Toxic Impact of Oke-Afa Closed Landfill Leachates on Albino Mice (*Musmusculus* Linnaeus, 1758)

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Abstract: ***Leachates are known to be produced during and after landfill operation. There is limited information on the toxic effect of closed landfill leachate on tissues and organ of mammals. The aim of this study was to evaluate the toxic effect of Oke-Afa closed landfill leachates on Musmusculus. Twenty-five female mice were used;the mice were divided randomly into 5 groups of 5 animals each. Group 1 was the control; the other four groupswere given 5-25% concentrations of the leachate. Animals were sacrificed after 28 days; organs and blood were collected for histopathological, biochemical, and haematological analyses. Significant decrease (P<0.05) was observed in the alanine aminotransferase, neutrophils, and mean cell heamoglobin concentration of the exposed mice. The mean cell volume and lymphocytes of the mice exposed showed a significant increase (P<0.05). Physio-chemical analysis of the leachate revealed low biological oxygen demand, chemical oxygen demand, Manganese and Cadmium while Copper, Iron, Mercury, Lead, and Zinc were high compared to the standard permissible limit. The heavy metals when ingested in the body can lead to liver and kidney damage, cancer, cardiac arrhythmias, immunotoxicity and anaemia. Closed Oke-Afa landfill leachate might be a threat to the health of the people ingesting groundwater within its vicinity.***

Keywords: Toxic, Leachates,Albino Mice, Immunotoxicity, Anaemia

1. Introduction

The practice of landfill system as a method of waste disposal in many developing countries is usually far from standard recommendations; they are disposed of in uncontrolled dumpsites and/or burnt, polluting water resources and air. Standardized landfill systems involves carefully selected location, and are usually constructed and maintained by means of engineering techniques, ensuring minimized pollution of air, water and soil risks to man and animals. Land filling involves 'placing' wastes in lined pit with appropriate means of leachate and landfill gas control (Alloway and Ayres, 1997).

Leachates are defined as the aqueous effluent generated as a consequence of rainwater percolation through wastes, biochemical processes in waste's cells and the inherent water content of wastes themselves (Renou 2008).Its composition and toxicity can vary a great deal, depending on what substances the landfill contains. Leachate from a landfill varies widely in composition depending on the age of the landfill and the type of waste that it contains, (Henry *et al* 1996). Leachates are highly concentrated "chemical soup," so concentrated that small amounts of leachate can pollute large amounts of groundwater rendering it unsuitable for use for domestic water supply (Lee 1994).

An assessment of the groundwater quality at the Olusosun landfill in Lagos, Nigeria was conducted by Akolade (2002), The study indicates that the concentrations of some metals (Cr, Fe, Cd, Mn, and Co) and other water quality parameters in some sampling locations were slightly above the World Health Organization (WHO) and the Nigerian Standard for Drinking Water Quality (NSDWQ) standard limits.Alimba et al 2012 also reported high concentration of heavy metals and anion in Olusosun leachate sample were above standard permissible limit. The influence of local hydrogeology underlying the active Olusosun landfill base in Lagos was investigated and the level of groundwater contamination in the vicinity of the landfill leachate migration pattern in was equally assessed by Longe (2007), Analytical results showed a measurable impact of leachate outflows on groundwater quality. Soil stratigraphy beneath the landfill base is an important factor in the natural attenuation of leachate constituents in the groundwater (Lavalin, 1992; Longe & Kehinde, 2005).

A review of epidemiologic literature on the health effects of residence near hazardous waste landfill sites by Vrijheid (2000) showed that people consuming well water contaminated with landfill leachate had increase occurrence of Spontaneous abortion, Birth defects, bladder and liver malfunction. Exposure to arsenic and dioxins in drinking water close to dump sites as been associated with hyperinsulinemia (Longnecker &Daniels, 2001). Landfill leachate at a minute quantity has been seen to cause liver and kidney dysfunction (Alimba *et al* 2012), Cytotoxic and Genotoxic effect (Victor et al 2014),and micronucleiabnormalities (Li *et al* 2004), induce oxidative stress in heart, kidney and spleenof mammals (Li *et al* 2006), alter haematological profile (Alimba 2012).

Haematological testing in rodents during toxicity and safety evaluations has been generally accepted as integral part of safety assessment or screening (Brown, 1992). Biochemical evaluation of enzymes found in organs such as liver and kidney are important in toxicity testing, itreflects imbalance within the systems manifestation. They are sensitive to membrane integrity, changes in metabolism, and excretion. The magnitude of responses often correlates with the severity of damage. Among the tissues and organs in the mammalian body, liver and kidney seem to be the most sensitive predictor of chemical toxicity, this is due to their involvement in metabolism, detoxification, storage and excretion of xenobiotic and their metabolites, making them important target organs for xenobiotic induced injuries (Alimba*et al*, 2012)

In this study, we investigated the toxic effect of closed Oke-Afa landfill leachate on the Liver, Kidney and haematological parameters of mice. Some physio-chemical parameters of the leachate were also analyzed.

2. Materials and Methods

2.1 Study Site

Oke-Afa Landfill is located at Isolo, Lagos, Nigeria. Isolo town lies between latitude 60° 32′N and 60° 33′N with longitude 30° 20′E. Oke-Afa dump site has been closed down for commercial dumping due to expiration of age (30 years). The dump site is still being managed by Lagos State waste management authority (LAWMA) in Nigeria. According to Lagos State waste management Board, Oke-AfaIsolo landfill has not been active since 1995. Raw leachate were collected from the landfills and thoroughly mixed to provide a homogenous representative sample for each sampling site. These were transferred to the laboratory in pre-clean 10 litres plastic containers, it was filtered and stored at 4^oC until use. These were considered as the stock sample (100%).

2.2 Physico-Chemical Analyses of Test Materials

Physical and chemical parameters of the leachates were analysed. These include Nitrate, pH, Total dissolved solid, Electrical conductivity, colour, total phosphate, biological oxygen demand, chemical oxygen demand, manganese, copper, zinc, iron, lead, cadmium, magnesium, mercury were determined.

2.3 Preparation of Text Solution

The various concentrations of leachate were obtained by mixing appropriate volume of water with raw leachate using dilution formula; $M_1V_1 = M_2V_2$
Where M_1 and M_2 are the initial and final concentration of the leachate, V_1 and V_2 are the initial and final volume used. 1,5,10 and 25% of leachate were prepared.

2.4 Biological Specimen Used as Test Animal

Healthy twenty five female 7–8 weeks old, *Musmusculus (*Albino rats) purchased from Lagos University Teaching Hospital was used for the toxicity testing. All the mice used were weighed prior to the experiment the weight range between 9g-22g with a mean of 15.8±0.8.

2.5 Acclimatization of Mice

The mice were acclimated for 2 weeks in an apparently pathogen free, well-ventilated animal house of the zoological garden of the University of Lagos. The animals were kept at a room temperature of 30 ± 3^oC and a relative humidity of about 35% with a 12hrs light/dark cycle inside a locally fabricated cage made of plastic at the side and the base with wire mesh used as covering for ventilation. They were fed ad-libitum on standard laboratory feed.

2.6 Bioassays Procedure

The mice were divided randomly into 5 groups (5 animals/ group). Animals in group 1 were given 0.5 ml of water intraperitoneally, as the control group. The other four experimental group were given different concentrations of the leachate (5-25%) and 0.5ml per mouse intraperitoneally. After 28 days of exposure to leachate, the animals were made to fast overnight and then sacrificed; organs and blood were collected for further analyses.

2.7 Haematological Determination of Mice

After 24h post exposure with overnight fasting, blood samples from the orbital plexus were collected in appropriate heparinised blood containers for determination of packed cell volume (PCV), Red blood cell (RBC), White blood cell (WBC), haemoglobin(Hb), Platelets(Plt), Mean cell volume(MCV), Neutrophils(N), Lymphocytes(L), Mid(M), Mean cell haemoglobin(MCH), Mean cell haemoglobin concentration (MCHC), Red cell distribution width coefficient of variation(RDW-CV), and Red cell distribution width standard deviation (RDW-SD), with the use of automated haematology analyser.

2.8 Histopathological Analyses of Kidney and Liver of Mice

Procedure for slide preparation
The organs (liver and kidney) were fixed in 10% formalin, and embedded in melted paraffin wax. The wax blocks were cut on a microtome to yield a thin slice of paraffin containing the tissues. The specimen slices were applied to a microscope slide, air dried, and heated to cause the specimen to adhere to the glass slide. Residual paraffin was dissolved by rinsing with an acid-alcohol followed by rinsing with water to remove the acid-alcohol.

The slides were contacted with a concentrated solution having a pH above 5.0 to turn the hematoxylin blue [bluing solution], The bluing solution were removed by rinsing with water, cytoplasmic elements were stained with an alcoholic solution of eosin Y, a red stain, and light green or fast green.Excess stains and water were removed by a series of sequential washes in a dehydrating reagent, The slides were contacted with a chemical-clearing agent (toluene, xylene, or t-butanol) to remove residual dehydrating reagent(graduated alcohol) remaining from the washing step. A cover-slip mountant and a cover-slip were applied after removing the slide from the chemical-clearing agent. The clearing agent evaporates and the mountant hardens leaving a stained and mounted slide. Histopathological assessment and photomicrography of the prepared slides were done using an Olympus light Microscope with attached Kodak digital camera.

2.9 Biochemical Evaluation of Liver and Kidney of Mice

Liver and kidney tissues were surgically removed, placed on ice bath to remove excess blood and then homogenized in ice cold isotonic phosphate buffer pH 7.4 and centrifuged at 10,000g for 15 min at 4 °C using cold centrifuge. The resultant supernatant were stored at 70 °C prior to subsequent biochemical analyses which was done by Roche/hitachi 902 automatic analyzer. Aspartate Amino Transferase (AST), Alanine Aminotransferase (ALT) and Alanine Phosphate (ALP) were assessed as biomarkers for liver while creatinine and urea were assessed as biomarkers for kidney.

2.10 Statistical Analyses

SPSS 16.0 statistical package was used for data analyses. Analyses of the differences in mean ± SE values for all data were determined using one way and two way ANOVA. Duncan Multiple Range test comparison at $P<0.05$, level of significance was used to compare the treated groups and corresponding controls.

3. Results

3.1 Physico-Chemical Analyses of Oke Afa Landfill Leachate

The leachate had a slight foul smell. The pH was slightly alkaline but were still within the permissible standard limit as shown in Table 3. The BOD, COD, Mn, and Cd did not exceed the standard permissible limit (Table 3). TDS, Nitrate, Phosphate, Cu, Fe, Hg, Pb, Zn were high compared to the standard permissible limits (Table 3).

Table 1: Physico-Chemical Parameters and Heavy Metal Analyzed in Oke-Afa Landfill Leachate

Parameters	Levels Detected	NESREA	USEPA
COLOUR	Light Brown	-	-
pH	7.9	6.0-9.0	6.5-8.5
BOD	20	50	-
COD	50	90	-
TDS	2090	2000	-
EC	3140	-	-
NITRATE	27.45	10	10
PHOSPHATE	2.87	2	-
Mn	0.074	0.2	0.05
Cd	0.154	0.2	0.05
Cu	10.245	0.5	1.3
Fe	72.8	0.5	0.3
Hg	0.005	-	0.002
Mg	80.51	-	-
Pb	3.02	0.1	0.015
Zn	95	0.2	-

*All values are in mg/l except pH
*NESREA- National Environmental Standards and Regulation Enforcement Agency (2009)
*USEPA- United State Environmental Protection Agency (2006)
*BOD-Biological Oxygen Demand
*COD-Chemical Oxygen Demand
*TS- Total Solid
*EC-Electrical Conductivity

3.2 Biochemical Evaluation of Liver

The levels of Aspartate amino transferase (AST) in the mice exposed to leachate were lower compared to the control, as shown in Figure 1. The AST level decreased from 0% to the control to 10% leachate concentration and then increased from 10% to 25% leachate concentration (Figure 1). There was no significant difference (P>0.05) of the various group compared to the control.The level of Alanine amino transferase (ALT) reduced at each concentration of leachate when compared to the control (Figure 2). The level of ALT increased from 5% to 10% and then reduced from 10% to 25% as shown 1n (Figure 2). There was significant difference (P<0.05) of the various group compared to the control.The levels of Alanine phosphate (ALP) in the landfill leachate exposed mice were higher compared to the control (Figure 3). The ALP level in the expressed mice reduced slightly with increase in leachate concentration as shown in Figure 3. There was no significant difference (P>0.05) among the various groups compared to the control.

3.3 Biochemical Evaluation of Kidney

The creatinine level reduced in 5% to 15% leachate concentration compared to the control and suddenly increased in 25% concentration (Figure 4). There was no significant difference (P>0.05) of the various group compared to the control.Urea levels were almost the same in both control and exposed mice except in concentration 5% and 10% (Figure 5). There was no significant difference (P> 0.05) of the various group compared to the control.

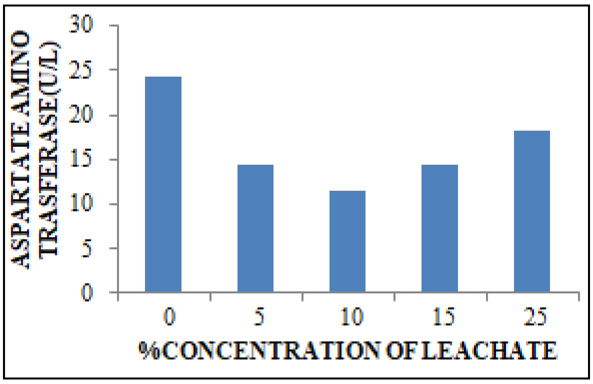

Figure 1; Effects of Landfill Leachate on Aspartate Amino Transferase Level of Mice

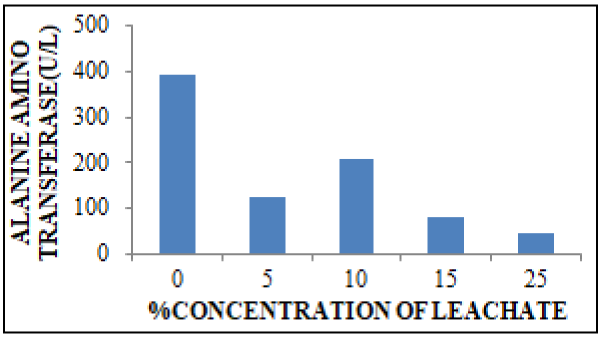

Figure 2: Effects of Landfill Leachate on Alanine Amino Transferase Level of Mice

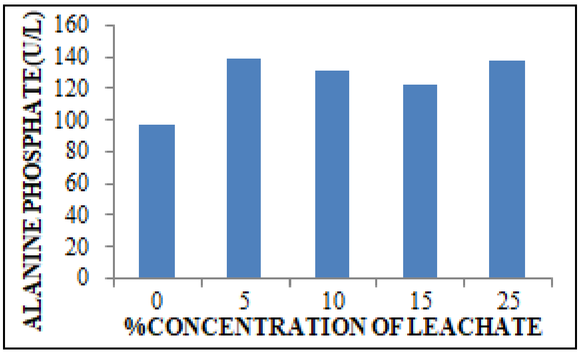

Figure 3: Effects of Landfill Leachate on Alanine Phosphate Level of Mice

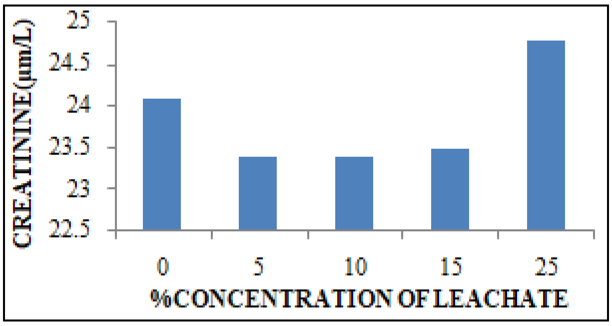

Figure 4: Effects of Landfill Leachate on Creatinine Level of Mice

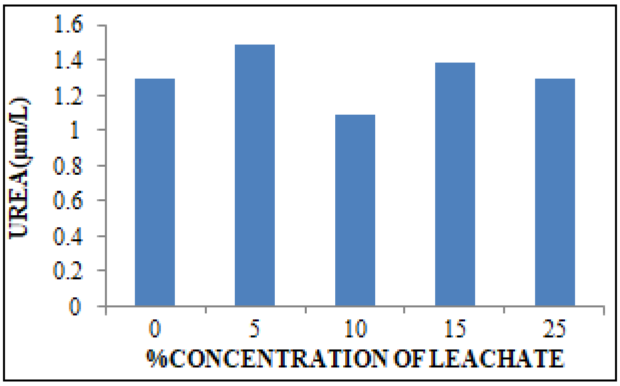

Figure 5: Effects of Landfill Leachate on Urea Level of Mice

3.4 Studies on Haematological Analyses

3.4.1 Haematological Analyses on White Blood Cell (WBC) of Mice

The level of the WBC in all the groups increased when compared to the control (Figure 6). As shown in figure 6 there was an increase from the control to 10% concentration and a decrease in 10% concentration to 25% concentration. There was no significant difference (P>0.05) of the various group compared to the control.

3.4.2 Haematological Analyses on Red Blood Cell (RBC) of Mice

The level of the RBC increased with increase in concentration of the landfill leachate, except in 25% concentration (Figure 7). There was no significant difference (P>0.05) of the various group compared to the control.

3.4.3 Haematological Analyses on Platelets (Plt) Of Mice

The level of the Plt from 5% to 25% concentration increased gradually when compared to the control as shown in Figure (8). Concentration 10% and 15% both have the same level of platelets (Figure 8). There was no significant difference (P>0.05) of the various group compared to the control.

3.4.4 Haematological Analyses on Haemoglobin (Hb) Of Mice

The level of Hb increased in the exposed mice at the different concentration when compared to the control (Figure 9). As shown in Figure 9 the Hb level of 10% concentration decreased to that of 5% concentration, also the 10% and 15% concentration had almost the same level of Hb. There was no significant difference (P>0.05) of the various group compared to the control.

3.4.5 Haematological Analyses on Packed Cell Volume (PCV) of Mice

The level of PVC of exposed mice as shown in Figure 10 at 5%, 15%, and 25% leachate concentration had consistent increase compared to the control, however the 10% leachate concentration had same level of PCV when compared to the control. There was no significant difference (P>0.05) of the various group compared to the control.

3.4.6 Haematological Analyses on Mean Cell Volume (MCV) of Mice

The level of MCV at 5%, 10%, 15% of concentration was lower compared to the control, however the 25% concentration was higher compared to the control (Figure 11). As shown in Figure 11 there was a reduction in the MCV level from the control to 10% concentration and an increase from 10% concentration to 25% concentration. There was significant difference (P<0.05) of the group 5%, 10% and 15% concentration compared to the control.

3.4.7 Haematological Analyses on Neutrophils(N) of Mice

The level of N of the entire treated group reduced when compared to the control (Figure 12). As shown in Figure 12 the N level increased from 5% to 15% and dropped at 25%. There was significant difference (P<0.05) of all the various group compared to the control.

3.4.8 Haematological Analyses on Lymphocytes (L) of Mice

The level of L in all the treated groups increased when compared to the control (Figure 13). As shown in Figure 13, the level of L in 15 % concentration was reduced compared to others. There was significant difference (P<0.05) of the entire various group compared to the control.

3.4.9 Haematological Analyses Onmixed Cell Count Containing Monocytes, Eosinophils and Basophils (M) of mice

The level of M were almost the same in both control and treated group except in 5% and 15% concentration (Figure 14). There was no significant difference (P>0.05) of the various group compared to the control.

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3.4.10 Haematological Analyses on mean Cell Haemoglobin (MCH) of mice

The level of MCH increases in leachate treated group except in 10% leachate concentration (Figure 15). As shown in Figure 15, 25% leachate concentration had lower level of MCH compared to 15% leachate concentration. There was no significant difference (P>0.05) of the various group compared to the control.

3.4.11 Haematological Analyses on Mean Cell Haemoglobin concentration (MCHC) of Mice

The level of MCHC at 5%, 10%, and 15% concentration of leachate exposed mice increased compared to the control as shown in Figure 16, but there was a decrease in 25% concentration compared to the control. There was significant difference (P<0.05) in group 10% concentration compared to the control.

3.4.12 Haematological Analyses on Red Cell Distribution Width of Coefficient Variation (RDW.CV) of Mice

The level of RDW.CV of 10%, 15% and 25% leachate concentration increased compared to the control except in 5% concentration which was reduced compared to the control (Figure 17). There was no significant difference (P>0.05) of the various group compared to the control.

3.4.13 Haematological Analyses on Red Cell Distribution Width Standard Deviation (RDW.SD) of Mice

The level of RDW.SD at 15% and 25% leachate concentration increased compared to the control but the 5% and 10% leachate concentration reduced compared to the control (Figure 18). As shown in Figure 18 there was a decrease in the RDW.SD level from the control to 10% leachate concentration and an increase in 10% to 20%. There was significant difference (P<0.05) in the group 15% and 25% concentration compared to the control.

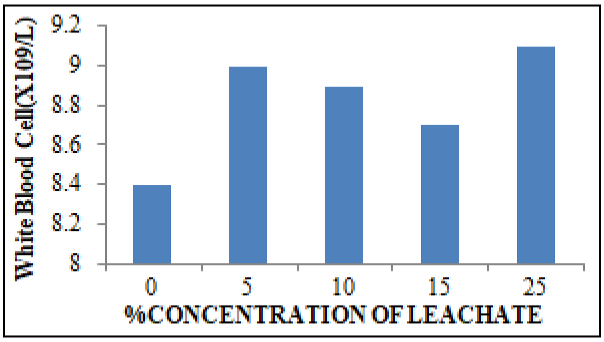


Figure 6: Effects of Landfill Leachate on White Blood Cell of Mice

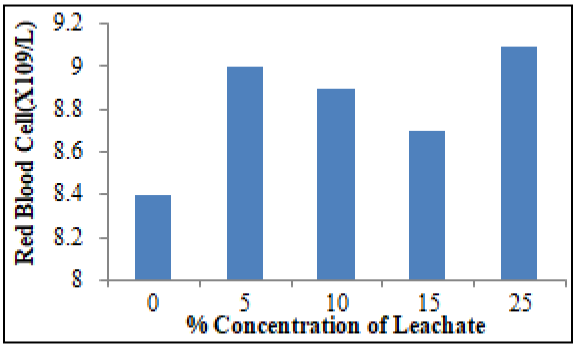


Figure 7: Effects of Landfill Leachate on Red Blood Cell of Mice

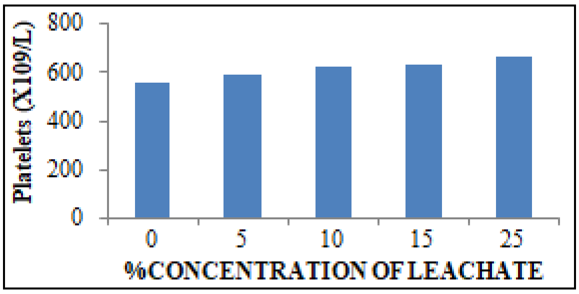


Figure 8: Effects of Landfill Leachate on Platelets of Mice

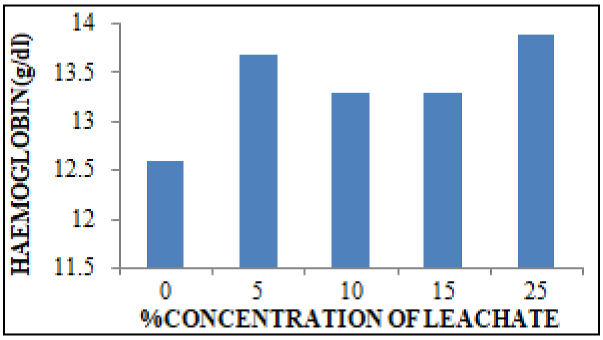


Figure 9: Effects of Landfill Leachate on Haemoglobin of Mice

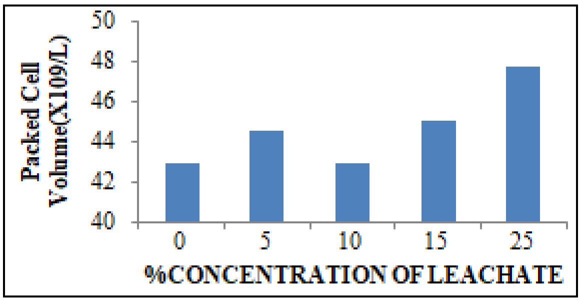


Figure 10: Effects of Landfill Leachate on Packed Cell Volume of Mice

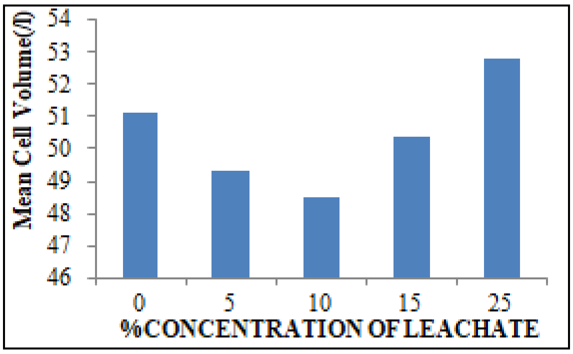


Figure11: Effects of Landfill Leachate on Mean Cell Volume of Mice

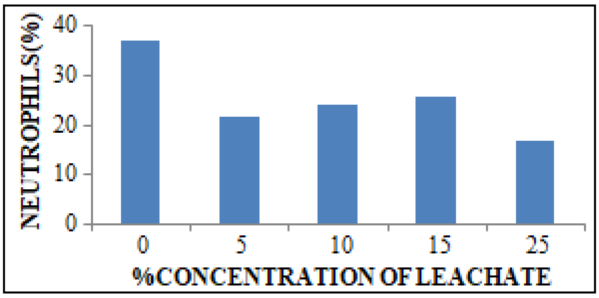


Figure12: Effects of Landfill Leachate on Neutrophils of Mice

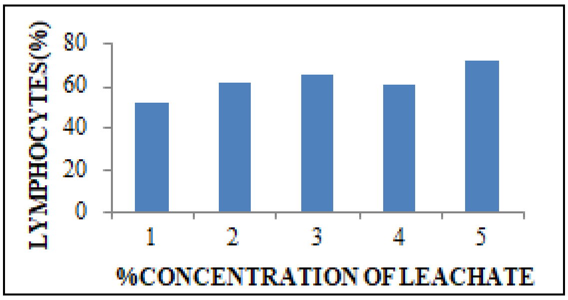


Figure 13: Effects of Landfill Leachate on Lymphocytes of Mice

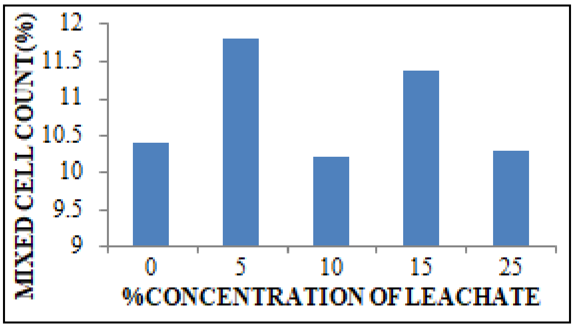


Figure 14: Effects of Landfill Leachate on Mixed Cell Count of Mice

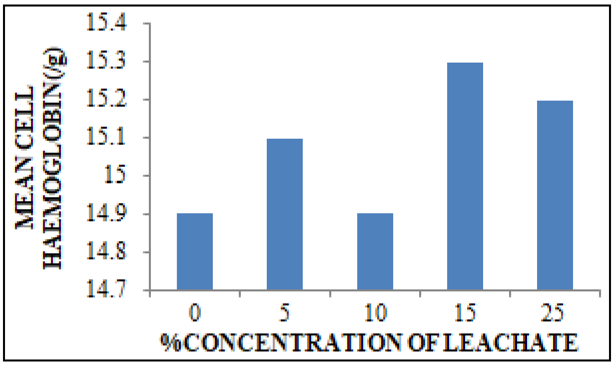


Figure 15: Effects of Landfill Leachate on Mean Cell Haemoglobin of Mice

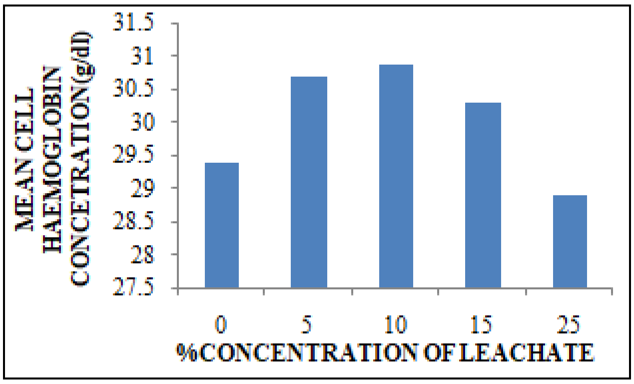


Figure 16: Effects of Landfill Leachate on Mean Cell Haemoglobin Concentration of Mice

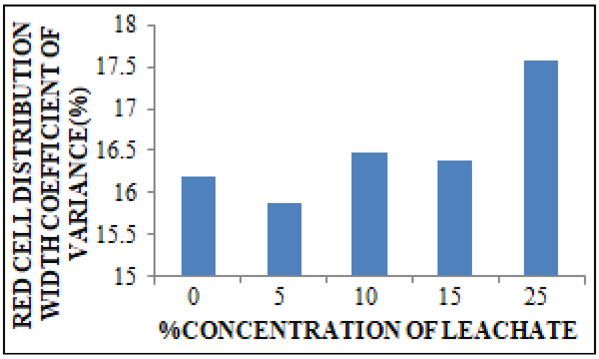


Figure17: Effects of Landfill Leachate on Red Cell Distribution Width Coeficient of Variance Of Mice

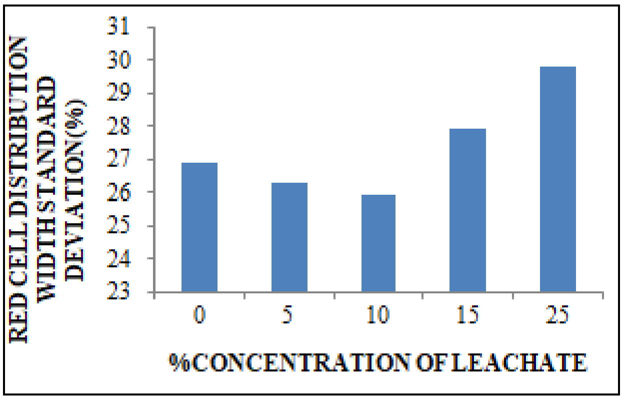


Figure 18: Effects of Landfill Leachate on Red Cell Distribution Width Standard Deviation

3.5histopathology of Kidney and Liver

3.5.1 Histopathology of Kidney

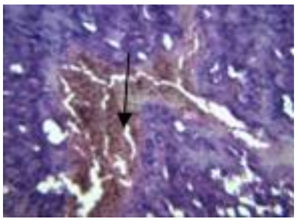


Plate K11: Severe Congestion of Renal Cortex

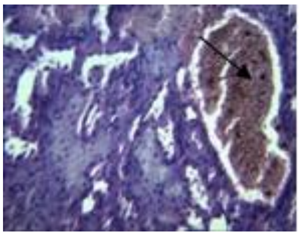


Plate K19: Congestion at the Renal Cortex

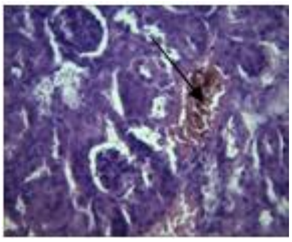


Plate K21: Cogestion of Renal Cortex

Plate K1-K5 were histopathological sections report for mice serving as control. There was a large focus of cellular infiltration at the interstitium and some tubules had proteinaceous material in the lumen in Plate K1. Moderate renal cortical congestionwere seen in Plate K2 and K5. No visible lesions wasseen in Plate K3 and K4.

Plate K6-K10 werehistopathological sections report for mice exposed to 5% concentration. There was congestion at the renal cortico medullary junction and, anda mild cellular infiltration around the same were seen in Plate K1. No visible lesions were seen in Plate K7, K8 and K9. There was a very mild congestion at the renal cortex in Plate K10.

Plate K11-K15werehistopathological sections report for mice exposed to 10% concentration. There was severe congestion at the renal cortex in Plate K11. No visible lesions were seen in Plate K12, K13, K14 and K15.

Plate K16-K20 were histopathological sections report for mice exposed to 15% concentration. There was severe congestion at the renal cortexin Plate K16. There was mild to moderate congestion at the renal cortex and a mild perivascular cellular infiltration in Plate K17. There was severe congestion at the renal cortex in Plate K18. There was mild to moderate congestion at the renal cortex in Plate K 19. No visible lesions were seen in Plate K20.

Plate K21-K25 were histopathological sections report for mice exposed to 25% concentration. In Plate K 21 there was mild to moderate congestion at the renal cortex, few tubules also appears to be degenerated and mild perivascular cellular infiltration was seen. There was foci severe interstitial cellular infiltration by mononuclear cells in Plate K 22. Mild epithelial ballooning of several renal tubules was seen in Plate K 24. No visible lesions was seen in Plate K23 and K24.

3.5.2 Histopathology of the liver

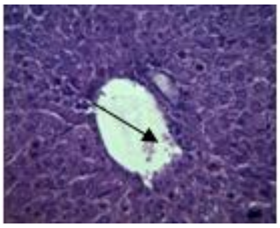


Plate L14; Hydropic Degeneration Seen

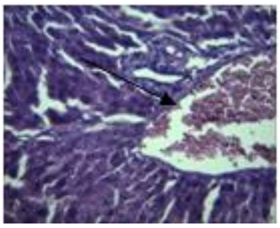
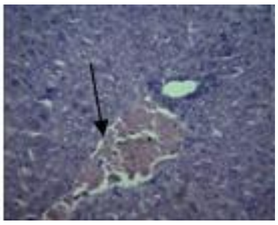


Plate L19; Portal Congestion Seen



Platel13; Congestion and Degenaration Seen

Plate L1-L5 werehistopathological sections report for mice serving as control. Plate L1 showed a moderate diffuse vacuolar degeneration of hepatocytes, with periportal cellular infiltration by mononuclear cells. There was a diffuse hydropic degeneration of the hepatocytes in Plate L2 and L3. Moderate to severe diffuse hydropic degeneration of the hepatocytes was seen in Plate L4 and Plate L5.

Plate L6-L10 werehistopathological sections report for mice exposed to 5% concentration. There was a moderate periportal cellular infiltration by mononuclear cells in Plate L6. No visible lesions seen were seen in Plate L7. There was a mild portal congestion in Plate L8 and a very mild periportal cellular infiltration in Plate L8 and L9. Mild periportal cellular infiltration was observed in plate L10.

Plate L11-L15 werehistopathological sections report for mice exposed to 10% concentration. No visible lesionswas seen in slide Plate L11. There was a mild portal and central venous congestion in Plate L12. There was a mild portal congestion and periportal cellular infiltration in Plate L13. Diffuse hydropic degeneration of hepatocytes was observed in Plate L14. There was a mild diffuse hydropic degeneration of hepatocytes in Plate L15.

Plate L16-L20 werehistopathological sections report for mice exposed to 15% concentration. There was a mild diffuse hydropic degeneration of hepatocytes, with very mild periportal cellular infiltration in Plate16. No visible lesions wasseen in Plate L17 and L18. Moderate portal congestion was observed in Plate L19. There was a mild diffuse hydropic degeneration of hepatocytes, with very severe periportal cellular infiltration by mononuclear cells in Plate L20.

Plate L21-L25 werehistopathological sections report for mice exposed to 25% concentration. There was a mild diffuse hydropic degeneration of hepatocytes in Plate L21, L22, L23. No lesions were observed in Plate L24 and L25.

Table 5: Frequency and Severity of Histopathological Alteration in Liver and Kidney of Mice Exposed to Oke-Afa Landfill Leachate

Histological	*Change on Liver and Kidney*				
Concentration	0%	5%	10%	15%	25%
Liver					
Necrosis	0	0	0	0	0
Cellular Infiltration	0	2	1	1	0
Congestion	0	1	1	1	0
Degeneration	4	1	3	1	2
Kidney					
Necrosis	0	0	0	0	0
Cellular Infiltration	1	1	0	1	1
Congestion	1	1	1	2	2

Severity of liver and kidney histological changes were assessed using the following scale;
0= a change that was either absent or sporadic in all animals of a group;
1=a change that was found in a few animals of a group
2=a change that was rare in all animals of a group
3=a change that was very often found in all animals of a group
4=a change that was very often found in all animals of a group

4. Discussion

Leachate from dumpsites varies widely in composition depending on the age of the landfills and the type of waste that it contains (Henry and Heinke 1996). In this study the physiochemical analyses of the leachate showed that the pH was slightly alkaline probably as a result of nitrate which was almost three times the acceptable limits. The rearing of cows seen at the dumpsite could possibly have led to the increase in nitrate. The value of the biological oxygen demand (BOD) and chemical oxygen demand (COD) were low compared to the NESREA and USEPA standard permissible limit. However, the low values were expected as the landfill of study was a closed type, up to 30 years old. Alimba*et al*(2012) reported higher values of BOD and COD from active landfill leachate Olusosun and Aba-eku landfill. The value of some of the heavy metal including Cu, Fe, Hg, Mg, and Pb exceeded the permissible limit of NESREA and USEPA, the value of Cu and Fe were exceedingly high (10.2 and 72.8) respectively, the value of Cu was similar to the findings of Nurudeen and Aderibigbe (2013) on the same site.

Metallic mercury is usually transformed to organic mercury which are distributed primarily to the kidneys. Long term exposure can cause permanent damage on the brain, kidneys and developing foetus (USEPA). Excess Fe intake could lead to cirrhosis, seizures, abdominal pain, vomiting, liver cancer and cardiac arrhythmias. Cu is readily absorbed by the stomach and small intestine, when in excess it causes gross dysfunction, anemia and disturbance of metabolism of other nutrients are. Excess Zn in the body causes anorexia, diminished growth, loss of hair and lowered food utilization. Pb has a toxic effect on kidney, it impairs transport of organic anions and glucose and also depresses glomerular filtration rate.

Liver and kidney malfunction have been associated with human exposure to hazardous waste (Haris*et al*, 1984). In this study decrease in AST and ALT and an increase in ALP were recorded in exposed mice compared to the control; only ALT showed a statistically significant decrease when compared to the control. The value of creatinine and urea exposed to leachate showed no marked difference compared to the control. The result was in contrast to the observation of Arojojoye and Farombi (2013).

Haematological changes are associated with haematopathology (Evans, 2008). The haematological analyses carried out in this study showed an increase in the WBC, RBC, Plt, Hb, PCV, M, MCH and RDW.CV although not significant ($P>0.05$). A significant difference ($P<0.05$) was observed in MCV, N, L, MCHC and RDW.SD, of the exposed mice compared to the control. However, Olabemiwo *et al*, (2011) observed a significant difference in all blood parameter of mice exposed to Olusosun Leachate. Increase in MCV and MCH with a decrease in MCHC observed in this study usually indicate macrocytic and hypochromic anemia (Olabemiwo *et al*, 2011). MCV, MCH and MCHC are erythrocyticindices which depend on RBC count, Hb concentration and PCV. Changes in the blood parameters of exposed mice may be an adaptive response of the bone marrow or peripheral blood cells to physiological and immunological changes due to the direct exposure of blood cells to heavy metals and organic components, which are usually present in leachate and their metabolic products (Olabemiwo*et al*, 2011).

The histopathological sections of mice exposed to Oke-afa landfill leachates showed no visible necrosis, only mild to moderate lesions were observed in the kidneys and liver of the mice. Similar results are recorded in the control. Histopathological analyses of tissues are useful to identify the type of lesions caused by a pollutant and are the end point for detecting toxicity (Lanning *et al*, 2002)

In conclusion, Oke-Afa landfill leachate can induce changes in the haematological and biochemical parameters of people exposed to the polluted groundwater via ingestion, this could lead to several health challenges such as cancer, hypertension and organ damage. An unhealthy citizen is a liability to the community. Subsequent landfill site should be well engineered and managed. Bioreactor landfills could also be looked into since the landfill gas produced from it would be beneficial to both the community and the government in terms of electricity generation.

5. Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper

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