



Assessment of Heavy Metal composition of leachate and groundwater at Kofar Na'isa solid waste dumpsite Gwale LGA of Kano State, Nigeria

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ABSTRACT

Assessment of leachates and groundwater at and close to Kofar Na'isa solid waste dumpsites were conducted. A total of 5 samples were collected for and analysed for heavy metals contents of the water as well as leachate using quick read arsenic test kit and AAS AgilentTech200 series, 240 FS. The result of analysis showed that the dumpsites have the following ranges of mean concentrations 0mg/l Ar, 0.017-0.021 mg/l Cd, 0-0.019 mg/l Cr, 0.082-0.105 Pb and 0.039-0.871mg/l Mn. The level of contamination of heavy metals are strong with lead and manganese, chromium and manganese in the three wells were significantly higher than their corresponding control while that of cadmium and lead were found to be higher in the control indicating low effect from leachate heavy metals with other reason for their high values in control. These suggested that solid waste dumpsite contributes to heavy metals

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Management of municipal solid waste is one of the major environmental and public health problems in major cities in the developing countries (S. Renou, J.G Givaudan and F.Dirassouyan 2008). The accumulation of waste in dumpsites around residential areas leads to formation/release of leachate and toxic gases into the environment (C G.Alimba, Aina OO, AA Bakare 2012,Schrapp and Al-Mutairi 2010). Thus, in developing countries, it's common to find unhygienic landfills and dumpsites in public places (i.e., close to residential buildings) and seasonal high-water table areas (Rowland E.D.,

Omonefe, F. 2022). Leachate, a highly toxic dark-colored strong smelling liquid which originates from the decomposition of organic matter, the intensity of pluvial waters and other liquids derived from waste (Sanda, 2013) .The toxicity and impact stimulated by the leachate on microflora and microfauna is very strong and they are influenced by various factors such as organic matter, heavy metals and nitrogen concentrations as well as mass flux of contaminations being transported,(Isidori, M M., Nardelli, R., and Parella, A. 2013).

Areas near dumpsites have greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby dumpsite. Dangers posed by leachate from municipal dumpsites depends on the waste composition, volume, life time, temperature, moisture, availability of oxygen, soil morphology and relative distance of the sites to the nearby living community and water body (Hammoumi 2013, Longe and Balogun, 2010.). Recent studies reported that metals from solid waste dumpsites can be accumulated and persist in leachate at an environmentally hazardous level (Amusan et al., 2015).

In Nigeria, leachate from refuse dumpsites constitutes a source of heavy metal pollution to the aquatic environment (Ade O. T. & Onajobi. J. 2009). Once leachate is formed and released to the groundwater environment, it migrates downward through the unsaturated zone until it eventually reaches the saturated zone. Contamination and subsequent pollution of the environment by toxic heavy metals has become an issue of global concern due to their sources, wide spread distribution and multiple effects on the ecosystem. The adverse environmental impact of leachates on groundwater and other water resources has recently gained attention within the realm of environmental sustainability (Mahmood et al., 2018, Ojekunle et al., 2020).

These include studies on, leachate from municipal solid waste (Zhao Yuocai 2018), threat of leachate as pollutant on

groundwater and soil David O. O, et al., 2022), effects of long term and continuous exposure to heavy metals (Manavi Yadav , 2019).

Materials and methods

Study area and site location

The study was conducted on a dumpsite at Kofar Na' Isa, behind Kofar Nai' sa grave yard Gwale LGA, Kano State. The Leachate sample was collected from the base of the dumpsite latitude 11.9819292/ longitude 8.51920557 while groundwater samples 1, 2, and 3 were taken at 50 m, 70m, 100 from the dumpsite respectively at different coordinates; W1 latitude: 11.9812725/ longitude 8.51922698, W2 11.9824851/8.52026181, W3 11.9825936/8.52081908.. The Control sample was collected at 150 m latitude. 11.982104/ longitude 8.523872.

Sample collection

Leachate sample was collected in February 2024, from vicinities of the Kofar Naisa solid waste dumpsites by digging a hole about 0- 30cm deep water was poured on the solid wastes and it drained into hole. The leachate was scooped and filtered with 250 mm filter paper into one litre plastic bottle. One each of both leachate and groundwater samples were obtained from the study locations making a total of (5) samples respectively for water and leachate.

Experimental procedure

The AgilentTech200 series, 240 FS AAS and arsenic test kit were used to carry out metal analysis of the leachate and

ground water samples. Standards were prepared for metals under consideration, the AAS was calibrated and calibration curves plotted automatically. The concentrations of Cr, Cd, Pb and Mn were read from the screen and tabulated while Arsenic was

tested at sampling site using quick read arsenic test kit, model S0005521, USA.

Results and discussions

Table 1: Heavy metals concentrations in leachate and groundwater samples

Heavy Metals(mg/l)	Leachate	W1	W2	W3	C	WHO 2017	NSDWQ 2017
Arsenic	0.000	0.000	0.000	0.000	0.000	0.01	0.01
Cadmium	0.018	0.017	0.019	0.019	0.021	0.003	0.003
Chromium	0.058	ND	0.015	0.019	0.011	0.05	0.05
Manganese	0.083	0.153	0.121	0.871	0.039	0.1	0.05
Lead	0.105	0.082	0.085	0.090	0.105	0.01	0.01

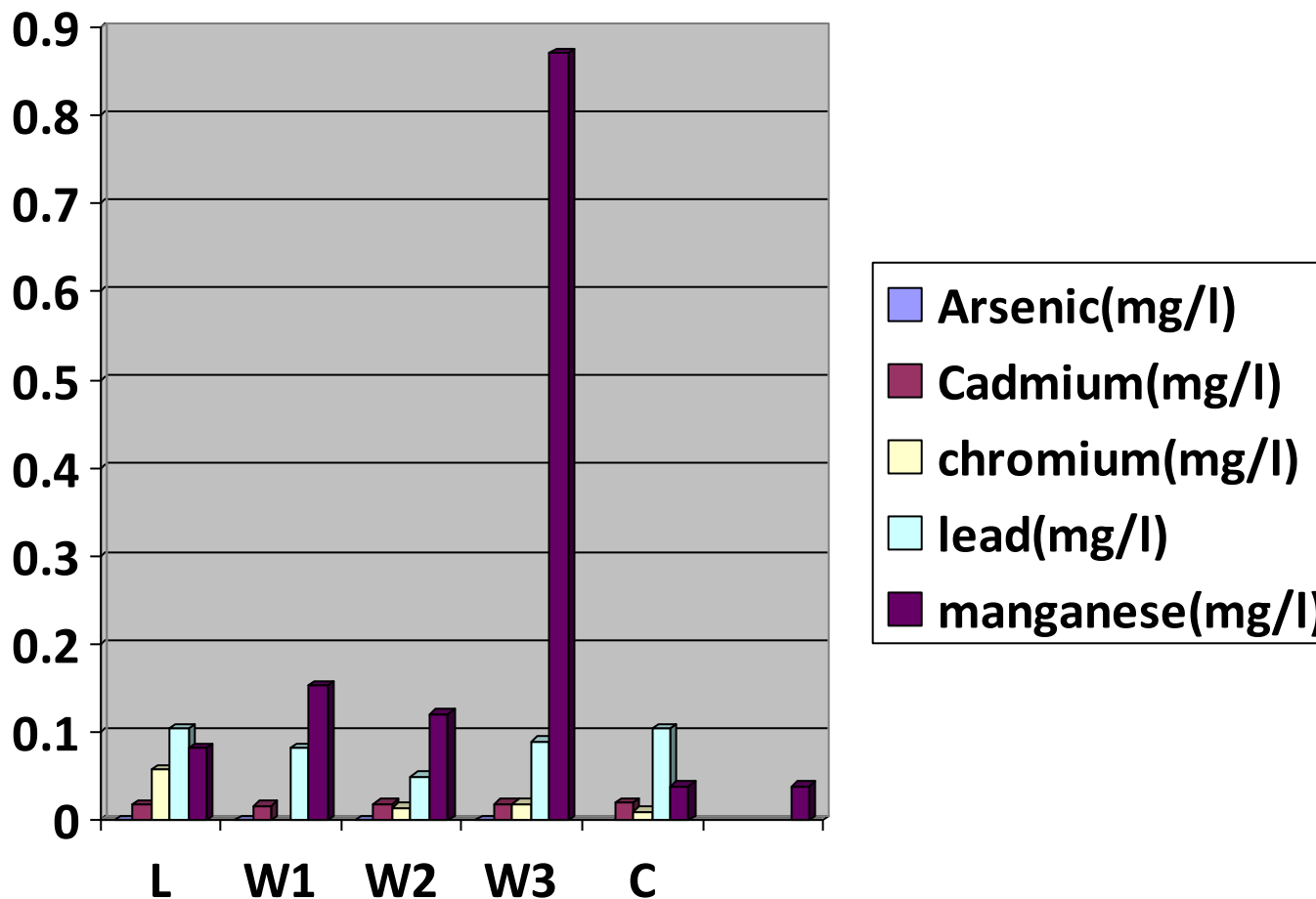


Figure 1: Variation of heavy metals in leachate and groundwater (well) samples from Kofar Na' Isa Kano State

Arsenic is highly toxic in its inorganic form and contaminated water used for drinking, food preparation and irrigation of food crops poses the greatest threat to public health from arsenic. The concentration of arsenic in leachate and water samples investigated is negligible 0mg/l.

Cadmium is a toxic metal having functions neither in human body or in animals or plants it found in material like motor car tyres and in burning of fossil fuel such as coal or oil. This present study reveal the mean concentrations range of cadmium for groundwater and leachates as 0.016 - 0.021 mg/L which exceeds the guideline value in drinking water which is 0.003mg/l, with a mean concentration of 0.019mg/l highly significant at a 95% confidence level, with level of significance $p < 0.05$ or 5%. These concentrations were quite higher than those reported by A.U Abubakar, (2021) as 0.001-0.013 mg/L and within the range reported by (Ogwoha et al., 2015) as < 0.05 mg/L.

Chromium is found naturally in rocks, plants, soil, and volcanic dust, it gets into ground and surface water due to improper disposal of mining tools and manufacturing equipment. The concentration of chromium ranged from 0.00 mg/l to 0.019 mg/l with mean concentration of 0.01125 mg/l which is significantly different from the WHO and NSDWQ standard of 0.05 mg/l at 95% confidence level. These concentrations were quite lower than those reported by Ojekunle ,(2022) as 0.002-0.054 mg/L. Chromium causes cancer (WHO, 2017).

Manganese occurs as soluble manganese bicarbonate which changes to insoluble manganese hydroxide when it reacts with atmospheric oxygen. High concentration of manganese slightly above the WHO and NSDWQ maximum permissible limit causes neurological and gastro-intestinal disorder. The concentrations of manganese range from 0.039 mg/l to 0.153 mg/l with mean concentration of 0.296 mg/. Some of these values were above the permissible limit of 0.1 and 0.05 mg/l of WHO and NSDWQ. These concentrations were quite lower than those reported by Ojekunle, (2022) as 0.015-1.9403 mg/L. Manganese is high in W1 and low in control indicating the impact from dumpsite leachate manganese in the groundwater. The presence of iron, copper and manganese can give undesirable taste.

The primary sources of lead are household plumbing, lead paints used in homes, and lead ammunition used during communal conflicts. The concentrations of lead recorded were significantly higher. The concentrations of lead ranged from 0.082 mg/l to 0.090 mg/l. However higher levels of lead (0.086 mg/l) were recorded in all water samples. This value was high compared to the WHO and NSDWQ permissible limit of 0.01 mg/l and 0.05 mg/l. These concentrations were quite higher than those reported by A.U Abubakar ,(2021) as 0.004-0.057 mg/L and within the range reported by(Ojekunle et al., 2015) as 0.003-0.199 mg/L. Lead is more prevalent in control although its high in

all the samples, this indicate there is another source of lead contamination close to control. A high dose of lead causes damage to the central nervous system impairs intelligence and causes attention deficiency. Lead also causes cancer, interferes with vitamin D metabolism, and affects mental development in infants (NSDWQ 2017).

Conclusions

The results of heavy metals analysis displayed in Tables 1 indicate that the dumpsite leachates and nearby groundwater have elevated concentrations of Manganese and lead except Cadmium and chromium were within the normal range in groundwater and leachates as reported by several authors even though the concentration of chromium and manganese in the three wells were significantly higher than their corresponding control while that of cadmium and lead were found to be higher in the control indicating low effect from leachate heavy metals with other reason for their high values in control. These prevalent heavy metals have health impacts such as neurological and gastrointestinal disorders and cancers in infants, young and adults (NSDWQ 2017).

References

- Ande, O. T. & Onajobi. J. (2009). Assessment of Effects of controlled land use types on soil quality using inferential method. African journal o f Biotechnology Vol. 8 (22), 6267 -6271
- Alimba C G, Aramide I., Bakare A A(2012). Brain Dysfunctions in Wistar Rats Exposed to Municipal Landfill Leachates
- Alimba C G., Latunji C, Bakare AA (2006) Municipal Landfill Leachates induced Chromosomes aberrations in rat bone marrow cells. Afr J biotechnol 5:2053-2057
- Amusan, k. Charles, & Ojo, S. J. (2005). Determination of Heavy Metals in Soil in the Vicinity of a Dumpsite in Ketaren Gwari Minna. International Journal of Science and Nature. @ 2004 - 2011 Society for Science and Nature (SFSN)
- Driss S, El-Hammoumi O, Ahmed F 2013, assessment of the impact of landfill on groundwater quality: a case study of the Mediouna site, Casablanca, Morocco. Journal of water resources and protection Vol.5 April 25, 2013
- Isidori, M M., Lavorgna, A., Nardelli, R., and Parella, A. (2013). Toxicity Identification Evaluation of Leachates from Municipal Solid Waste Landfills, and approach to chemosphere 85-94
- Nigerian Standard for Drinking Water Quality,NSDWQ(2007): Nigerian Standard for Drinking Water Quality. Nigerian Industrial Standard. NIS:554:13-14
- Sanda D.B (2013), The Impact Assessment of Contamination Pattern Of Solid Waste Dumpsites On Soil and Leachate:

A comparative study of Bauchi Metropolis

- Ojekunle, O.Z Balogun, M.A Ojekunle, O.O (2022), Health risk assessment of heavy metals in drinking water leaching through improperly managed dumpsite in Kurata, Ijoko Sango area of Ogun State, Nigeria
- Rowland, E.D., Omonefe, F. (2022) Environmental monitory and impact assessment of solid waste dumpsite using multispectral imagery in Yenagoa, Bayelsa state, Nigeria. *Int. J. Environ. Sci. Technol.* 19, 1007–1024. <https://doi.org/10.1007/s13762-021-03456-2>
- Renou S., Dirassouyan F, Givaudan J.G. (2008). Landfill Leachate Treatment:review and opportuniy
- Schrapp K, Al- Mutairi N (2010) associated health effects among residencers neat Jeleeb Al-shoyoukh landfill, *Am J Environ sci*6:184-190
- WHO (2011) Guidelines for drinking water quality, 4th edn. World Health Organisation

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