AN ASSESSMENT OF THE EFFECT OF AUTOMOBILE EMISSION ON ROADSIDE SOIL AND VEGETATION

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ABSTRACT

The present study investigated the comparative assessment of the soil and vegetation exposed to automobile emission along Sapele road, Benin City, Nigeria. Three plots each with an area of 100cm^2 and mapped out at intervals of 10m away from the road were the treatments. The plots were A (0-10m), B (10-20m), C (20-30m) and a fourth plot was the control (100-110m) plot. Population sampling was done to determine the species diversity across the plots. Soil samples were collected from each plot and microbial and physico-chemical analyses were carried out. Population studies showed that the control plot had the highest diversity among the plots. The result of soil physico-chemical analyses showed that treatment soil samples contained heavy metals which decreased with distance away from the road. It was also observed that the high soil nutrient level masked the effect of the heavy metals on the plants.

KEYWORDS: Heavy Metals, Automobile, Population

INTRODUCTION

In modern times, pollution has become the biggest menace for the survival of the biological species. Anthropogenic activities such as fossil fuel combustion, industrial effluents and solid waste disposal, agricultural practices (use of fertilizers, insecticides, pesticides and herbicides), mining and metal processing, automobile emissions and other industrial processes have altered the environment significantly (Wang *et al.,* 2008).

Among the numerous environmental pollutants, an important role is ascribable to heavy metals whose concentration in soils, water and air are continuously increasing in consequence of anthropogenic activity (Abechi *et al.*, 2010). The term heavy metal includes transition metal, metalloids, lanthanides and actinides which have been propounded based on their density, atomic number and their chemical properties and toxicity (John 2002).

Pollution of the natural environment by heavy metal is a worldwide problem because these metals are indestructible and most of them have toxic effect on living organisms when they exceed a certain concentration (Ghrafet and Yusuf, 2006). Notwithstanding the fact that some heavy metals at low concentration are essential micronutrients for plants, their high concentrations cause metabolic abnormalities and growth reduction in various plant species particularly those growing along roadsides (Nawazish *et al.,*2012)

Road side soils have been shown to have considerable contamination due to both deposition from vehicle derived-heavy metals and relocation of metals deposited on the road surface (Harrison *et al.,* 1981). According to Adefolalu (1980) and Mabogunje (1980), in developing countries like Nigeria, improved road accessibility creates a variety of ancillary employment which include vehicle repairers, vulcanizers, welders, auto electricians, battery chargers and dealers in other facilitators of motor transportation. These activities send trace metals into the environment which are subsequently deposited into nearby soils.

Roads serve as major link among communities through which foods and other important commodities are transported. It plays a role in enhancing social and economic activities. However road construction has also resulted in heavy environmental pollution especially on soils (Bai *et al.*, 2009). The pollution of soils by heavy metals from automobile sources is a serious environmental issue. Results show that road side soil near motorways is heavily polluted by heavy metals from automobiles (Onianwa and Adoghe, 1997; Moller *et al*., 2005). These metals are released during different operations of road transport such as combustion, component wear, fluid leakage and corrosion of metals (Okunola *et al.,* 2008). There have been many studies on heavy metal contamination in soils along major roads due to adverse environmental, ecological and health effects of these heavy metals, which can be harmful to the road side vegetations, wildlife and the neighbouring human settlements (Turer and Maynard, 2003; Awofolu, 2005).

The assessment of heavy metals in soil is an index to determine the degree of metal contamination in the plant tissues (Galiulin *et al*., 2002). This is a key issue in assessing the effect of metals in the environment (Abulude and Adesoje, 2006). As important suppliers of dietary minerals for humans and animals, plants form a bridge between the soil elemental composition and food chain. Consequently contaminated soils with potentially toxic elements may affect crop production and the food chain and hence human health (Cuypers *et al.,* 2011)

Sapele road is the depot for the sale of fairly used vehicles in Benin City. It is a road with very high volume of traffic. The objective of the study therefore is to investigate how this impacts on the soil and the vegetation of this area.

MATERIALS AND METHOD

Study Area: The study area was located at Sapele Road Benin City, Edo State.

Treatments: The area was mapped out into three (03) plots at 10m interval distance away from the road. The control sample was collected 100-110m away from the road.

Population Studies: A quadrant was used for random sampling of the vegetation and species were identified and their population determined.

Microbiological Analysis

Sterilization of materials

The glasswares used for this study were thoroughly washed with detergent and rinsed with distilled water. The glasswares such as beakers, conical flasks, test tubes and pipettes were wrapped with aluminium foil and appropriately sterilized in the hot air oven at 160 °C for 1 hour. The culture media were sterilized in an autoclaved at 121 °C for 15 minutes. Inoculating wire loop was sterilized by dipping in 70% ethanol and then flamed in Bunsen flame.

Preparation of media

Media for microbiological analysis was weighed according to the manufacturer's specifications.

Nutrient agar

Twenty-eight grammes (28 g) of nutrient agar were dissolved in 1000 ml of distilled water in a conical flask corked with cotton wool and foil paper and allowed to dissolve in 1000 ml of distilled water in a conical flask. The medium was then placed in an autoclave to sterilize it for 15 minutes at 121 °C. After sterilization, the flask was allowed to cool.

Potato dextrose agar

Thirty-nine grammes (39 g) of potato dextrose agar were dissolved in 1000 ml of distilled water in a conical flask corked with cotton wool and foil paper and allowed to dissolve in 1000 ml of distilled water in a conical flask. The medium was then placed in an autoclave to sterilize it for 15 minutes at 121 °C. After sterilization, the flask was allowed to cool.

Isolation of microorganisms

Ten (10.0) g of each soil samples was mixed with 90.0ml of sterile distilled water in a beak. The samples were serially diluted using tenfold serial dilution and 0.1 ml of the appropriate dilution pour plated onto nutrient agar (NA) and Potato dextrose agar (PDA) respectively for bacteria and fungi isolations. The nutrient agar plates were incubated at 37°C for 24 hours under aseptic condition while Potato dextrose agar plates were incubated at 28°C for 72 hours.

Identification of microbial isolates: Aseptically purified representative discrete colonies were obtained by streaking on NA and PDA plates. They were stored in agar slants for further characterization. All the bacteria isolated were initially examined microscopically. They were later referred to appropriate genus and species following various physiological and biochemical tests (Gram staining, indole catalase, motility, citrate utilization, urea production, oxidase, coagulase and oxidative / fermentative utilization of lactose and glucose). Similarly, the fungal isolates were identified using their cultural and morphological characteristic.

Sub-culturing

The isolates were subcultured to obtain pure cultures. The pure cultures so obtained were transferred to agar slants by streaking; and from there further biochemical tests were carried out to identify them.

Identification of isolates

Biochemical tests characterization were used to identify the isolates. The biochemical tests performed include: catalase, oxidase, coagulase, indole, citrate, urease, glucose and lactose fermentation test.

Gram staining

Smears of the isolates were prepared and heat fixed on clean grease free slides. The smears were stained for one minute with crystal violet. This was washed out with distilled water. The slides were flooded with dilute Grams iodine solution for one minute. This was washed off with distilled water and the smears were decolorized with 95% alcohol for 30 seconds and rinsed off with distilled water. The smears were then counter stained with saffranin solution for one minute. Finally, the slides were washed off with distilled water, air dried and observed under oil immersion objective.

Spore stain

The malachite green staining method was used. Smears of the pure isolates were made on grease free glass slide and heat fixed. The slides were flooded with 5% w/v malachite green solution.

The slides were flamed in such a way that the stain steamed but did not boil. The slides were then allowed to stand for 5 minutes. The stains were washed out in running tap water. The smears were counter stained with saffranin for 30 seconds. This was washed off and the slides were blotted, dried and examined under the oil immersion objective. The spores stained green while vegetative cells stained red.

Biochemical Tests

Catalase Test

This test was used to demonstrate which of the isolates could produce the enzyme catalase that releases oxygen from hydrogen peroxide. This test is usually used as an aid to differentiate staphylcocci from streptococci and to differentiate other catalase positive organism from catalase negative. A loopful of the pure colony was transferred on to a plane, clean glass slide. The isolate was then mixed with a drop of 3% v/v hydrogen peroxide. The reaction was observed immediately. Gas production indicated by the production of gas bubbles confirmed the presence of catalase.

Coagulase Test

The Slide method was used. In slide test, clean slide was divided into two sections, to one section of the slide the test organism was smeared on it using a sterile wire loop while a drop of distilled water was added to the other section which serves as control. Then human plasma was added to both sections and the slide was rocked gently for some minutes. A clumping/agglutination of the plasma were used to indicate the presence of coagulase.

Oxidase Test

This was carried out to identify bacterial species that will produce the cytochrome oxidase enzyme. *Pseudomonas aeruginosa* and *Escherichia coli* were employed as positive and negative controls respectively. A piece of filer paper was placed in a clean Petri dish and 2-3 drops of fresh oxidase reagent was added. A colony of test organism was collected using a wire loop and smeared on the filter paper and observed. Purple color within few a seconds showed a positive test.

Urease Test

This test was used to demonstrate the ability of the isolates to produce the enzyme urease which splits urea forming ammonia. The test is usually used to differentiate organisms like Proteus from other non urease positive organisms. A loopful of the isolates was used to inoculate a tube of urea-agar. The tubes were incubated at 37°C. A change in color from yellow to red confirmed the presence of urease.

Indole Test

This test was used to determine which of the isolates has the ability to split indole from tryptophan present in buffered peptone water. The test is usually used as an aid in the differentiation of gram- negative bacilli especially those of the enterobacteriacene. Tubes of peptone water were inoculated with young culture of

the isolates. The tubes were incubated at 37°C for 48 hours about 4 drops of KOVAC reagent were added into 1ml of each of the culture tubes. Positive test was indicated by the red color that occurs immediately at upper part of the test tube. KOVAC's reagent consists of the following, 150ml of Amyl alcohol, 10g of 0-Dmethyl amino benzalaldelyele and 50ml of concentrated hydrochloric acid.

Citrate Utilization Test

This test was used to identify which of the isolates can utilize citrate as the sole source of carbon for metabolism. The medium used for this test of Simon's citrate agar. Slant types of Simon's citrate agar were inoculated with young culture of the isolates. The inoculation was done by stabbing the medium on the tubes using sterile straight inoculation wire containing the culture. The tubes were then incubated at 37°C for about 24 hours. A change in colour from green to blue after about 24hours of incubation indicted positive result.

Sugar Fermentation Test.

Each of the isolates was tested for its ability to ferment a given sugar with the production of acid and gas or acid only. Since most bacteria especially Gram negative bacteria utilize different sugars as source of carbon and energy with the production of either acid and gas or acid only, the test is used as an aid in their differentiation. The growth medium used was peptone water and the peptone water was prepared in a conical flask and the indicators; phenol red was added.

The mixture was dispensed into test tubes containing Durhams tubes. The tubes with their content were sterilized by autoclaving at 121°C for 15 minutes. 1% solution of the sugar was prepared and sterilized separately at 115°C for 10 minutes. This was then ascetically dispensed in 5ml volume into the tubes containing the peptone water and indicator. The tubes were inoculated with young culture of the isolates and incubated at 37°C. Acid and gas production or acid only were observed after about 24 hours of incubation. Acid production was indicated by the change of the medium from light green to yellow colour while gas production was indicated by the presence of gas in the Durham's tubes.

Lactophenol cotton blue Test

Each fungal isolate was mixed with a drop of lactophenol cotton blue stain on grease-free glass slide and covered with a cover slip and viewed under x 10 and x 40 objective of the microscope.

Soil physicochemical analysis

Sample Preparation

Soil samples were air dried for 3-4 days at room temperature. These were then ground to pass a 2 mm stainless steel sieve to produce "fine earth" for the physicochemical analysis.

pH and electrical conductivity

Twenty grammes (20 g) of fine soil was placed in a container and 50 ml of distilled water added. The suspension was shaken for 30 min and allowed to settle. Electrical conductivity and pH of the solution were then measured using a PH meter and conductivity meter. The $_{P}$H meter was first standardized using a buffer solution.

Nitrogen

One gramme (1.0 g) of the soil sample was placed into Kjedahl digestion flask. One table of a catalyst and 20 ml concentrated tetraoxosulphate acid was added and the mixture was hand shaken to ensure mixing. At completion of digestion, 10 ml distilled water was added and the solution was filtered through a Whatman filter paper. Nitrogen was determined colorimetrically at 625 nm.

Organic carbon

One gramme (1.0 g) of the soil sample was placed in a 250 ml conical flask. Then 10 ml of $K_2Cr_2O_7$ and 20 ml conc. H_2SO_4 were added and the mixture was hand shaken for about 5 minutes. Distilled water was then added to make the volume up to 150ml. 10 ml of phosphoric acid and 8 drops of diphenylamine solution

were then added. A blank determination was done by using 10ml $K_2Cr_2O_7$ and 20 ml concentrated H_2SO_4 solution and titrated to a green colour with 0.N Ferrous Ammonium sulphate solution.
T O C was calculated as:

$$\%T\ O\ C = \frac{\text{Titre value of blank- titre value of sample} \times 0.3 \times M1.334}{\text{Weight of sample}}$$

Available phosphorus
One gramme (1.0 g) of soil was shaken for 5 minutes with 10 ml of extracting solution containing 0.03 N NH_4F and 0.1 N HCl. The solution was filtered through Whatman filter paper and 3 ml of the filtrate was transferred into a test tube and 3ml of ammonium molybdate was added. Thereafter, 5 drops of mixture of boric acid, sodium sulphite and sodium sulphate were added. The Phosphorus content was determined colorimetrically .

Cation Exchange Capacity
Five grammes (5 g) of soil placed into sterile conical flask and 20 ml of extracting solution (NH_4OAc) was added into the 250 ml volumetric flask containing the soil samples. Whatmen filter paper was then used to filter the solution. Also 0.1 ml of the filtrate was tansfered to a test tube and diluted with 10 ml 0.015 % stronium chloride solution. The sample analyzed for sodium (Na) and potassium (K) by flame emission and for Ca and Mg by Atomic Absorption Spectrophotometry (AAS).

Particle size analysis
Twelve grammes (12 g) of air-dried, 2 mm soil sample was pretreated first with 20 ml hydrogen peroxide and dried at 80^{o}C. The soil was further treated with 20 ml hydrogen peroxide and then dried at 100^{o}C. The soil was then cooled and weighed. The mineral soil was shaken overnight with 100 ml water and 10 mL of solution containing sodium metaphosphate and Na_2CO_3. The mixture is quantitatively transferred to a 250 ml graduated cylinder and enough water added to make up the total volume to 200 ml and shaken. Twenty-five ml of the suspension was pipetted from a depth of 6 cm, evaporated to dryness and the weight taken. This weight representing 1/8 of the clay fraction, was multiplied by 8 to get the corrected weight. The rest of the slurry was washed through a 50 µm sieve and the fraction retained on the sieve quantitatively recovered, dried and weighed. This represents the sand fraction. Percent clay and % sand are calculated on the basis of the weight of the soil. The silt content (%) was determined by difference.

Sample preparation analysis of metals
Both soil and soil samples were ground into fine powder. 2.0 g portions of the samples were weighed accurately and 10.0ml of concentrated HNO_3 was added to each. The samples were digested on a hot plate for 15 minutes. The digest was cooled and 5 ml of concentrated nitric acid was added and heated for additional 30 minutes. The later step was repeated and the solution was reduced to about 5 ml without boiling. The sample was cooled again and 5ml of concentrated hydrochloric acid and 10 ml of distilled water was added and the samples was heated for additional 15 minutes without boiling. The sample was cooled and filtered through a whatman.No.42 ashless filter paper and diluted to 60 ml with distilled water, metal content in the digested samples were analyzed for Cu, Zn, Cd, Mg, Pb, Mn and Ni using Atomic Absorption Spectrophotometer.

RESULTS/ DISCUSSION
Table 1 shows the physiochemical properties of the soil in the treatments and the control. The pH of the soil in the control (X) was found to be 6.5, plot A was 6.6, plot B was 7.1 and plot C was 6.3. The control soil

was more acidic than that of plots A, and B and less acidic than plot C. Conductivity was lowest in X and highest in the C. Plot C had the most concentration of organic carbon, Ca, Mg and Na while X had the least. The result did not follow a consistent pattern. Plot A had the highest K while X had the lowest value.

Table 1: Physicochemical property of the soil samples used for the present study.

Parameters	X (Control)	A (1-10m)	B (11-20m)	C (21-30m)
PH	6.5	6.6	6.3	7.1
Conductivity	4.3	7.1	5.2	10.1
Carbon (%)	0.93	2.45	1.6	2.87
Nitrogen (%)	0.08	0.12	0.07	0.13
Phosphorus (%)	1.9	3.38	2.4	2.72
Sand (%)	72.9	54.3	63.2	64.6
Silt (%)	10.5	21.9	25.6	25.4
Clay (%)	16.6	23.8	11.2	10
Ca (meq/100g)	0.83	1.31	1.25	1.62
Mg (meq/100g)	0.45	0.78	0.54	1.01
Na(meq/100g)	0.18	0.32	0.33	0.5
K(meq/100g)	0.22	0.47	0.42	0.28

Soil pH is one of the most important factors determining the concentration of metals in the soil solution, their mobility and availability to plants. The pH values of this study showed that the treatment A had a pH of 6.6 which was higher than that of treatment B (6.3) and X (control) pH is 6.5. Treatment C recorded the highest pH.

The pH values for plots X, A and B were acidic. The acidic condition of soil creates higher availability of heavy metal (Vwioko, 2006). It would be expected that the control pH would be higher than the treatment. This case was different apparently because of the organic waste present in A owing human activities by the roadside and the texture soil which was more of clay as opposed to the sandy soil of X.

Conductivity provides a clue to the nutrient content of the soil. Soil analysis showed that the conductivity of C treatment was higher than the other treatments and the control. The control (X) had the lowest conductivity level hence the lowest nutrient concentration when compared to the treatments. The level of conductivity was in the other- C > A > B > X plots.

Soil organic carbon was highest in plot C than in control and the other treatment plots. Plot C had a highest nitrogen content compared to other treatments and control. Plot A had the most phosphorus. The cations Ca, Mg and Na were highest in plot C while the highest amount of potassium was found in A. The control had the lowest level of these cations. The granulomeric composition analysis of the soil showed that X (control) was mostly sandy while plot A was mostly clayey. The result of the physiochemical analysis of the soil sample showed that the control soil had the least quality when compared to the other treatments.

Table 2 shows the plant species identified in the control and treatment plots. Some species were found growing only in X (control), while some were present in particular treatment plots, although some species were common to all the plots. For example *Cleome rutidosperma* and *Chromoleona odorata* were found only in X, *Amaranthus spinosus* and *Aeschynomene indica* were found strictly in plot A (0-10m) and *Cyperus tuberosus* and *Digitaria horizontalis* were found in plots B (10-20m) and C (20-30m) and X (control) but not in A (0-10m).

The presence of *Cleome rutidosperma* and *Chromoleona odorata* strictly in plot X may be that these plants are the least tolerant of heavy metals.

Table 2: Plant species identified in the control and in the treatment.

SPECIES	FAMILY	CONTROL	1-10m	11-20m	21-30m
Aeschynomene indica	*Leguminosae*	-	260	-	-
Amaranthus spinosus	*Amaranthaceae*	-	30	-	-
Aspillia Africana	*Asteraceae*	30	-	-	200
Brachiaria deflexa	*Poaceae*	260	-	-	-
Calopogonium mucumoides	*Fabaceae*	-	60	60	300
Centrosema pubiscens	*Fabaceae*	30	-	60	160
Chasmanthera dependens	*Menispermaceae*	60	-	-	-
Chromolaena odorata	*Asteraceae*	30	-	-	-
Cleome rutidosperma	*Cleomaceae*	60	-	-	-
Commelina erecta	*Commelinaceae*	-	30	-	100
Croton hirtus	*Euphorbiaceae*	30	60	-	-
Cyperus rotundus	*Cyperaceae*	230	560	630	100
Cyperus tuberosus	*Cyperaceae*	230	-	730	60
Dactyloctenium aegyptium	*Poaceae*	330	430	-	30
Digitaria horizontalis	*Poaceae*	360	-	200	260
Dioscorea bulbifera	*Dioscoreaceae*	30	-	-	-
Eclipta alba	*Asteraceae*	-	30	-	-
Euphorbia hyssopifolia	*Euphorbiaceae*	-	100	-	30
Gomphrena celosioides	*Amaranthacea*	-	130	-	-
Hyptis suaveolens	*Lamiaceae*	-	30	-	-
Ipomea involcrate	*Convolvulaceae*	100	-	-	30
Luffa aegyptiaca	*Cucurbitaceae*	-	-	-	30
Mariscus alternifolius	*Cyperacea*	230	230	130	400
Mariscus longibracteatus	*Cyperacea*	-	-	100	-
Mimosa pudica	*Fabaceae*	130	-	-	-
Mitracapus villosus	*Rubiaceae*	30	-	-	100
Momordica charantia	*Cucurbitaceae*	-	-	-	60
Panicum maximum	*Poaceae*	330	260	1260	1230
Paspalum scrobiculatum	*Poaceae*	-	-	-	30
Passiflora foetida	*Passifloraceae*	-	-	130	-
Phyllantus amarus	*Euphorbiaceae*	30	-	-	30
Schrankia leptocarpa	*Leguminosae-Mimosoideae*	30	260	30	200
Sida acuta	*Malvaceae*	30	230	230	430
Sida darckeana	*Malvaceae*	30	-	-	-
Spigelia anthelmia	*Loganiaceae*	-	30	-	-
Synedrella nodiflora	*Asteraceae*	160	-	-	-

In the natural setting, certain plants have been identified which have the potential to take up heavy metals. At least 45 families have been identified to have hyperaccumulation potentials; some of the families are *Brassicaceae, Fabaceae, Euphorbiaceae, Asteraceae, Lamiaceae,* and *Scrophulctriaceae* (Salt *et al.,* 1998). Among the best-known hyperaccumulators is *Thlaspi caerulescens* commonly known as alpine pennycress (Kochian, 1996). Without showing injury, it accumulated up to 26,000 mg/kg of Zn; and up to 22 % of soil

exchangeable Cd from contaminated site (Brown *et al.,* 1995; Gerard *et al.,* 2000). *Brassica juncea,* commonly called Indian mustard, has been found to have a good ability to transport lead from the roots to the shoots. The phytoextraction coefficient for *Brassica juncea* is 1.7 and it has been found that a lead concentration of 500 mg/1 is not phytotoxic to *Brassica* species (Henry, 2000).

Variability in response to "toxic" levels of metals by different plants is due to a number of defenses. These include exclusion from the root, translocation in nontoxic form, sequestering in nontoxic form in the root or other plant parts, and formation of unusable complexes containing metals that may otherwise be inserted into biomolecules instead of the proper element (e.g., As replacing P) (Peterson, 1983). In this study however, there may not have been much challenge from the heavy metals due to the influence of pH, the clayey nature of the roadside soil and other related factors. Spurgeon and Hopkin (1996) observed that changes in chemical properties of soils affect the concentration of free metals and result in changes in their availability for plants. With increasing pH, content of organic matter and clay, the solubility of most metals decreases due to their increased adsorption. The decreased availability of metals is affected by higher adsorption and precipitation in alkaline and neutral environments (Moraghan and Mascani, 1991; Morel, 1997).

Table 3 shows the diversity index of the plants. The control plot had the highest value compared to the treatment plots. Population sampling showed that X (control) had the highest number of species than the other treatments. It was observed that grasses and sedges were more than any other plant. This is because grasses have a fibrous root system which stabilize soil and support microbial rhizosphere degradation.

Table 3: Effects of automobile emission on the diversity of species of plant on the site

Treatment	Number of Species
X (Control)	1.169
A (1-10m)	1.036
B (11-20m)	0.807
C (21-30m)	1.012

Each value represents Shannon-Wiener diversity index (H) of the plots.

The result obtained for the soil microbial load in the control and treatment plots is presented in table 4. The result did not follow a definite pattern consistent with the distance away from the road. While treatment plots A (0-10m) and B (10-20m) recorded an apparent depression of its microbial load in that order, there was however an enhancement in the microbial load recorded in C (20-30m). Plot C recorded 1.51 x 10^5cfu/g and 3.1 x 10^4cfu/g for the bacterial and fungal count respectively while control plot recorded 1.28 x 10^5cfu/g and 2.3 x 10^4cfu/g for the bacterial and fungal count respectively. Plot B recorded the least values with a bacterial and fungal count of 0.9 x 10^5cfu/g and 0.8 x 10^4cfu/g respectively.

Table 4: Microbial counts of the soil samples

Treatment	Bacterial counts (x 10^5 cfu/g)	Fungal counts (x 10^4 cfu/g)
X (Control)	1.28	2.3
A (1-10m)	1.05	1.9
B (11-20m)	0.9	0.8
C (21-30m)	1.51	3.1

Most processes in soil are driven by micro-organism, the most abundant being bacteria and fungi. Micro-organism are the dominant component of soil biomass. They are the main drivers for the turnover of soil organic matter, release of nutrient and degradation of organic pollutants. The biomass of all soil micro-organism reacts to changes of quality and quantity of soil acidic matter, soil acidity and heavy metal content of the soil. Metallic elements accumulated in the soil inhibit the growth of microorganisms that inhabit it, leading to a distortion of their basic life functions, and especially the processes of decomposition and transformation of organic matter (Fijalwosky *et al*, 2012).

Generally the bacterial counts were higher than the fungal counts. This could be because the pH recorded for the soil (6.3-7.1) will favour the proliferation of bacteria than that of fungi (Obire *et al* 2002). The microbial count of the soil sample shows that the plot C had the highest bacterial /fungal counts when compared to the control and the treatments. This can be attributed to the higher percentage of carbon there in (table 1) and the high pH. In general, microbial biomass increases with increasing organic carbon contents in soil as organic carbon is the main food and energy supply for the microorganisms.

Diverse effects produced by these heavy metals on individual groups of microbes result from specific physiological, morphological and genetic characteristics of the former (Binet *et al*., 2003, Renella *et al*., 2006, Paul *et al*., 2007).

Table 5 shows the species of bacteria and fungi present in the soil sample obtained from the different plots. Plots A and C had the highest variety of fungal isolates while plot B had the least number of bacterial and fungal isolates. The species of microorganism varied along with increasing distance from the road. The only bacterium species common to all the plots was *Bacillus sp* and for the fungal isolates, *Aspergillus sp* was common to all the plots.

Table 5: Species of microorganism present in the soil samples

Sample code	Bacterial isolates	Fungal isolates
X (Control)	*Bacillus sp*	*Aspergillus* sp.
	Micrococcus sp.	*Penicillium* sp.
	Streptococcus sp.	*Fusarium* sp.
	Pseudomonas sp.	
A (1-10m)	*Enterobacter sp.*	*Fusarium* sp.
	Acinetobacter	*Mucor* sp.
	Bacillus sp.	*Aspergillus* sp.
	Klebsiella sp.	*Penicillium* sp.
	Pseudomonas sp.	*Trichoderma* sp.
B (11-20m)	*Staphylococcus sp.*	*Aspergillus* sp.
	Bacillus sp.	
	Pseudomonas sp.	
C (21-30m)	*Escherichia coli*	*Aspergillus* sp.
	Bacillus sp.	*Trichoderma* sp.
	Micrococcus sp.	*Pencillium* sp.
	Streptococcus sp.	
	Staphylococcus sp.	

Table 6 shows the heavy metal content of the soil samples that were analyzed. The result followed a consistent pattern. The concentration of the heavy metals (cadmium, chromium, lead, nickel, copper, manganese, zinc and iron) decreased with increasing distance from the road, an indication that the road was the source of the pollution. The heavy metal content of the soil samples decreased in this order: A> B> C> D. Voergbola and Chirgarri, (2007) had made similar findings. They recorded that the concentration of cadmium, chromium, lead, nickel, copper, manganese, zinc in soil and their vegetation all decreased with increasing distance from the road, indicating their relation to traffic. From the soil analysis, Fe recorded the highest concentration followed by zinc. The metal with the lowest concentration was cadmium. The presence of lead observed could be attributed to lead particle from gasoline combustion which consequently settles on roadside soils (Abechi *et al.*, 2010).

Table 6: Heavy metals content of the soil samples

METALS	X (Control)	A (1-10m)	B (11-20m)	C (21-30m)
Ni(mg/kg)	0.58	2.42	2.05	1.89
Mn(mg/kg)	0.1	27.7	13.48	12.95
Cr(mg/kg)	0.1	1.27	0.88	0.62
Cd (mg/kg)	0.02	0.58	0.46	0.17
Lead (mg/kg)	0.17	2.24	1.95	1.03
Zn (mg/kg)	13.12	69.2	56.84	50.73
Fe(mg/kg)	17.63	427.55	306.7	294.1
Cu (mg/kg)	1.09	5.35	3.83	3.48

Conclusion

The findings of this study corroborate earlier researches which observed pollution from heavy metals in roadside soils. Other variables such as pH, organic content of the soil and the nature of the soil however determine the availability of these heavy metals to plants. That these metals may not be available to the plants as observed should not make us go to sleep as these heavy metals will remain in the soil and may change location and consequently, adversely affect the ecosystem.

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