



## Determination of Heavy Metals Pollution in Grass and Soil along Major Highways in Kano

\*Saidu, U<sup>1.</sup>, Said, M.D<sup>2.</sup> and Ayodele, J.T<sup>2.</sup>

1. Department of Chemistry, Sule Lamido University, P.M.B. 048, Kafin Hausa.
2. Department of Pure and Industrial Chemistry, Bayero University, P.M.B 3011, Kano.

\*Corresponding author's Email/phone no.: [usmaniyya2000@gmail.com](mailto:usmaniyya2000@gmail.com)/[+2347039778737](tel:+2347039778737)

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### Abstract

*Pollution caused by traffic activities is increasingly becoming a great threat to urban environmental quality and human health in many cities of the world. Therefore, in this study grass (Paspalum Orbiculare) and soil samples were collected from four major highways in Kano, at distance interval of 1, 2, 3, 4 and 5 meters away from the edge of the road. The samples were analyzed for Cu, Ni and Cr using Atomic Absorption Spectrophotometer (AAS). The levels of Cu, Ni and Cr in grass were found to be  $3.20 \pm 0.84$  -  $4.60 \pm 0.55 \mu\text{g/g}$ ,  $5.20 \pm 1.79$  -  $6.40 \pm 1.82 \mu\text{g/g}$  and  $1.20 \pm 0.57$  -  $3.00 \pm 0.79 \mu\text{g/g}$  dry weight respectively. The ranges of concentrations in soil were from  $1.80 \pm 0.84$  -  $2.60 \pm 1.14 \mu\text{g/g}$ ,  $2.20 \pm 0.84$  -  $3.20 \pm 1.30 \mu\text{g/g}$  and  $0.90 \pm 0.42$  -  $1.30 \pm 0.82 \mu\text{g/g}$  dry weight for Cu, Ni and Cr respectively. Heavy metals in the four major roads were significantly higher ( $P < 0.05$ ) than those on the reference site. The results showed that the levels of Ni and Cr exceeded the EU limit levels ( $0.20$  -  $5.00$ - $\mu\text{g/g}$  for Ni and  $0.02 \mu\text{g/g}$  -  $0.50 \mu\text{g/g}$  for Cr) and signify that metal dynamics up the food chain is highly possible.*

**Keywords:** *Pollution; heavy metals; copper; nickel; chromium.*

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### 1.0 INTRODUCTION

With the rapid increase in the number of automobiles, pollution caused by traffic activities has become an important contributor to urban environmental deterioration and public health troubles (Fakayode and Olu-owolabi, 2003; Davydova, 2005). Plants and animals take up metals from the soil and concentrate them. Some of these metals are essential in low concentration for the survival of all forms of life and are described as essential trace elements. When present in greater quantities the heavy metals may cause metabolic anomalies (Annexes, 2003). Metals are non-biodegradable and therefore persist in soils for long periods.

This may be transported through soils to reach ground waters or may be taken up by plants. Excessive accumulation of heavy metal through traffic emission may results in soil contamination and elevated heavy metal uptake by plants, and thus affects food chain quality and safety (Garcia and Millan, 1998; Ho and Tai, 1998). Food chain contamination is one of the important pathways for the entry of these toxic pollutants (Atayese *et. al.*, 2009). Previous studies have shown that traffic pollution can cause significant accumulation of certain heavy metals such as Pb, Cd, Zn, Cr and Cu in both roadside soils and plants, primarily resulting

from vehicle emissions, and mechanical abrasion and normal wear and tear (Munson and Nelson, 1990; Garcia and Millan, 1998; Ho and Tai, 1998).

**2.0 MATERIALS AND METHODS**

In the preparation of reagents, analytical grade chemicals and distilled deionized water were used. All glass wares were washed with detergent

**2.1 Sampling**

The sampling sites are Kano - Zaria, Kano - Katsina, Kano - Maiduguri and Kano -Gwarzo roads (Fig. 1). 20 samples were taken on both sides of the road from each sampling area. Each sides with 2 rows, 10m away from each other. On each row, grass samples were taken at a distance

**2.2 Sample Treatment**

The grass samples were dried in an oven at 100°C for 48h. The dry samples were crushed in a mortar and passed through 250µm sieve (Ma and

The aim of this paper was to assess the levels of contamination of roadside soil and grass by Cu, Ni and Cr along four major roads in Kano and to assess how these levels may pose risks on animals and human health through food chain.

and rinsed with distilled water before drying in the oven at 105°C. All weighing were on Toledo AB54 analytical weighing balance.

interval of 1, 2, 3, 4 and 5 meters from the edge of the road. Similarly, the soil was also sampled in the same way as the grass. The control samples were taken in a site characterized by no traffic densities. The site is sparsely populated and basically residential with no industrial activity taking place.

Hung, 2006). Each soil sample was oven dried at 110°C to constant weight. The resulting powder was packaged in a polyethene bottle for the analysis of the heavy metals.

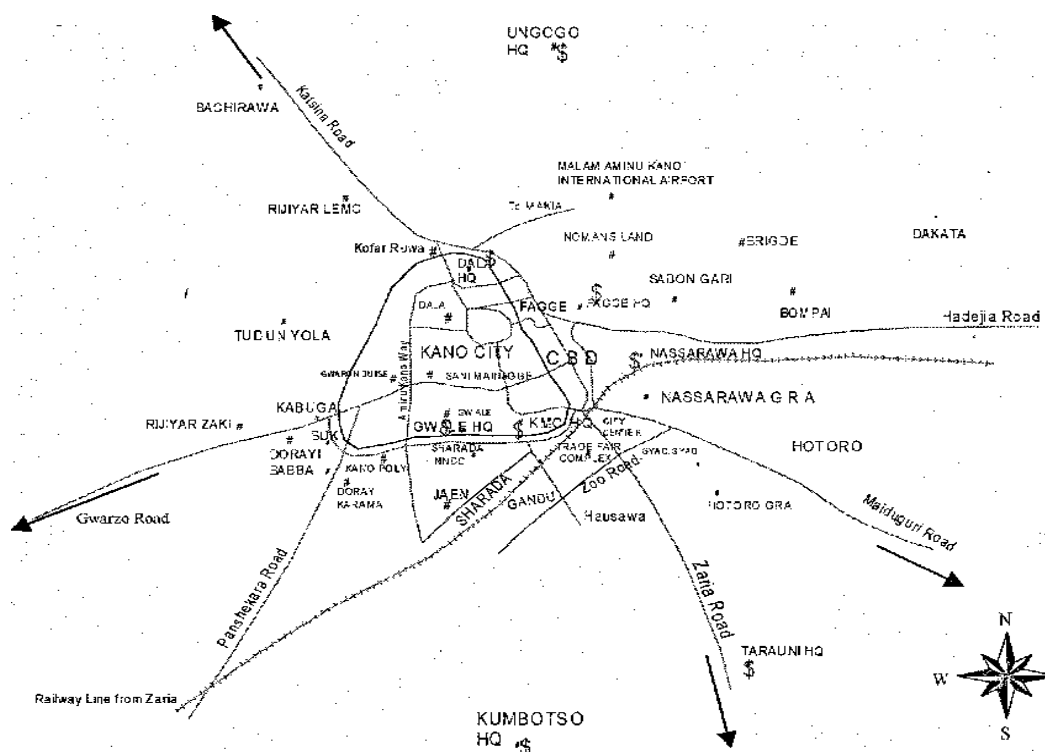


Figure 1. Map of Kano showing the Sampling Sites (areas).

### 2.3 PROCEDURE

0.5g of the grass sample was transferred to a 25cm<sup>3</sup> conical flask; 5cm<sup>3</sup> of concentrated H<sub>2</sub>SO<sub>4</sub> was added followed by 25cm<sup>3</sup> of conc. HNO<sub>3</sub> acid and 5cm<sup>3</sup> of conc. HCl. The contents of the conical flask were heated at 200°C for 1h in fuming hood, and then cooled to room temperature. Then, 20cm<sup>3</sup> of distilled water was added and the mixture was filtered using filter paper to complete the digestion. The mixture was transferred to a 50cm<sup>3</sup> volumetric flasks, filled into the mark, and

allowed to settle (Atayese *et. al.*, 2009). The resultant solution was analyzed for Cu, Ni and Cr. The same procedure was used for the soil samples.

Metal concentrations were determined on a Buck Scientific Model 210VGP Atomic Absorption Spectrometer (AAS). The result of each sample was the average of four replicate readings. Distilled water used as blank was digested using the above procedures.

### 3.0 RESULTS AND DISCUSSION

The trace metal concentrations in grass and soil samples from various sites are as shown in Figs. 2 - 9. The various sampling areas are Kano - Zaria, Kano - Katsina, Kano - Maiduguri, and Kano - Gwarzo roads.

Kano- Zaria road has a traffic flow of about 120,000 vehicles per day (FRSC, 2009). The concentration of heavy metals in grass and soil samples along Kano - Zaria road at 1-5 meters from the edge of the road is shown in Figs. 2 and 3, respectively. The Cu concentrations in grass decreased from 4.00µg/g to 2.00µg/g (Fig. 2), while in soil it decreased from 3.00µg/g to 1.50µg/g (Fig. 3). Heavy metals concentrations in grass samples were found to follow the order; Ni > Cu > Cr, while the concentrations in soil were found to follow the order; Cu > Ni > Cr. The result showed that the heavy metals concentration in both grass and soil samples were significantly correlated with distance ( $P > 0.05$ ). The high concentrations of these metals in grass are as a result of its direct deposition. This deposition pattern is similar to results earlier reported by other workers (Onder *et. al.*, 2007; Uwagboe and Hymore, 2008).

The concentrations of heavy metals in grass and soil samples along Kano- Katsina road are as shown in Figs. 4 and 5 respectively. The Cu concentrations in grass decreased from 5.00µg/g to 2.00µg/g (Fig. 4), while in soil it decreased from 3.00µg/g to 1.00µg/g (Fig. 5). The concentrations of these heavy metals in roadside grass and soil followed the order; Ni > Cu > Cr. There is general decreased in concentration with increased in distance in all

the samples analyzed. This result is in line with other result earlier reported (Atayese *et. al.*, 2009).

Kano- Maiduguri road has a traffic flow of about 95,000 vehicles per day (FRSC, 2009). The concentration of heavy metals in grass and soil samples along Kano - Maiduguri road at 1-5 meters from the edge of the road is as shown in Figs. 6 and 7 respectively. At a meter away from the road, Ni concentration in grass was 9.00µg/g while in soil was 5.00µg/g. As the distance increased, its concentrations decreased to 3.00µg/g and 1.00µg/g in grass and soil respectively. The concentrations of these heavy metals in both grass and soil samples followed the order; Ni > Cu > Cr. The result showed that Ni concentrations in grass and soil were significantly correlated with distance ( $P > 0.05$ ).

The concentrations of heavy metals in grass and soil samples along Kano - Gwarzo road at 1-5 meters from the edge of the road are as shown in Figs. 8 and 9 respectively. The Ni concentration in grass decreased from 8.00µg/g to 4.00µg/g, while in soil, it decreased from 5.00µg/g to 2.00µg/g. The concentrations of these metals in both grass and soil samples followed the order; Ni > Cu > Cr. Generally, there is the evidence of decreased in concentration of these heavy metals with increase in distance from the edge of the road in both grass and soil samples. This result is similar to that of Atayese *et. al.* (2009).

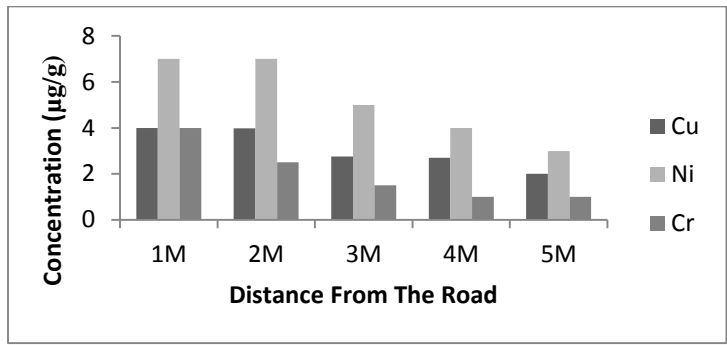


Figure 2. Heavy metals concentration in grass along Kano-Zaria Road.

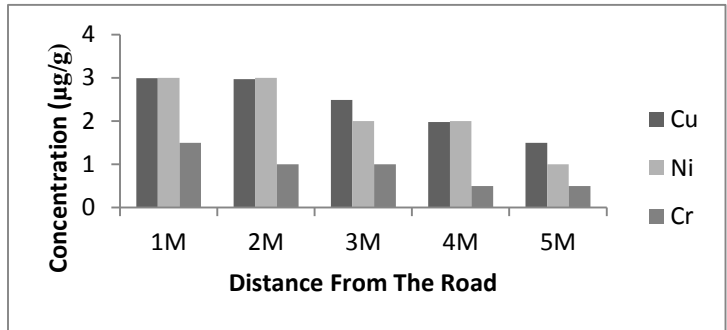


Figure 3. Heavy metals concentration in soil along Kano -Zaria Road.

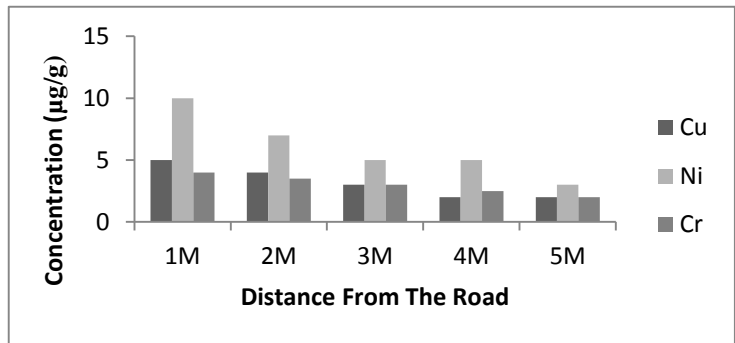


Figure 4. Heavy metals concentration in grass along Kano -Katsina Road.

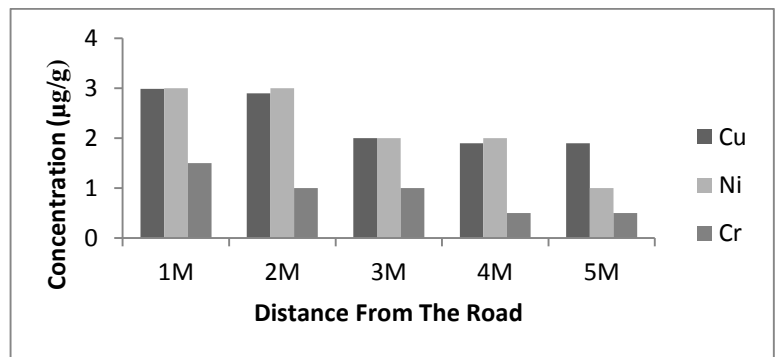


Figure 5. Heavy metals concentration in soil along Kano -Katsina Road.

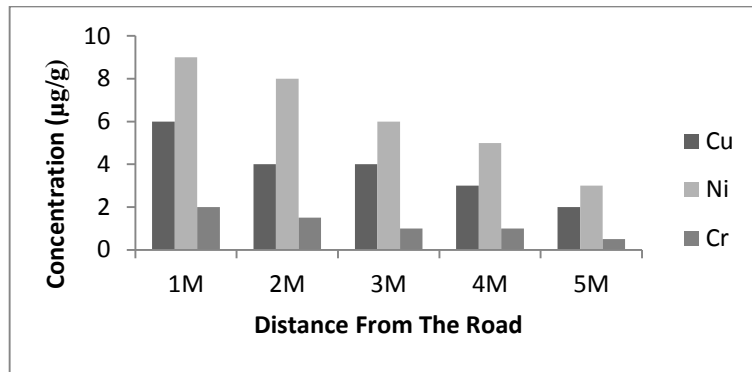


Fig. 6. Heavy metals concentration in grass along Kano -Maiduguri Road

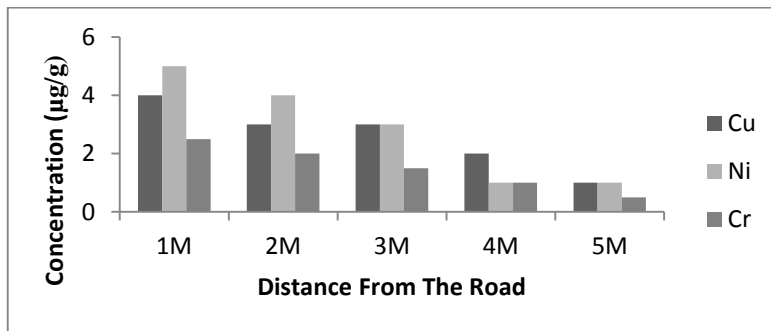


Figure 7. Heavy metals concentration in soil along Kano -Maiduguri Road.

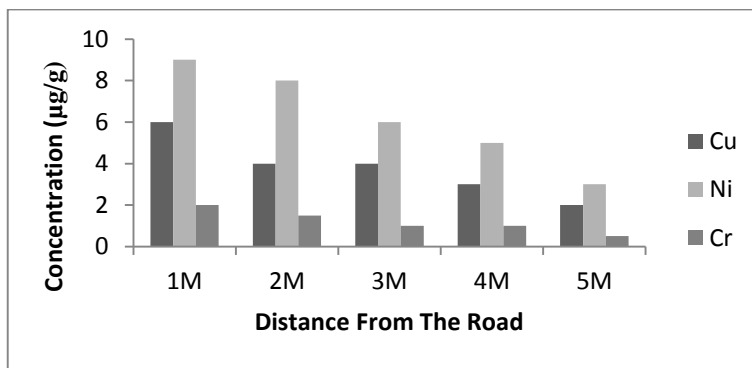


Figure 8. Heavy metals concentration in grass along Kano - Gwarzo Road.

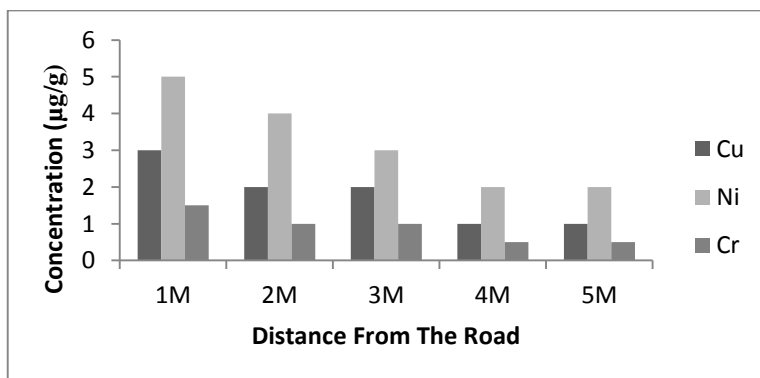


Figure 9. Heavy metals concentration in soil along Kano - Gwarzo Road.

The mean concentrations of heavy metals under study in roadside grass and soil samples along major highways in Kano are as shown in Tables 1 and 2, respectively.

A comparison of the concentrations of heavy metals in the grass and soils reveals that the values in the four major highways are higher than

in the reference site (control samples). This is probably due to vehicular traffic. A similar finding was reported by Jaradat and Momani (1999), who reported that roadside soil and plants had significantly high contents of heavy metals and their levels increased with increasing traffic densities.

Table 1: Mean heavy metal concentration ( $\mu\text{g/g}$ ) in grass samples.

Sites	Cu	Ni	Cr	Vehicles/day
K – Z	3.20 $\pm$ 0.84	5.20 $\pm$ 1.79	2.00 $\pm$ 1.27	120,000
K – K	3.20 $\pm$ 1.32	6.00 $\pm$ 2.65	3.00 $\pm$ 0.79	69,000
K – M	3.80 $\pm$ 1.48	6.20 $\pm$ 2.39	1.20 $\pm$ 0.57	95,000
K – G	4.60 $\pm$ 0.55	6.40 $\pm$ 1.82	1.40 $\pm$ 0.65	70,0000
REFERENCE	2.20	1.12	0.03	-

**Key:** K – Z Zaria, K – K = Kano – Katsina, K – M = Kano – Maiduguri, K – G = Kano – Gwarzo.

Table 2: Mean heavy metal concentration ( $\mu\text{g/g}$ ) in soil sample.

Sites	Cu	Ni	Cr	Vehicles/day
K – Z	2.40 $\pm$ 0.65	2.20 $\pm$ 0.84	0.90 $\pm$ 0.42	120,000
K – K	1.80 $\pm$ 0.84	2.20 $\pm$ 0.84	0.90 $\pm$ 0.42	69,000
K – M	2.60 $\pm$ 1.14	8.2 $\pm$ 3.42	1.30 $\pm$ 0.82	95,000
K – G	1.80 $\pm$ 0.84	2.80 $\pm$ 1.79	0.90 $\pm$ 0.42	70,0000
REFERENCE	1.50	0.91	0.01	-

**Key:** K – Z Zaria, K – K = Kano – Katsina, K – M = Kano – Maiduguri, K – G = Kano – Gwarzo.

Copper content in soil ranges from 2.5 - 60 $\mu\text{g/g}$ , but values up to several hundred  $\mu\text{g/g}$  are found in contaminated soil (Okunola *et. al.*, 2007). In this result, concentrations of Cu vary from 3.00 - 5.00 $\mu\text{g/g}$  in grass, and 2.00 - 3.00 $\mu\text{g/g}$  in soil. The highest Cu concentration (5.00 $\mu\text{g/g}$ ) was found in Kano - Gwarzo road grass, although the differences between the concentrations in grass and soil were minimal. The result show that Cu concentrations in both grass and soil samples were low implying that contamination of the metal, if present, were mild. This result is similar to that of Okunola *et. al.*, (2007).

The critical level for Ni in soil is around 0.2 $\mu\text{g/g}$  - 5.0 $\mu\text{g/g}$  (Onder *et. al.*, 2007). The highest Ni

content in this study was found in Kano - Zaria road grass (13.00 $\mu\text{g/g}$ ). Nickel toxicity is generally seen in soil irrigated with waste water (Onder *et. al.*, 2007). The higher level of Ni in Kano - Zaria road compared to other study area could be as a result of irrigation activities which is common along the road.

The highest mean chromium concentration was found in Kano - Zaria road soil (3.60 $\mu\text{g/g}$ ). The toxic level of Cr in soil is around 0.02 $\mu\text{g/g}$  - 0.5 $\mu\text{g/g}$  and its critical levels for the plants are 0.05 $\mu\text{g/g}$  - 0.10 $\mu\text{g/g}$  (Onder *et. al.*, 2007). The results show that most of the sites have Cr concentration within this range and present a risk of Cr pollution.

#### 4.0 CONCLUSION

Heavy metal concentrations in grass along highways at graded distances from the road were high compared with the soil. By determining the concentrations of heavy metals in roadside grass and soil, the effect of road traffic can now be well

managed. Heavy metals were detectable beyond 5meters from the road; however their concentrations were highest near the roads. The results showed that the levels of Ni and Cr exceeded the limit levels (0.20-5.00 $\mu\text{g/g}$  for Ni,

and 0.02 - 0.50µg/g for Cr) and reach pollution levels. Since heavy metals can be transferred through food chain, there could be potential risk for ruminant grazing along the road. Based on these results, the following recommendations could be made: grazing along highways by ruminants should be discouraged. Planting of

grains and vegetables along highways should also be discouraged. It is necessary to widen the study to other pollutants, other fodder crop species and to extend the distance to several meters away from the road. All these measures will go a long way to reducing the rate of ingesting heavy metals into the body system.

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