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SEASONAL ANALYSIS FOR LEAD IN ROAD SIDE SOIL SAMPLE AS INDICATOR FOR ENVIRONMENTAL CONTAMINATION IN MINNA-NIGERIA

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ABSTRACT: *The concentration of Lead in road-side soil samples within Minna Municipality and locations in She'e village along Kuta road was determined during dry and wet seasons by Atomic Absorption Spectrophotometer (AAS). Analysis showed that the concentrations of Lead were found to be higher, 10.60±0.10 ppm (dry) in areas of increased vehicular activities than 2.20±0.14 ppm (wet). These values were also higher than World Health Organisation (WHO) permissible level. This is an indicator that Minna roads are contaminated with Lead. Paired T-test statistic and correlation analysis shows significant difference and there was a positive correlation in dry and wet seasons in Minna and She'e locations*.

KEYWORDS: Seasonal Analysis, Road Side Soil Sample, Environmental Contamination, Minna-Nigeria

INTRODUCTION

Lead (Pb) is one of the oldest metals known to man . Lead has been used for various purposes in the past, but in modern times it is used mostly in batteries, oil paint pigments and in plumbing. Organic lead used as gasoline additive is the current chief source of environmental lead pollution. (Adaudi and Aliu,1980; Egereonu *et al*, 2012).The practice of using tetraethyl lead and other lead tetra alkyls as additives in petrol was introduced in 1923 to improve the octane rating of low quality petrol for use in high compression engines and to prevent semi-explosive combustion or knocking in the engine. During combustion, the inorganic lead passes into the air in the exhaust gases and is released into the atmosphere, (Ideria *et al* 2005;Bowon, 1971; Duong and Byeong 2011). The increased industrial, mining and construction activities and the phenomenal increase in the number of vehicles, plying Nigerian roads as a result of the oil boom in the mid-seventies to early eighties enhanced the potential hazards of environmental lead to man and animals (Hathway *et al.*, 1996; Seyferth 2003).

Lead has been the subject of much investigation as it has become a serious cumulative body poison and is to be avoided. The necessity of checking and preventing environmental pollution by this element and other members of the group cannot be overemphasized. Certain employers such as policemen, garage workers have accumulated relatively high body lead concentration. Similarly, residents living near motor ways and interchanges are also at risk where there is a sustained high concentration of vehicle exhaust fumes, (Dudka *et al.*, 1995; Jankiewicz *et al.*, 2001).

Lead is the ultimate product of various radioactive decay series. Radiation carcinogenesis in man, genetic effects, experimental radiation carcinogenesis and developed effects of radiation on the utero have been recently reviewed, (Goodman and Gilman, 1995). The most important somatic effects are malignant diseases and diseases in pre-natal development. Recurring lead poisoning may be followed by permanent injury to the kidney. This problem can be arrested by administering chemical substances that allow lead to be excreted more easily from the body.In view of the above and increased government efforts to protect the environment, it has become very necessary to carry out seasonal studies to determine the extent of lead contamination on Minna Municipal roads and bring to the knowledge of the population the danger that may befall their health on the long-run, (Weatheral, 1994).

MATERIALS AND METHODS

Minna is the capital of Niger State, Nigeria on $9^0$9'N and $6^0$6E of the longitude and latitude respectively.

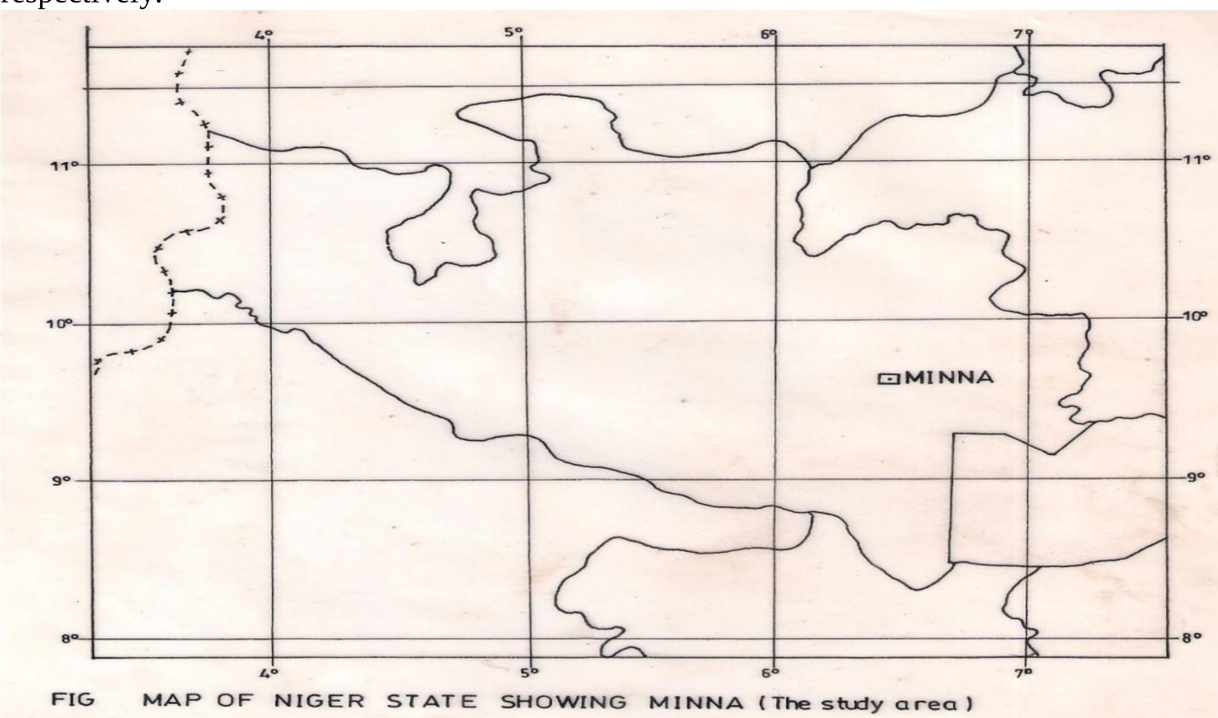


Figure 1: Map of Niger State showing Minna in Nigeria.

(a) All the reagents used in the study were all of Analytical grade and deionised water were used. They were used as received without any further purification. All glasses and plastic containers used were soaked in 1% v/v HNO_3 for 24 hrs, cleaned thoroughly with deionised water and dried.

(b) **Sample collection and preparation.**
Samples (soil/dust) were taken at random intervals,(Ronsberg, 2003) along the following routes: Minna-Suleja, Minna-Bida, Minna-Zungeru, Minna-Kuta roads and locations in She'e village

coded 1-16 respectively. Samples were also taken from isolated bush land along airport road. The samples were homogenised to make sub-samples and preheated by drying in an oven at $120^0 \pm 1^0$C. They were stored in polythene bags, (Mitra, 2003). 1g of each of the homogenized soil samples was weighed into a 250cm^3 beaker in duplicate. 60cm^3 of acid mixture, (253cm^3 of conc trioxointrate (V) acid and 60cm^3 of conc HCl acid in one litre volumetric flask and made up to mark using deionised water) was accurately measured and added to the sub-sample in the beaker. These were digested on a steam bath for two hours, (Awolalu, 2005).The blank was prepared by washing the filter paper in a funnel with 60cm^3 of the acid solution and made up to mark in a 100cm^3 volumetric flask using deionised water.After digestion, the solutions were allowed to cool and filtered using Whatman filter paper number 1 and washed with deionised water. The filtrates were poured into a 100 cm^3 volumetric flask and made up to the mark. Measurements were made with a Buck Model 210 Atomic Absorption Spectrophotometer (AAS) equipped with Lead (Pb) hollow Cathode lamp, (Adeniyi, 1996).

(c) **Preparation of Calibration Curve**

Stock solutions of lead was prepared by dissolving 1.5980g of lead trioxonitrate (V) in 50 cm^3 of 2.0 mol/dm^3 and the solution was made to volume in 1000 cm^3 flask with deionised water to make 1000 ppm Pb solution. Standard solutions containing 0-15ppm were prepared and aspirated at the wavelength 283.3nm. A calibration curve was drawn and was used to find the concentration of Lead in the samples, (Tan, 1996; Kapu 1989).

RESULTS AND DISCUSSIONS

Statistical analysis for both seasons are given on table 3. The table 4 is for the She'e village which was used as control. T-test statistical analysis is used to observe the significant difference between seasons for lead on Minna roads and She'e village. Table 1 and 2 showed a seasonal variation between 0.40±0.12 – 2.20±0.14ppm and 0.65±0.15 – 10.60±0.10ppm for wet and dry seasons respectively. Mean concentrations of 1.12 ± 0.10 (wet) and 3.55±0.12 (dry) ppm respectively accounts for the seasonal interplay and is greater than the permissible and maximum limit of 0.01 ppm allowed by World Health Organisation, (WHO, 1994). Correlation is used to see the relationship between Minna and She'e locations for dry and wet seasons.

Table 1
Results of analysis for Lead on Minna roads

S/No	Location	Wet Season (ppm)	Dry Season (ppm)
1.	Tunga 1	0.60±0.10	2.80±0.04
2.	Tunga 2	0.80±0.02	2.60±0.01
3.	Mobil Junction	1.60±0.12	4.80±0.12
4.	NITECO road	0.65±0.10	1.80±0.21
5.	Bosso (FUT Bus Stop) 1	1.40±0.13	2.20±0.15
6.	Bosso (Under bridge) 2	1.60±0.15	3.40±0.13
7.	Mypa Junction 1	0.80±0.02	2.60±0.11
8.	Mypa Road 2	1.40±0.10	2.20±0.12

9.	Bosso Estate rd	1.00±0.01	3.00±0.17
10.	Tudun Fulani	1.60±0.12	3.20±0.12
11.	Maikunkele road	1.40±014	2.60±0.12
12.	Kuta road (New Mkt)	1.00±0.01	2.20±0.16
13.	Minna park	2.20±0.00	8.20±0.12
14.	Bida road (kpakungu)	2.00±010	4.00±0.01
15.	Kpakungu park	2.20±0.14	10.60±0.10
16.	Bush Land (Airport road)	0.40±0.12	0.65±0.12

Table 2: Result of analysis for Lead on She'e sites

S/No	Location	Wet Season (ppm)	Dry Season (ppm)
1.	Grinding Engine site	0.65±0.01	1.00±0.02
2.	Main Bus Stop	1.00±10.02	1.40±0.12
3.	She'e road (i)	1.40±0.12	1.80±0.20
4.	" " (ii)	0.60±0.02	0.80±.0.12
5.	" " (iii)	0.65±0.04	0.95±0.04
6.	" " (iv)	1.20±0.12	1.40±0.02
7.	She'e Local park	1.40±0.00	1.60±0.12

Table 3: Paired sample T-test and correlation for Lead on Minna roads

				Paired sample test				
Season	**Mean**	**N**	**Std Dev**	**Mean**	**Std Dev**	**Correlation**	**T**	**sig(2-tailed)**
Wet	1.2906	16	0.56634	-2.2625	2.0907	0.77	-4.329	0.001
Dry	3.5531	16	2.4996					

The table 3 above shows paired sample T-test and correlation for lead on Minna roads. A significant difference (P<0.05) was observed between dry and wet seasons in the roads. Correlation of 0.77 shows positive correlation. This indicates the two seasons increase in performance, (Harrisson *et al*., 1981).

Table 4: Paired sample T-test and correlation for lead on She'e sites

				Paired sample test				
Season	**Mean**	**N**	**Std Dev**	**Mean**	**Std Dev**	**Correlation**	**T**	**Sig(2-tailed)**
Wet	0.9167	6	0.3357	-0.3083	0.0917	0.972	8.232	0.000
Dry	1.2250	6	0.3738					

The above analysis shows a significant difference (P<0.05) between dry and wet seasons on She'e site lead. Positive correlation of 0.972 shows that increase in wet season also increase dry season, (Page *et al*., 1971). The variation in the results could be attributed to the washing away of the top soil by rain water. The presence of oxides of sulphur, nitrogen and carbon in the atmosphere from human activities may alter the pH of the rain water towards acidic conditions which may help to elute the lead from the soil surface. The amount of lead found in the dry season could be more or less for a particular site as wind erosion may carry the emitted lead away in the direction of the wind and may not be deposited in the area of interest. On the other hand, it may be deposited on the immediate vegetation, (Piotroski *et al*., 1994; Duruibe *et al*. 2007, and Jenson, 1992, Harrison *et al.*, 1981). Interferences could cause variation in the observed results chiefly due to incomplete dissociation or formations of refractory compounds among others as viscosity and bulk properties. This could be overcome by the use of new treatment products such as Xtreme fuel treatment, XFT. (Syntek Global, 2013; Seyferth 2003). The 283.3nm wavelength is often preferred for better signal to noise ratio and lower background interference effect, (Jankiewicz *et al*., 2007).

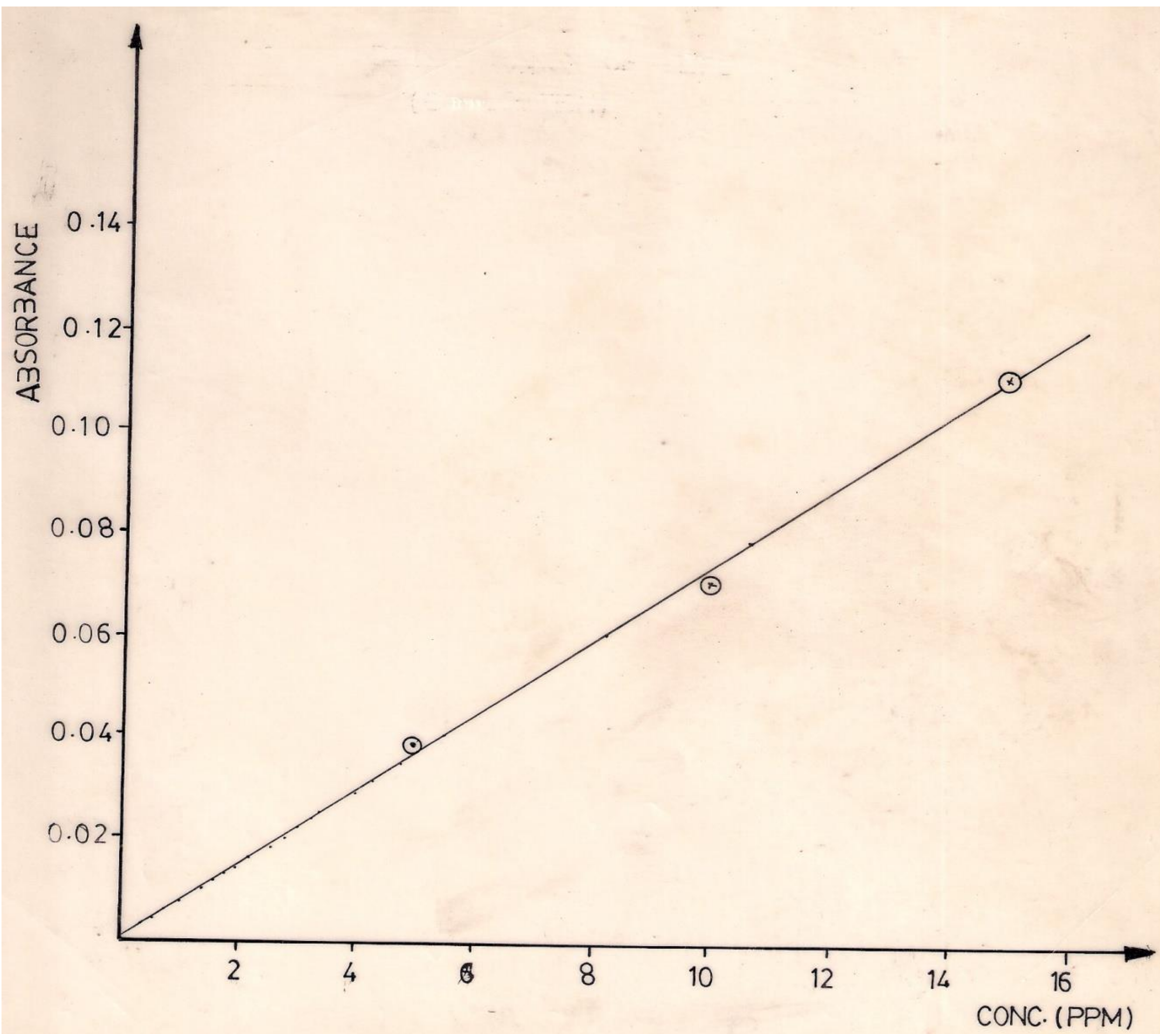
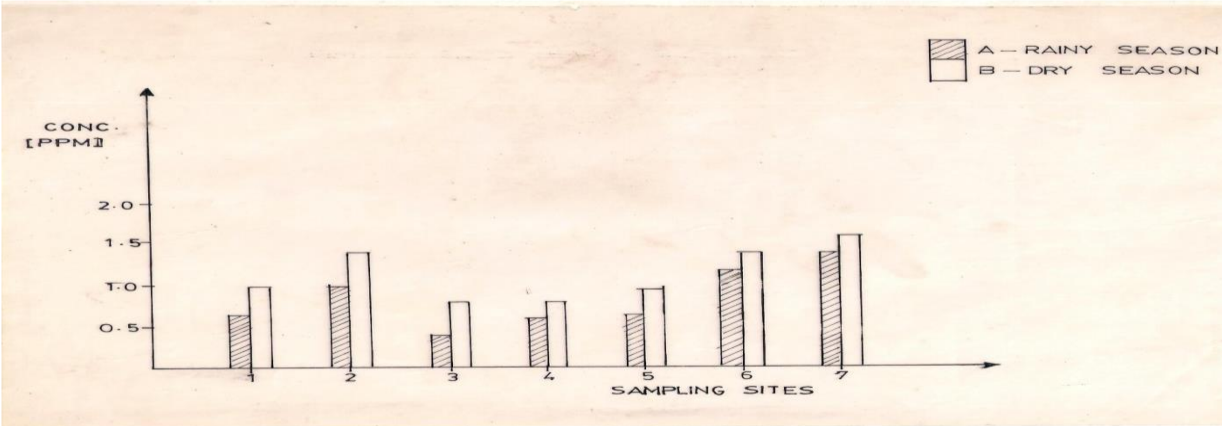


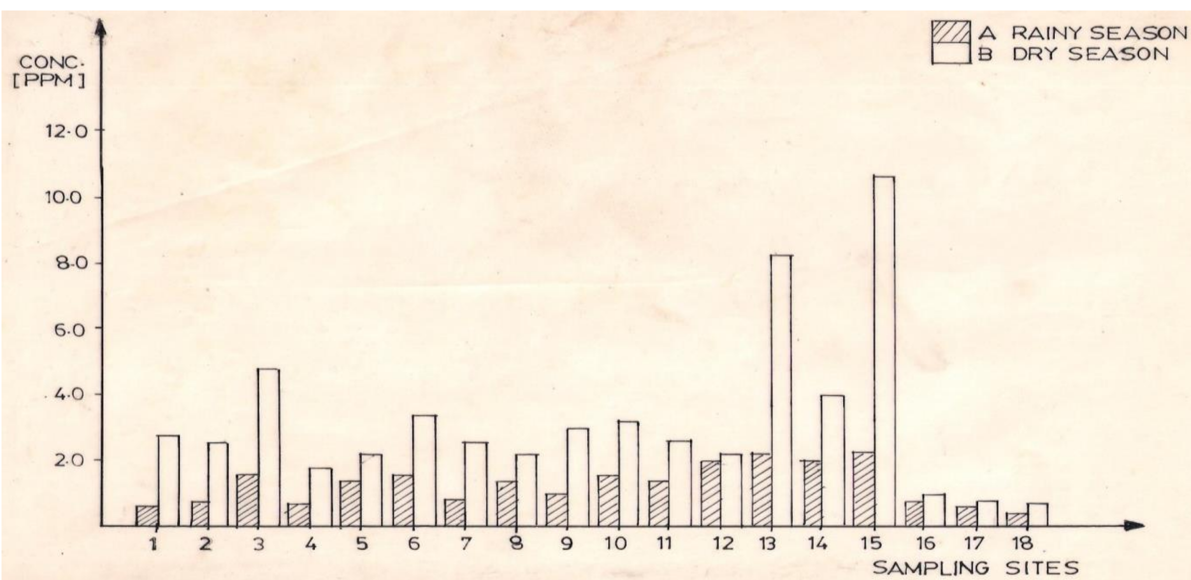
Figure 2: Calibration graph for determination of Lead (Pb).



1-Grinding site, 2-Main bus stop, 3,4,5,6-She'e roads(i-iv); 7-She,e local park

Figure 3 Distribution of Lead from She'e village

Figures 3 and 4 shows Lead contents for samples taken from the most travelled routes within the Minna Municipal and She'e Village during the wet and dry seasons. Significant differences were observed (fig. 3) in the amount found within Minna municipality due to increased in vehicular activities involving simple and heavy automobiles capable of emitting this metal Egereonu *et al* 2012). The amount of lead found from the parks are appreciably higher as the vehicles are left standing for a long time before take-off with continuous emission. In She'e village, (figure 3) the vehicular flow is generally low as few vehicles were seen along the sampling sites. The average amount of Lead found was low compared to the Minna municipal routes for the reasons already advanced and could be reduced for almost a nil. This compares favourably with the findings of Dudka *et al.*, 1995, Abbabel and Cottenie, 1985, Egereonu *et al* 2012).



1-Tunga 1, 2-Tunga 2, 3-Mobil junction, 4-Niteco road, 5-Bosso 1, 6-Bosso 2, 7-Mypa junction, 8-Mypa road, 9-Bosso estate road, 10-Tudun Fulani, 11-Maikunkele road, 12-Kuta road, 13-Minna park, 14-Bida road, 15-Kpakungu park, 16,17,18-Bush lands

Figure 4 Distribution of Lead in Minna municipality

CONCLUSION

The extent of lead contamination cannot be decided until a research of this nature is carried out to constantly monitor the seasonal variations over a period of time. Analysis showed that the concentrations of lead were found to be higher, 10.60±0.10 ppm (dry) in areas of increased vehicular activities than 2.20±0.14 ppm (wet). These values were also higher than World Health Organisation (WHO) permissible level. Paired T-test statistic and correlation analysis shows significant difference and there was a positive correlation in dry and wet seasons in Minna and She'e locations. This is an indicator that Minna municipal roads are contaminated with Lead. Efforts to 'get the Lead out' of gasoline, to which on the average about 2 or 3g used to be added per gallon (3.8 litres), are thus based mainly on concern with the growing amounts of Lead aerosols in urban atmospheres and their possible effects over long periods of time. Gasoline without tetra ethyl lead additive is lower in octane rating and therefore less suitable for modern compression internal combustion engines. Gasoline of sufficiently high octane rating with lead can be produced and will require additional refinery capital investments and the gasoline will cost more per gallon. A change from leaded to lead free gasoline is likely to involve a number of effects. Cars burning unleaded gasoline are said to have low maintenance costs because of such things as longer spark plug and muffler life. On the other hand; the lead in leaded gasoline acts as a lubricant around the engine valves and its removal will increase valve seat wear unless substitute lubricants are used.
This study recommends possible ways to reduce motor vehicle emission by instituting controls on the gasoline internal combustion engines or by the use of new products such as Xtreme fuel treatment (XFT), develop new type of engines like steam or other Rankline cycle engines, Wankel engines, gas turbines using gasoline or other fuels; and reducing motor vehicle use through educational programmes with better mass transportation system for intracity and intercity travel or Government controls. A number of different Rankline cycle engines are being developed for possible use in motor vehicles. Their advantage include low pollutant emissions, good safety, reliability and durability and not too expensive; but are bulky and slow to start. The fact that lead is poisonous over a period of time, we may have to live with the important advantage of unleaded gasoline not interfering with the operation of catalytic reactions oxidizing unburned hydrocarbons and carbon monoxide in the internal combustion engines. The octane rating ratings could be raised by increasing the amounts of aromatic and other higher octane hydrocarbons.

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