

Heavy Metals in Leaf, Stem Bark of Neem Tree (*Azadirachta indica*) and Roadside Dust in Maiduguri Metropolis, Borno State, Nigeria

Joseph Clement Akan¹, Lawan Bukar Inuwa¹, Zaynab Muhammad Chellube¹ & Babagana Lawan¹

¹Department of Chemistry, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria

Correspondence: J. C. Akan, Department of Chemistry, University of Maiduguri, P.M.B. 1069, Maiduguri, Borno State, Nigeria. Tel: 234-803-600-0506. E-mail: joechemakan@yahoo.com

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Abstract

Street dust and neem tree samples (*Azadirachta indica*) from Maiduguri Metropolis, Borno State, Nigeria were collected for the determination of trace elements. The highest concentrations of metals were found to be higher at the seven sampling points, while the lowest levels were observed in the street dust samples from the control sites. The concentrations of all the metals in plant samples were significantly highest in the leaves of *Azadirachta indica*, while the stem bark shows the least values. Levels of chromium (Cr), lead (Pb), nickel (Ni), cobalt (Co), cadmium (Cd) and arsenic (As) in plant samples exceeded the world health organization standard limits for medicinal plants. At the same time, the traffic situation in the area of study might be regarded as a source of heavy metal content in the roadside dust and plant samples.

Keywords: heavy metals, leaf, stem bark, neem tree, *Azadirachta indica*, roadside dust

1. Introduction

Vehicular emission and traffic congestions are major source of road side soil pollution (World Health Organization [WHO], 2006). Motor vehicles have directly and indirectly impacted on the metabolism of roadside plants due to emission of trace elements (Viskari et al., 2000). There has been interest in the levels of trace elements and their source identification associated with urban dusts in past decades (Chatterjee & Banerjee, 1999). Research has established people exposed to trace elements such as lead (Pb), Cadmium (Cd), Arsenic (As), manganese (Mg) and nickel (Ni) develop alterations in nervous system functions, with neurophysiological consequences constituting a health hazard (Olivero & Solano, 1998). Many studies throughout the world have identified vehicular traffic, industrial and commercial areas as sources of trace elements in urban dusts (Al-Chalabi & Hawker, 1997) as well as weathering or building facades (Akhter & Madany, 1993).

Such toxic elements (e.g. Pb, Cd, As, Mg, and Ni) are deposited on the roadside might be as a result of combustion, component wear, fluid leakage and corrosion of metals. Most heavy metals are release as a result fuel burning, tyres wearing, oils leakage and battery corrosion. Majority of heavy metals are toxic to living organisms and even those considered essential can be toxic if present in excess (Akhter & Madany, 1993). Trace elements can impair important biochemical processes posing a threat to human health, plant growth and animal life (Silva et al., 2005). Research from other studies showed heavy metals can be harmful to roadside plants, animals, and human settlements situated closer to a roads (Akbar et al., 2006).

Trees in urban areas can improve the quality of air through respiration and uptake of gases and particles (Beckett et al., 2000). Urban trees are important to man and the environments, and can be damaged when exposed to trace elements (Beckett et al., 2000). The mechanism of elemental uptake by plants is based on root uptake and foliar absorption, including deposition of particulate matter on the plant leaves. (Baycu et al., 2006). The uptake of trace elements by trees depends on the reserves of nutrients in soil and its bioavailability (Verma et al., 2006). The exposure of roadside plants to traffic emissions can changes in foliar anatomy and caused injury (Verma et al., 2006; Joshi & Abhishek, 2007).

Maiduguri (Lat. 11°50'N, Long 13°10'E) is located in Borno State, Nigeria. It is underline by the sediments of Lake Chad basin. Temperature ranges between 22 and 28 °C, with means of the daily maximum exceeding 40 °C before the onset of the rainy season, of March, through May. During the winter (December through February) the temperature falls to 12 °C. Neem Tree (*Azadirachta indica*) is tropical evergreen tree native of tropical South

East Asia, Africa and other southeast countries. They are widely planted along the street of Maiduguri Metropolis to improve the microclimate and as a result they tend to provide shelter during the summer months. The tree can survive drought and poor soil conditions and is considered an annual and can grow to more than 30 meters high. In Nigeria, neem extracts have been widely used for decades to treat many health problems (Sofowora, 1982). Pure neem leaves and barks are used locally in producing natural medicines and herbal cosmetics and has been used in the treatments of skin diseases, such as chickenpox (Sofowora, 1982). Crude extracts are also used in the treatment of fever caused by malaria. The stem bark and leaves contain compounds with proven antiseptic, antiviral, antipyretic, anti-inflammatory, anti-malaria, anti-infertility, anti-ulcer and antifungal uses (Ganguli, 2002). Traffic congestion, metals construction workshop, Iron bending and welding of metals is common practice along the street of Maiduguri. These activities might contribute to pollution of the roadside dust and trees.

2. Material and Methods

2.1 Sampling Collection Points

All sampling points for Roadside dust and neem tree (*Azadirachta indica*) were within Maiduguri, Borno State, Nigeria. Dust samples were collected from different points designated as S1 to S7. Point S1 is located at the University of Maiduguri teaching hospital gate; Custom roundabout S2; Westend junction S3; opposite Borno express motor park S4; Post office roundabout S5; Dambou road junction S6; Opposite NNPC depot S7. For each of the sampling points, dust and neem tree samples were also collected 200 meters away from each sampling point to serve as a control. Roadside dust samples were collected from the seven designated points and control points by using brush and plastic hand trowel to collect settle dust along the roads. The stem-bark and leaves of neem tree (*Azadirachta indica*) were collected and identified by Professor S. S. Sanusi a plant taxonomist in the Department of Biological Science, University of Maiduguri, Nigeria. Roadside dust leaves and stem-bark of neem trees were collected weekly from the seven designated and control points for a period of six months.

2.2 Samples Preparation

Two grams of each air-dried and sieved dust samples was ashed in a muffle furnace at 500 °C for 4 hours. The ash was digested in 10 ml Aqua regia (1 part conc. HNO₃ to 3 parts HCl) in a digestion tube on a hot plate until the volume reduced to 5 ml as the heating continued. After the digestion, the digestates were centrifuged and 10 ml HNO₃ was added. Samples were cooled and then made up to the volume of 100 ml with distilled water. For neem trees, samples were dried and crushed with a mortar and pestal with the resulting powder digested by weighing 0.5 g of oven-dried ground and sieve (< 1 mm) into an acid-washed porcelain crucible and placed in a muffle furnace for four hours at 500 °C. Crucibles were removed from the furnace and allowed to cool. Once at ambient temperatures, 10 ml of distilled water (H₂O), concentration nitric acid (HNO₃) and perchloric acid (HClO₄) were added to all the beakers. These were heated on a hot plate until the volume reduced to about 5ml as the heating continued. The beakers were removed from the hot plate and cooled. On cooling another 10 ml of 2M HNO₃ and 30 ml of distilled water were added, mixed and filtered into a 100 ml volumetric flask and made up to volume with distilled water (Radojevic & Bashkin, 1999).

Metal concentrations for Copper (Cu), Zinc (Zn), Cobalt (Co), Lead (Pb), Manganese (Mn), Nickel (Ni), Arsenic (As), Cadmium (Cd), Chromium (Cr), and Iron (Fe) were determined using Atomic Absorption Spectrophotometer (AAS, Unicam 969).

3. Results

The levels of Cr in the roadside dust for points S1 to S7 ranged from 5.32±1.03 to 24.54±0.28 µg/g. For Cu concentrations the levels ranged from 13.34±0.32 to 65.60±2.86 µg/g; 108.02±2.04 to 467.86±8.93 µg/g Fe; 1.01±0.01 to 4.67±0.54 µg/g Ni; 0.48±0.01 to 2.61±0.16 µg/g Co; 1.02±0.01 to 6.04±0.37 µg/g Mn; 0.33±0.01 to 1.43±0.03 µg/g Cd; 0.05±0.01 to 0.43±0.02 µg/g As and 62.12±2.31 to 435.54±15.66 µg/g Zn. Levels of all metals in the roadside dust were higher at point S5, while point S7 showed the least values in Table 1.

Concentrations of heavy metals in the stem bark of neem trees for the sampling points are presented in Table 2. The levels of Cr ranged from 0.15±0.02 to 2.11±0.01 µg/g; 1.05±20.04 to 3.65±0.12 µg/g Pb; 0.23±0.06 to 0.48±0.05 µg/g Cu; 1.21±0.33 to 4.88±0.12 µg/g Fe; 0.11±0.04 to 0.43±0.11 µg/g Ni; 0.12±0.04 to 0.33±0.05 µg/g Co; 0.24±0.02 to 1.56±0.02 µg/g Mn; 0.11±0.04 to 0.44±0.01 µg/g Cd; 0.02±0.01 to 0.10±0.03 µg/g As and 0.76±0.21 to 3.21±0.11 µg/g Zn.

The concentrations of heavy metals in the leaves of neem for all sampling points are presented in Table 3. The levels of Cr ranged from 1.64±0.11 to 3.54±0.33 µg/g; 2.33±0.12 to 5.87±0.21 µg/g Pb; 0.37±0.02 to

2.64±0.10 µg/g Cu; 2.12±1.43 to 6.32±0.21 µg/g Fe; 0.21±0.01 to 0.55±0.01 µg/g Ni; 0.12±0.04 to 0.44±0.02 µg/g Co; 0.33±0.01 to 2.43±0.21 µg/g Mn; 0.12±0.05 to 0.54±0.12 µg/g Cd; 0.07±0.02 to 0.22±0.01 µg/g As and 1.43±0.06 to 4.49±0.12 µg/g Zn.

Table 1. Concentrations of heavy metals in Road Side Street dust in different locations of Maiduguri Metropolis, Borno State, Nigeria

	Concentrations (µg/g)									
	Cr	Pb	Cu	Fe	Ni	Co	Mn	Cd	As	Zn
S1	7.34±0.23	86.65±1.32	13.45±0.73	132.45±3.29	3.23±0.02	1.02±0.01	3.08±0.12	0.65±0.04	0.06±0.01	123.06±4.02
S2	11.44±0.54	106.76±1.87	18.65±0.82	153.88±4.05	3.56±0.07	2.03±0.10	3.89±0.21	0.88±0.02	0.12±0.03	154.03±5.43
S3	15.32±0.32	165.66±2.31	34.55±1.02	265.45±5.06	4.09±0.34	2.45±0.12	4.33±0.33	1.21±0.05	0.16±0.04	245.72±7.08
S4	24.54±0.28	265.88±5.04	54.03±2.22	467.86±8.93	4.67±0.54	2.61±0.16	6.04±0.37	1.43±0.03	0.43±0.02	344.52±12.03
S5	21.32±0.44	342.67±6.44	68.60±2.86	423.45±6.70	3.87±0.12	1.34±0.03	5.66±0.02	0.99±0.01	0.21±0.05	435.54±15.66
S6	9.44±0.43	94.57±2.01	15.34±3.01	233.43±4.56	1.23±0.03	0.56±0.01	2.22±0.10	0.78±0.03	0.05±0.01	218.01±3.86
S7	5.32±1.03	58.56±0.22	13.34±0.32	108.02±2.04	1.01±0.01	0.48±0.01	1.02±0.01	0.33±0.01	0.06±0.02	62.12±2.31
Control	0.73±0.32	1.34±0.04	0.81±0.02	3.45±0.21	0.43±0.02	0.18±0.02	0.13±0.01	0.05±0.01	0.02±0.01	12.83±1.05

S1 = University of Maiduguri S2 = Teaching Hospital Gate; S3 = Custom; S4 = West-end Junction S5 = Opposite Borno Express Pack; S6 = Post office; S7 = Opposite N. N. P. C Gate; Control = 200 metre away from each points.

Table 2. Concentrations of heavy metals in the stem-back of Nem tree (*AzadirachtaIndica*) different locations of Maiduguri Metropolis, Borno State, Nigeria

Sample Locations	Concentrations (µg/g)									
	Cr	Pb	Cu	Fe	Ni	Co	Mn	Cd	As	Zn
S1	0.32±0.01	2.07±0.05	0.33±0.01	3.22±1.03	0.23±0.06	0.22±0.04	1.02±0.04	0.11±0.01	0.02±0.01	2.33±0.22
S2	1.03±0.04	2.43±0.01	0.36±0.03	3.94±0.32	0.32±0.02	0.27±0.07	0.67±0.01	0.08±0.03	0.03±0.02	1.42±0.21
S3	1.00±0.02	2.65±0.03	0.43±0.07	4.21±0.04	0.37±0.01	0.08±0.01	1.56±0.02	0.44±0.01	0.06±0.01	3.21±0.11
S4	2.11±0.01	3.21±0.01	0.48±0.05	4.88±0.12	0.43±0.11	0.12±0.04	0.52±0.03	0.33±0.05	0.10±0.03	2.11±0.01
S5	1.14±0.03	3.65±0.12	0.31±0.01	3.43±1.03	0.38±0.03	0.22±0.02	1.27±0.05	0.21±0.04	0.05±0.01	2.16±0.19
S6	0.15±0.02	1.05±0.04	0.23±0.06	2.45±0.23	0.21±0.01	0.33±0.05	0.33±0.06	0.34±0.02	0.02±0.01	1.05±1.84
S7	1.05±0.01	2.03±0.03	1.43±0.02	1.21±0.33	0.11±0.04	0.13±0.01	0.24±0.02	0.11±0.04	0.02±0.01	0.76±0.21
Control	0.03±0.01	0.22±0.07	0.05±0.01	0.55±0.02	0.03±0.01	0.05±0.01	0.03±0.01	0.02±0.01	0.01±0.01	0.12±0.01

S1 = University of Maiduguri S2 = Teaching Hospital Gate; S3 = Custom; S4 = West-end Junction; S5 = Opposite Borno Express Pack; S6 = Post office; S7 = Opposite N.N.P.C Gate; Control = 200 metre away from each points.

Table 3. Concentrations of heavy metals in the Leaves of Nem tree (*Azadirachta Indica*) different locations of Maiduguri Metropolis, Borno State, Nigeria

Sample	Concentrations ($\mu\text{g/g}$)									
Locations	Cr	Pb	Cu	Fe	Ni	Co	Mn	Cd	As	Zn
S1	2.11±0.12	3.55±0.24	0.54±0.03	4.66±0.32	0.43±0.01	0.34±0.01	2.11±0.13	0.24±0.02	0.12±0.01	3.65±0.43
S2	3.54±0.33	3.98±0.41	0.48±0.02	5.33±0.32	0.54±0.01	0.38±0.02	0.87±0.12	0.12±0.05	0.21±0.04	2.83±0.10
S3	2.43±0.22	4.56±0.17	0.51±0.01	5.98±0.21	0.41±0.11	0.12±0.01	2.34±0.12	0.54±0.12	0.14±0.03	4.49±0.12
S4	3.22±0.21	5.87±0.21	0.72±0.03	6.32±0.21	0.55±0.01	0.24±0.02	0.66±0.04	0.45±0.04	0.22±0.01	3.24±0.21
S5	2.12±0.15	4.77±0.54	0.45±0.01	4.33±0.35	0.53±0.10	0.31±0.01	2.43±0.21	0.31±0.01	0.13±0.02	3.72±0.23
S6	1.64±0.11	2.33±0.12	0.37±0.02	3.45±1.23	0.33±0.13	0.44±0.02	0.54±0.13	0.41±0.10	0.07±0.02	2.44±0.12
S7	2.34±0.35	3.56±0.22	2.64±0.10	2.12±1.43	0.21±0.01	0.24±0.01	0.33±0.01	0.23±0.01	0.10±0.02	1.43±0.06
Control	0.52±0.04	0.64±0.07	0.11±0.01	0.32±0.02	0.01±0.01	0.02±0.01	0.01±0.01	0.01±0.01	0.02±0.01	0.41±0.02

S1 = University of Maiduguri S2 = Teaching Hospital Gate; S3 = Custom; S4 = West-end Junction S5 = Opposite Borno Express Pack; S6 = Post office; S7 = Opposite N. N. P. C Gate; Control = 200 metre away from each points.

4. Discussion

4.1 Heavy Metals in Roadside Samples

4.1.1 Lead

The highest Pb concentration in the road side dust was $342.67 \pm 6.44 \mu\text{g/g}$ and was detected at sampling point S5 which is located opposite Borno express pack follow by S4, while point S7 shows the least value. The high concentration of Pb at point S4 and S5 when compared to other points might be due to the differences in traffic density, metals construction work, Iron bending and welding of metals which is a common practice along the street of Maiduguri. Results also show that the levels of Pb in dust samples were higher than the control. High values of Pb when compared to control are because all the sample points were in the areas of high traffic density. The traffic situation in this area might be regarded as a source of Pb in the roadside dust. Wear and corrosion of vehicle parts might also be one of the potential sources of heavy metals. Results of analysis of variance confirmed a significant difference in Pb content in the seven sampling points. Concentrations of Pb in the dust samples from the study area were higher than that reported by Charlesworth et al. (2003) of $48 \mu\text{g/g}$, and was also higher than the range of $1.01\text{--}2.9 \mu\text{g/g}$ reported by Al-Khashman (2006).

4.1.2 Copper (Cu)

Copper may be toxic to both humans and animals when its concentration exceeds safe limits (Bakirdere & Yaman, 2008). The highest Cu concentration in roadside dust was found at point S5 than at S4, while point S7 shows the lowest value. The high concentration of Cu at point S4 and S5 when compared to other points might be due to the differences in traffic density and metals construction work. High values of Cu in the seven sampling points when compared to the controls might be due to corrosion of metallic car parts (Al-Khashman, 2004; Al-Khashman & Shawabkeh, 2006).

4.1.3 Iron (Fe)

Iron was found to be the dominant metals detected compared with others in the roadside dust. Iron is vital for almost all living organisms, participating in a wide variety of metabolic processes, including oxygen transport, DNA synthesis, and electron transport. It is known that adequate Fe in a diet is very important for decreasing the incidence of anemia (Lynch & Baynes, 1996). High concentration of Fe in dust samples was observed at point S4 than is S5, while point S7 shows the least concentration. High concentration of Fe was detected at point S4 and S5 may be contributed to differences in traffic density. (Adachi & Tainosho, 2004). Analysis of variance (ANOVA) confirmed a significant difference in the Fe content within the seven sampling points, which shows that vehicular activities varied from one point to the other.

4.1.4 Nickel (Ni)

Nickel pollution on a local scale is caused by emissions from vehicle engines that use gasoline which contains Ni and by the abrasion and corrosion of Ni from vehicle parts (Al-Shayeb & Seaward, 2001). The burning of fossil fuels as well as the refining of metals such as Cu introduces considerable amounts of Ni into the atmosphere (Lee et al., 2005). The highest Ni concentration in the dust samples was found at point S4, while point S7 shows the least concentration. Analysis of variance (ANOVA) confirmed a significant difference in the Ni content in the seven sampling points, which shows that vehicular activities varied from one point to the other. Nickel values in the dust samples from the seven sample points were found to be higher than the control sites and may be the result of high traffic density within the study area.

4.1.5 Cobalt (Co)

The highest Co concentration in the dust samples was observed at point S4, while the least value was detected at point S7. Cobalt values in the dust samples from the seven sample points were found to be higher than the control sites. This may be the result of high traffic density within the study area. Analysis of variance (ANOVA) confirmed a significant difference in the Ni content within the seven sampling point, which shows that vehicular activities varied from one point to the other.

4.1.6 Manganese (Mn)

The deficiency of manganese in the human body can produce severe skeletal and reproductive abnormalities in mammals. High doses of Mn produce adverse effects primarily on the lungs and brain. The highest Mn concentration in the dust samples was observed at point S4 follow by S5, while the least value detected at point S7. Analysis of variance (ANOVA) confirmed a significant difference in the Ni content within the seven sampling points, which shows that vehicular activities varied from one point to the other.

4.1.7 Cadmium (Cd)

It was reported that cadmium is accumulated mainly in kidneys, spleen, and liver, and its blood serum level increases considerably following mushroom consumption (Kalac & Svoboda, 2001). Cadmium is now most commonly encountered in cadmium–nickel battery production, although it continues to be used in paints as well as in plastic production where it is an effective stabilizing agent. Highest Cd concentration in dust samples was observed at point S4, while point S7 shows the least concentration. Cadmium values in dust samples from the seven sample points were found to be higher than the control site; such variation might be attributed to high traffic density. Analysis of variance (ANOVA) confirmed a significant difference in the Cd content within the seven sampling points. The concentrations of Cd in the roadside samples world-wide has been reported to be 0.5–4.0 µg/g (Fergusson & Kim, 1991). Cadmium levels in dust samples did not exceed this ranged.

4.1.8 Zinc (Zn)

The highest Zn concentration in dust samples was observed at point S5 than at S4, while point S7 shows the lowest value. The traffic situation in the study area is regarded as a source of zinc in the roadside dust. Wear and corrosion of vehicle parts (brakes, tyres, radiators, body, and engine parts) might also be one of the potential sources of Zn in roadside dust. Zn values in the dust samples from the seven sample point were found to be higher than the control sites.

4.2 Heavy Metals in Leaf and Stem Bark of Neem Tree (*Azadirachta indica*)

The highest concentration of Cr in stem bark (2.11 ± 0.01 µg/g) was observed at point S4, while the minimum concentration (0.15 ± 0.02 µg/g) was observed in point S6. For Pb concentrations the maximum (3.65 ± 0.12 µg/g) was obtained in point S5, while the minimum was observed in point S6. Point S6 shows the least concentration for Cu, while point S4 showed the highest level. The maximum concentrations of Fe, Ni, Cd and As was observed at point S4, while the minimum was at point S7.

The highest concentration of Cr in leaves samples of neem trees was observed at point S2, while the minimum concentration was in point S6. For Pb concentrations the maximum was at point S4, while the minimum was observed in point S6. Point S6 shows the least concentration of Cu, while point S7 showed the highest level. The maximum concentrations of Fe, was observed at point S4, while the minimum was at point S7. For Ni levels, the highest concentration was found at point S4, while point S7 showed the least. Co was maximum at point S6, while point S3 showed the minimum. The concentration of Mn was highest at point S5 and point S7 showed the least value. Cd and Zn were found to be highest at point S3.

The concentrations of all the metals were significantly highest in leaves of *Azadirachta indica*, while the stem bark shows the least values. The daily dietary allowable intake for Cr ranged from 0.05–0.1 mg/kg, while the

FAO guideline ranged from 0.01–0.2 µg/g. The levels of Cr in the leaves and stem bark exceeded this value. The concentration lead in the leaves and stem bark of *Azadirachta indica* exceeded the WHO limit of 0.1 µg/g, while the concentration of copper in the plant samples were within the daily dietary intake of 2–3 mg/kg. Iron levels in *Azadirachta indica* was found in order of leaves > stem bark. In view of the recommended daily dietary intake of iron as 10-28 mg/day, the levels of Fe in the plant samples did not exceed these values. Nickel levels in the plant samples are far above the recommended daily dietary intake of nickel which is about 0.025 mg per day and the WHO guideline limit of 0.02 µg/g. Cobalt is beneficial for humans because it is a part of vitamin B₁₂, which is essential for human health. However, too high concentrations of cobalt may damage human health. And it may cause asthma and pneumonia, vision problems, nausea, heart problems and thyroid damage. When plants grow on contaminated soils they may accumulate cobalt, especially in the parts of the plant that we eat, such as fruits, leaf and seeds. The concentrations of Co in the plant samples were higher than the recommended daily dietary intake of 0.04 mg/day and WHO limit of 0.02 µg/g. Manganese is one of the major minerals, which is related to the carbohydrate and fat metabolism. The daily dietary intake of 2-5 mg manganese is considered to be suitable for human. The concentrations of Mn in the leaves and stem bark of *Azadirachta indica* did not exceed this ranged. Cadmium is used in batteries, pigments, fertilizers, detergents and it is also present in refined petroleum products. Plant samples of *Azadirachta indica* leaves and stem bark had concentrations exceeding the WHO limit of 0.1 µg/g reported for medicinal plants (Ghosh et al., 2009). The concentrations of As also exceed the WHO limit of 0.01 µg/g reported for medicinal plants (Ghosh et al., 2009). The concentrations of all the metals in the leaves and stem bark of *Azadirachta indica* from the seven sample points were found to be higher than the control sites. This may be as a result of high traffic density and metals construction work which is a common practice along the street of Maiduguri.

In general, plants grow by absorbing nutrients from the soil. Their ability to do so depends on the nature of the soil, its location, combination of sand, silt, clay, and organic matter. The pH determines the extent to which nutrients are available to plants. Usually metals preferentially concentrate in the leaves next is roots and then stem. Large number of factors control metal accumulation and bioavailability associated with soil and climatic conditions plant genotype and agronomic management, including: active/passive transfer processes, sequestration and speciation, redox states, the type of plant root system and the response of plants to elements in relation to seasonal cycles (Kabata-Pendias & Pendias, 1984). In the present study the same pattern seems to be followed. There was higher metal accumulation in leaves than in stem bark. Results of analysis of variance (ANOVA) show significant variations in the levels of heavy metals within the leaves and stem bark of *Azadirachta indica* from the seven sampling point. This variation may be due to the fact that different parts, even different leaves of the same plant may contain different proportion of same different metals, depending upon age of plant and other environmental factors, as can be observed between the various sampling points and control.

5. Conclusion

In all the sampling points, Fe, Zn and Pb show the highest concentrations in roadside dust. The high concentration of these metals in the roadside dust samples may be attributed to metals construction work, Iron bending and welding of metals. At the same time, the traffic situation in this area of study might be regarded as a source of heavy metal content (copper, chromium, nickel, manganese, and zinc) in roadside dust. The concentrations of all the metals in the seven sampling points were higher than that the control.

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