FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 6 No. 1, March, 2022, pp 308 - 313
DOI: https://doi.org/10.33003/fjs-2022-0601-829

SUB-CHRONIC EXPOSURE TO LEACHATE FROM OJOTA, LAGOS IS ASSOCIATED WITH LIVER AND KIDNEY TOXICITY IN RATS

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ABSTRACT

This study evaluated the toxicity of Leachate from Ojota, Lagos dumpsite on the kidney and liver of male *Wistar* rats. Forty-five male albino rats weighing 180 ±5.5 grams were randomly divided into five groups (n=9). Group A rats drank distilled water throughout the experimental period while rats in group B, C, D and E were exposed to 25%, 50%, 75% and 100% leachate via drinking water for 45 days respectively. Daily intake of leachate was measured for each group. On the last day, the animals were fasted 8 hours overnight and blood samples were collected for liver and kidney function tests. Our finding revealed that rats exposed to 25%, 50% and 75% drank more of the leachate. There were marked increase ($p<0.05$) in the activities of aspartate aminotransferase (AST) and alkaline phosphatase (ALP) in rats exposed to different concentrations of the leachate. Rats exposed to 75% and 100% leachate showed significant increase ($p<0.05$) in serum Alanine aminotransferase (ALT) activity, γ-glutamyltransferase (GGT) activity was higher in other groups compared to control, while rats exposed to 25% and 50% leachate had increase in the serum direct bilirubin concentration ($p<0.05$). Creatinine level was markedly high in rats exposed to 100% leachate while the rats that were exposed to 50% and 100% leachate had elevated urea level. Conclusively, leakage of leachate into water bodies especially ground water and its exposure through drinking may pose a high risk on liver and kidney function.

Keywords: Leachate, Toxicity, Lagos, Exposure

INTRODUCTION

The annual generation of municipal solid wastes (MSW) in Nigeria is 29.78 x 10^9 kg (Oshode *et al*., 2008) and this may increase due to rapid urbanization and population growth rate. Industrial activity such as food processing, chemical manufacturing and improper dumping of refuse either to landfill or rivers generate a wide variety of waste, most of these are known to be poisonous to man, animals and plants. When rain falls on such wastes, waste water effluents are discharged into the environment. The disposal sites are capable of releasing large amounts of harmful chemicals to nearby water sources and air via leachate and landfill gas all of which can affect health either through direct exposure to harmful toxicants or through, air and water pollution (Alimba *et al*., 2006).

The chemical makeup of leachates emitted from solid waste has been extensively studied by researchers all over the world (Abdel-Shafy and Mansour, 2018). Leachate can readily find their way into ground water, posing major threats to ecosystems and human health. Leachate may contain bacteria, some of which are opportunistic pathogens, in addition to harmful substances. These microorganisms could release poisons that are harmful to people's health (Oshode *et al*., 2008). Epidemiological studies have documented the risks associated with living in areas close to landfills (Mataloni *et al*., 2016; Che *et al*., 2013; Mattiello *et al*., 2013). The risk of living near municipal solid waste landfills include; elevated risks of poor birth outcomes including weight, respiratory conditions including bronchitis and shortness of breath, colon cancer, liver, kidney and pancreas impairments to mention a few (Cabral *et al*., 2021; Norsa'adah et al., 2020; De and Debnath, 2016).

In Nigeria, improper waste management has been attributed to poorly implemented policy which gives room for untidy industrial discharge, anthropogenic waste disposal into water way and poorly implemented waste management system. Leachate and waste chemicals find their way into ground water which is the major source of water used in Nigeria for drinking and domestic purposes. Several studies have evaluated hazards associated with improper waste management and leachate exposure to biological system on both animal and human. However, there is need for continuous awareness and time to time research on possible risk and biohazard associated with disposal of waste around urban settlements. Based on this, there is need to evaluate the health risks associated with exposure to the leachate vis-a-vis focusing on the major metabolizing organ. This research therefore investigated the effect of exposure to landfill leachate from Ojota on the kidney and liver of male albino rats.

MATERIALS AND METHODS

Materials

Alanine amino transferase, Aspartate amino transferase, γ-Glutammyl transferase, Bilirubin, Urea and creatinine assay kits were product of Randox, UK. Other chemicals and materials used are of analytical grades.

Animal care and management

Forty-five (45) adult male Wistar rats (180 ±5.5 grams) were obtained from the animal breeding unit in University of Ibadan and transported to Animal House, Department of Biochemistry, Lead City University, Ibadan, Nigeria. The rats were housed in clean plastic cages and were allowed to acclimatize in the new environment for 14 days before the experiment. The animals were fed with a standard laboratory diet (rat pellets) and water *ad libitum* under room temperature and relative humidity. The experiments were carried out in line with institution guidelines for Laboratory Animal Care and Use.

Experimental Design

The rats were divided into five groups (n=9/group) and assigned as follows; Group A animals drank distilled water throughout the experiment period, Group B animals drank 25% waste effluent, leachate (25% waste effluent + 75% distilled water), Group C animals drank 25% waste effluent (50% waste effluent + 50% distilled water), Group D animals drank 75% waste effluent (75% waste effluent + 25% distilled water), Group E animals drank 100% leachate. The animals were exposed to leachate for 45 days to assess the sub chronic toxicity of the leachate according to the method of Quaye et al, 2017 and Monji et al. (2011).

Blood sample collection

After 45 days of exposure, blood was collected from each rat via retro-orbital puncture and centrifuged at 4000 rpm for 15 minutes to obtain serum. The serum collected was used for biochemical analysis.

Biochemical analysis

The following analysis were carried out on the serum of the rats using Randox bioassay kits: ALT (Reitman and Frankel, 1957) , AST(Reitman and Frankel, 1957) , ALP , GGT (Szasz, 1969), total Bilirubin (Jendrassik-Groff, 1938) , direct bilirubin (Jendrassik-Groff, 1938) , urea (Weatherburn, 1967) and creatinine (Bartels and Bohmer, 1971) .

Statistical Analysis

Data obtained from animal experiments were expressed as mean ± SEM. Results were statistically evaluated by using one-way ANOVA with Dunnett's multiple comparison test. Mean difference were taken to be significantly different at P< 0.05

RESULTS

Table 1: Concentration of heavy metals detected in the leachate

PARAMETERS	LEACHATE SAMPLE	FEPA	USEPA
Copper	6.2	0.3	1.0
Lead	13.2	0.01	0.015
Cadmium	0.36	0.05	0.05
Arsenite	0.12	-	-
Cobalt	0.44	-	-
Chromium	0.26	0.05	0.1
Mercury	0.41	0.1	-
Nickel	0.003	<0.1	-
Iron	0.07	0.05	0.3
Zinc	0.21	<0.1	-

*FEPA- Federal Environmental Protection Agency permissible limits for drinking water
*USEPA-United States Environmental Protection Agency permissible limits for drinking water

Table 1 shows the concentrations of heavy metals detected in the leachate. Figure 1 shows the average daily intake of leachate, rats exposed to 50% and 75% had higher intake of 564.9 ± 26.37 mL and 546.6±19.29 mL respectively. Alkaline phosphatase, Aspartate aminotransferase and gamma glutamyl transferase were markedly increased in rats exposed to leachate compared to control (Pp<0.05). There was significant increase (p<0.05) in alanine aminotransferase activity in rats that were exposed to 75% and 100% leachate. Rats exposed to 100% leachate showed increase in concentration of total bilirubin, while those exposed to 25% and 50% have serum increase in direct bilirubin concentration compared to control. Detailed trend on the effect of leachate on liver function test can be found in figure 2. Figure 3 shows the effect of rat exposure to leachate on (a) urea concentration and (b) creatinine concentration. Rats that were exposed to 100% leachate had significantly high level of urea in serum. There was increase in the level of creatinine which is not dose dependent in rats exposed to 50% and 100% leachate.

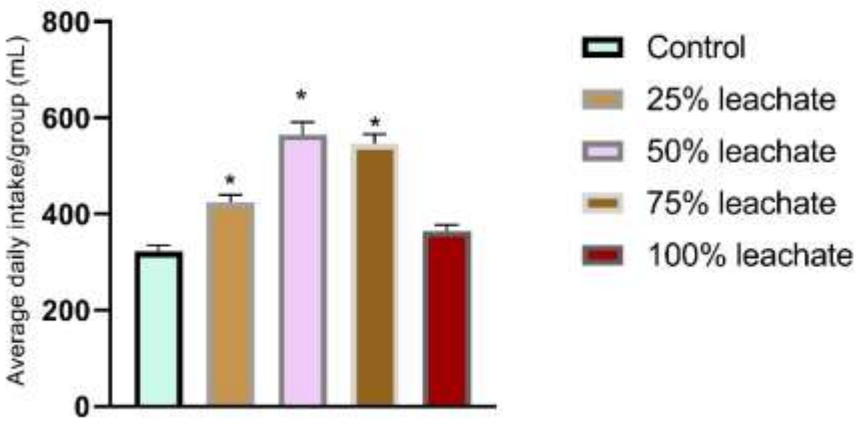


Figure 1: Average daily intake of leachate in each group compared to control group (distilled water)

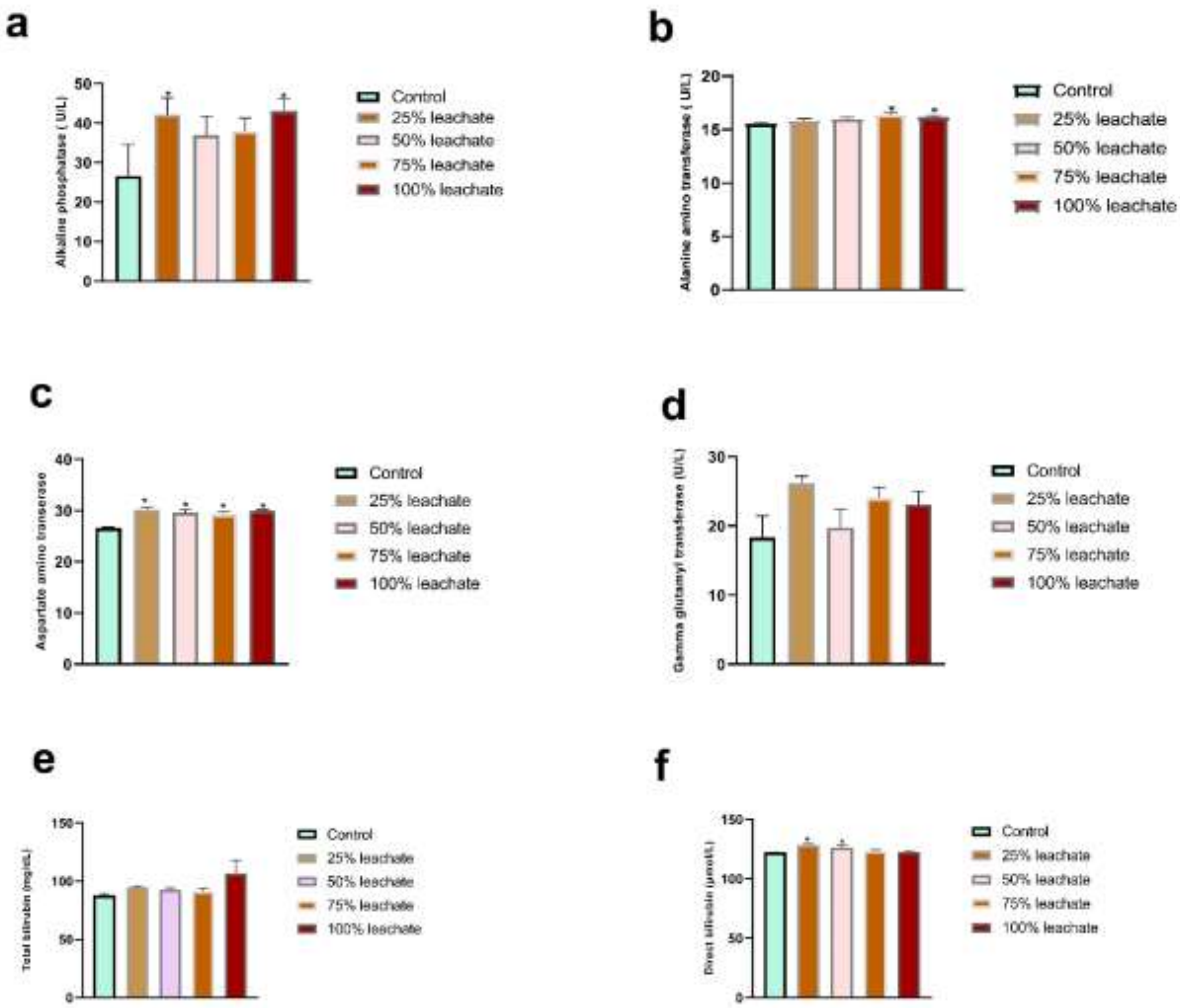
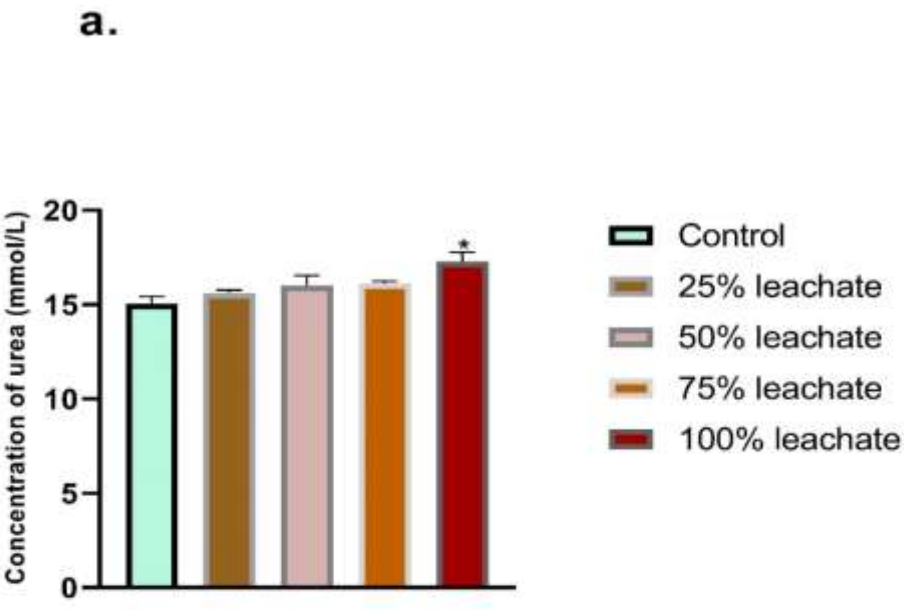


Figure 2: The effect of exposure to leachate on liver function markers: (a) alkaline phosphatase activity (b) alanine amino transferase (c) aspartate amino transferase (d) gamma glutamyl transferase (e) total bilirubin (f) direct bilirubin



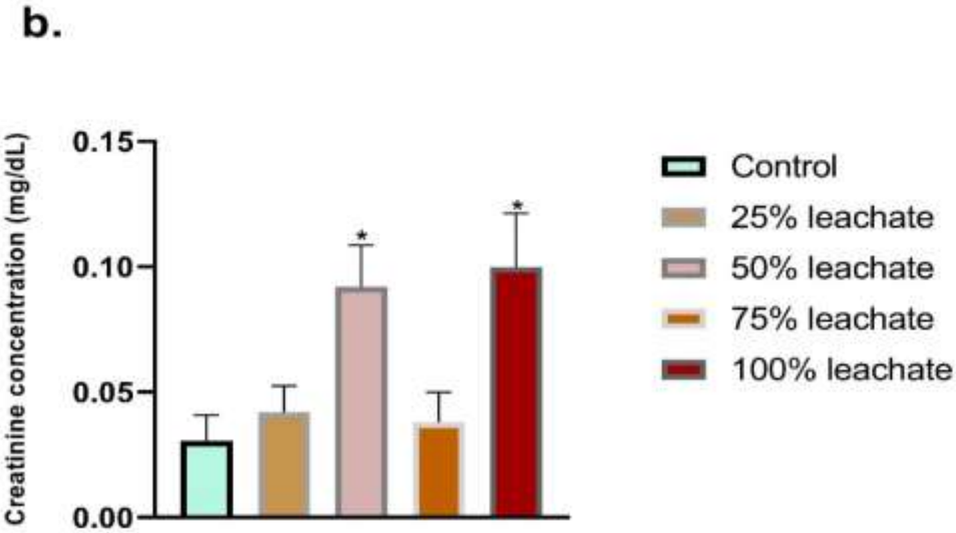


Figure 3: The effect of exposure to leachate on kidney function markers: (a) concentration of urea (b) creatinine concentration

DISCUSSION

Leachate increased liver enzyme activities (ALT, AST, GGT and ALP) which are physiological enzymes distributed majorly in the liver and some other tissues. The increase in serum activities of these enzymes indicate liver impairment caused by the leachate. In this study, significant increase of serum levels of liver enzymes was observed in rats that were exposed to 75% and 100% leachate when compared with rats exposed to lower percentage of leachate. Our study supports information provided from previous studies that leachate contain accumulated toxic compounds such as heavy metals, microbial toxins, and organic toxicants which are capable of causing toxicity in soft tissues (Weleh *et al*., 2020). Other studies in Nigeria have previously reported that animals exposed to leachate are susceptible to liver damage (Bakare et al 2013; Weleh *et al*., 2020). This assumption is supported by the findings of Fu *etal.* (2020) and García-Niño and Pedraza-Chaverrí(2014) that accumulation of heavy metals from leachate is associated with liver damage. Mortality observed among the rat during exposure was probably due to acute effect of the leachate constituents especially heavy metals as shown in table 1. Our finding corroborates with output from Rehman *et al*. (2018) on mortality associated with exposure to leachates. There is high possibility that metals and other toxic components of leachate may induce oxidative tissue damage to the hepatocytes which led to increase in the cell membrane permeability thereby causing leakage of liver enzymes to the blood stream. (Anifowoshe *et al*., 2018).

Elevated level of bilirubin in the serum which was observed in rats exposed to leachate has been strongly associated with liver damage. Findings by Alimba *et al*. (2012) had suggested that higher bilirubin levels in the serum may cause an increase in the rate of destruction of red blood cells in the rats exposed to leachate (Alimba *et al*., 2012).

Thus, observed increase in the activities of these enzymes and elevated level of bilirubin in the serum of the animals exposed to the leachate further substantiate its hepatotoxic effect. Acute and chronic ingestion of leachate contaminated ground water has been associated with massive occurrence of liver dysfunction among some residents living close to dumpsites (Ahamad *et al*., 2019).

Also, leachate exposure showed significant increase in urea and creatinine serum level. Raised serum level of urea and creatinine caused by the leachate in rats can be associated with kidney impairment. Creatinine level in the blood observed in this study suggest that there could be decrease in creatinine clearance. High concentration of urea in the blood could also suggest that there is decrease in urea excretion; this could probably be caused by kidney impairment. Similarly previous studies have demonstrated the possibility of kidney impairment in animal model studies (Ademola *et al*., 2020) and human cell culture (Jabłońska-Trypuć, 2021).

CONCLUSION

Leachate collected from Ojota Lagos increased the activities of liver enzymes, concentration of bilirubin, urea and creatinine which are markers associated with liver and kidney damage. This implies that the leachate is capable of causing both liver and kidney impairments in human if exposure occurs. Therefore, in order to safeguard the health of people, it is recommended that government should implement more effective waste management practices.

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