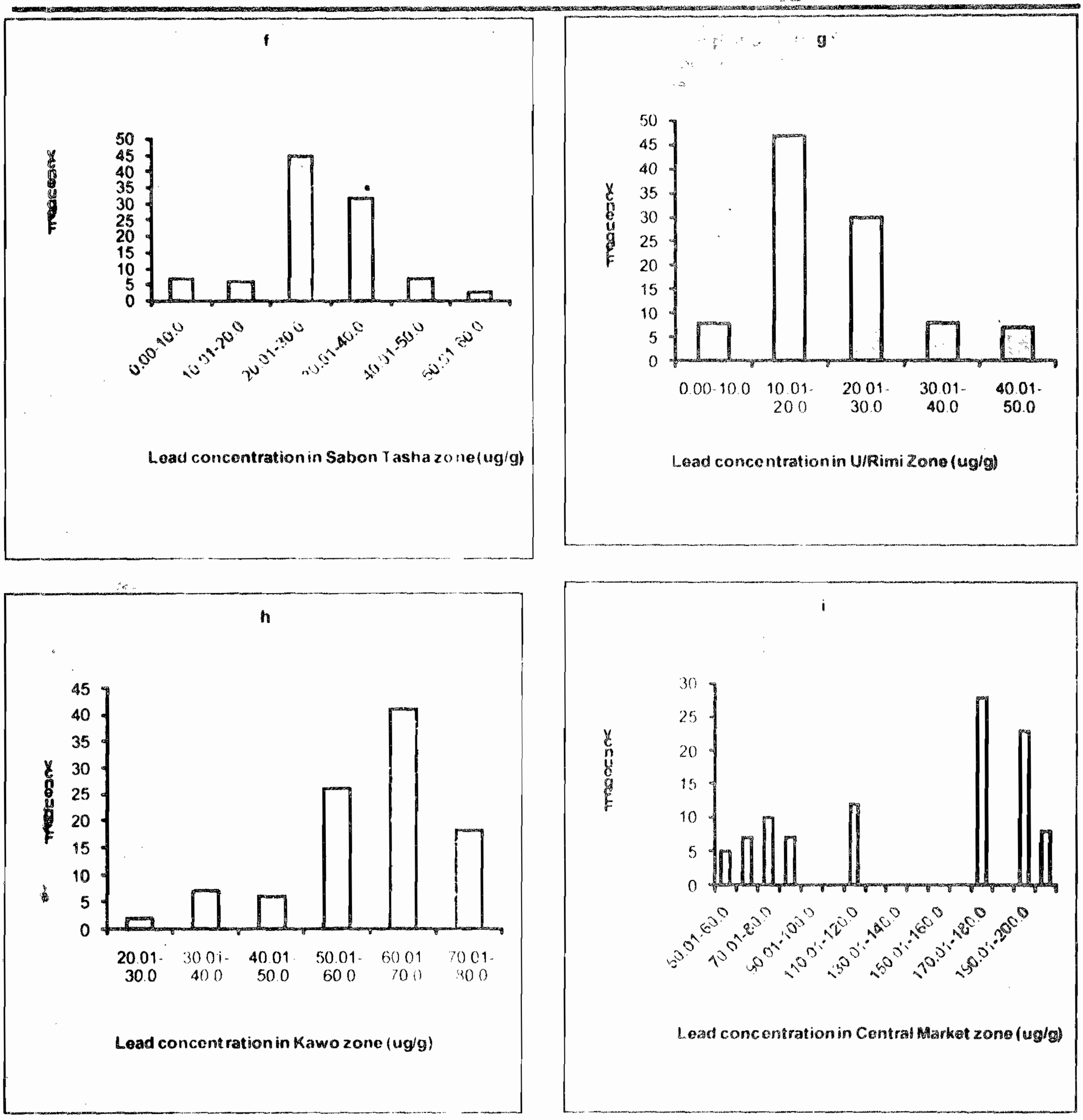

Fig 2f-i Frequency distribution of Lead Concentrations in zones f-i

The frequency distribution pattern for copper in Kaduna metropolis street dust is as shown in Fig 2a The distribution is multimodal and is skewed towards high frequency of low concentration with a mean of 46 13μgg^{-1}, and coefficient of variation of 98 78%. The results obtained are different from those reported by Birch and Scollen. (2003) and Loredo *et al* (2003). The frequency distribution pattern for Cu in zone b is as shown in Fig 3b. The distribution is multimodal with a mean of 24 96μgg^{-1}and coefficient of variation of 20.95%.The frequency distribution pattern for Cu in zone c is as shown in Fig.3c The distribution is multimodal and is skewed towards high frequency of low concentration with a mean of 33.08μgg^{-1} and coefficient of variation of 16 48%. Source of copper are from waste incinerations motor vehicles, municipal plumbing cooking utensils and releases from agricultural chemicals (Loredo *et al*. 2003) The frequency distribution pattern for copper in zone d is as shown in Fig 3d. The distribution is multimodal and is skewed towards high frequency of high concentration with a mean of 26.60μgg^{-1} and coefficient of variation of variation of 34.59%. Sources of copper may be from motor vehicles, plumbing and fittings, release from manufacturing processes in electrical companies such as recoiling of compressors. cutting of crankshafts and from automotive brake debris (Loredo *et al.*, 2003). The frequency distribution of copper in zone e is as shown in Fig 3e The distribution is multimodal and is skewed towards high frequency of high concentration with a mean of 111.62μgg^{-1}and coefficient of variation of 22.71% Source of Cu are from motor vehicles automotive brake debris, dust containing copper as releases from electrical industries, manufacturing electrical cables, and from plumbing tubes fittings (Loredo et al., 2003; Hodel and Chang, 2004). The frequency distribution pattern for copper in zone f. is as shown in Fig 3f. The distribution is skewed towards high frequency of low concentration with a mean of 20.91μgg^{-1} and coefficient of variation of 29.37%. Primary sources of copper in this zone include municipal plumbing, trash incineration and from motor vehicles (Loredo et al., 2003). The frequency distribution pattern for copper in zone g is as shown in Fig 3g. The distribution is uniform; having a mean of 12.72μgg^{-1}and coefficient of variation of 41.28%. The zone being mainly residential, the source of Cu is from motor vehicles, municipal plumbing and waste incineration (Loredo et al., 2003). The frequency distribution of copper in zone h is as shown in Fig 3h. The distribution is skewed towards high frequency of high concentration with a mean of 22.08μgg^{-1} and coefficient of variation of 31.22%. Source of copper include waste incineration, automotive brake debris municipal plumbing and releases from motor vehicles (Loredo et al., 2003). The frequency distribution of copper in zone i am as shown in Fig 3i. The distribution is skewed towards high frequency of high concentration with a mean of 130.73μgg^{-1} and coefficient of variation of 14.85%. Source of copper are from heavy and congested automobile traffic, waste incineration and resuspension of soil particles (Loredo et al., 2003).

The lead concentrations in street dust of industrial areas were higher than those of other sites. This clearly showed the direct influence of the type of activities on the concentrations of the metals. The higher concentrations of lead and copper in the industrial area compared with those of the residential or residential/commercial centres might be attributed to the wide range use of leaded gasoline and industrial uses of these metals (Duggan,1984; Fergusson,1987; Fergusson and Simmonds,1983, Fergusson and Ryan,1987; Fergusson et al.,1980). The mean lead and copper concentrations and their co-efficient of variations in all the zones are as shown in Table 1. Comparing the mean lead and copper concentrations in the industrial with the rest of the municipality, a significant difference ($p < 0.05$) was indicated except for the commercial centre indicating that the activities in a particular area affect their trace metal levels. How ever the mean lead concentration in Kaduna in the industrial, commercial and residential areas was less than those reported by Jiries (2003).

High concentrations of lead and copper were observed in zone I because of its traffic volume and dirty nature.

Table1: Mean and co-efficient of variation of Lead and Copper Concentrations (μgg^{-1}) in Kaduna municipality street Dust

	Municipal	Abakpa	T/Wada	Kabala	Kudenda	S/Tasha	U/Rimi	Kawo	Market
Lead ($\bar{X}$)	74.19	65.11	43.01	54.91	183.01	28.51	20.91	60.11	144.81
COv%	78.10	15.28	36.25	23.30	19.30	39.02	50.4	20.17	37.16
Copper ($\bar{X}$)	46.13	24.96	33.08	26.60	111.62	20.91	12.72	22.08	130.73
Cov%	98.78	20.95	16.48	34.59	22.71	29.37	41.28	31.22s	14.85

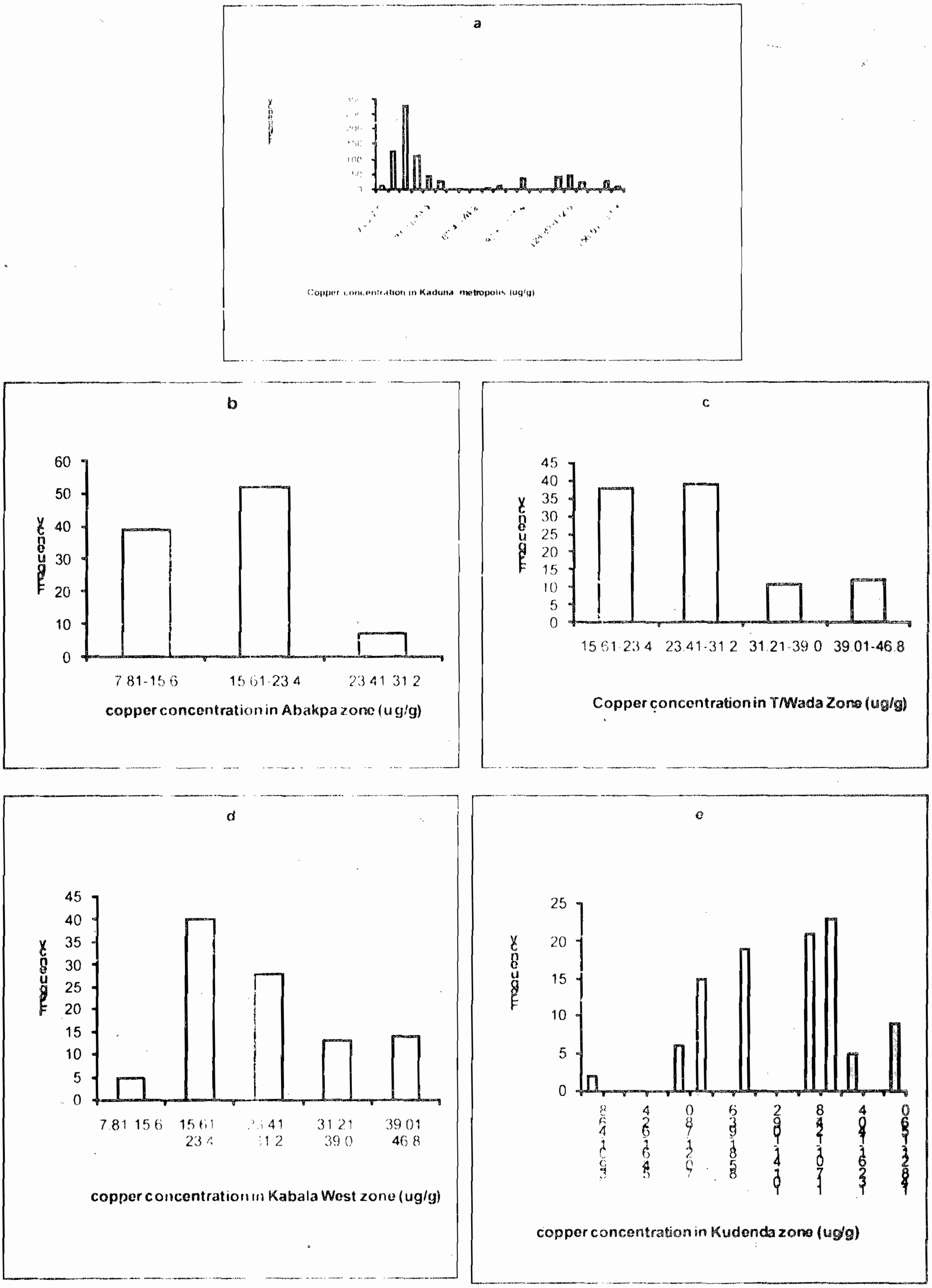

Fig3 a-e Frequency distribution of Copper Concentrations in zones a-e

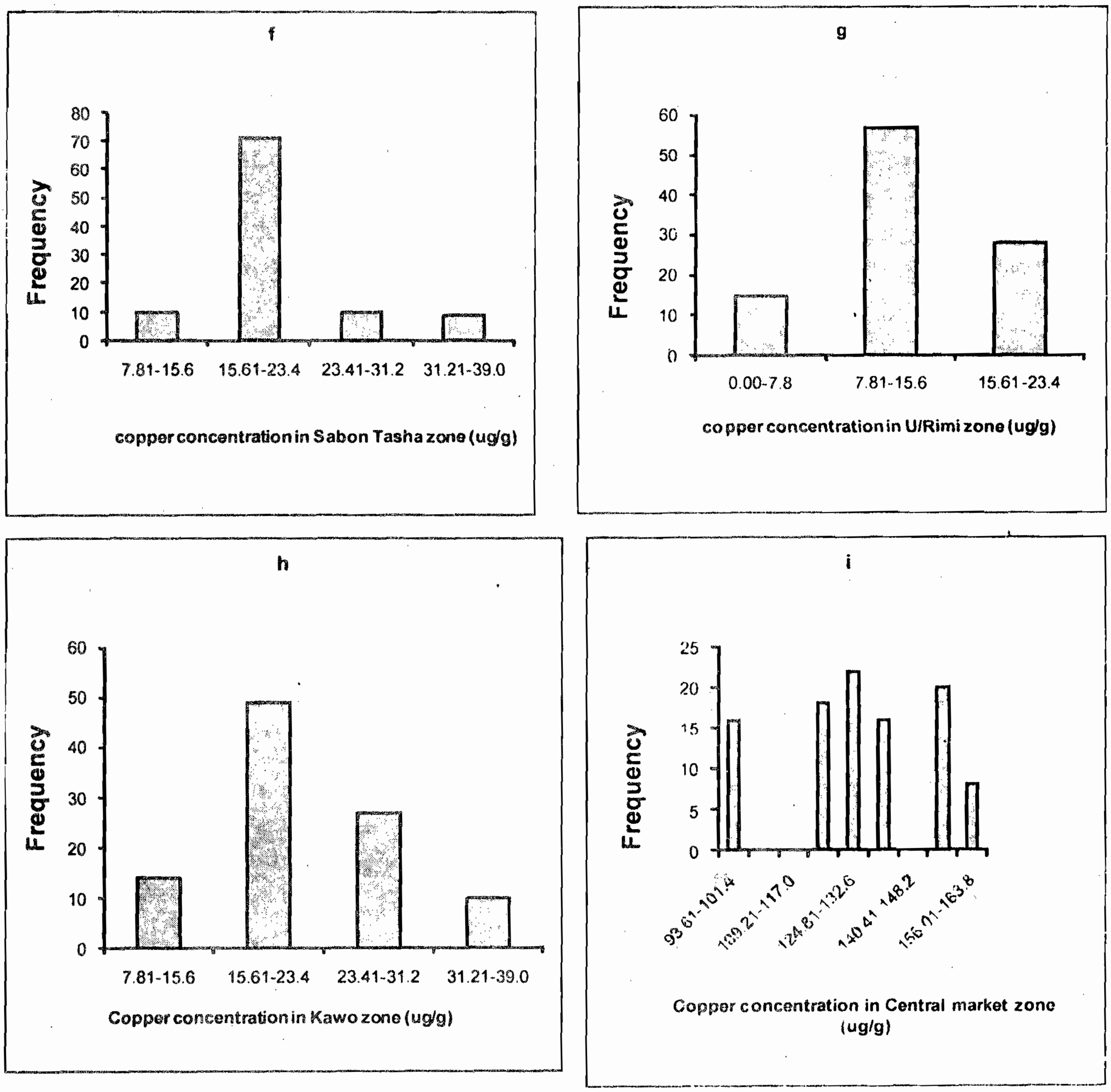

Fig3 f-i Frequency distribution of Copper Concentrations in zones f-i

CONCLUSION

In the light of these observations, it can be assumed that dust particulate in residential/commercial, residential, commercial and industrial areas are as a result of the activities of traffic flow and the cleanliness of the area. It is however evident from the results that industrial and areas with heavy traffic/commercial activities were more polluted than other areas and the residential are the least polluted comparatively. This study has provided the important base line information that varied street activities and traffic flows can affect its metal levels.

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