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ASSESSMENT OF AUTOMOBILE MECHANIC WORKSHOP SOILS IN LAGOS AND THE GENOTOXIC POTENTIAL OF THE SIMULATED LEACHATE USING *ALLIUM CEPA* L.

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Abstract

In the face of the increasing numbers and haphazard siting of mechanic workshops and the consequent environmental pollution due to its activities, there is paucity of information in the literature on the possible genotoxic and mutagenic effects of the associated waste and the soils of these workshops. This study therefore aimed at assessing the pollution level of the soils from the automobile workshop in Lagos and the genotoxic potential of their simulated leachate using *Allium cepa* L. 2 kg of soil samples were collected at a depth of 0 – 15 cm (top soil) using soil auger from five different points at the automobile mechanic workshop in order to get a representative sample (composite sample) and transferred directly into clean, sterile containers. A control soil sample was obtained from the Botanical garden of the University of Lagos, Akoka. The physicochemical analysis of the soil was also carried out using standard methods. The samples were analysed for lead (Pb), chromium (Cr), cadmium (Cd), zinc (Zn), arsenic (As), nickel (Ni), and mercury (Hg) using inductively coupled plasma atomic emission spectroscopy (ICP-AES) after acid digestion. Aliphatic and aromatic hydrocarbons, TPH and oil and grease were determined. Leachate simulation from the soil was carried out according to the American Society for Testing and Materials. The result showed an obvious influence of automobile workshop activities on the physicochemical properties of soil as well as on the root meristem of *Allium cepa*. Automobile workshop soil contained significantly higher concentrations for all analysed heavy metals (Cd, As, Cu, Pb, Ni and Zn) in comparison to the uncontaminated garden soil. Cd, Cu and Pb levels were higher than specified regulatory standards. All the leachates concentrations showed one form of aberration: sticky chromosomes, C-mitosis, bridges, lagging chromosomes, binucleate, vagrant cells and micronuclei. The highest aberration occurred in 50% concentration of the treatment while the lowest occurred in the control. The aberrations observed varied with exposure time. The results of the present study showed that simulated leachates from an automobile workshop is genotoxic and mutagenic in the bioassays used in this study. The soils

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contained heavy metals in higher concentrations than the control and standards set by regulatory authorities. Also, higher TPH was observed too. The observed genotoxicity and mutagenicity are believed to be caused by the leachate constituents.

Keywords: *genotoxicity, automobile workshop, leachates, allium cepa, soil, heavy metals, TPH*

Introduction

A great number of noxious and toxic chemical compounds are being released in to our soil, water, and air environment constantly and continuously, originating mostly from workshops, industrial and agricultural activities and many of them having ecological implications and effects (Adesuyi et al., 2016; Adesuyi et al., 2018a; Njoku et al., 2018). Automotive service and repair shops are one of the main contributors of hazardous wastes. Auto repair/automobile shops create many different types of waste during their daily operations. Petroleum-related activities worldwide have raised concerns about the adverse effects of contamination of petroleum products on the environment. Petroleum hydrocarbon oils are of environmental interest because they are toxic to the human system, plants and animal resources. Yet, they pervade the environment beyond the vicinities of petroleum exploration and production activities due to storage, disposal and other handling activities during which contamination of the environment sometimes occur (Chukwujindu et al., 2008). Wastes from automobile workshop activities can be categorized into either maintenance or materials handling wastes (Alabi et al., 2013). They include used heaty transfer fluids, spent oil and lubricants, dirty shop rags, used parts, asbestos from brake pads and wastes from solvents used for cleaning parts.

One of the most dangerous waste commonly created in auto-mechanic shops is from the solvents used to clean parts. These solvents have been reported to be extremely dangerous to humans and the environment (Imevbore and Adeyemi, 1981). If the used fluids and solvents from auto mechanic workshops are not properly handled and managed, they can find their way into the air, water, soil, lakes and streams (Adeniyi and Afolabi, 2002; Adesuyi et al., 2015). Also, the disposal of large amounts of spent engine oil (SEO) into gutters, water drains, open vacant plots and farms is a common practice in Nigeria, especially by motor and generator mechanics (Okonokhua et al., 2007). The illegal dumping of used motor oil is an environmental hazard with global implications (Alabi et al., 2013). Spent engine oil when present in the soil, creates an unsatisfactory condition for life in the soil, which is due to the poor aeration it causes in the soil, immobilization of soil nutrients and lowering of soil pH (Atuanya, 1987). Used oil may contain components such as lead (Pb), cadmium (Cd), barium and other potentially toxic metals (Edebiri and Nwanokwale, 1981; Vazquez-Duhalt and Bartha, 1989;

USEPA, 2001). There are relatively large amounts of hydrocarbons in the SEO including the highly toxic polycyclic aromatic hydrocarbon (Wang et al., 2000).
Heavy metals are considered serious pollutants because of toxicity, persistent and nondegradable conditions in the environment. Extensive trace metal pollution of soil within and around automobile mechanic workshops implies that water bodies (surface and groundwater) within and away from their vicinity may equally be polluted with trace metals due to continuous interactions between soil and water and high dispersion rate in the tropical rain forest belt (Nwachukwu et al., 2010). Heavy metals easily accumulate in the topsoil to toxic levels due to their persistence and eventually make their way to humans through the food chain, where they perturb biological processes (Adesuyi et al., 2015).
Allium cepa has been well-thought-out as a most easy and effectual test organism to indicate the presence of mutagenic chemicals due to its kinetic characteristics of proliferation and possession of chromosomes appropriate for cytotoxic study (Adesuyi et al., 2018). Different parameters of *Allium cepa* such as root shape, growth, mitotic index, and chromosomal aberrations can be used to estimate the cytotoxicity and mutagenicity of environmental contaminants and pollutants (Soumya et al., 2016). Also, bioaccumulation of chemicals in specific tissues, inhibition of root and leaf elongation, and oxidative stress responses have been characterized in various toxicological studies with *A. cepa*. Practical advantages in the use of plants as bio-indicator of pollutants include sensibility, reproducibility and rapidity of results, as well as the need of small volumes of samples and low cost. Several authors have pointed out the Allium test has been a useful tool for the detection of potentially genotoxic substances (Akinboro and Bakare, 2007; Yekeen and Adeboye, 2012; Adesuyi *et al*., 2018).
Literatures have reported soil pollution problems associated with spilling of automobile wastes in Nigeria (Oguntimehin and Ipinmoroti, 2008; Okoro et al., 2013; Adewoyin et al., 2015; Nkwoada et al., 2018) with few of those studies in Lagos (Odunlami and Salami, 2017; Owoso et al., 2017). Dioka et al. (2004) investigated blood Pb-level among a group of students on one side and a group of automobile mechanics drafted from a mechanic village at Nnewi near the Imo River Basin. Results of their study showed high lead blood levels in the mechanics, due to their exposure to lead in Nigeria petrol. This increases the concentrations of uric acid (357±123µ mol/L) and phosphate (1.5±0.5m mol/L), that may compromise liver and renal function. In the face of the increasing numbers and haphazard siting of mechanic workshops in Lagos and the consequent environmental pollution and health risk due to their activities, there is paucity of information in the literature on the possible genotoxic and mutagenic effects of the associated waste and the soils of these workshops. This study therefore aimed at assessing the pollution level of the soils from automobile workshop and the genotoxicity of their simulated leachates using *Allium cepa* bioassay.

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Materials and methods

Sampling site

The study site is an automobile/mechanic workshop (Lat 6.548481° and Lon 3.355974°) located in Ilupeju area of Lagos in Mushin local government area, which is close to the popular Oshodi market in Lagos State, South west Nigeria (Fig. 1). It has been in operation for about 25 years. Wastes generated from this automobile workshop activity include solvents, paints, spent heat, transfer fluids, hydraulic fluids, spent lubricants and stripped-oil sludge.

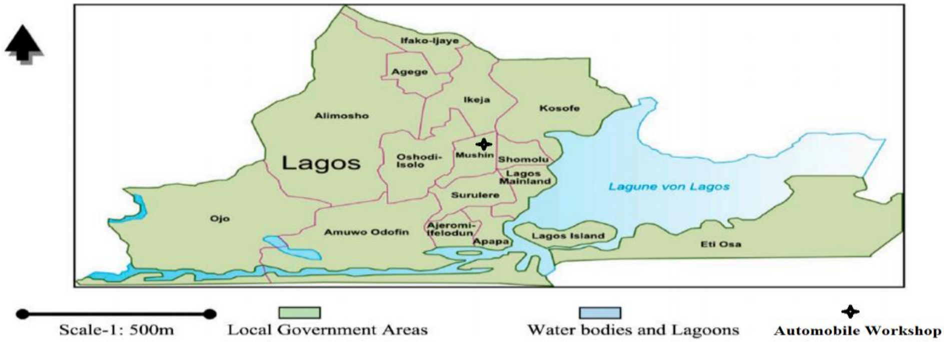

Figure 1. *Study area*

Sampling collection, physiochemical analysis and leachate simulation

2 kg of soil samples were collected at a depth of 0 – 15 cm (top soil) using soil auger from five different points at the automobile mechanic workshop in order to get a representative sample (composite sample) and transferred directly into clean, sterile containers. A control soil sample was obtained from the Botanical garden of the University of Lagos, Akoka.

Soil for the determination of selected relevant physicochemical properties was dried at an ambient temperature range (22 – 26 ^{o}C), crushed in a porcelain mortar and sieved through a 2 mm (10 mesh size) stainless sieve. The <2 mm fractions were used for the various determinations.

Soil pH was determined using pH meter 3015 (Jenway, U.K.) (Njoku et al., 2016). Electrical conductivity measurements were taken after calibrating the conductivity meter in a series of KCl standard solutions. Soil moisture content was determined by comparing the field moist weight with oven dried samples (Wang et al., 2011). Phosphates and nitrates were determined colorimetrically according to Osmond's method using molybdophosphoric blue colour formation and nitrophenol disulfonic acid medium respectively (Okoro et al., 2011). Digestion and analysis of soil samples for heavy metals content (cadmium, arsenic, copper, lead, mercury, nickel, and zinc) using inductively coupled plasma atomic emission spectroscopy (ICP-AES - Thermo Fisher ICAP 6300) as was described by Vittori Antisari et al. (2011) and Adesuyi et al. (2018a).

Aliphatic hydrocarbons were determined using GC-FID (USEPA Method 8015). Aromatic hydrocarbons were determined using GC-FID and GC-MS following the USEPA Method 8100. Oil and grease in soils was done in accordance with Extraction / Photometric Method (Method No: API-RP 45), and total petroleum hydrocarbon were determined using a gas chromatograph (GC) equipped with a flame ionization detector (FID) (i.e. GC-FID) in accordance with USEPA Methods 8000 and 8100. The accuracy of the instrumental method and analytical procedures used was checked by triplication of the samples, as well as by using reference material, which was run after every 10 samples to check for drift in the sensitivity. Replicated measures of International Reference Materials (BCR 141) and laboratory internal standards (MO and ML), reagent blanks and three soil sample repetitions were used to assess contamination and precision (Vittori et al., 2011).

Leachate simulation from the soil was carried out according to the American Society for Testing and Materials (ASTM-D 3987-35) (2012). 1000 ml of distilled water was added to 250 g of the dried sample in a 1.5 litre glass container and manually mixed with a glass rod for dissolution of the soil in water. The container was closed and placed on a shaker for 48 hours. The mixture was then allowed to settle for 30 minutes before filtration using wool in a glass funnel and a 2.5 μm filter (Whatman® No. 42), respectively (Bakare et al., 2007). Six concentrations: 100%, 50%, 25%, 10%, 5% and 0% (control treatment) were prepared with distilled water used as the diluents as well as the control. For 5%, 5 ml of leachate to 95 ml of distilled, for 10% 10 ml of leachate to 90 ml of distilled were mixed. The same thing was done for other concentrations.

Allium cepa assay

Equal-sized onion bulbs, Allium cepa were obtained commercially at Bariga market in Lagos, Nigeria. The onions were sun dried for 2 weeks before the start of the experiment. About four times the number of onion bulbs needed for the experiment were obtained to compensate for bulbs that may dry up, rot or be destroyed by mould (Fiskesjo, 1985). These were then used to evaluate the toxic effects of the leachates via root growth inhibition and in vivo induction of chromosomal aberration according to the modified Allium test (Akinbola et al., 2011).

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Seven *Allium cepa* bulbs for each of the 6 concentrations; 100%, 75%, 50%, 10%, 5% and 0%, of stock solution, were initially placed in transparent bottles containing 50 ml distilled water for 24 hours. The bottles were thereafter filled with 50 ml of the respective solution while 0% solution was of distilled water only serving as the control for the treatment (Fig. 2). After every 24 hours, root length of onions was measured, and the treatment samples were renewed in the cup so that the root of the onions would be bathed with fresh samples. Exposure was done for a total of 96 hours.

Figure 2. *Showing the process of root growth and set up*

The experiment was set up in the dark at 28°C for 72 h. Test pesticides concentrations were changed daily. Photographs of test materials were taken with *Nikon* Digital Camera D80 (Nikon Corp., Japan) and special note was taken of change of the morphology.
The root tip was removed from each bulb, fixed in ethanol: glacial acetic acid (3:1, v/v) and hydrolysed with a solution of 1 N HCl at 65°C for 3 min. After staining the tissue, the specimen on the slide was gently covered with a cover slip, allowing the stain to spread evenly over the square parts of the cover slip to eliminate air bubble. The slide with the specimen was then placed in between two folds of the filter paper and using the blunt end of a pen, gentle tapping and pressure was applied around the square area of the cover slip for even squashing of the specimen. Finally, the square edges of the cover slip of the squashed onion roots was sealed with white transparent nail hardener to prevent drying out of the preparation by the heat of the microscope (Grant, 1982). Three slides were prepared for each concentration and control. After 96 h, mean length of root bundles were obtained as described by Fiskesjo (1985) and the EC_{50} values was extrapolated from the graph of percentage root growth relative to control (inhibition) against concentrations. The slides were viewed under the microscope to observe mitotic stages and chromosomal aberrations to produce photomicrographs. The mitotic index (MI) was calculated as the ratio of number of dividing cells to number of observed cells (Fiskesjo, 1997). The frequency of

aberrant cells (%) was calculated based on the number of aberrant cells per total cells scored at each concentration of each effluent. Cells were scored for the frequency and occurrence of different types of chromosomal aberrations in the dividing cells (Bakare et al., 2000). These are calculated as follows:

$$\text{Frequency of Aberations} = \frac{\text{No of aberrant cells}}{\text{No of cells scored}} \text{x100} \quad [1]$$

$$\text{\% root Inhibition} = \frac{\text{Mean root length of control – Mean root lenght of treatment}}{\text{Mean root length of control}} \text{x 100} \quad [2]$$

$$\text{Mitotic Index (MI)} = \frac{\text{Number of dividing cell in the treatment}}{\text{Total number of cell}} \text{x 100} \quad [3]$$

$$\text{Mitotic Inhibition} = \frac{\text{Mitotic index of control – Mitotic index of treatment}}{\text{Mitotic index of control}} \text{x 100} \quad [4]$$

Statistical analysis

Data was analysed using the GraphPad 7.0 version to calculate means with the standard errors, t-test for treatments and Analysis of variance (ANOVA). Statistical significance was considered at 5% level.

Results and discussion

Physicochemical characteristics of soils from the automobile workshop in Lagos, Nigeria

Our result shows an obvious influence of automobile workshop activities on the physicochemical properties of soil as well as on the root meristem of *Allium cepa L*. The pH was 6.24±0.05 while the control soil had a pH of 7.50±0.01 (Table 1). The contamination in the mechanic village resulted in the low pH.

Table 1 *Physicochemical characteristics of soils from the automobile workshop in Lagos, Nigeria*

S/n	Physicochemical characteristics	Contaminated soil	Control
1	pH at 25°C	6.24±0.05	7.50±0.01
2	Electrical Conductivity (µS/cm)	293.3±1.3	482.1±1,0
3	Moisture (%)	15.15±0.05	29.33±1.10
4	Phosphate (mg/kg)	174.0±1.2	315.0±2.5
5	Nitrate (mg/kg)	150.0±0.9	207.5±0.6

Soil electrical conductivity is a measure of soluble salt content in the soil and is used as an overall indicator of the level of macro- and micronutrients in the soil.

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Conductivity was estimated as 293.3±1.3 μS cm^{-1} in the contaminated soil, compared to 482.1±1.0 μS cm^{-1} in the uncontaminated soil. This indicates that the mechanic villages waste contamination affects soil structure and modified its physicochemical properties. The inadvertent release of petrochemical agents directly to the soil triggers a chain of events which negatively impacts on biotic and abiotic elements within the environment (Kawo et al., 2018).
The mean moisture content in control soil was 29.33±1.10 % while that of the polluted soil was 15.15±0.05 % ($p<0.05$). Thus, hydrocarbon oil spillage reduced soil moisture availability or holding capacity, or increased moisture deficit in soils (Njoku et al., 2008). Also, nitrate and phosphate were significantly lower in the oil affected soils than in the control soils. It has been established that petroleum-based contamination in soil leads to reduction in the two major organic nutrients; nitrate – nitrogen and phosphate – phosphorus (Paul and Clark, 1996). There is also compelling evidence on the effect of chemical pollutants (e.g., heavy metals) on the N and P cycle due mainly to the interruption of microbial functions in these processes by those pollutants (Wang et al., 2007; Kapoor et al., 2015).
Automobile workshop contaminated soil contained significantly higher concentrations for all analysed heavy metals (Cd, As, Cu, Pb, Ni and Zn) in comparison to the uncontaminated garden soil (Table 2).

Table 2. *Heavy metal and Total petroleum hydrocarbon level in soils from the automobile workshop*

S/n	Concentration (mg/kg)	Contaminated top soil (0-15 cm)	Control (0-15 cm)	DPR (2002)		USEPA (2002)	LASEPA 2016 (FEPA)
				Target value	Intervention value		
1	Cadmium	10.23±0.45	0.75±0.02	0.80	12	0.48	- (-)
2	Arsenic	0.12±0.01	0.01±0.01	29	55	0.11	-
3	Copper	1500.1±1.2	2.05±0.01	36	190	270	- (70-80)
4	Lead	307.5±2.2	2.10±0.10	85	530	200	1 (1.6)
5	Mercury	< 1	< 1	0.3	10	1	<1
6	Nickel	69.44±2.05	0.05±0.01	35	210	72	1
7	Zinc	223.1±4.7	2.51±0.03	140	720	1100	<1(300-400)
8	Aliphatic Hydrocarbons	3211.1±9.5	5.90±3.16				
9	Aromatic Hydrocarbons	301.9±2.5	1.17±1.12	1	40		
10	Total Petroleum Hydrocarbons	2246.5±2.6	0.97±0.01				
11	Oil & Grease	7628.8±7.7	10.40±2.14				

Cd, Cu and Pb levels were higher than specified by regulatory organizations (FEPA, 1991; USEPA, 2002). Studies had shown that heavy metals such as vanadium, lead, aluminium, nickel, chromium, lead, iron and copper are very high in spent engine oil compared to unused engine oil (USEPA, 2001; Alabi et al., 2013). This result is of public health importance as heavy metals in soil are toxic and some of the soluble metals may find their way into soil, rivers, lakes and streams resulting in pollution and may lead to geoaccumulation, bioaccumulation and biomagnifications in the ecosystems. Thus, it's possible for soil pollution to change whole ecosystem (Seifi et al., 2010).

In this study the total petroleum hydrocarbon (TPH) concentration found in the mechanic workshop contaminated soil was 2246.51±2.64 mg kg^{-1}, in comparison to 10.97±0.01 mg kg^{-1} in soil of uncontaminated garden site. Our findings corroborate with TPH concentration for the top soils measured at 0–15 cm depth ranging from 55.00±13.00 to 302.00 ± 14.00 mg kg^{-1} from the Niger Delta region of Nigeria 3 months after an extensive oil spillage (Okop and Ekpo, 2012). Much higher levels of TPHs in the order of 1,179.3 to 6,354.9 mg kg^{-1}, with the average of 2,676.6 mg kg^{-1}, were reported from agricultural soils adjacent to petrochemical complex in Guangzhou, the capital city of Guangdong Province in southern China (Li et al., 2012). The high TPH is as result of soil contamination through the operation of the automobile garage on the site.

Root growth inhibition of *A. cepa* induced by automobile workshop leachate

The maximum root growth (17.83 cm) was at 10% concentration of the leachate, which occurred after 48 hours exposure while the minimum root growth (2.6 cm) was at 0% concentration and this was recorded at the initial growth. In the leachate, minimum growth was observed at 100% concentration in all the days except at the 24 hours exposure where minimum growth occurred at the 75% concentration of the leachate (Fig. 3).

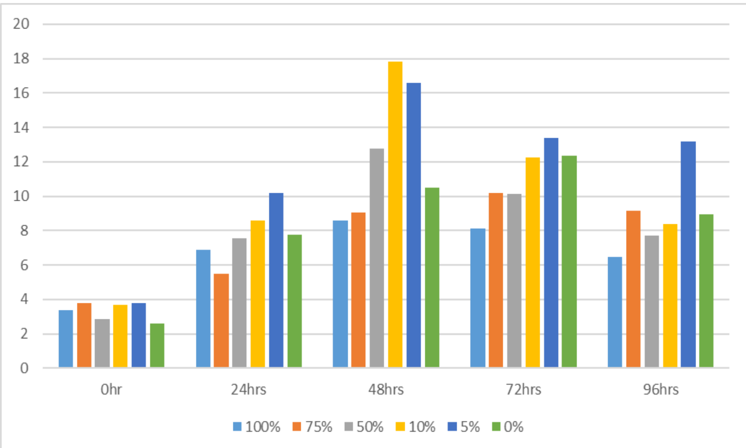

Figure 3
Mean root length against period of exposure in leachates

The maximum growth occurred in the 5% concentration of the leachate in all the days except on the 48 hours exposure where maximum growth occurred in the 10%

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concentration of the leachate. The decreased growth rate of the A. cepa might be attributed to the high level of Cd, Pb and other constituents of the leachates. Cd is a non-essential element that negatively affects plants growth and development (Orsuamaeze et al., 2018).

Stomata opening, transpiration and photosynthesis have been reported to be affected by cadmium in nutrient solutions, but the metal was taken up into plants more readily from nutrients solutions than from soil (Akila et al., 2015). In general, cadmium has been shown to interfere with the uptake, transport and use of several elements and water by plants. Chlorosis and leaves stunting are the main easily feasible symptoms of cadmium toxicity in plant leaves. Cadmium toxicity may have affected the plasma membrane permeability causing a reduction in its water content.

The root tips were brown from the third day in 50% concentration and above, but the roots look healthy despite the change in colour. White and healthy roots were observed in the control solution. The effective concentration of the leachate (EC_{50}) for percentage inhibition was 75% of stock concentration as shown in figure 4.

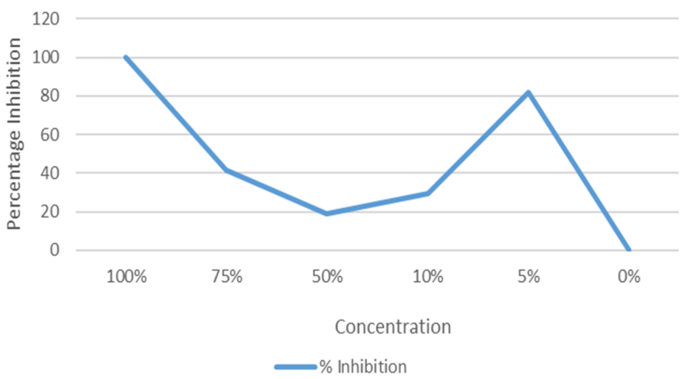

Figure 4 *Percentage inhibition of Allium cepa induced by Mechanic workshop Leachate cromosomal aberration*

The mitotic index values recorded varied from 5.94% in leachate to 7.70% in the control. The mitotic index values for the treatments were all below the control (table 3).

The value of the mitotic indices recorded decreased with increase in the concentration of the leachate. The least mitotic indices were observed in the roots treated with 100% leachate. The mitotic inhibition was observed to be inversely proportional to the mitotic index.

All the leachate concentrations showed one form of aberration or another on *Allium cepa* root tip chromosome integrity (Table 4 and Fig. 4).

Table 3. *Frequencies of mitotic indices and mitotic inhibition in root tips of Allium cepa in the different concentrations of the test chemicals.*

Concent. (%)	No of cells	No of dividing cells	P	M	A	T	M.I (%)	M. In (%)
0 Control	500	42	20	10	5	7	8.40	-
5%	480	37	23	6	3	5	7.70	8.33
10%	430	24	12	5	4	3	5.58	33.57
50%	390	24	12	4	5	3	6.15	26.78
75%	360	22	14	5	2	1	6.11	27.26
100%	320	19	14	3	1	1	5.94	29.28

P = Prophase, M = Metaphase, A = Anaphase, T = Telophase, M.I-Mitotic Index, and M.In-Mitotic Inhibition.

Table 4. *Chromosomal aberration caused by the leachat*

Concentration (%)	Sticky	C-mitosis	Bridges	Lag	BN	Vag	MN
0	2	-	-	-	-	-	-
5	45	-	-	-	10	6	6
10	13	-	30	25	15	6	8
50	50	-	-	37	20	9	10
75	16	20	-	-	9	10	10
100	15	15	15	10	12	-	5

Lag = laggard, BN = binucleated, Vag = vagrant, MN = micronuclei

These include sticky chromosomes, C-mitosis, bridges, lagging chromosomes, binucleate, vagrant cells and micronuclei. The highest aberration occurred in 50% concentration of the treatment while the lowest occurred in the control. Sticky chromosomes, binucleate and micronuclei cells were observed among all the concentrations. The aberrations observed varied with exposure time. All the aberrations except sticky chromosome were absent in the control.

The detected genotoxicity and mutagenicity in this study might be due to the presence of the analysed heavy metals and hydrocarbons in the leachate. It has been suggested that DNA damage induced by leachates might be due to the presence and interactions of heavy metals with DNA (Alabi and Bakare, 2011). The poisoning effects of heavy metals are due to their interference with the normal body biochemical processes (Ukoh et al., 2018). There is also the possibility of other constituents in the sample that might be responsible for the observed mutagenicity and genotoxicity in this study. Although the exact mechanism of leachate-induced genetic damage is not clear, some studies are suggesting that it could be via free radical damage mechanism (Alabi et al., 2013; Koshy et al., 2007), and heavy metals have been known to induce oxidative stress.

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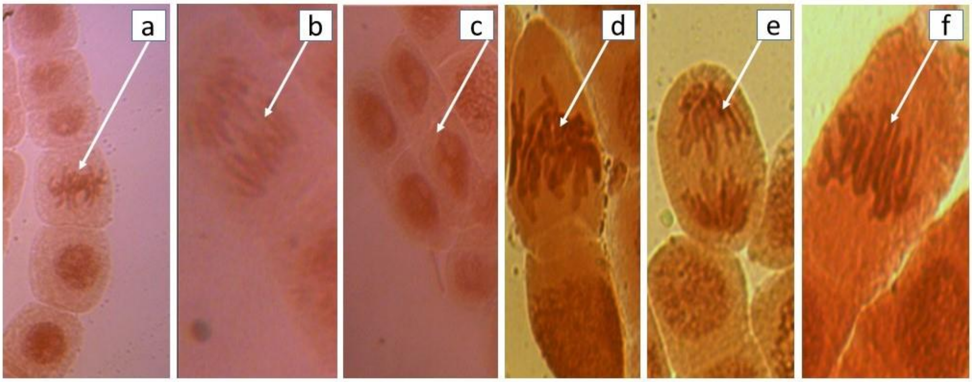

Figure 4. *Different chromosomal aberration caused by the leachate (a = Sticky, b = Laggard, c = Binucleated, d = Vagrant, e = Bridged, f =C-mitosis)*

The exposure to heavy metals may prevent plant cells from entering cell division phases which may leads to decrease in the mitotic index as observed in this study (Abubacker and Sathya, 2017). The primary action of heavy metal on the mitotic spindle promoted spindle related chromosomal abnormalities during cell division (Singh, 2015). The decreased mitotic index is due to disturbances in the cell cycle or chromatin disfunction induced by metal-DNA interaction which leads to significant reduction of mitotic index as reported in this study (Kopliku and Mesi, 2013).

There was no simple positive relationship between frequency of chromosome aberrations and concentration of the leachates. For instance, the frequency of chromosome aberrations at 50% of the sample was higher than that at 75% and 100% concentrations. A probable explanation for this, is that with increasing concentration and consequent toxicity, there may be an inhibitory effect of the leachate on cell division and consequent hindrance of the passage of affected cells into the mitotic cycle.

Conclusion

The results of the present study showed that simulated leachates from an automobile workshop is genotoxic and mutagenic in the bioassays used in this study. The soils contained heavy metals in higher concentrations than the control and standards set by regulatory authorities. Also, higher TPH was observed too. The observed genotoxicity and mutagenicity are believed to be caused by the leachate constituents. This is of environmental and public health significance in the study considering the fact that automobile workshops are found in all areas (residential and industrial) across Nigeria and little or no attention is given to monitoring of the waste products been released into the environment.

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