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Comparative Study of Heavy Metals in Elephant Grass (*Penniseteum Purpureum*) Grown along Major Road Sides in Amassoma and Igbogene Expressway Bayelsa State Nigeria

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Abstract

Determination of heavy metals in elephant grass (*penniseteum purpureum*) was carried out. The plant samples were gotten from Amassoma and Igbogene expressways with the control from Niger Delta University (new site). The samples were digested using mixture of HNO_3 acid and H_2SO_4 (3:1). The filtrate were analyzed using Atomic Absorption spectrophotometer. Results obtained for Cd in the leaf of Amassoma, Igbogene and the control sample were 0.305>0.297>0.287mg/kg, Cd in the root of the control, Amassoma and Igbogene were 0.298>0.289> 0.287mg/kg. Pb in the leaf of Amassoma, Igbogene and the control sample were 0.965>0.811> 0.790mg/kg, Pb in the root of Amassoma, Igbogene and the control sample were 0.736>0.726 >0.691mg/kg, Cr in the leaf for Igbogene, control sample and Amassoma -0.227 > -0.077 > ND mg/kg, Cr in the root of the control sample, Amassoma and Igbogene 0.072 > -0.429 > -0.367mg/kg , Ni in the leaf of the Igbogene, control sample and Amassoma are 0.626 > 0.558 > 0.447mg/kg, Ni in the root of the control sample, Amassoma and Igbogene are 0.474 > 0.459 >0.373mg/kg. The result of the study revealed that Pb, Cr and Ni have a lower value than the WHO standard value, Pb= 10, Cr= 1.3, Ni= 2.0 and Cd has a higher value than the WHO standard value, Cd= 0.02.

Keywords: Elephant grass; Heavy metal; Wind; Flood; Road sides; Environment.

1. Introduction

Elephant grass (*Pennisetumpurpureum*) is a tropical grass, that is mainly seen along highways in Nigeria. It has several species that grows in a range of conditions: dry or wet conditions, small holder scale or large scale agriculture. It's a valuable forage and very popular throughout the tropics [1, 2]. The plant has a robust, rhizomatous complex root system, which developed from the nodes of its stolons. The culms are rough, and may be 4-7m in height. Elephant grass is a dense. The leaves are flat, straight and hairy, about 1-1.2m long and 1-5 cm width with a bluish-green colour. The leaf margin is toothed and have midrib. There is little or no seed formation. When seeds are present they are very small (3 millionseeds/kg) CABI [3]. Elephant grass is very similar in appearance to sugarcane (*Saccharum officinarum*) but its leaves are narrower and its stems are taller [4]. Elephant grass is useful for forage making due to its high productivity. It is particularly suited for feeding herbivores. Elephant grass can be made into silage or hay. Livestock feed on the younger leaves [1, 5]. Elephant grass is used to make fences, thatch and energy source in the USA [6]. Leaf and Culm infusions have diuretic properties [7]. Elephant grass has several environmental applications. It has been used to make mulch and control soil erosion. It suppresses weed growing around it. and, has been used as a trap plant to fight against stem borers in maize crops [8]. Elephant grass is considered as an ideal crop and have some traces of metals accumulated from the soil naturally. These heavy metals may be from different sources in urbanized area. One of the sources is vehicle emission. Three factors known to influence the levels of metals in plant samples, are traffic, industry and weathered materials. Surface soil and dusts in urban areas are used as indicators for heavy metal contamination study. It was mentioned that areas close to the vehicular roads are polluted by heavy metals., from traffic [9]. These heavy metals are dangerous to human and animals. The availability of these metals is influenced by the type of materials, climate and relative mobility on the soil. Properties such as mineralogy, texture and soil type is important. Soils pollution by heavy metals from automobile sources is an environmental issue. These metals are released during transportation, combustion, wearing of parts of machines, fluid leakage and corrosion of metals etc. [10]. Most heavy metals are toxic, even those regarded as essential can become toxic when present in excess. Heavy metals may affect important biochemical processes, thereby becoming a threat to human health, plant growth and animal life Alfvén, *et al.* [11] and Khan, *et al.* [12]. Soil is an important environmental medium, which is subjected to a number of pollutants due to human activities [13]. The quest for economic and social development have put a great burden on soil with the increasing demand for metals during the course of industrialization and urbanization, more pollutants are released [14]. Though studies on sources of these heavy metals accumulation in the soils are documented, little or no attention have been

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given on the activities of humans such as wet market, mechanic workshop, dump sites, paddy field and car wash which have relevant influence on the soils. These wastes include petrol, grease, oils, suspended solid, organic solvents, junked car parts etc. that may be photo toxic to plants and harmful to animals (Federal environmental Protection Agency1991). Environmental pollution by heavy metal from road traffics emissions have received attention in recent years due to problems associated with their long-term accumulation. Heavy metals such as Pb, Cu, and Zn have been reported to be released into the atmosphere during different operations [15].

Elevated amount of trace metals as a result of human activities have been observed since ancient times [16] which are associated with industrial activities. However, excessive discharge of toxic heavy metals onto the roadside and the associated health issues have become significant and have developed to be a global phenomenon [17].

Lenntech [18] defined heavy metal as any metallic element that has a relatively high density and is toxic or poisonous even at low concentration. Long-term accumulation of heavy metal pollutants have resulted to health effects [19]. Although, heavy metals are important for proper functioning of the body system, bioaccumulation at high concentration may result to health challenges of the inhabitants [18] Metals like As, Cd and Pb have been reported not to have bio-importance in human biochemistry, physiology and consumption. At very low concentrations, can be toxic [20]. Heavy metals are emitted from anthropogenic and natural sources. The anthropogenic sources include industrial and automobile emissions [21, 22]. Oil spillage contributes to heavy metal pollution. Tanee and Kinako [23] and Tanee and Akonye [24] observed that there was an increase of Zn and Cu in crude oil polluted soil. Automobile emission have been reported to be the largest source of heavy metal in the environment [21]. Too much heavy metals accumulation in agricultural land may lead to increased heavy metal uptake by plants [25]. The result obtained from this study will broaden our view on the danger of heavy metal pollution in our environment by providing information on the danger of road-side farming, a practice among rural farmers. Heavy metals like As, Cd, Hg, Pb and Se are not essential for plant growth. They do not have any physiological function in plants. Others, such as Co, Cu, Fe, Mn, Mo, Ni and Zn are trace elements needed for growth and metabolism of plants. These metals can cause poisoning when their concentration is higher than optimal value. Uptake of heavy metals by plants and accumulation along the food chain is a potential threat to animal and human health, [26]. The absorption by the plant root, is the routes of entrance of trace metals into the food chain [15]. Absorption and accumulation of heavy metals in plant tissue is influenced by temperature, moisture, organic matter, pH and nutrient availability. The uptake and accumulation of Cd, Zn, Cr and Mn in Beta vulgaris (Spinach) were found to be higher in summer season, whereas Cu, Ni, and Pb accumulated more in winter season [27]. It's expected that in summer season, decomposition rate of organic matter is high which may release heavy metals into the soil which result to Possible uptake by plants. Sharma, *et al.* [27]. Heavy metal accumulation in plants is dependent on the plant species which is evaluated by either plant uptake or soil to plant transfer factors [28]. Pb in high concentration, may decrease soil productivity, and a very low Pb concentration may reduce some vital plant processes, like photosynthesis, mitosis and Water uptake with toxic symptoms of dark green Leaves, drying of older leaves, retarded foliage and Brown short roots [9]. Heavy metal pollution have negative effects on parameters relating to plant quality and yield but also causes changes in size, composition and activities of the microbial community [29]. Heavy metals are seen as one of the sources of soil pollution [30]. Heavy metals somehow affect soil enzymatic activities by influencing the microbes which synthesizes enzymes [31]. Long-term heavy metal effects can increase bacteria and fungi tolerance, which can play a relevant role in the restoration of contaminated ecosystems [32]. Diversity and activity of soil microbes play significant roles in recycling of plant nutrients, soil structure maintenance, breaking down of heavy chemicals and regulation of plant pests are relevant indices for soil quality. Ashraf and Ali [33], said is important to investigate the functions of soil micro-organisms in the ecosystems that are exposed to long-term contamination. Plant absorption of heavy metals from soils at high amount may cause health risk considering the food-chain. Uses of food crops contaminated with heavy metals is a route for human exposure. Plants whose system is exhaustive and have continuous cultivation have capacity to extract these elements from the soils. The cultivation of such plants in contaminated soil is a potential risk since their tissues can accumulate heavy metals [34]. Heavy metals become toxic when they are not discharged and are accumulated in the soft tissues [35]. Chronic level of digestion of trace metals has undesirable impacts on humans and their harmful impacts become noticeable after many years of exposure [28]. Pb, Zn, Cu and Cd are known to damage nervous connections, cause food poisoning and cancer in humans [36]. Cd is a heavy metal toxicant with a specific gravity of 8.65 times greater than water. Cd toxicity affect organs like liver, placenta, kidneys, lungs, brain and bones. Depending on the level of exposure, the symptoms include nausea, vomiting, abdominal cramps, dyspnea and muscular weakness. Exposure may result in pulmonary failure and death [14]. Intake of Cu in much quantity may lead to severe mucosal and central nervous system irritation, widespread capillary damage, hepatic, renal damage followed by depression. Severe gastro intestinal irritation and possible necrotic changes in the liver and kidney may occur. The effects of Ni exposure cause skin irritation, damage to lungs, nervous system, and mucous membranes [36]. Pb is physiologically and neurologically toxic to humans. Acute Pb poisoning may results to dysfunction in the kidney, reproduction system, liver and brain resulting in sickness and death [37]. Other effects include damage grey matter of the brain, thereby resulting in poor intelligence quotient (IQ). There are reports of heavy metal accumulation by plants grown on roadsides in the developed countries [17, 38, 39].

Ashraf and Ali [33], reported that heavy metals exert toxic effects on soil microorganism. Heavy metals may inactivate enzyme reactions by completing the substrate, by reacting with protein-active groups of enzymes, by reacting with the enzyme-substrate complex or indirectly by altering the microbial community which synthesizes enzymes [34]. Enzyme activities are influenced in different ways by different metals, different chemical affinities of the enzyme system. Cd is more toxic to enzymes than Pb. Pb decreases the activities of urease, catalase, invertase significantly, Cd affects protease, alkaline phosphatase and akylsulfatase but no significant effect on that of invertase. [40]. Studies showed that the exposure to road vehicles emission introduce large amount of metals into terrestrial, aquatic and atmosphere [41]. Konnespayeva, *et al.* [42]. Safety process to obtain safe products with the highest quality and contribution to food security stimulated this work. Cu, Cr, Zn and Pb in elephant grass located along express road in Bayelsa state were determined.

The interest is to determine the vehicle traffic emission on the metal contents of the surrounding. Elephant grass use in Bayelsa state and all over the world. i.e. it is common to use grass located on the edge of road with high vehicle traffic flow to feed animals. However, this kind of procedures does not involve the possible grass due to vehicle emission [43]. Study by Baker [44], revealed that excluder from, by contrast lead to constant physiological properties of accumulation and excluders' metal tolerance mechanisms. Carlos, *et al.* [45], determined the content in samples of grass located proximity to vehicle traffic, which result indicated high in grass proximity to the vehicle traffic road and to all element studied, they showed that after 120meters of distance the content of the metals is stable and minimal

Mushrifa, *et al.* [46] showed remediation techniques to be the best alternatives, to minimize heavy metal effectively. Study was done by Yadav [47]. Toxicity, which reveals that a principal class of chelation known in plant is phytochelatins (PCs) a family of cys-rida peptides. PCs are synthesized non-translation ally from reduced glutathione in a transpeptidation reaction catalyzed by the enzymes, phytochelatinsynthesis (PCs). Therefore, availability of glutathione is very essential for PCs synthesis in plants at least during their exposure to heavy metal. Heavy metal toxicity in plants depends on the bioavailability of these elements in soil elution, where the function of pH, organic matter and cation exchange capacity of the soil. Non-essential metals such as Hg, Cd, Cr, Pb, As and Sb are toxic both in their chemical combined or elemental forms and plants respond to these elements vary across a band spectrum from tolerance to toxicity [46]

2. Materials and Method

2.1. Study Areas

This study was carried out along Amassoma and Igbogene express way in Bayelsa State. While the control plant was taken from the school premises in Niger Delta University, Wilberforce Island(new site) in Bayelsa state.

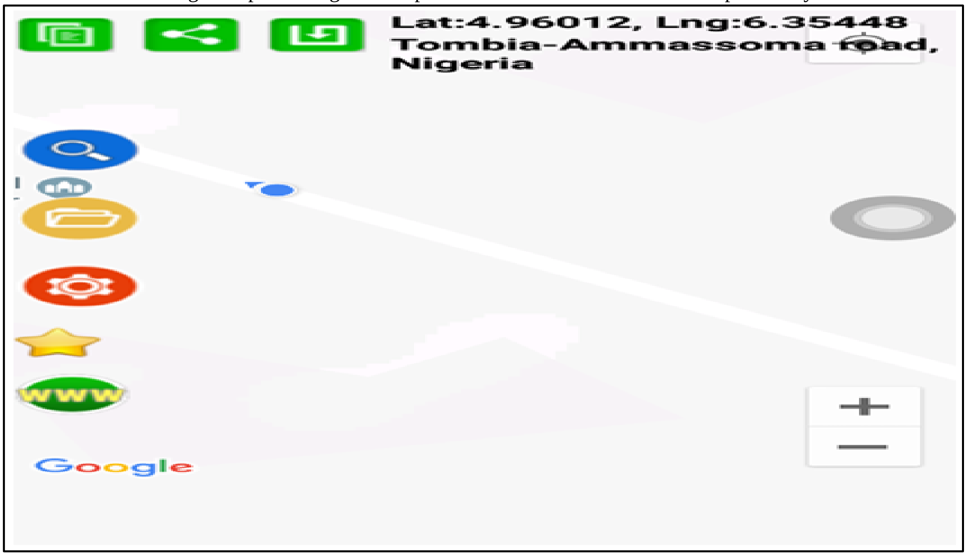
Igbogene express way is a major road which is the main road connecting to the east-west road in south-south region part of Nigeria, with high traffic and market activities taking place on the road; the plant sample lie between latitude 5.608N and longitude 6.388E

Amassoma express way is located in Southern Ijaw Local Government Area in Bayelsa state.

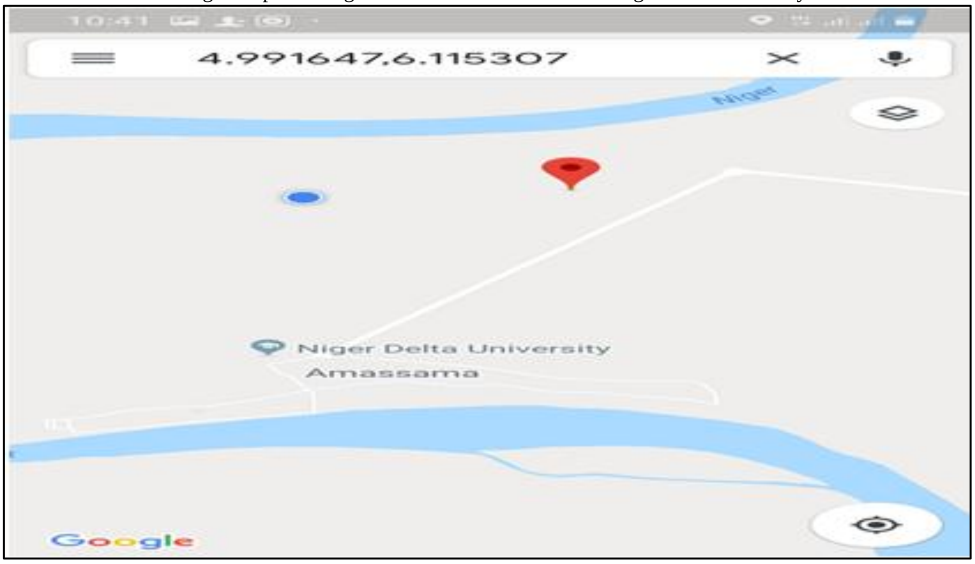
The plant sample collected from the express way lie between latitude 4.961N and longitude 6.354E. The express way lead to the Niger Delta University where vehicles and trucks travelling out and in, transportation is one of the major activities on this express way,while the control site is located in the Niger Delta University new site campus.The plant sample lies between latitude 4.992N and longitude 6.115E, which has a car parklocated close to the sample collection site.

Google Map Showing the Sample Collection Site in Igbogene Express Way

Google Map Showing the Sample Collection Site in Amassoma Express Way



Google Map Showing the control Collection Site in Niger Delta University



2.2. Sampling and Preparation

The plantssamples were collected using a spade and labeled properly for identification which was taken to the laboratory for analysis.Samples were rinsed thoroughly with water, the root and leaves were separated, then was oven dried at 70^{o}C for 26 hours and filtered through a 2mm sieve to receive fine particle.

2.3. Materials

Nitric acid, Hydrogen Tetraoxosulphur (vi) Acid, fume cupboard, measuring cylinder, hot Plate, watchman filter Paper, 250mL Beaker, 100ml Bottle, Distilled Water and Atomic Absorption Spectrophotometer (Gbc Avanta Pm A6600)

2.4. Method

Two grams of the ground powdered sample was weighed into a 250mL beaker and acid mixture of Nitric and hydrogen tetraoxosuphur (vi) acid (3:1) was added and mixed properly to homogenous solution and heated in hot plate inside a fume cupboard for digestion. The digested sample was allowed to cool; 50mL of distilled water was added and was then filtered using a watchman filter paper into a 100mL sample bottle. Thefiltrate wasthen analyzedusing Atomic Absorption Spectrophotometer (AAS).

3. Results and Discussion

3.1. Amassoma Express Way

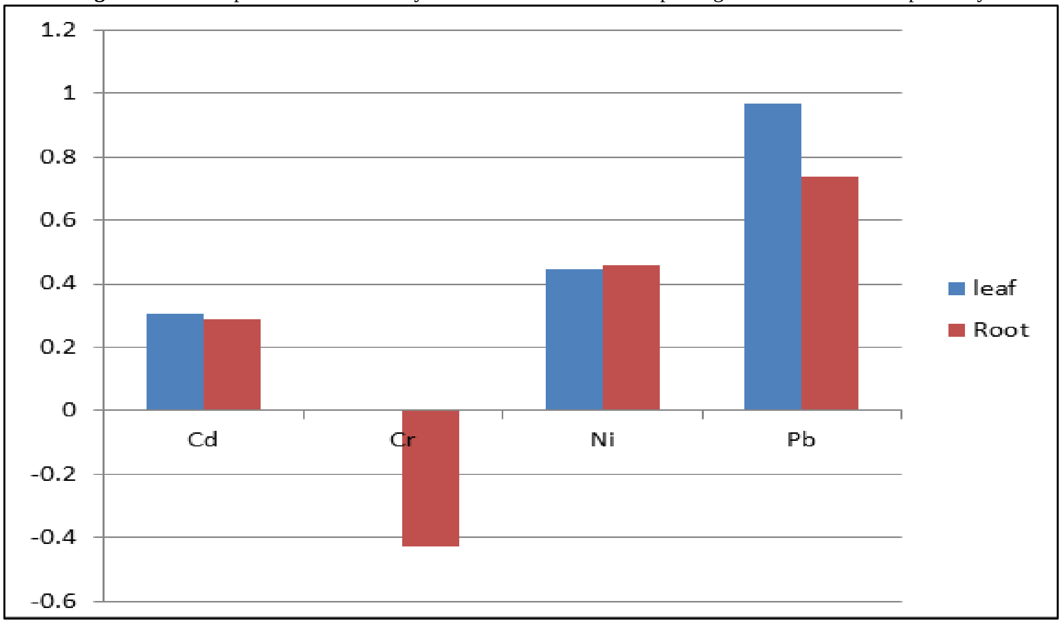
From table 1, the order of heavy metals concentration in the leaf is: Pb > Ni > Cd, while the root has same arrangement prior to their concentration.Heavy metal accumulation in the leaf and the root varied based on the absorption rate oftheir individual elements. The element Cadmium(Cd) and lead(Pb)has a higher concentration in the leaf (Cd:0.305 and Pb:0.965)ppm than the concentration in the root (Cd:0.289 and Pb:0.736)ppm .While Nickel (Ni) has a higher concentration in the root(0.459)ppm than the concentration in the leaf (0.447)ppm.

For Chromuim (Cr): heavy metals concentrations were not detected in the leaf but have little trace of heavy metals in the root. This signifies that the absorption of the metals in the root was through the soil.

Table-1. HeavyMetal concentration of elephant grass in Amassoma

Elements	Leaf (ppm)	Root (ppm)
Cd	0.305	0.289
Cr	ND	-0.429
Ni	0.447	0.459
Pb	0.965	0.736

Fig-1. Bar chart representation for heavy metals concentration of elephant grass in Amassoma Expressway



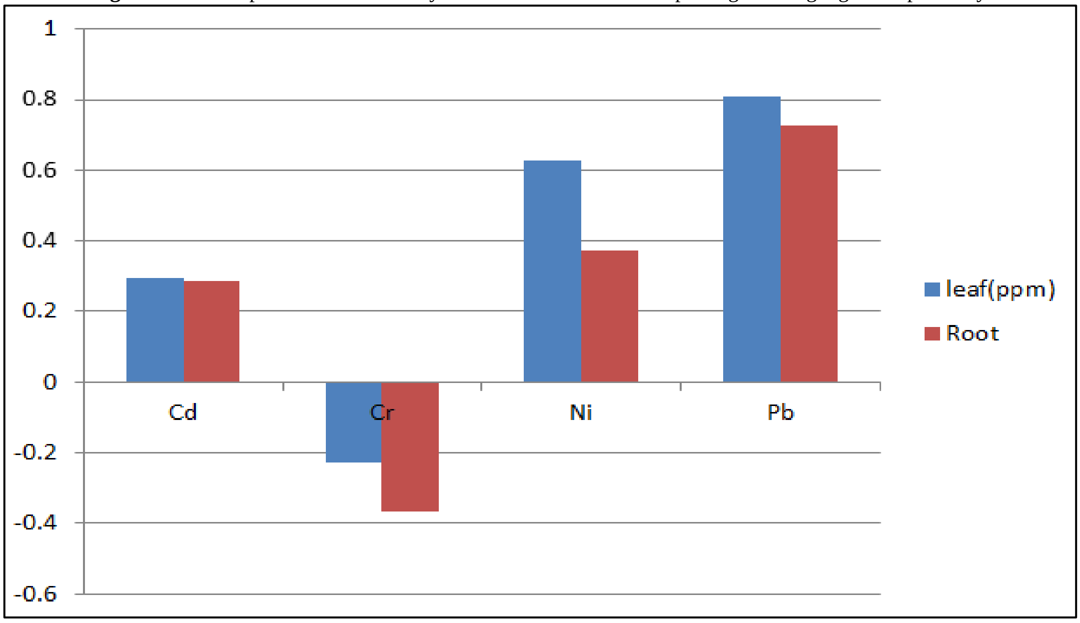
3.2. Igbogene Expressway

From the table below, the sample(Elephant grass) in Igbogene expressway shows that Cr has little trace of heavy metal in the leaf and the root. While lead (Pb) has higher concentration of heavy metal in the leaf and root than other elements. The order of the concentration of heavy metals in the four elements are Pb > Ni > Cd > Cr both in the leaf and root.

Table-2. Heavy Metal concentration of elephant grass in Igbogene expressway

Element	Leaf (ppm)	Root (ppm)
Cd	0.297	0.287
Cr	-0.227	-0.367
Ni	0.626	0.373
Pb	0.811	0.726

Fig-2. Bar chart representation for heavy metals concentration of elephant grass in Igbogene Expressway



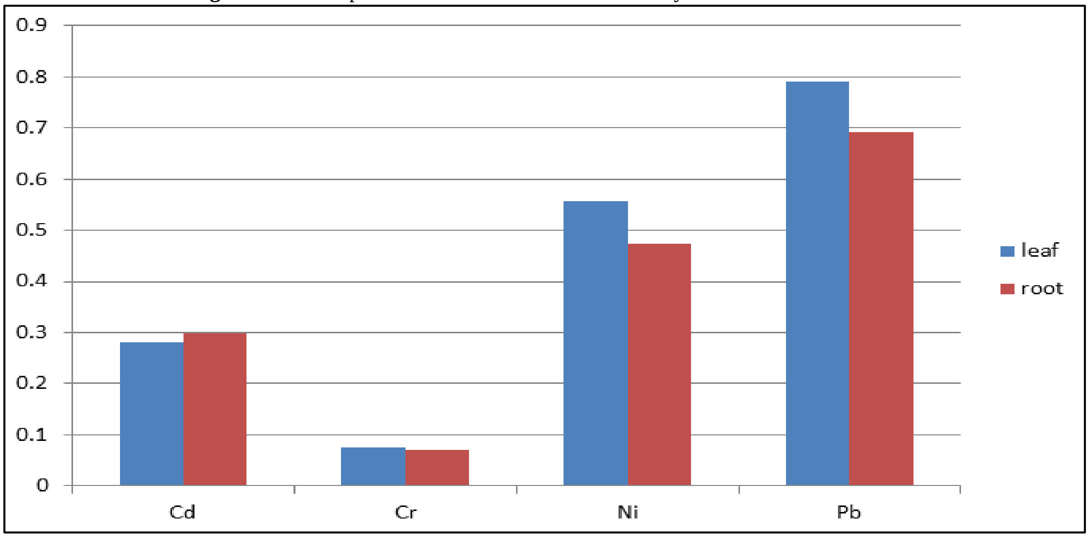
3.3. HeavyMetal Concentration of Elephant Grass in the Control Site

From the table below, the result reveals that lead (Pb) and Nickel (Ni) has higher heavy metals concentration in the leaf than the heavy metals concentration in the root. But cadmium (Cd) and chromium (Cr) has higher heavy metal concentration in the root than the heavy metals concentration in the leaf. The order of the concentration of heavy metals in the leaf and root are: Pb> Ni> Cd> Cr.

Table-3. Heavy metal concentration of elephant grass in the control site

Element	Leaf (ppm)	Root (ppm)
Cd	0.280	0.298
Cr	-0.077	0.072
Ni	0.558	0.474
Pb	0.790	0.691

Fig-3. Bar chart representation for concentration of heavy metals in the control site



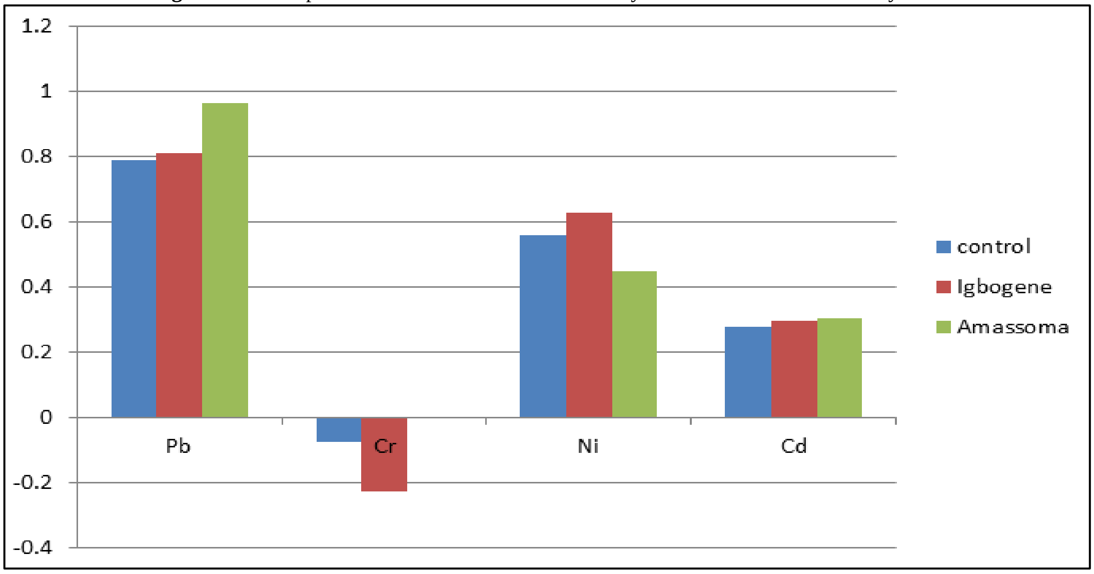
3.4. Comparative Studies of Heavy Metals in the Leaf of the Study Sites

Generally, the study of the heavy metals in the leaves indicates that Ni has higher heavy metal concentration in the leaf of Igbogene expressway than that of the control site and Amassoma expressway. Cr was not detected in the leaf of Amassoma expressway, but slightly detected in the control site and Igbogene expressway. The elements Lead (Pb) and cadmium(Cd) has higher concentration of heavy metals in the leaf of Amassoma expressway than that of the control site and Igbogene expressway.

Table-4. Concentration of heavy metals in the leaves of the study sites

Elements	Control	Igbogene	Amassoma
Pb	0.790	0.811	0.965
Cr	-0.077	-0.227	ND
Ni	0.558	0.626	0.447
Cd	0.280	0.297	0.305

Fig-4. Bar chartrepresentation for concentration of heavy metals in the leaf of the study sites



3.5. Comparative Studies of Heavy Metals in the Roots of the Study Sites

The comparative studies in the root of the elephant grass,shows that Lead (Pb) has a higher concentrationof heavy metals in the root ofAmassomaand Igbogene expressway than the control site. The metalsChromium (Cr) and Nickel (Ni) has higher concentration in the root of the control site than the root of Amassoma and Igbogene expressway due to emission of heavy metals from vehicles on the traffic way. While Cadmium (Cd) has higher concentration in the root of the control site and Amassoma expressway than the root of Igbogene expressway, thisis because the topographical location of the control site has lower grounds than the expresswaywhich may be contributed by erosion,wind and natural occurrences of the metals.

Table-5. Concentration of heavy metals in the root of the study sites

Element	Control	Igbogene	Amassoma
Pb	0.691	0.726	0.736
Cr	0.072	-0.367	-0.429
Ni	0.474	0.373	0.459
Cd	0.298	0.287	0.289

Fig-5. Bar chart representation for concentration of heavy metalsin the root of the study sites

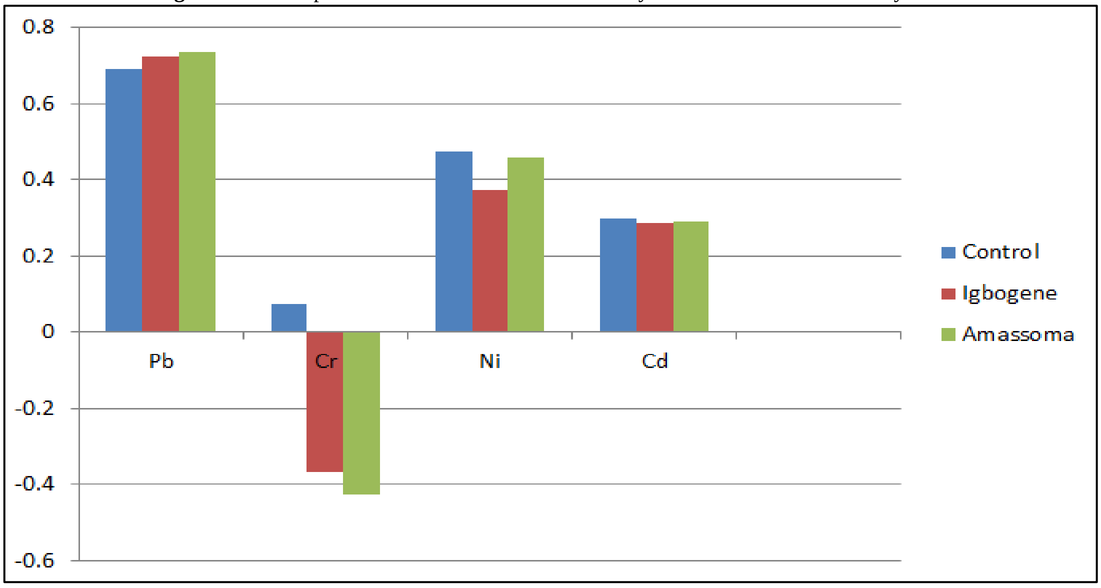


Table-6. WHO standard value for heavy metals in plant

Elements	Standard value of plants (mg/kg)
Cd	0.02
Cr	1.3
Ni	2.0
Pb	10

4. Conclusion

The traffic emission on the vehicular road in the environments is one of the major concerns in the society. Plants' growing away from the vehicular road using the control result was seen to be higher than the plants growing on the high ways. This could be as a result of the effect of wind which carries exhausts inform of gas and dust from their point of discharge to plants that are far away. Rainfall and flooding also contribute to the movement of heavy metal away from their point of discharge as a result of flow and are deposited on plants far away from the point of discharge.The result revealed that the metals Cr, Pb and Ni are lower than the WHO standard values in plant, except Cd whose value is higher than the WHO standard values in the plant. Hence, theheavymetal involved examines effects on plants far away from the point of discharge.Vehicular oil, diesel and petrol should be modified in order to reduce the amount of heavy metals that are released in the environment.

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